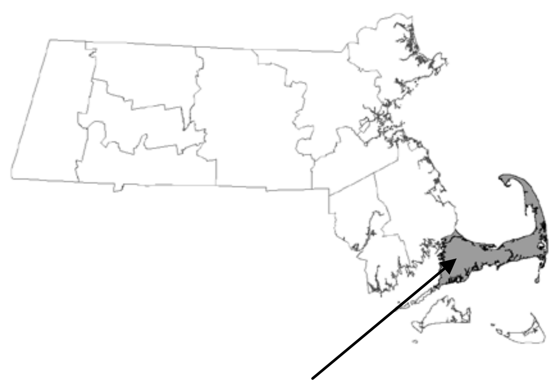
FLOOD INSURANCE STUDY

BARNSTABLE COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)



COMMUNITY NAME	COMMUNITY NUMBER
BARNSTABLE, TOWN OF	250001
BOURNE, TOWN OF	255210
BREWSTER, TOWN OF	250003
CHATHAM, TOWN OF	250004
DENNIS, TOWN OF	250005
EASTHAM, TOWN OF	250006
FALMOUTH, TOWN OF	255211
HARWICH, TOWN OF	250008
MASHPEE, TOWN OF	250009
ORLEANS, TOWN OF	250010
PROVINCETOWN, TOWN OF	255218
SANDWICH, TOWN OF	250012
TRURO, TOWN OF	255222
WELLFLEET, TOWN OF	250014
YARMOUTH, TOWN OF	250015

Effective
July 16, 2014

Federal Emergency Management Agency

**FLOOD INSURANCE STUDY NUMBER
25001CV000A**

NOTICE TO
FLOOD INSURANCE STUDY USERS

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

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

Initial Countywide FIS Effective Date: July 16, 2014

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FLOOD INSURANCE STUDY
BARNSTABLE 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 Barnstable County, Massachusetts, including the Towns of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet and Yarmouth (referred to collectively herein as Barnstable 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.

This FIS was prepared to incorporate all the communities within Barnstable 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:

Barnstable, Town of	The hydrologic and hydraulic analyses in the February 19, 1985 study represent a revision of the original analyses by the New England Division of the U.S. Army Corps of Engineers (USACE) for the Federal Emergency Management Agency (FEMA) under Inter Agency Agreement No. IAA-H-02-73 and IAA-H-19-74, Project Order No. 14 and 15, respectively. The updated version was prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. That work was completed in September 1983 (Reference 1).
Bourne, Town of	For the December 5, 1984, FIS report and June 5, 1985 Flood Insurance Rate Map (FIRM), the hydrologic and hydraulic analyses (which revised the analyses prepared by the USACE for

Bourne, Town of - continued	the January 2, 1976 FIS) were prepared by Anderson-Nichols & Co., Inc. for FEMA, under Contract No. H-4605. That work was completed in September 1983 (Reference 2). For the August 9, 1999 revision, revised coastal analyses were prepared by ENSR Consulting & Engineering for FEMA under Contract No. EMW-93-C-420 1. Mapping was provided by James W. Sewall Co. That work was completed in October 1994. Dewberry & Davis subsequently revised the ENSR Consulting & Engineering analyses for FEMA (Reference 3).
Brewster, Town of	The hydrologic and hydraulic analyses for the December 19, 1985 study were prepared by PRC Harris for FEMA, under Contract No. H-4776 (completed in August 1980) and Contract Modification No. M010. That work was completed in August 1983 (Reference 4).
Chatham, Town of	The hydrologic and hydraulic analyses in the January 16, 1992 study represent a revision of the previous analyses prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. The work for that study was completed in September 1983. The 1992 revised hydrologic and hydraulic analyses of Chatham Harbor/Pleasant Bay reflecting the breaching of Nauset Beach in the updated study were prepared by Stone & Webster Engineering Corporation (SWEC) for FEMA under Contract No. EM-89-C-2817. That work was completed in January 1990 (Reference 5).
Dennis, Town of	The hydrologic and hydraulic analyses in the July 3, 1986 study represent a revision of the original analyses by USACE for FEMA under Inter-Agency Agreement No. IAA-H-2-73, Project Order No. 2. The hydrologic and hydraulic analyses for this study were conducted by Schoenfeld Associates, Inc. under subcontract to the USACE. That study was completed in September 1983. The updated version was prepared by Anderson-Nichols & Co., Inc. for FEMA, under Contract No. H-4605. The hydrologic and hydraulic analyses in the updated 1986 study were computed by Anderson-Nichols & Co., Inc. (Reference 6).
Eastham, Town of	The hydrologic and hydraulic analyses for the July 3, 1986 study were prepared by PRC Harris

Eastham, Town of - continued	for FEMA, under Contract No. H-4776 (completed in May 1981) and under Contract Modification No. M010. That work was completed in August 1983 (Reference 7).
Falmouth, Town of	The hydrologic and hydraulic analyses in the May 15, 1986 study represent a revision of the original analyses by Anderson-Nichols & Co., Inc. for FEMA. The original work was completed in 1979. The updated version was also prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. That work was completed in August 1983 (Reference 8).
Harwich, Town of	The hydrologic and hydraulic analyses in the December 3, 1991 study represent two revisions of the original analyses. The first revision was prepared by Anderson-Nichols & Co., Inc. for FEMA, under Contract No. H-4605, and was completed in August 1983. The second revision was prepared by Dewberry & Davis under Contract No. EMW-89-C-2906, and was completed in August 1990 (Reference 9).
Mashpee, Town of	The hydrologic and hydraulic analyses in the December 5, 1984 study represent a revision of the original analyses by the USACE, New England Division for FEMA, under Inter-Agency Agreement No. IAA-H-2-73, Project Order 14, and Inter-Agency Agreement No. IAA-H-1974, Project Order 15. The 1984 updated version was prepared by Anderson-Nichols & Co., Inc. under agreement with FEMA, under Contract No. H-4605. This work was completed in August 1983. The hydrologic and hydraulic analyses in the updated study were computed by Anderson-Nichols & Co., Inc. (Reference 10).
Orleans, Town of	The hydrologic and hydraulic analyses for the original September 4, 1986 study were prepared by PRC Harris for FEMA, under Contract No. H-4776, (completed in June 1981), and under Contract Modification No. M010. That work was completed in August 1983. In December 3, 1991, the hydrologic analysis for Pleasant Bay, which includes Little Pleasant Bay, The River and the Namequoit River

Orleans, Town of - continued	estuaries, were revised by Dewberry & Davis. That work was completed in August 1990 (Reference 11).
Provincetown, Town of	The hydrologic and hydraulic analyses for the December 19, 1984, study were prepared by Anderson-Nichols & Co., Inc., for FEMA, under Contract No. H-4605. That work was completed in September 1983 (Reference 12).
Sandwich, Town of	The hydrologic and hydraulic analyses in the original June 18, 1980 study were prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. The October 1983 revision was prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. A second revision was done in 1985, also prepared by Anderson-Nichols & Co., Inc., incorporated wave height and wave runup analyses. A third revision was done in 1991, prepared by Dewberry & Davis for FEMA, incorporating erosion analyses and recent regulatory changes in the definition of coastal high hazard areas. That work was completed in June 1989 (Reference 13).
Truro, Town of	The hydrologic and hydraulic analyses for the January 3, 1985 study were prepared by Anderson-Nichols & Co., Inc. for FEMA under Contract No. H-4605. That work was completed in September 1983 (Reference 14).
Wellfleet, Town of	The hydrologic and hydraulic analyses for the December 19, 1984, study were prepared by PRC Harris for FEMA under Contract No. H-4776 (completed in August 1981) and Contract Modification No. M010. That work was completed in August 1983 (Reference 15).
Yarmouth, Town of	The hydrologic and hydraulic analyses for the June 17, 1986 study were prepared by Anderson-Nichols & Co., Inc., for FEMA under Contract No. H-4605. That work was completed in September l983 (Reference 16).

FIRM panels, base map information shown was derived from digital orthophotography. Base map files were provided in digital form by Massachusetts Geographic Information System (MassGIS). USGS High Resolution orthophotography dated March and April 2009 produced at one foot resolution cells. The projection used in the preparation of this map was Massachusetts State Plane mainland zone (FIPSZONE2001). The horizontal datum was NAD83, GRS1980 spheroid (Reference 17).

Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

The coastal wave height analysis for this FIS was prepared in two phases. The first study for open water flooding source of Cape Cod Bay in the community of Provincetown was prepared by Ocean & Coastal Consultants Inc. (OCC) for FEMA under Contract No. EME-2003-CO-0340 and was completed August 17, 2007. The second analyses for open water flooding sources within the communities of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown (Atlantic Ocean), Sandwich, Truro, Wellfleet, and Yarmouth was prepared by the Strategic Alliance for Risk Reduction (STARR) for FEMA under Contract No. HSFEHQ-09-D-0370 and completed March 17, 2013. These new analyses resulted in revisions to the Special Flood Hazards Areas (SFHAs) within the Towns of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, and Yarmouth.

1.3 Coordination

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

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

TABLE 1 – INITIAL, INTERMEDIATE, AND FINAL CCO MEETINGS

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Barnstable, Town of	August 11, 1977	August 22, 1983	October 3, 1984
Bourne, Town of	November 1, 1977	August 12, 1983	July 17, 1984
Brewster, Town of	March 24, 1978	October 19, 1983	July 31, 1984
Chatham, Town of	June 1, 1988	September 14, 1989	March 7, 1991
Dennis, Town of	August 3, 1977	August 12, 1983	September 7, 1984
Eastham, Town of	March 24, 1978	November 8, 1983	October 17, 1984
Falmouth, Town of	August 9, 1977	June 15, 1983	August 14, 1984

TABLE 1 – INITIAL, INTERMEDIATE, AND FINAL CCO MEETINGS - continued

Community Name	Initial CCO Date	Intermediate CCO Date	Final CCO Date
Harwich, Town of	August 2, 1977	February 2, 1983	June 7, 1984
Mashpee, Town of	August 11, 1977	March 25, 1983	March 25, 1983
Orleans, Town of	March, 24 1978	November 8, 1983	October, 18 1984
Provincetown, Town of	August 2, 1977	July 19, 1983	March 30, 1984
Sandwich, Town of	August 2, 1977	March 17, 1983	June 18, 1984
Truro, Town of	August 5, 1977	July 19, 1983	August 6, 1984
Wellfleet, Town of	March 30, 1978	October 19, 1983	October 19, 1983
Yarmouth, Town of	August 3, 1977	July 11, 1983	July 19, 1984

For this countywide FIS, the initial CCO meeting was held during the last week of November 2006 as was attended by representatives of FEMA, ENSR Corporation and Barnstable communities. For the 2013 study, outreach meetings were held on April 14, 2011. Letters were sent to inform the communities of the scope of the FIS, and to solicit pertinent local information. Work map discussion meetings were held with the communities on February 25 and 26, 2013, to discuss the initial results of the new coastal flood hazard analysis. The results of this countywide study were reviewed at the final CCO meetings held on June 17, 2013, and attended by representatives of the communities, FEMA, Massachusetts Department of Conservation and Recreation (MA DCR), and STARR. All problems raised at that meeting were addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Barnstable 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 project development or proposed construction.

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 FIRM (Exhibit 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.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS

Flooding Source Name	Description of Study Reaches
Area of shallow flooding	Shallow flooding within the corporate limits of the Towns of Eastham, Truro, and Wellfleet.

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Atlantic Ocean	Wave action and flooding in the Towns of Chatham, Truro and Provincetown; Tidal flooding, including wave action in the Towns of Eastham, Orleans, and Wellfleet.
Bass River	Tidal flooding including its wave action in the Towns of Dennis and Yarmouth.
Blackfish Creek	Tidal flooding including its wave action in the Town of Wellfleet.
Boat Meadow River	Tidal flooding including its wave action in the Town of Eastham.
Buttermilk Bay	Tidal flooding including its wave action in the Town of Bourne.
Buzzards Bay	Tidal flooding including wave action within the Towns of Bourne and Falmouth, and shallow flooding along the coastline in the Town of Falmouth.
Cape Cod Bay	Coastal flooding including its wave action within the Towns of Provincetown and Truro; Tidal flooding including its wave action in the Towns of Barnstable, Bourne, Brewster, Dennis, Eastham, Orleans, Sandwich, Wellfleet and Yarmouth; and shallow flooding along the coastline in the Town of Barnstable. In the Town of Barnstable, tidal flooding and wave action from Cape Cod Bay affect Barnstable Harbor, Lewis Bay, Cotuit Bay, Poponesset Bay and West Bay. In the Town of Orleans, tidal flooding and wave action from Cape Cod Bay affect the Namskaket Shore.
Cape Cod Canal	Tidal flooding including wave action within the Town of Bourne.
Chatham Harbor	Breaching of Nauset Beach in the Town of Chatham.
Deans Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Duct Creek	Tidal flooding, including its wave action in the Town of Wellfleet.

[1] Elevation in North American Vertical Datum of 1988

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Fells Pond	Tidal flooding upstream to a point where its channel reaches a vertical elevation of 19 feet[1] in the Town of Mashpee.
Flat Pond	Tidal flooding upstream to a point where its channel reaches a vertical elevation of 19 feet[1] in the Town of Mashpee.
Freeman's Pond Brook	Tidal flooding, including its wave action in the Town of Brewster.
Great River	Tidal flooding upstream to a point where its channel reaches a vertical elevation of 19 feet[1] in the Town of Mashpee.
Hamblin Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Hatches Creek	Tidal flooding including its wave action in the Town of Eastham.
Herring River	Tidal flooding including its wave action in the Towns of Eastham, Harwich, and Wellfleet.
Jehu Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Little Flat Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Little River	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Mashpee River	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.

[1] Elevation in North American Vertical Datum of 1988

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Nantucket Sound	Tidal flooding including its wave action in the Towns of Barnstable, Dennis, Harwich, Mashpee, and Yarmouth; Tidal flooding in the Town of Chatham; Shallow flooding on the Southern Shoreline in the Town of Yarmouth and along the coastline in the Town of Barnstable. In the Town of Barnstable, tidal flooding and wave action from Nantucket Sound affects Barnstable Harbor, Lewis Bay, Cotuit Bay, Poponnesset Bay and West Bay.
	In the Town of Mashpee, tidal flooding and wave action from Nantucket Sound affects Poponesset Bay and Waquit Bay, which affects Hamblin Pond.
Ockway Bay	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.
Oyster Pond	Coastal flooding including its wave action in the Town of Chatham.
Parkers River	Tidal flooding including its wave action in the Town of Yarmouth.
Pleasant Bay	Breaching of Nauset Beach in the Town of Chatham; Tidal flooding including its wave action in the Towns of Chatham, Harwich, and Orleans.
	Backwater effects on Muddy Creek in the Town of Harwich.
Pleasant Bay	In the Town of Orleans, tidal flooding and wave action from Pleasant Bay includes Little Pleasant Bay, The River, and the Namequoit River estuaries.
Poponesset Bay	Wave action affects Hamblin Pond in the Town of Mashpee.
Quaker Run	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Quashnet River	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].

[1] Elevation in North American Vertical Datum of 1988

TABLE 2 – FLOODING SOURCES STUDIED BY DETAILED METHODS – continued

Flooding Source Name	Description of Study Reaches
Red Brook	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Quaker Run	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Quashnet River	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Red Brook	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Rock Harbor Creek	Tidal flooding including its wave action in the Towns of Eastham and Orleans.
Sage Lot Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Santuit River	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1].
Stage Harbor	Coastal flooding including its wave action in the Town of Chatham.
Stony Brook	Coastal flooding including its wave action in the Town of Brewster.
Town Cove	Tidal flooding including its wave action in the Towns of Eastham and Orleans.
Vineyard Sound	Tidal flooding including wave action in the Town of Falmouth.
Waquoit Bay	Wave action affects Hamblin Pond in the Town of Mashpee.
Wellfleet Harbor	Tidal flooding including its wave action in the Town of Wellfleet.
Witch Pond	Tidal flooding upstream to a point where its channel reached vertical elevation of 19 feet[1] in the Town of Mashpee.

[1] Elevation in North American Vertical Datum of 1988

In the August 9, 1999 revision for the Town of Bourne, Buzzards Bay and Cape Cod Bay were restudied by detailed methods along their entire shorelines using updated methodologies and definitions of the coastal high hazard areas and primary frontal dunes. Also, Chatham Harbor and Pleasant Bay were restudied to reflect the 1987 breaching of Nauset Beach (a more recent beach breach occurred in 2007). In addition, Pleasant Bay and its backwater effects on Muddy Creek were revised in order to incorporate updated stillwater elevations.

For this countywide study, revised coastal analyses were performed for open water flooding sources in the communities of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown, Sandwich, Truro, Wellfleet, and Yarmouth. Primary frontal dune evaluations were performed for all communities in Barnstable County and mapped where sufficient data was available to support the delineation.

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 Barnstable County. All or portions of the flooding sources listed in Table 3, "Flooding Sources Studied by Approximate Methods," were studied by approximate methods in the precountywide FISs.

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS

Flooding Source Name	Community (ies)
Baker Pond	Orleans
Bassetts Lot Pond	Yarmouth
Bearse Pond	Barnstable
Beaton Bog	Bourne
Bennett Pond	Bourne
Blackfish Creek	Wellfleet
Blueberry Pond	Brewster
Cahoon Pond	Brewster
Cape Cod National Seashore	Truro
Clapps Pond	Provincetown
Clay Pond	Bourne
Cliff Pond	Brewster, Orleans
Cluffs Pond	Bourne
Cobbs Pond	Brewster
Cranberry Bogs	Orleans
Crystal Lake	Orleans
Dennis Pond	Yarmouth
Deep Pond	Orleans
Depot Pond	Eastham
Duck Pond	Provincetown, Wellfleet
Dyer Pond	Wellfleet
Elbow Pond	Brewster
Ellis Pond	Bourne
Elishas Pond	Yarmouth
Emery Pond	Chatham

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community (ies)
Flax Pond	Bourne, Brewster
Freeman Pond	Bourne
Fresh Brook	Wellfleet
Cedar Pond	Orleans
Goat Pasture Pond	Bourne
Goose Pond	Chatham
Gould Pond	Orleans
Grassy Pond	Brewster
Great Herring Pond	Bourne
Great Pond	Bourne, Eastham, Wellfleet, Truro
Greenland Pond	Brewster
Greenoughs Pond	Yarmouth
Halfway Pond	Yarmouth
Hamblin Pond	Barnstable
Herring Pond	Eastham
Horse Pond	Yarmouth
Horseleech Pond	Truro
Higgins Pond	Brewster
Icehouse Pond	Orleans
Kinnacum Pond	Wellfleet
Lawrence Pond	Sandwich
Long Pond	Barnstable, Wellfleet, Bourne, Brewster, Yarmouth
Lovers Lake	Chatham
Lower Mill Pond	Brewster
Lovells Pond	Barnstable
Lily Pond	Bourne
Lily Pond Bog	Bourne
Little Cliff Pond	Brewster
Little Greenoughs Pond	Yarmouth
Mashpee Pond	Sandwich
Middle Pond	Barnstable
Minister Pond	Eastham
Mill Pond	Eastham
Mill Pond	Brewster
Millers Pond	Yarmouth
Muddy Pond	Barnstable, Yarmouth
Myricks Pond	Brewster
Mystic Lake	Barnstable
Namequoit, ponds between	Orleans
Nightingale pond	Bourne
No Bottom Pond	Brewster
Nye Bog	Bourne
Pamet River	Truro
Perch Pond	Yarmouth
Peters Pond	Sandwich
Plashes Pond	Yarmouth

TABLE 3 – FLOODING SOURCES STUDIED BY APPROXIMATE METHODS - continued

Flooding Source Name	Community (ies)
Pine Pond	Brewster
Pilgram Lake	Truro
Round Pond	Truro
Ryder Pond	Truro
Quanset, ponds between	Orleans
Schoolhouse Pond	Brewster, Chatham
Several Cranberry Bogs	Bourne
Seymour Pond	Brewster
Shallow Pond	Barnstable
Shawne Lake	Sandwich
Shank Painter Pond	Provincetown
Sheep Pond	Brewster
Shoal Pond	Orleans
Shop Pond	Bourne
Slough Pond	Brewster, Truro
Shubael Pond	Barnstable
Smalls Pond	Brewster
Smith Pond	Brewster
Snake Pond	Sandwich
Snow Pond	Truro
Spectacle Pond	Sandwich, Wellfleet
Triangle Pond	Sandwich
Twinings Pond	Orleans
Uncle Harvey Pond	Orleans
Uncle Israels Pond	Orleans
Uncle Seth's Pond	Orleans
Unnamed areas of low development potential	Harwich, Provincetown, Sandwich, Truro, Wellfleet, Yarmouth
Unnamed inland Pond	Provincetown
Unnamed Ponds	Barnstable
Upper Mill Pond	Brewster
Upper Pond	Bourne
Upper Shawme Pond	Sandwich
Vespers Owl Pond	Brewster
Village Pond	Truro
Walker Pond	Brewster
Wakeby Pond	Sandwich
Wash Pond	Orleans
Wequaquet Lake	Barnstable
White Pond	Chatham

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

TABLE 4 - LETTERS OF MAP CHANGE

Community	Case Number	Flooding Source(s)	Letter Date
Town of Falmouth	11-01-2284P	Buzzards Bay	April 23, 2012

2.2 Community Description

Barnstable County is located in the southeastern portion of Massachusetts, consisting of Cape Cod and associated islands. Cape Cod is a peninsula in the easternmost portion of Massachusetts and has the same boundaries as the county. There are 15 towns in Barnstable County; the Towns of Barnstable, Sandwich, Bourne, Falmouth and Mashpee are located in the western part of the county; the Towns of Yarmouth, Dennis, Harwich, and Brewster are located in the southern-central part of the county; the Towns of Chatham and Orleans are located in the southeastern portion of the county, while the Towns of Provincetown, Truro, Wellfleet and Eastham line the northeast coast of the County.

Barnstable County borders Plymouth County to the northwest and is bordered by Dukes and Nantucket Counties to the south.

According to census records, the population of Barnstable County was 215,888 in 2010, 222,230 in 2000 and 186,605 in 1990 (Reference 18). The total land area in Barnstable County consists of 396 square miles.

The towns in Barnstable County are primarily summer resort towns, with an economy based principally upon retail businesses. Construction, small manufacturing firms, and local fishing and cranberry industry bolster the year-round economy. Development along the coast is mostly residential.

The terrain of the county consists of rolling land, with elevations varying from sea level along the coast to approximately 200 feet. The land surface is dotted with numerous cranberry bogs, marshes, sand dunes, and ponds. The soil ranges from sandy loam or loam, to peat found in swampland areas of the county. The shoreline along Buzzards Bay is very irregular and is characterized by many inlets, peninsulas, islands, inlets, and small bays.

The entire Cape Cod area is composed of unconsolidated sand and gravel deposits, possibly the most prevalent type of aquifer in Massachusetts. There are three major types of deposits, all composed of waterborne material. They were deposited in contact with glacial ice during the Pleistocene Period as outwash in drainage areas of the melting glaciers, or as alluvial materials associated with streams unrelated to glaciation.

All of the towns have coastline on one or more of Buzzards Bay, Nantucket Sound, the Atlantic Ocean, and Cape Cod Bay. Because of the geography and topography of the county, coastal flooding is the dominant form of flood risk.

2.3 Principal Flood Problems

In Barnstable County, flooding generally occurs as a result of Hurricanes and Northeasters. Severe coastal storms commonly referred to as northeasters can occur at any time of the year but are more prevalent during the winter months. Past history has shown that although hurricanes occur less frequently than northeasters, they are capable of causing severe flooding. Hurricanes usually occur during the late summer and early fall months. High tides, rain runoff, tidal surges, storm surges, and wave action occur as a result of these storms. Flooding by higher than normal tides is usually the result of storm activity, either as a tropical hurricane or as a northeaster. Due to the general location, coastal areas on Cape Cod Bay suffer more from exposure to northeasters, while those on Nantucket Sound are most affected by tropical hurricanes.

The flood problems for the communities within Barnstable County have been compiled from the previous FIS and are described below:

Flooding in the Town of Barnstable is essentially limited to coastal areas where waters can inundate during high tide conditions. Between 1901 and 1960, a total of 16 hurricanes occurred on Cape Cod. Of these, the hurricanes of 1938, 1944, and 1954 resulted in severe flooding.

Flooding along the northeast coast of the Town of Bourne generally results from the high tides and storm surges associated with New England northeasters. Serious flooding resulted in the Town of Bourne during the hurricanes of September 21, 1938, and August 31, 1954.

The entire coastline of the Town of Brewster has been determined to be subject to wave action. The storm that affected Brewster in February 1978 was approximately a 1-percent-annual-chance event, as determined by elevation- frequency analyses.

Flooding along the coast of the Town of Chatham generally results from storm tides caused by northeasters. The highest tide recorded at the Stage Harbor National Ocean Service (NOS) Subordinate Tide Gage was during the September 14-15, 1944, hurricane. An elevation of 8.45 feet, which at the time was measured using the National Geodetic Vertical Datum (NGVD) was recorded during this storm. This elevation is 0.65 foot NGVD below the 1-percent-annual-chance elevation of 9.1 feet NGVD assigned for the Chatham coastline by the USACE (References 19 and 20).

Serious flooding has also occurred along the eastern coastline of Chatham as a result of northeasters. On January 2, 1987, large waves generated by a northeaster combined with an extreme high tide cut across one of several low and narrow points of the North Beach east of Chatham Light. Within a week the channel was 100 yards wide. By the spring of 1987, the channel was a quarter mile wide, and by May 1988, the breach was over a mile wide. During the initial period of barrier beach breaching, severe erosion occurred along the eastern inner shoreline of Chatham, particularly between Water Street and Wilkey Way. Almost 250 feet of land was eroded at the Andrew Harding's Landing, resulted in losses of the Landing parking lot and several water front homes. Portions of the eastern inner shoreline of Chatham facing the barrier beach opening will be subject to the direct storm surge and wave effects from the Atlantic Ocean.

The February 1978 northeaster also caused serious flooding on Nauset Beach and inside Chatham Harbor. During this storm, substantial erosion occurred along the eastern inner shoreline of the Town of Chatham, particularly at Mataguasson Point. Several homes in Pleasant Bay were flooded out. Chatham police stated that high tides flooded one foot over Bridge Street and covered the road to Morris Island with several inches of water. The local newspaper reported Harding Beach parking lot was also inundated by coastal flood water (Reference 21). Fortunately, Nauset Beach, which forms a barrier along the eastern shoreline of Chatham, absorbed the brunt of the storm waves created by the extremely high winds. As a result of the tremendous amount of wave energy absorbed during this and past storms, Nauset Beach has undergone significant changes.

Flooding along the coast of the Town of Dennis is generally associated with tidal surges and is further aggravated by coincidental rainfall runoff. Relatively frequent tidal inundation and flooding is experienced in the various estuaries and their adjoining land areas. Salt marshes are naturally subjected to flooding by normal spring tides. Developed areas which have been subjected to flooding include Dr. Bottero Street in the vicinity of Taunton Avenue, Sea Street at Quivett Creek, the area north of State Route 28 and west of Cove Road at the Bass River, the northwest shore of Kelleys Pond, and the area between Weir Creek and Swan Pond River south of Lower County Road. Shore erosion due to wave action generally occurs along both the north and south coastlines of Dennis. The major estuaries in Dennis are Chase Garden Creek, Sesuit Harbor and Creek, Quivett Creek, Bass River, Weir Creek, and Swan Pond River. These estuaries are subject to tidal surges.

Eastham is highly susceptible to northeasters as well. Both the eastern and western shorelines of the Town of Eastham are subject to wave action. The storm of February 1978, estimated as an approximately 1-percent-annual-chance event, caused inundation along much of Eastham's shorelines below elevations of 9.1 to 11.1 feet NGVD. The strength of this storm was demonstrated by the loss of public beach area and the parking lot at Coast Guard Beach on the Atlantic Ocean. The dunes and bathhouse at Coast Guard Beach were also lost to the attacking waves, while the storm surge inundated the bike trail bridge. Storm waters washed over many locations on Nauset spit, carrying away houses and eroding dunes. At Nauset Beach, waves eroded the base of the cliffs, causing some damage to the parking lot. A book by one of the locals documented many areas were inundated by the storm surge including the parking area at Rock Harbor, houses along Town Cove on Ellis Road, the Town Cove area, and portions of Bridge Road (Reference 22). During the storm of January 9, 1978, the bayside beaches suffered erosion due to gale force winds from the southwest occurring at the peak of the tide. These beaches suffered further damage during the February 1978 storm from the tidal surge which elevated waters at least three feet above the normal high tide. Winds were from the northeast at the time of the peak tides; therefore, waves generated did not damage south and west facing shorelines.

Flooding can occur along the entire coast of the Town of Falmouth, principally as the result of hurricane storm surge. Major coastal flooding occurred several times in the past 100 years, the most notable of which were in 1938, 1944, and 1954. The flood of record on Nantucket and Vineyard Sounds in the Falmouth area was the 1944 flood, which was approximately a 1.85-percent-annual-chance flood (54 year recurrence interval). The most recent flood along the sounds occurred in 1954 and was also approximately a 1.85-percent-annual-chance flood (54 year recurrence interval). The 1938 flood was approximately a 3.3-percent-annual-chance flood (30 year recurrence interval). The flood of record along Buzzards Bay was the 1938 flood, was approximately a 0.8-percent-annual-chance flood (125 year recurrence interval) near Sippewissett and approximately a 1.2-percent-annual-chance flood (83 year recurrence interval) near Megansett Harbor. The 1954 flood is also the most recent minor flood for Buzzards Bay. This was approximately a 1-percent-annual-chance flood near Sippewissett and approximately a 1.4-percent-annual-chance flood (71 year recurrence interval).

Flooding along the Nantucket Sound coastline of the Town of Harwich is generally the result of hurricane-induced storm surges. The highest recorded tide at the Wychmere Harbor NOS Subordinate Tide Gage was during the September 14-12, 1944, Hurricane. An elevation of 8.9 feet NGVD was measured during this storm. This elevation is 0.2 foot NGVD below the 1-percent-annual-chance elevation of 9.1 feet NGVD assigned for the Harwich coastline by the USACE from the FIS for the Town of Dennis and the report titled “Hurricane Flood Levels, Profile No. 10” (References 6 and 19). Flooding along the small segment of tidal shoreline on Pleasant Bay, in the northeastern corner of the Town of Harwich, is usually the result of northeasters, although hurricanes may also cause serious flooding in this area. A flood elevation of 4.1 feet NGVD was measured at the southwest end of Pleasant Bay during the February 1978 northeaster (Reference 23).

Flooding in the Town of Mashpee is essentially limited to coastal areas where ocean waters can inundate under high-tide conditions. Flooding by higher than normal tides is usually the result of storm activity, often in the form of a tropical hurricane. The annual exceedence of a hurricane which will cause severe flooding is approximately 20 years, or a 5-percent-annual-chance storm. The coastal areas in Mashpee most susceptible to flooding and subsequent flood damage are the Poponesset and Deans Pond development; the shorelines of Poponesset Bay and Ockway Bay; and the shoreline of Waquoit Bay, including Little River, Great River, Hamblin Pond, and Jehu Pond.

The Town of Orleans is highly susceptible to northeasters as well. Northeasters often last long enough to be accompanied by at least one high tide, resulting in severe coastal flooding. In addition to flooding, damaging waves may accompany the tidal surge in coastal areas. The shorelines of both Namskaket and Nauset Beach are subject to wave action.

The Town of Provincetown is susceptible to northeasters and hurricanes. Two storms of high magnitude occurred in Provincetown in the winter of 1978. On Monday, January 9, 1978, strong southwest winds combined with high tides and a new moon to cause flooding of 70 east end homes. Business establishments along Bradford and Commercial Streets were also damaged (Reference 24). On Tuesday, February 8, 1978, the town experienced a northeaster that produced water levels higher than any others ever recorded (Reference 25). Unlike most northeasters, which tend to race up the Atlantic coast along a cold front, this storm stalled due to a large high pressure system over Labrador. Unable to continue northward as it intensified, the storm temporarily stood still over Cape Cod, causing severe flooding. The surge created by the storm combined with an already above normal spring tide to produce a still water elevation of 10 feet (NGVD). Other storms that caused significant flooding in Provincetown were the hurricanes of 1954 and 1938 (Reference 26).

Flooding along the coast of the Town of Sandwich generally results from storm tides caused by northeasters. The highest tide recorded at the Cape Cod Canal gage, which has been in operation since 1955, was the February 6 and 7, 1978, storm with a flood height of 9.2 feet (NGVD) (Reference 27). Prior to 1978, the flood of record had occurred on December 29, 1959, with a flood height of 7.97 feet (NGVD). In February 1940, before the Cape Cod Canal gage was in operation, a northeaster caused damage throughout the Cape Cod area, especially in Sandwich. Most of the damage was to summer homes (Reference 26). Hurricanes, although rare, can also cause flooding within Cape Cod Bay. On September 11, 1954, Hurricane Edna caused waves as high as 15 feet (NGVD) in Sandwich (References 26 and 28).

Each year, the Town of Truro is also subject to northeasters. In addition to northeasters, Truro is also susceptible to hurricanes that occasionally reach the outer cape. On February 8, 1978, Truro experienced a northeaster that produced the highest water levels ever recorded in the town (Reference 29). In low-lying areas adjacent to Ballston Beach, huge rollers poured over the dunes and in to the Pamet River valley, temporarily isolating Provincetown and North Truro Another storm that caused significant flooding in Truro was the hurricane of 1954 (Reference 26). During the hurricane of August 1954, the high-water elevation was 7.9 feet (NGVD) at Provincetown. The December 1959 northeaster produced estimated high-water marks of 8.6 feet (NGVD) at Wellfleet Harbor, 8.1 feet (NGVD) at Provincetown, and 7.6 feet (NGVD) at North Truro.

The Town of Wellfleet is highly susceptible to northeasters and has experienced severe flooding in the past, including the storm of February 1978, which was designated a 1-percent-annual-chance event throughout the Cape Cod Bay area, and on the coastlines of eastern Massachusetts, New Hampshire, and southern Maine.

Historically, flooding in the Town of Yarmouth has resulted from high tides associated with severe coastal disturbances, primarily in the form of hurricanes and northeasters. Such was the case with the hurricane of 1944, which caused extensive flood damage throughout Yarmouth. Documentation exists for the storms of 1938, 1944, and 1954. The hurricane of September 14-15, 1944, is the storm of record and was also very close to the intensity of the statistically determined 1-percent-annual-chance flood for the south shore of Yarmouth. The north shore of Yarmouth can be expected to be somewhat less damage prone than the south shore for two reasons. There is relatively less development in terms of homes and other structures are susceptible to sustaining damage on the north shore, and much of the shoreline is actually the edge of broad, flat, saltwater marsh inlets which may lessen damage, depending on the storm approach angle. Due to tidal influence, areas bordering the shore and certain inland water bodies can be expected to incur damage. These areas are in the vicinities of Follins Pond, Tom Matthews’s pond, Mill pond, and Dinahs Pond. According to local residents, the effect of tidal inflow up the Bass River during the 1944 hurricane was as far inland as the Mill Pond area.

Hurricane Gloria in September 1985 arrived at low tide, minimizing damage to the coastline. Hurricane Bob in August 1991 passed close to Barnstable 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 causing hurricane force wind gusts and heavy rain through several high tides. The Water Service Meteorological Observatory (WSMO) in Chatham recorded wind gusts greater than 60 mph for more than 15 straight hours and greater than 70 mph for six hours (Reference 30). This event was labeled as the Perfect Storm by the National Weather Service. Tides were estimated to be three to four feet above normal high tide along the entire Massachusetts coastline, causing flooding and wind damage to several counties, including Barnstable (References 31 and 32).

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. Barnstable County has received state or federal disaster declarations for severe storms in December 1992, December 2003, March 1993, January 1996, December 2003, October 2005, April 2007 (Reference 10).

In September 2010, rainfall of three to five inches from Tropical Storm Earl as it passed 98 miles southeast of Nantucket Island, Nantucket County, MA resulted in minor coastal flooding in the Towns of Chatham and Harwich (Reference 33).

In August 2011, Hurricane Irene, weakened to a tropical storm, before affecting Barnstable County. Irene's strong winds and surf caused damage to residents with downed trees, power outages, and minor flooding (Reference 34).

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 Barnstable 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 36 mph were reported by the Automated Surface Observing System at Barnstable Municipal – Boardman Airport in Hyannis and Sandy produced wind gusts to 61 mph and minor to moderate coastal flooding occurred within Barnstable County. Seas built to between 20 and 25 feet just off the east coast of Massachusetts 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 33).

2.4 Flood Protection Measures

In Barnstable County, many coastal areas are protected by private seawalls and jetties. In most cases, these only provide minimum protection from damage caused by the 1-percent-annual-chance floods. In addition to these structures, efforts have been made to preserve or to improve existing coastal dunes through the use of snow fencing and control of pedestrian access. Also, many private landowners have placed seawalls and/or grouted stone slopes along the watersides of their properties. The heights and types of this construction vary greatly from site to site.

The riverine areas are protected by restrictions that prohibit development within 100 feet of a stream. This same restriction applies to some extent in the area of cranberry bogs. The large number of cranberry bogs in the county constitutes a significant amount of potential flood-storage capacity; however, since the prime purpose of these bogs is to produce cranberries, the flood storage may not be available when needed. There is no formal means of public or private control of cranberry bog flow or water-surface elevations. Also, cranberry bogs are subject to development pressure and may be completely lost for flood storage as land-use patterns change.

The zoning laws in Barnstable County have been amended to conform with FEMA requirements pertaining to the protection of new construction from flooding and waves resulting from the 1-percent-annual-chance flood. It may be the case that some of the communities within Barnstable County have instituted stricter flood protection measures.

Most of eastern Town of Eastham and portions of the Town of Orleans are part of the Cape Cod National Seashore, where development is prohibited and natural conditions including natural flood storage areas are conserved. Outside of this Seashore District, the towns maintain a natural flood control measure in the wetlands district where protection is provided for flood storage areas. In the Town of Orleans, there are Conservancy Districts established by protective bylaws which regulate future development within floodplain areas. This not only helps to protect against flood damages to new structures, but also assures that the natural flood storage areas in the town will be protected.

A large portion of the Town of Wellfleet is within the Cape Cod National Seashore as well, but development is only limited, not prohibited, by the National Park Service program of land acquisition. Development still occurs when acquisition funding is limited. The western shoreline of Wellfleet is somewhat protected from damaging storm waves because of its location on Cape Cod Bay. Wellfleet Harbor is sheltered even further by the Great Island Peninsula. Structural flood protection measures include a breakwater near the town pier, seawalls along the Mayo Beach area, and a tide gate at Chequesset Neck Road on the Herring River. The seawalls and breakwater are designed primarily to dissipate wave energy, not for total flood protection. The tide gate is designed to reduce flooding in low lying areas.

To provide meaningful protection for the north and south Town of Yarmouth coasts against tidal floods of the magnitude of the 1-percent-annual-chance and 0.2-percent-annual-chance events, structures would have to be placed around more than half the town. Along the south shore, however, there is presently a good deal of construction designed to protect the shore from erosion. While these measures are not for flood protection, they do provide some protection against wave action associated with the 10-percent-annual-chance and 2-percent-annual-chance floods. They are not generally sufficient to significantly impede the 1-percent-annual-chance and 0.2-percent-annual-chance floods. Some degree of protection to the Lewis Bay area is naturally afforded by Great Island and the neck leading to it. Similar protection is provided to the Lewis Pond/Parkers River estuary by the beach on the land spit separating this area from the ocean. As with the erosion protection measures cited above, these offer only marginal protection against the larger floods.

The Barnstable County communities have no major flood control structures planned or proposed at this time.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that 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 community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Coastal Hydrologic Analysis

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, Barnstable 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.

<u>August 17, 2007 Coastal Analyses</u>

As part of this countywide update, revised coastal analyses were performed for the open water flooding source of Cape Cod Bay in the community of Provincetown. 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 35) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 36).

The stillwater elevation (SWEL) is the elevation of the water due to effects of astronomic tides and storm surge on the water surface. For the open water flooding source of Cape Cod Bay in the community of Provincetown, published values in the USACE's Tidal Flood Profiles (Reference 20) were used to estimate the stillwater elevations for the 10-, 2-, and 1-percent-annual-chance floods. The 0.2-percent-annual-chance stillwater elevations for the revised flooding source was extrapolated based on the more the frequent stillwater elevations in the tidal flood survey.

Stillwater elevations for the open water flooding source of Cape Cod Bay in the community of Provincetown are presented in Table 5.

TABLE 5 –SUMMARY OF STILLWATER ELEVATIONS - AUGUST 17, 2007 STUDY

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CAPE COD BAY				
Entire coastline in the Town of Provincetown	8.4	8.6	9.0	9.9

[1]North American Vertical Datum 1988

The elevations presented in the USACE's Tidal Flood Profiles (Reference 20) 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. A datum conversion factor of +0.15 feet for Cape Cod Bay in Provincetown was applied to the data in the tidal flood survey.

2013 Coastal Study

Revised coastal analyses were studied for the open water flooding sources for the communities of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown (Atlantic Coast), Sandwich, Truro, Wellfleet, and Yarmouth. Below is a summary of the analyses performed.

Several previous studies were reviewed to determine the most appropriate SWEL values to use in the Barnstable County coastal analysis, including: effective FIS for the communities within Barnstable County (References 1 through 16); "Tidal Flood Profiles, New England Coastline" (Reference 37); and "Updated Tidal Profiles for the New England Coastline" (Reference 38).

After consulting with FEMA Region I, it was decided that the 10-percent, 2-percent, and 1-percent, and 0.2-percent stillwater elevations should be taken from the effective FIS for the communities within Barnstable County, Massachusetts (References 1 through 16).

For communities studied in 2013 coastal study, coastal flood hazard data, the 10-, 2-, 1- and 0.2-percent-annual-chance stillwater elevations are the same as published in the previous effective FIS. These elevations have been adjusted to the NAVD88 datum for this countywide FIS.

Stillwater elevations for the 2013 Coastal Study are presented in Table 6.

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ATLANTIC OCEAN				
Chatham and Orleans corporate limits	5.1	7.6	9.1	13.6
North of Inlet at Nauset Beach In Town of Eastham	6.0	7.5	9.1	13.6
South of inlet at Nauset Beach in the Town of Eastham	5.7	7.6	9.2	13.7
Entire shoreline within the Town of Orleans	5.6	7.5	9.1	13.6
Entire coastline in the Town of Provincetown	7.2	8.0	9.2	12.5
At the Truro/Provincetown town boundary	6.9	8.2	9.1	11.6
At the Truro/Wellfleet town Boundary	7.0	7.9	9.1	12.4
Southern shoreline in the Town of Wellfleet	6.3	7.5	9.1	13.6
Northern shoreline in the Town of Wellfleet	6.7	7.5	9.1	13.6
BASS RIVER				
Confluence with Nantucket Sound in the Town of Dennis	4.9	7.5	9.1	13.9
State Route 28 in Town of Dennis	4.4	6.8	8.4	12.5
U.S Route 6 in Town of Dennis	2.6	3.8	5.1	7.1

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BASS RIVER - continued				
Follins Pond in Town of Dennis	2.3	3.3	4.3	6.0
Confluence with Nantucket Sound in the Town of Yarmouth	4.9	7.5	9.1	13.9
State Route 28 in the Town of Yarmouth	4.4	6.8	8.4	12.5
U.S Route 6 in the Town of Yarmouth	2.6	3.8	5.1	7.1
Follins Pond in the Town of Yarmouth	2.3	3.3	4.3	6.0
BLACKFISH CREEK				
Drummer Cove to U.S Route 6 in the Town of Wellfleet	9.4	10.4	10.7	11.7
BOAT MEADOW RIVER				
Mouth to Bridge Road in Eastham	9.1	10.0	10.3	11.3
Bridge Road to tidal limit in Eastham	9.1	10.1	10.2	11.4
BUTTERMILK BAY				
Entire shoreline within Bourne corporate limits	8.7	12.3	13.8	17.0
BUZZARDS BAY				
North Falmouth to Scraggy Neck in the Town of Bourne	8.3	11.8	13.2	16.4
Scraggy Neck to Wings Neck	8.7	12.2	13.7	16.8

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
BUZZARDS BAY - continued				
Wings Neck to Cape Canal in the Town of Bourne	8.7	12.3	13.8	17
From Penzance Point to the Knob in the Town of Falmouth	7.0	10.6	12.1	15.7
From the Knob to Megansett Harbor in the Town of Falmouth	8.3	11.7	13.1	16.3
West Falmouth Harbor	7.6	10.8	12.1	15.2
CAPE COD BAY				
At the Sandwich/Barnstable Corporate limits	8.6	9.6	9.9	10.9
At the Barnstable/Yarmouth Corporate limits	8.8	9.8	10.1	11.1
North of Sandwich corporate limits in the Town of Bourne	8.7	9.6	9.9	10.6
Entire shoreline within Brewster	9.6	10.6	10.9	12
Chase Garden Creek to Sesuit Harbor in Dennis	9.0	10.0	10.3	11.5
Sesuit Harbor to the Dennis-Brewster Corporate limits	9.2	10.2	10.5	11.5
Entire shoreline within the Town of Eastham	8.9	9.9	10.2	11.2

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CAPE COD BAY - continued				
Entire shoreline within community in the Town of Orleans	9.4	10.4	10.7	11.8
At Bourne/Sandwich corporate limits	8.2	9.1	9.5	10.5
At Barnstable/Sandwich corporate limits	8.4	9.4	9.7	10.7
At North Truro	7.9	8.7	9.1	10.1
Near Moon Pond in the Town of Truro	8.2	9.0	9.4	10.4
At Truro	8.7	9.3	9.9	10.7
At South Truro	8.9	9.7	10.2	11
Entire shoreline within the Town of Wellfleet	9.1	10.1	10.4	11.4
Entire coastline in the Town of Yarmouth	8.9	9.9	10.3	11.3
Wings Neck to Cape Cod Canal in the Town of Bourne	8.8	12.4	13.9	17.1
CAPE COD CANAL				
At Sandwich corporate limits	8.2	9.1	9.5	10.5
Sagamore Bridge to a point approximately 250 feet east of Sandwich corporate limits	8.4	10.2	10.4	12.9
East central reach	8.4	10.7	11.2	13.9
West central reach	8.5	11.2	12	14.8

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
CAPE COD CANAL - continued				
Bourne Bridge to Buzzards Bay	8.6	11.8	12.9	15.9
CHATHAM HARBOR				
Southern End	5.1	7.6	9.1	13.6
Northern End; Pleasant Bay	5.8	8.6	10.6	14.1
DUCK CREEK				
The Cove to U.S Route 6 in the Town of Wellfleet	9.5	10.5	10.8	11.8
FREEMAN'S POND BROOK				
Entire Shoreline within Brewster	9.6	10.6	10.9	12.0
HATCHES CREEK				
Mouth to confluence at North Sunken Meadow Road extended in Eastham	8.9	9.9	10.2	11.3
Confluence at North Sunken Road extended to tidal limit in Eastham	9.1	10	10.4	11.4
HERRING RIVER				
Mouth to approximately 500 Feet upstream of mouth in Eastham	8.9	9.9	10.2	11.2
Approximately 500 feet Upstream of mouth to tidal limit in Eastham	9.0	10.0	10.3	11.2
At Route 28 bridge in the Town of Harwich	2.8	5.2	6.6	11.4
At North Road Bridge in The Town of Harwich	0.5	3.3	5.1	11.7

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
NANTUCKET SOUND				
At the Mashpee/Barnstable Corporate limits	4.5	8.1	10.1	14.9
At West Bay	4.5	8.1	10.1	14.9
At Centerville Harbor	4.6	7.9	9.7	14.5
At Barnstable/Yarmouth Corporate limits	4.7	7.8	9.4	14.2
Coastline from Harwich Corporate limits to South End Nauset Beach	4.9	7.5	9.1	13.9
Entire shoreline within Dennis	4.9	7.5	9.1	13.9
Entire coastline of Harwich	4.9	7.5	9.1	13.9
Entire shoreline in the Town of Mashpee	4.5	8.1	10.1	14.9
Thatcher's Beach in the Town of Yarmouth	4.7	7.8	9.4	14.2
Near the Yarmouth-Dennis town boundary	4.9	7.5	9.1	13.9
OYSTER POND				
Town of Chatham	3.3	5.5	7.0	14.0
PARKERS RIVER				
Confluence with Nantucket Sound in the Town of Yarmouth	4.7	7.5	9.1	13.9
Approximately 400 feet downstream Route 28 in the Town of Yarmouth	4.1	7.0	8.4	13.5

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
PARKERS RIVER - continued				
Approximately 400 feet upstream of State Route 28 in the Town of Yarmouth	1.8	6.1	8.1	13.5
Swan Pond in the Town of Yarmouth	1.8	6.1	8.1	13.6
PLEASANT BAY				
Town of Harwich	3.8	5.7	13.9	13.9
Harwich/Orleans corporate limits in the Town of Orleans	3.8	5.8	11.0	14.1
Sipson Island in the Town of Orleans	3.9	5.8	11.1	14.1
Namequit Point in the Town of Orleans	3.9	5.9	11.4	14.2
North End Pochet Island in the Town of Orleans	4.0	6.0	11.6	14.3
Frostfish Cove in the Town of Orleans	4.1	6.1	11.8	14.4
ROCK HARBOR CREEK				
Mouth to Rock Harbor In Orleans, Massachusetts	9.4	10.4	10.7	11.8
Rock Harbor Road to approximately 1300 feet downstream of Town Way in Eastham	9.5	10.5	10.8	20.9
Approximately 1300 feet downstream of Eastham Town Way to tidal limit	9.5	10.6	10.8	11.9

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
ROCK HARBOR CREEK - continued				
Confluence to Rock Harbor Road in the Town of Orleans	9.4	10.4	10.7	11.8
Rock Harbor Road to approximately 1,300 feet Downstream of Town Way in the Town of Orleans	9.5	10.5	10.8	11.9
Approximately 1,300 feet downstream of Town Way to Tidal Limit in the Town of Orleans	9.5	10.6	10.9	11.9
STAGE HARBOR				
Town of Chatham	4.3	8.7	8.2	13.9
STONY BROOK				
From the confluence with Cape Cod to 0.38 mile Upstream in Brewster	9.6	10.6	10.9	12.0
From 0.38 mile upstream of its confluence to State Route 6A in Brewster	9.7	10.7	11.0	12.1
From State Route 6A to tidal limit in Brewster	4.6	5.1	6.3	12.1
TOWN COVE				
Mouth to Tidal Limit in Town of Eastham	6.1	7.6	9.2	13.7
Nauset Harbor shoreline to Snow Point in the Town of Orleans	5.7	7.6	9.2	13.7
Snow Point to Tidal Limit in the Town of Orleans	5.8	7.7	9.2	13.7

[1]North American Vertical Datum 1988

TABLE 6 –SUMMARY OF STILLWATER ELEVATIONS – 2013 COASTAL STUDY – continued

FLOODING SOURCE AND LOCATION	ELEVATION (feet NAVD[1]) 10-PERCENT	2-PERCENT	1-PERCENT	0.2-PERCENT
VINEYARD SOUND				
From Penzance Point to Waquoit Harbor	6.4	8.1	10.1	14.9
Oyster Pond in the Town of Falmouth	4.2	6.1	7.1	11.9
Bourne's Pond in the Town of Falmouth	4.4	7.5	9.1	13.6
WAQUOIT BAY				
Entire shoreline in the Town of Mashpee	4.4	8.1	10.1	14.9
WELLFLEET HARBOR				
West and North shorelines in the Town of Wellfleet	9.1	10.1	10.4	11.4
East shoreline, South of Town Pier in the Town of Wellfleet	9.3	10.4	10.7	11.7

[1]North American Vertical Datum 1988

3.2 Coastal Hydraulic Analyses

August 17, 2007 Coastal Study

Wave setup along the open coast areas of Cape Cod Bay in Provincetown was calculated using the procedures detailed in the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 36). Specifically, the Direct Integration Method (DIM) was applied. Because much of the Barnstable 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 community, except for areas inundated by wave runup.

For the revised portion of Cape Cod Bay in Provincetown, wave characteristics representing a 1-percent-annual-chance storm were determined using a restricted fetch analysis and the USACE ACES software package. Mean wave characteristics were determined as specified in the FEMA guidance for V Zone mapping.

Wave heights and wave runup in the revised portion of Cape Cod Bay in Provincetown 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.

Table 7 provides a description of the transect locations, the 1-percent-annual-chance stillwater elevations, and the maximum 1-percent-annual-chance wave crest elevations for the August 17, 2007 study.

TABLE 7 – TRANSECT DESCRIPTIONS – AUGUST 17, 2007 STUDY

		ELEVATION (FEET NAVD[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
070	Approximately 730 feet southwest from the intersection of Mayflower Avenue and Route 6A, extending south into Provincetown Harbor.	9.0	15
071	Approximately 60 feet southeast from the intersection of Snail Road and Route 6A, extending southeast into Provincetown Harbor.	9.0	17
072	Approximately 440 feet southeast from the intersection of Duncan Lane and Route 6A, extending southeast into Provincetown Harbor.	9.0	17
073	Approximately 300 feet southeast from the intersection of Freeman Street and Commercial Street, extending southeast into Provincetown Harbor.	9.0	14
074	Approximately 425 feet southeast from the intersection of Tremont Street and Nickerson Street, extending southeast into Provincetown Harbor.	9.0	14

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

For the revised open water flooding sources in the Town of Provincetown, the coastal transects were field surveyed (Reference 39). The survey data was supplemented with community supplied 2-foot contour information (Reference 40). As appropriate, coastal protection structure details and 0.0 foot NAVD elevation were included and noted in the transect field surveys. Bathymetric data from NOAA Nautical Charts were used to extend the transects offshore for wave runup calculations. Coastal processes that may affect the transect profile, such as dune erosion and seawall scour and failure, were estimated in accordance with Appendix D "Guidance for Coastal Flooding Analyses and Mapping," (Reference 41) of the Guidelines and Specifications, as well as, the "Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update", (Reference 36).

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 land development within the community undergoes 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 41). WHAFIS 3.0 was used to predict wave heights (Reference 42).

During significant coastal storms, shoreline profiles are altered due to episodic erosion and can allow for greater landward propagation of waves. As a result, flood hazard analysis and mapping was based on eroded profiles, where applicable. For this study, the eroded profile was calculated within the Erosion Module of the Coastal Hazards Analysis Modeling Program (CHAMP) version 2.0 (Reference 43) for sand beaches with a well-defined dune in accordance with available FEMA Guidelines. FEMA's new guidance identifies the size of the frontal dune reservoir, or the cross-sectional area of the dune above the total water elevation (1-percent-annual-chance SWEL plus wave setup), as the key attribute in determining the relative stability of the dune.

The guidance outlined in FEMA's Procedure Memorandum 47 allows for several methods to be used to determine wave runup: RUNUP 2.0 computer program (Reference 43); procedures outlined in the Shore Protection Manual (for vertical walls) of the Atlantic Ocean and Gulf of Mexico Coastal Guidelines Update (Reference 36), and guidance in the "Technical Advisory Committee for Water Retaining Structures". Each of the aforementioned methods has an appropriate set of nearshore conditions for which it should be applied. 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 for the Cape Cod Bay shoreline in the Town of Provincetown. Accurate topographic, land-use, and land cover data are required for the coastal analyses. Community supplied data which meets the accuracy standards for flood hazard mapping were used for the topographic data (Reference 40). Depths below mean low water were determined from National Ocean Survey Coastal Charts (Reference 44). The land-use and land cover data were obtained by field surveys and aerial photographs (Reference 45).

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 3 feet.

In accordance with 44 CFR Section 59.1 of the NFIP the effect of the Primary Frontal Dune (PFD) on coastal high hazard area (VE Zone) mapping was evaluated for the Town of Provincetown (Cape Cod Bay). In areas that had appropriate topographic data, the extent of the PFD was calculated in accordance with the Massachusetts Office of Coastal Zone Management methodology (Reference 46), then field verified. For other areas, the extent of the PFD was determined from field survey.

Table 8 "Transect Data," lists the flood hazard zone and base flood elevations for each transect along with the 1-percent-annual-chance stillwater elevation for Cape Cod Bay in the Town of Provincetown.

TABLE 8 - TRANSECT DATA – AUGUST 17, 2007 STUDY

	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])
70	8.4	*	9.0	*	*	VE	12-14
					*	AE	14
71	8.4	*	9.0	*	*	VE	15-17
					*	AE	9
72	8.4	*	9.0	*	*	VE	15-17
					*	AE	9
73	8.4	*	9.0	*	*	VE	13-14
					*	AE	9-13
74	8.4	*	9.0	*	*	VE	13-14
					*	AE	

*Data not available
[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 1988

2013 Coastal Study

Offshore (deepwater) wave heights, wave setup, and wave runup for each transect were calculated using Mathcad sheets (Reference 47) developed by STARR to apply methodologies from the USACE's Coastal Engineering Manual (Reference 48) and FEMA Guidelines and Specifications (Reference 36). 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 (References 49 and 50), within the Coastal Hazard Analysis for Mapping Program (CHAMP) (Reference 43), 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 Mathcad outputs and the Automated Coastal Engineering System (ACES) (References 47 and 51); 3) performing the off-shore engineering analysis; 4) preparing WHAFIS input data and populating the CHAMP database (References 43, 49, and 50); 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 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 (References 43, 49, and 50) . 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 (Reference 47).

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 43) 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 36) and the Coastal Hazard Analysis Modeling Program user's guide found in the software documentation (Reference 52).

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 53), 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 (References 49 and 50).

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 54). 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 (References 43, 49, and 50).

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 36) 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 36). Runup estimates were developed for vertical walls using the guidance in Figure D.2.8-3 of the FEMA Guidelines and Specifications (Reference 36), taken from the Shore Protection Manual (Reference 55). 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 (Reference 43). Both the SPM and RUNUP 2.0 provide mean wave runup. The mean wave runup was multiplied by 2.2 to obtain the 2-percent-annual-chance runup height. Wave runup elevation was added to the stillwater elevation and does not include wave setup.

The limit of moderate wave action (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 56). 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.

In accordance with 44 CFR Section 59.1 of the NFIP the effect of the Primary Frontal Dune (PFD) on coastal high hazard area (VE Zone) mapping was evaluated for the communities of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown (Atlantic Coast), Sandwich, Truro, Wellfleet, and Yarmouth. 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 within each community in the county.

Figure 1, "Transect Schematic," represents a sample transect, which illustrates the relationship between the stillwater elevation, the wave crest elevation, the ground elevation profile, and the location of the A/V zone boundary.

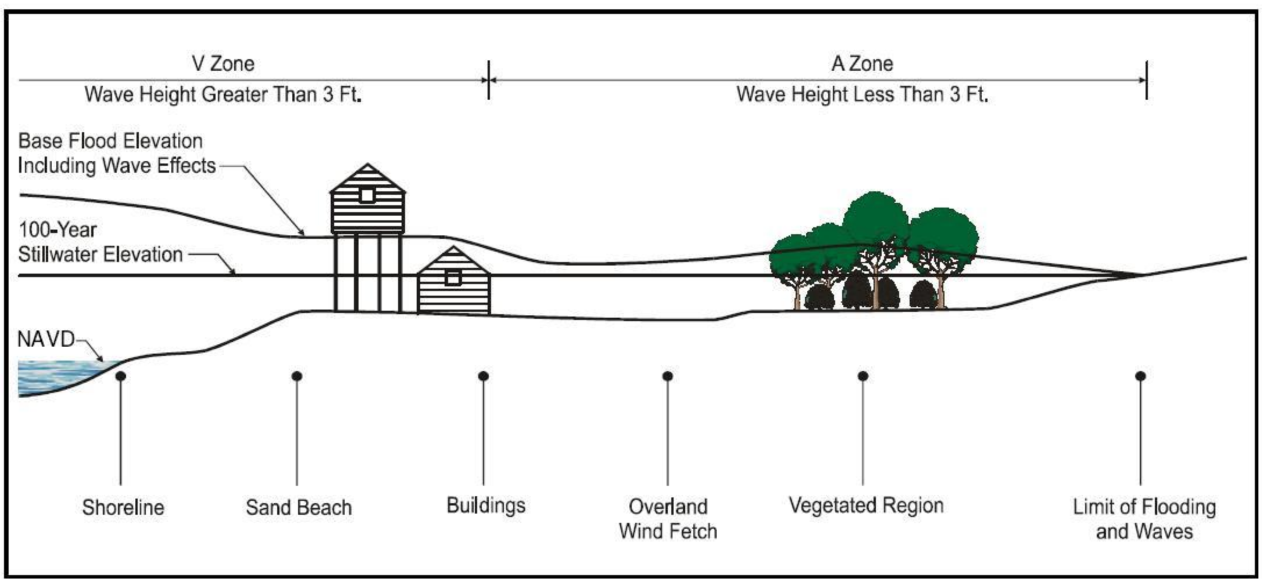

Figure 1 – Transect Schematic

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 57). 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) and Hydro flattened breakline data collected in 2010 by Photo Science (Reference 58). Data was collected at 1.0 meter post spacing with a vertical accuracy of 9.25 centimeters and 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 59). 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 9 provides a description of the transect locations, the 1-percent-annual-chance stillwater elevations, and the maximum 1-percent-annual-chance wave crest elevations for the 2013 Coastal Study. Figure 2, "Transect Location Map," illustrates the location of the transects for the entire county.

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
001	The transect crosses beach & high bluffs into dense residential, terminates at Spencer Dr in Bourne.	9.9	22.3

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
002	The transect crosses beach & high bluffs into dense residential area, terminates at Williston Rd in Bourne.	9.9	21.4
003	The transect crosses beach & dunes into thin strip of residential area, intersects with Phillips Rd in Sandwich and extends across marsh area before terminating in residential area at Siasconset Dr. in Bourne.	9.5	20.7
004	The transect crosses beach & dunes into thin strip of residential, intersects with Phillips Rd and terminates in rigid vegetation running parallel to Scusset Beach Rd. in Sandwich.	9.5	20.9
005	The transect crosses beach & dunes into dense residential area, runs parallel to Shawme Ave, terminates at Wood Ave in Sandwich.	9.6	20.9
006	The transect crosses beach & dunes into marsh area, then intersects with Mill Creek and runs across more marsh before entering dense residential at Dewey Ave, intersects with Hwy 6A, terminates at Beale Ave in Sandwich.	9.6	20.6

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
007	The transect crosses beach & dunes into thin strip of dense residential at Salt Marsh Rd., extends across marsh area of Spring Hill Creek and Old Harbor Creek, terminates in residential area at Spring Hill Rd in Sandwich.	9.6	20.2
008	The transect crosses beach & dunes into dense residential area at Shore Blvd., crosses channel of Scorton Ck into more dense residential where it runs parallel to Ploughed Neck Rd and terminates ater intersecting with Fleetwood Rd in Sandwich.	9.6	20.7
009	The transect crosses beach & dunes, over channel of Scorton Ck, into residential area, then crosses marsh area, intersecting with multiple points of Scorton Creek interscts, Hwy 6A in residential area, terminating at Hoxie Pond in Sandwich.	9.7	20.8
010	The transect crosses beach & 10' revetment into dense residential area, terminates at Captain Paine Rd in Sandwich.	9.7	22.0
011	The transect crosses beach & high bluffs into sparse residential area, runs along Lloyd Ln and terminates at Oak Ridge Rd in Sandwich.	9.7	21.5

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
012	The transect crosses 25' dunes into sparse residential area at Cranberry Trail, terminating at Cranberry Bogs in Sandwich.	9.7	20.7
013	The transect crosses 25' dunes into marsh area of Sandy Neck Beach Park dunes, intersects wih Great Island Creek, Scorton Creek, and Spring Creek before entering into residential area, terminates at Packet Landing Way. in Barnstable.	9.9	19.1
014	The transect extends across Sandy Neck Beack Park dunes where it intersects with Brickyard Creek at multiple points, intersects with railroad tracks, terminates in residential area at Watergate Ln in Barnstable.	10.1	19.3
015	The transect extends across Sandy Neck Beack Park dunes, over Barnstable Harbor, into residential area, running parallel to Pin Oak Rd and terminates before 6A in Barnstable.	10.1	19.3
016	The transect crosses dunes at the Eastern point of Sandy Neck, extending over Barnstable Harbor, crossing a revetment at George Barnstable Harbor Street, running parallel with it, and then terminating at Deacon Ct in Barnstable.	10.1	18.1

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
017	The transect crosses 4' dunes low grassy area, then rigid vegetation, terminating at Bone Hill Rd in Barnstable.	10.1	16.7
018	The transect crosses marsh/estuary of Bass Creek and Clays Creek into scrub/brush vegetation area, enters residential area at Winter Street in Yarmouth where it then terminates.	10.3	18.1
019	The transect crosses dunes at Chapin Memorial Beach, crosses channel & Chase Gardens Creek into marsh area, extends across small residential area, crosses Whites Brook, and terminates at Yarmouthport Golf Club.	10.3	18.5
020	The transect crosses beach & 15' revetment, intersects with Doctor Bottero Rd, extends for marsh at Chase Gardens Creek, enters residential area and terminates at Marsh Side Dr in Dennis.	10.3	20.8
021	The transect crosses beach & dunes at Horse Foot Path, into dense residential area, terminating after intesecting with Tauton Ave in Dennis.	10.3	19.2
022	The transect crosses beach & 20' revetment into dense residential area, terminates before Silverleaf Ln in Dennis.	10.3	21.2

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
023	The transect crosses beach & 6' revetment into residential area, runs along East side of Bleak House Circle and terminates at Ezra Ln in Dennis.	10.3	19.8
024	The transect crosses beach & 25' dunes into sparse wooded residential area, terminates before reaching Sesuit Neck Rd in Dennis.	10.3	20.0
025	The transect crosses 13' revetment into dense residential area at Harbor Rd., terminates before Sesuit Rd in Dennis.	10.3	21.9
026	The transect crosses beach & dunes into residential area, runs along Sea St and terminates at Cobbs Grove in Dennis.	10.5	19.9
027	The transect crosses beach & dunes at Quivett Neck in Dennis, into Quivett Ck, intersects with Main St in residential area, and terminates at Stony Brook Rd in Brewster.	10.5	18.9
028	The transect crosses beach, 7' revetment, & dunes, intersects with upper stream to Freemans Pond, runs parallel in between Cedar Hill Rd and Paines Creek Rd, terminates at Captain Youngs Way in Brewster.	10.9	19.4

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
029	The transect crosses beach & dunes into dense residential area, intersects with Robbins Hill Rd, terminates at George Porter Cartway in Brewster.	10.9	19.4
030	The transect crosses beach & 20' bluffs into dense residential area, intersects with Governor Prence Rd, extends across Cobbs Pond, terminates before reaching Wauquanesit Dr in Brewster.	10.9	19.2
031	The transect crosses beach & dunes into residential area, runs along Charles St and terminates before reaching Point of Rocks Rd in Brewster.	10.9	19.2
032	The transect crosses beach & 7' revetment into dense residential area, runs along Nelson St before terminating before it reaches Robert Rd in Brewster.	10.9	21.9
033	The transect crosses beach & dunes into residential area, intersects with Linnell Landing Rd and then terminates among wooded area in Brewster.	10.9	19.3
034	The transect extends across inlet, marsh and various points of Namskaket Creek, then enters into residential area and terminates at Upland Circle in Brewster.	10.9	19.3

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
035	The transect crosses dunes & into marsh area, running along Willie Atwood Rd in residential area. After intersecting with Cpt Linnell Rd, transect extends across vegetaion and Little Namskaket Ck before terminating at Burning Bush Ln in Orleans.	10.7	20.2
036	The transect crosses beach & dunes into residential area at Uncle Ben Way, continues through residential area until termination at Hwy 6 in Orleans.	10.7	19.0
037	The transect crosses through inlet for Rock harbor creek & 8' Seawall into residential area, runs parallel to Rock Harbor Rd, terminates at Captain Doanes Way in Orleans.	10.7	30.1
038	The transect crosses beach & dunes into residential area, after intersecting with Sunset Ave it extends over marsh area then back into residential area before it intersects with Bridge Rd and terminates at Goody Hallet Ave in Eastham.	10.2	18.3
039	The transect crosses marsh/estuary area of Boat Meadow River, enters into residential area near Widgeon Dr and terminates just after intersecting with Bridge Rd in Eastham.	10.3	18.9

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
040	The transect crosses beach & dunes at Hatch Beach, intersects with Samoset Rd, extends across Herring River and marsh, enters residential area, and then terminates before Bridge Rd in Eastham.	10.2	19.0
041	The transect crosses beach & 25' bluffs into dense residential area, intersects with Bayberry, Beach Plum and Cobett Ln before terminating at Clayton Rd in Eastham.	10.2	19.9
042	The transect crosses beach & dunes into dense residential area at Nycoma Way, intersects Fisher Rd and Penny Ln before terminating at Leland Rd in Eastham.	10.2	18.8
043	The transect crosses beach, 9' revetment, & bluff, then into dense residential area, intersects with Shurtleff Rd before terminating off Western Ave in Eastham.	10.2	19.6
044	The transect crosses beach & 7' revetment on bluff into dense residential area, intersects with Shurtleff Rd in Eastham before terminating in residential area.	10.2	20.0

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
045	The transect crosses beach & 9' revetment into dense residential area where it intersects with Sparow Rd and Hatch Rd in Eastham before terminating in wooded residential area.	10.2	20.2
046	The transect crosses beach & dunes, intersects with Harmes Way before moving into marsh/estuary of Sunken Meadow, intersects with Sunken Meadow into residential area and terminates past Massasoit Rd in Eastham.	10.2	17.9
047	The transect crosses beach & 7' revetment/dunes, intersects with Harmes Way before moving into marsh/estuary of Sunken Meadow, then crosses into residential near Eldridge Rd/Freeman Way, Terminates in wooded area approaching Massasoit Rd in Eastham.	10.2	19.0
048	The transect crosses marshy coast & 10' bluffs into residential area then back into marsh/estuary area until intersecting with residential area at Bayberry Ln in Wellfleet; terminates in Wooded area.	10.7	19.4
049	The transect crosses beach & dunes at Lieutenant Island, crosses into marsh/estuary area, then goes into residential area where it terminates at 3rd Ave.	10.7	18.7

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
050	The transect crosses rocky shoreline into residential area at Lieutenant Island, intersects with 3rd and 4th Ave before terminating at high ground in residential area.	10.7	21.2
051	The transect crosses beach & high bluffs into residential area at Old Wharf Pt, intersects with Old Briar Cliff Rd before crossing marsh area and going back to residential area where it teminates at Eastwind Circle in Wellfleet.	10.7	17.9
052	The transect crosses beach & 10' revetment at bluff and into residential area at Indian Neck, extends across marsh area of Wellfleet Harbor then back into residential area, terminates at Cove Rd in Wellfleet.	10.7	20.6
053	The transect crosses beach & 6' Seawall into dense residential area at Indian Neck, passes along coastline at The Cove, enters into dense residential area again, runs along Cove View Rd until termination.	10.7	18.7
054	The transect crosses beach & 12' Seawall into dense residential area, intersects with Kendrick Ave and Hiller Ave before terminating just past Pratt Ave in Wellfleet.	10.4	19.9

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
055	The transect crosses beach & 7' revetment into residential area, intersects with Chequessett Neck Rd in Wellfleet, terminates near golf course.	10.4	20.2
056	The transect crosses beach & dunes at Great Island then extends across marsh until it terminates in Wellfleet Harbor.	10.4	19.0
057	The transect crosses beach & dunes into scrub/brush vegetation area where it terminates at Great Island Wellfleet.	10.4	20.0
058	The transect crosses beach & dunes at The Gut, then terminates in Wellfleet Harbor.	10.4	19.3
059	The transect crosses beach & large bluffs into wooded area, intersects with Griffin Island Rd and then terminates before Herring River.	10.4	19.5
060	The transect crosses beach & dunes into scrub/brush area, intersects with Bound Brook, continues through vegetation until termination at Old County Rd in Truro.	10.2	18.8
061	The transect crosses beach & bluffs into wooded area, runs along wooded residential area at Cooper Rd and terminates at Old County Rd in Truro.	10.2	19.3

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
062	The transect crosses beach & dunes into sparse residential area, crosses over marsh/estuary area enters back in residential area at Abby Ln, terminates at Mill Pond Rd in Truro.	9.1	17.5
063	The transect runs between two 6' revetments at inlet to Pamet River, crosses 6' revetment and continues along Pamet River into residential area near Bridge Lane, terminates at Truro Center Rd.	9.4	16.2
064	The transect crosses beach & dunes into sparse residential, intersects with Corn Hill Rd and Old Colony Way, runs along Little Pamet River/marsh area until it terminates at Hwy 6 in Truro.	9.4	17.1
065	The transect crosses beach & large bluffs into wooded residential area, runs along Parker Drive, interscts with Fishermans Rd and Bayberry Rd, terminates just before Highway 6 in Truro.	9.4	17.9
066	The transect crosses beach & large bluffs into residential area at Twine Field Rd, runs parallel to Pond Rd, terminates at Pond Village Heights.	9.4	18.4

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
067	The transect crosses beach & 5' Seawall, intersects with Shore Rd, goes through wooded area, intersects with Hwy 6, terminates at resort.	9.4	17.6
068	The transect crosses Pilgrim Beach & 6' Seawall into residential area, intersects with Shore Rd and Hwy 6, extends over Pilgrim Lake into marsh/dune vegetation area where it terminates.	9.4	19.4
069	The transect crosses Pilgrim Beach & dunes into residential area, intersects with Shore Rd and Hwy 6, extends over Pilgrim Lake into dune area where it terminates.	9.4	17.7
075	The transect crosses Herring Cove Beach & dunes into dune/marsh area, intersects with Province Lands Rd, crosses scrub/brush vegetation, then over Shank Painter Pond, terminating at water tanks at Cpt. Bertie Way in Provincetown.	9.2	17.3
076	The transect crosses Race Point Beach & dunes into dune vegetation, terminates before it reaches Race Point Rd in Provincetown.	9.2	18.6

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
077	The transect crosses Head of the Meadow Beach & dunes into Salt Meadow which then turns into dune vegetation area, terminates before it reaches Pilgrim Heights Rd in Truro.	9.1	19.8
078	The transect crosses beach and large bluff into Highland Golf Course and then into scrub/brush vegetation, terminating before Highland Rd in Truro.	9.1	20.9
079	The transect crosses beach & 10' dunes into marsh area and runs along the Pamet River which it crosses at various points; terminating at Hwy 6.	9.1	20.4
080	The transect crosses beach and bluff, and over wooded area where it terminates near Fox Bottom in Truro.	9.1	20.4
081	The transect crosses Newcomb Hollow Beach, dunes, bluff, and into wooded area, intersects with Way 657, extends over Higgins Pond and then terminates at Steele Rd in Wellfleet.	9.1	20.5
082	The transect crosses LeCount Hollow Beach and bluff, and into residential area, intersects with Ocean View Dr, continues into wooded area where it terminates.	9.1	16.7

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
083	The transect crosses Marconi Beach into dunes and wooded area terminates before it reaches Old Kings Hwy in Wellfleet.	9.1	19.7
084	The transect crosses Coast Guard beach, dune area, and over marsh area North of Nauset Bay, terminating before Doane Rd in Eastham.	9.1	20.1
085	The transect crosses marshy shoreline, intersects with a residential area at Tomahawk Trail, runs through wooded area until it terminates at Doane Rd.	9.1	12.4
086	The transect extends through breach in Nauset Beach at Salt Pond Bay, crosses marsh area and into the center of Eastham, intersects with Highway 6, and terminates at Mill Pond in Eastham.	9.1	19.2
087	The transect crosses into a residential area at Ellis Rd from Town Cove, intersects with Hwy 6A at commercial area, extends across Cedar Pond, crosses over wooded area and terminates at Harbor Hill Dr in Orleans.	9.2	13.2
088	The transect extends over marshy shoreline from the South end of Town Cove to Residential area at Route 28 in Orleans.	9.2	14.2

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
089	The transect crosses barrier dune at Nauset beach in Eastham, extends into Nauset harbor, then intersecting a revetment at Snow Point in Orleans.	9.2	20.0
090	The transect crosses barrier dune into Nauset Harbor, reaches beach and bluffs then terminates in dense residential area at Tonset Way South of Woods Cove in Orleans.	9.2	19.4
091	The transect crosses 5' revetment at Nauset Harbor, into wooded residential area, terminates before Champlain Rd in Orleans.	9.2	13.6
092	The transect intersects the shoreline at the narrow spit at Mill Pond Rd, then crosses over Mill Pond into residential area, terminating at Harbor View Ln in Orleans.	9.2	11.6
093	The transect crosses dunes at Nauset Beach, intersecting into residential area at Nauset Knolls Ln and Nauset Rd, intersects with Grandview Dr in Orleans where it then terminates.	9.1	19.9
094	The transect crosses expansive dune at Nauset Beach then crosses estuary into wooded residential area, terminates at Sparrowhawk Rd in Orleans.	9.1	19.3

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
095	The transect crosses barrier dune at Nauset Beach into Little Pleasant Bay then crosses beach into residential area and terminates at Orie Ln in Orleans.	9.1	19.3
096	The transect crosses beach and bluffs and into wooded residential area at Barley Neck in Orleans and terminates.	11.4	13.3
097	The transect crosses beach and bluff into sparse wooded residential area, intersects with Kenneth Ln, runs parallel to Kescayoganset Rd and terminates before Andre/Linell Ln in Orleans.	11.8	17.2
098	The transect crosses beach & 20' bluffs into wooded area, intersects and terminates at Namequoit Rd in Orleans.	11.4	19.9
099	The transect crosses barrier dune at Nauset Beach, into Little Pleasant Bay and then crosses beach into wooded area, terminating at Horseshoe Ln in Orleans.	9.1	20.2
100	The transect crosses rocky shoreline onto Orleans Rd and then into sparse residential where it runs parallel to Tar Kiln Rd in Orleans for a short distance and terminates.	11.0	18.4

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
101	The transect crosses beach and dunes North of Muddy Creek, intersects with Hwy 28 and then into sparse residential area where it terminates at Bay Rd in Harwich.	13.9	22.5
102	The transect crosses 12' revetment at a large bluff 800 feet north of Fox Hill Rd in Chatham, intersects the golf course at Eastward Ho Country Club in Chatham, then terminates before Fox Hill Rd.	10.8	18.2
103	The transect crosses 25' bluffs 400 feet west of Rush Drive in Chatham, crosses into Eastward Ho Country Club, then terminates before reaching Fox Hill Rd.	10.8	18.1
104	The transect crosses dunes into marsh area at Nickersons Neck in Chatham, terminates before hitting Cranberry Ln.	10.1	15.6
105	The transect crosses 8' revetment and bluff into dense residential area at Nickerson Neck and terminates at Racoon Run in Chatham.	10.1	17.1
106	The transect crosses barrier dunes at Nauset Beach, extends into Chatham Harbor, then crosses 6' revetment at Allen Pt, terminating at Old Wharf Rd in Chatham.	9.1	21.0

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
107	The transect crosses barrier dune at Nauset Beach into Chatham Harbor then 10' bluffs into residential area at Emery Ln, terminating before Kent Ln in Chatham.	9.1	19.5
108	The transect crosses barrier dunes Nauset Beach, extends into Chatham Harbor, intersects dunes, and terminates at golf course in the center of Chatham.	9.1	19.4
109	The transect crosses 8' revetment into sparse residential and terminates just past Shore Rd in Chatham.	9.5	15.3
110	The transect crosses beach & 10' revetment into dense residential area at Water St before terminating past Main St in Chatham.	9.1	20.4
111	The transect crosses beach & dune area at Chatham Lighthouse, and extends into residential area where it terminates at Silver Leaf Ave in Chatham.	9.3	18.8
112	The transect crosses barrier dune at Nauset Beach, extends over Chatham Harbor and then crosses 10' revetment into wooded residential area at Morris Island in Chatham.	9.1	19.4

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
113	The transect crosses beach & dunes at Harding Beach, extends into marsh area, crosses Oyster Pond River into wooded residential area, terminating at Harbor Hill in Chatham.	9.1	17.1
114	The transect crosses beach & dunes into dense residential area at Billings Rd, terminates at Buena Vista Rd in Chatham.	9.1	17.5
115	The transect crosses beach & dunes at Harding Beach, extends into marsh area, intesects with Nantucket Rd and teminates at Whitman Ave in Chatham.	9.1	16.8
116	The transect crosses beach & 6' seawall at Cockle Cove, extends into wooded residential area, intersects residential area at Port View Rd, crosses eastern side of Taylors Pond and terminates at Cockle Cove Rd in Chatham.	9.1	17.9
117	The transect crosses beach & dunes at Forest Beach, extends into marsh area, crosses several parts of Mill Crk and then moves into wooded residential area at Bayview Rd, then terminates at Phoebe Ln in Chatham.	9.1	16.3

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
118	The transect crosses beach & dunes into residential area where it terminates at Wadsworth Rd and Pleasant St intersection in Chatham.	9.1	16.5
119	The transect crosses Red River Beach & 3' seawall, extends into estuary, reaches residential area at Uncle Venies Rd, crosses Skinnequit Pond and terminates in wooded area before Route 28 in Harwich.	9.1	17.0
120	The transect crosses beach and dunes, extending into residential area terminating at Walther Rd in Harwich.	9.1	16.2
121	The transect crosses Bank St Beach & dunes, extends into residential area at Bayview Rd, terminates at Snow Inn Rd/Bay Ln intersection in Harwich.	9.1	16.5
122	The transect crosses Bank St Beach and 10' revetment, and extends into dense residential at the Campground area in Harwich, runs parallel along Central Ave and terminates between Union and Grove St.	9.1	17.5

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
123	The transect crosses beach & dunes into residential area at Dunes Rd, crosses Doanes Creek and extends through residential area, intersects with Hwy 28 and terminates at Great Western Rd in Harwich.	9.1	16.4
124	The transect crosses 6' revetment at Pleasant Rd Beach, extends into dense residential area at Shore Rd, intersects with US 28 extending across marshland, terminates just after crossing East Reservoir in Harwich.	9.1	17.2
125	The transect crosses dunes into dense residential area at Shore Rd, continues past US 28 and extends across marshland area and crossing Herring River at several points, terminates just after crossing East reservoir in Harwich.	9.1	16.2
126	The transect crosses beach and 5' Seawall into residential area at Chase Ave, then terminates at Georgias Way in Dennis.	9.1	17.8
127	The transect crosses beach & 15' revetment into residential area at Old Wharf Rd, terminates just past Old Wharf Rd in Dennis.	9.1	18.2

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
128	The transect crosses Glendon Rd Beach into dense residential area, crosses conservation area after Route 28, and extends over Swan Pond before terminating at Whistler Lane in Dennis.	9.1	16.3
129	The transect crosses Haigis Beach & 10' revetment into dense residential area, extending across marshland after Route 28, then crosses Swan River, terminating West of Swan Pond past Searsville Rd in Dennis.	9.1	17.9
130	The transect crosses a barrier dune at the mouth of Swan Pond River and runs along river & surrounding marsh, intersects with Lower County Rd and Main St, terminating in sparse residential west of Swan Pond in Dennis.	9.1	15.6
131	The transect crosses beach and dunes and enters dense residential area at Lanyard Ln, intersects with Lower County Rd crosses marsh area before intersecting residential area and terminating at Trotting Park Rd in Dennis.	9.1	16.6
132	The transect crosses Davis Beach and extends across a backwater marsh, intersects a 5' Seawall into dense residential area, then terminates at Chase Ave in Dennis.	9.1	15.7

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
133	The transect crosses dunes at Davis Beach in Dennis and extends across Bass River and Stage Island, then continues through sparse residential before terminating just south of State Hwy 28 in Yarmouth.	9.1	16.0
134	The transect crosses Bass River Beach and dunes into resort area at Shore Dr, continues through dense residential area before terminating near Main St in Yarmouth.	9.1	16.5
135	The transect crosses Thachers Beach and 4' revetment into dense residential area, then crosses Parkers River into marsh before re-entering dense residential area and intersecting with Main St, transect terminates at Arbutus Path in Yarmouth.	9.1	16.6
136	The transect crosses Sea Gull Beach and dunes before crossing over Lewis Pond inlet, then enters dense residential area at Iroquois Blvd, intersects with Main St and terminates at Joshua Baker Rd in Yarmouth.	9.1	16.1
137	The transect crosses Sea Gull Beach and dunes, extends into dense residential area at Powers Lane, crosses Lewis Pond before entering dense residential area at Sea Ave, then terminates just past Acadia Rd in Yarmouth.	9.1	16.3

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TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
138	The transect crosses 10' revetment into wooded residential area, terminates just after intersecting with Great Island Rd in Yarmouth.	9.1	17.7
139	The transect crosses beach and dunes and into wooded residential area, terminates at Smith Point Rd Yarmouth.	9.4	16.8
140	The transect crosses beach & 7' revetment into dense residential area at Hedge Row, terminates at Berwyn Ave in Yarmouth.	9.4	15.4
141	The transect crosses dunes at Dunbar Pt in Barnstable, extends across Lewis Bay crossing 4' revetment at dense residential area at Glenwood St, crosses marsh area at Mill Pond and terminates North of Route 28 in Yarmouth.	9.4	16.5
142	The transect crosses beach & 6' Seawall into residential area at Hawes Ave, extends up Snows Creek and over residential area South of Hyannis, crosses Hyannis Inner Harbor, and terminates at Lewis Bay Rd in Hyannis.	9.4	18.7
143	The transect crosses Keyes Memorial Beach, over dunes, and up Stewarts Creek, continues past Twin Brooks Golf Course and terminates at Sports Club before Scudder Ave in Barnstable.	9.4	16.7

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[2]North American Vertical Datum 1988

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
144	The transect crosses beach & dunes into a dense residential area at Irving Ave, then terminates at Washington Ave in Barnstable.	9.4	17.1
145	The transect crosses beach & bluff at Squaw Island, then extends across estuary area before terminating in residential area at Ocean Dr in Barnstable.	9.4	17.7
146	The transect crosses Coville Beach and dune area, intersects wooded residential area at Irving St, and terminates just past Harbor View St in Barnstable.	9.7	18.1
147	The transect crosses Long beach barrier dunes, intersects Centerville River then crosses into dense residential area at Main St, crosses Scudder Bay and terminates before Falmouth Rd in Barnstable.	9.7	18.0
148	The transect crosses barrier dunes at Dowses Beach, crosses East Bay, then intersects marshland and sparse residential area before terminating next to Caillouet Ln in Barnstable.	9.7	17.5

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
149	The transect crosses Wianno Beach and 10' revetment, extends into dense residential area at Seaview Ave, crosses Crystal Lake, and terminates near golf course after intersecting with Parker Rd in Barnstable.	9.7	19.3
150	The transect crosses a 10' Seawall and extends into wooded residential area at Seaview Ave, it then terminates near Park Rd and Leonard Dr in Barnstable.	10.1	19.4
151	The transect crosses beach, dunes, and extends into residential area at Seaview Ave, then crosses West Bay, Little Island, and North Bay, it then terminates at Dam Pond in Barnstable.	10.1	18.0
152	The transect crosses dunes at Sampsons Island then crosses the Seapuit River before entering residential area and terminating at Grand Island Dr in Barnstable.	10.1	18.6
153	The transect crosses dunes at Sampsons Island, spans across Cotuit Bay into sparse residential area, terminates among wooded residential area at Hummock Ln in Barnstable.	10.1	17.2

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
154	The transect crosses beach and dunes into sparse residential area at Cotuit Highlands, intersects with Main St and continues through residential area, terminates at intersection of Oak St and Cherry St in Barnstable.	10.1	18.5
155	The transect crosses beach and 3' seawall into wooded residential area, it then terminates at Vineyard Rd in Barnstable.	10.1	18.7
156	The transect crosses barrier dunes at Popponesset Beach before continuing across Popponesset Bay, enters dense residential area at Mashpee Neck and terminates at Buccaneer Way in Mashpee.	10.1	17.2
157	The transect crosses Popponesset Beach and 3.5' seawall into dense residential area, terminates at Uncle Edwards Dr in Mashpee.	10.1	19.1
158	The transect crosses beach and dunes and intersects with Shore Dr before crossing Dean Pond into residential area, runs parallel to Elizabeth island Rd and terminates before Nashawena Rd in Mashpee.	10.1	18.0
159	The transect crosses beach and 25' revetment built into bluff, then crosses into residential area where it terminates at Triton Way in Mashpee.	10.1	22.3

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
160	The transect crosses South Cape Beach and dunes, extends up wooded area of Great Neck for half a mile, enters dense residential neighborhood where it continues until terminating at Topping Lift in Mashpee.	10.1	17.6
161	The transect crosses beach and dunes on Washburn Island in Falmouth, continues across Waquoit Bay before intersecting 12' revetment at a residential area, runs across Hambian pond, through wooded residential area, ends at Red Brook Rd in Mashpee.	10.1	16.9
162	The transect crosses beach and bluff, and into wooded residential area, crosses Whistlers Way and part of Bog Pond before it terminates near Bourne Pond in Falmouth.	10.1	19.4
163	The transect intersects offshore barrier dune at Washburn Island, crosses over Eel pond, crosses a 5' revetnment at Seacoast Shores Blvd, extends through dense residential area, passing through estuary and terminating at Debbie Lane in Falmouth.	10.1	17.6
164	The transect crosses beach and dunes, continues through residential area of Davisville and terminates just past Captain Davis Ln in Falmouth.	10.1	17.4

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
165	The transect crosses beach and 9' revetment following Davis Neck Rd into residential neighborhood, continues through residential area, terminates near Seashell Ln in Falmouth.	10.1	19.8
166	The transect extends over 6' seawall into low-lying residential area at Acapesket, crosses over Great Pond, ending at residential area at Great bay St in Falmouth.	10.1	18.7
167	The transect extends over beach and 4' seawall, extending into residential area of Falmouth Heights landward of Grand Ave.	10.1	19.4
168	Transect extends over steep bluff reinforced with a 5 foot seawall, ending at Crown Ave in Falmouth Heights.	10.1	22.5
169	The transect extends over 7' revetment through residential area at Grand Ave, over Falmouth Inner Harbor, and into the center of Falmouth.	10.1	19.7
170	The transect crosses over 6' dunes at Falmouth Beach, extending into low-lying residential area, through Siders Pond.	10.1	17.5

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	ELEVATION (feet NAVD 88[2]) MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
171	The transect crosses small dunes with residential development at Falmouth Beach, extends over Salt Pond and up to residential area near Woods Hole Rd in Falmouth.	10.1	17.6
172	The transect crosses mixed shoreline and small dune then extends into residential wooded upland, terminating at Oyster Pond Rd in Falmouth.	10.1	18.9
173	The transect extends over 12' Revetment and up steep bluff at Nobska Lighthouse.	10.1	20.8
174	The transect extends over 6' revetment at Juniper Point in Falmouth.	10.1	19.7
175	The transect extends over 8 ft seawall crossing through large buildings in downtown Woods Hole; extends over Eel Pond, then terminates by Buzzards Bay Ave in Falmouth.	10.1	16.5
176	The transect extends over 12' revetment, crosses into residential area at Penzance Point, and ends by Penzance Rd in Falmouth.	12.1	23.4
177	The transect extends over 4' seawall into residential area by Gosnold Rd; terminates in Woods Hole.	12.1	21.1

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
178	The transect extends over 12' Revetment, up steep bluff, and over residential area by Gardiner Rd in Falmouth.	12.1	23.4
179	The transect extends over revetment at Racing Beach Ave, then crosses low lying marshy area into residential area by Widgeon Rd in Falmouth.	13.1	23.5
180	The transect extends over 15' revetment at shoreline, crossing over condo complex and into residential area by Sippewissett Rd Falmouth.	13.1	26.3
181	The transect extends over dunes at Wood Neck Beach then crosses backwater marsh, terminating at residential area at Maker Ln in Falmouth.	13.1	22.3
182	The transect extends over large dunes at Back Beach, crosses the Great Sippewisset Marsh, and terminates East of Route 28A in a wooded residential area.	13.1	23.3
183	The transect crosses a 10' seawall at Chappaquoit Beach, extends over Chappaquoit Rd, into dune area and over backwater estuary area, ending at a wooded residential area East of Route 28.	13.1	22.8

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
184	The transect crosses a 12' revetment at shoreline, extends over Chappaquoit residential area, and ends at Associates Rd.	13.1	23.9
185	The transect crosses beach and dunes, extending into residential area off of Jetty Ln in Falmouth.	13.1	22.6
186	The transect crosses a 15' revetment at Old Silver Beach and extends into residential area at Temset Rd and Santuit Rd in Falmouth.	13.1	22.9
187	The transect crosses 10' seawall at Wild Harbor, extends over residential area crossing Moses Rd and West Ave, extends inland over low-lying area, crossing Rands Harbor, ends at Brainerd Rd in Falmouth.	13.1	21.7
188	The transect crosses a 15' revetment at Sunset Point. Extends over residential area back to Westwood Rd in Falmouth.	13.1	23.7
189	The transect crosses 5' revetment West of Fiddlers Cove, intersects a residential area by Waterside Dr, then ends past Highcrest Rd in Falmouth.	13.1	21.2

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
190	The transect crosses an offshore dune at Megansett Harbor, extends into residential area by the intersection of Squeteague Harbor Rd and Mystery Ln, terminates at Squeteague Harbor Rd in Bourne.	13.2	21.9
191	The transect extends over a sandy beach and into a wooded residential area of Scraggy Neck. Terminates at Rams Head Rd in Bourne.	13.2	22.7
192	The transect crosses over an offshore barrier dune at Bassetts Island, crosses 8' revetment at the end of Handy Pt, then ends at Elgin Rd in Bourne.	13.7	21.5
193	The transect extends over a beach at Hen Cove, crossing intersection of Circuit Ave and Saco Ave, ending in a dense residential area.	13.7	18.2
194	The transect extends over a 15' revetment at a steep bluff at Wing's Neck Lighthouse and terminates in a wooded area past row of houses.	13.7	25.3
195	The transect crosses a 7' seawall at shoreline extending over a dense residential area at Wenaumet Bluff Dr; transect parallells N Shore Rd and ends past Mariners Ln in Bourne.	13.9	20.7

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

TRANSECT	LOCATION	ELEVATION (feet NAVD 88[2]) 1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
196	The transect crosses a sand bar at Tobys Island, crosses backwater area, and extends over Briarwood Ln and Shore Rd, and ends in wooded area East of Railroad tracks.	13.9	22.9
197	The transect crosses the shoreline at the Monument Beach area, extending over a 6' seawall, crossing a residential area, and ending at Chapel Ave in Bourne.	13.9	19.9
198	The transect crosses a 12' revetment at shoreline of Mashnee Island, then extends up steep bluff at intersection of Captains Row and Mashnee Rd, ending in a dense residential area at top of bluff.	13.9	27.1
199	The transect extends over a 4' seawall, crosses into residential area at Benedict Rd, over backwater cove, then terminates at Warren Rd in Bourne.	13.9	18.3
200	The transect crosses an 8' revetment at Massachusetts Maritime Academy, extends through low lying residential area, follows Main St in Buzzards Bay, then terminates South of Route 6.	13.9	24.5

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

TABLE 9 – TRANSECT DESCRIPTIONS – 2013 COASTAL STUDY - continued

		ELEVATION (feet NAVD 88[2])	
TRANSECT	LOCATION	1-PERCENT-ANNUAL-CHANCE STILLWATER[1]	MAXIMUM 1-PERCENT ANNUAL CHANCE WAVE CREST[1]
201	The transect crosses the Eastern shore of Buttermilk Bay, at a steep bluff rising to the intersection of Lewis Point Rd and Nye Ln in Bourne.	13.8	19.2
202	The transect crosses a steep bluff reinforced with revetment at Buttermilk Bay, and intersects an area of dense cottages off of Head of the Bay Rd in Bourne.	13.8	20.0

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

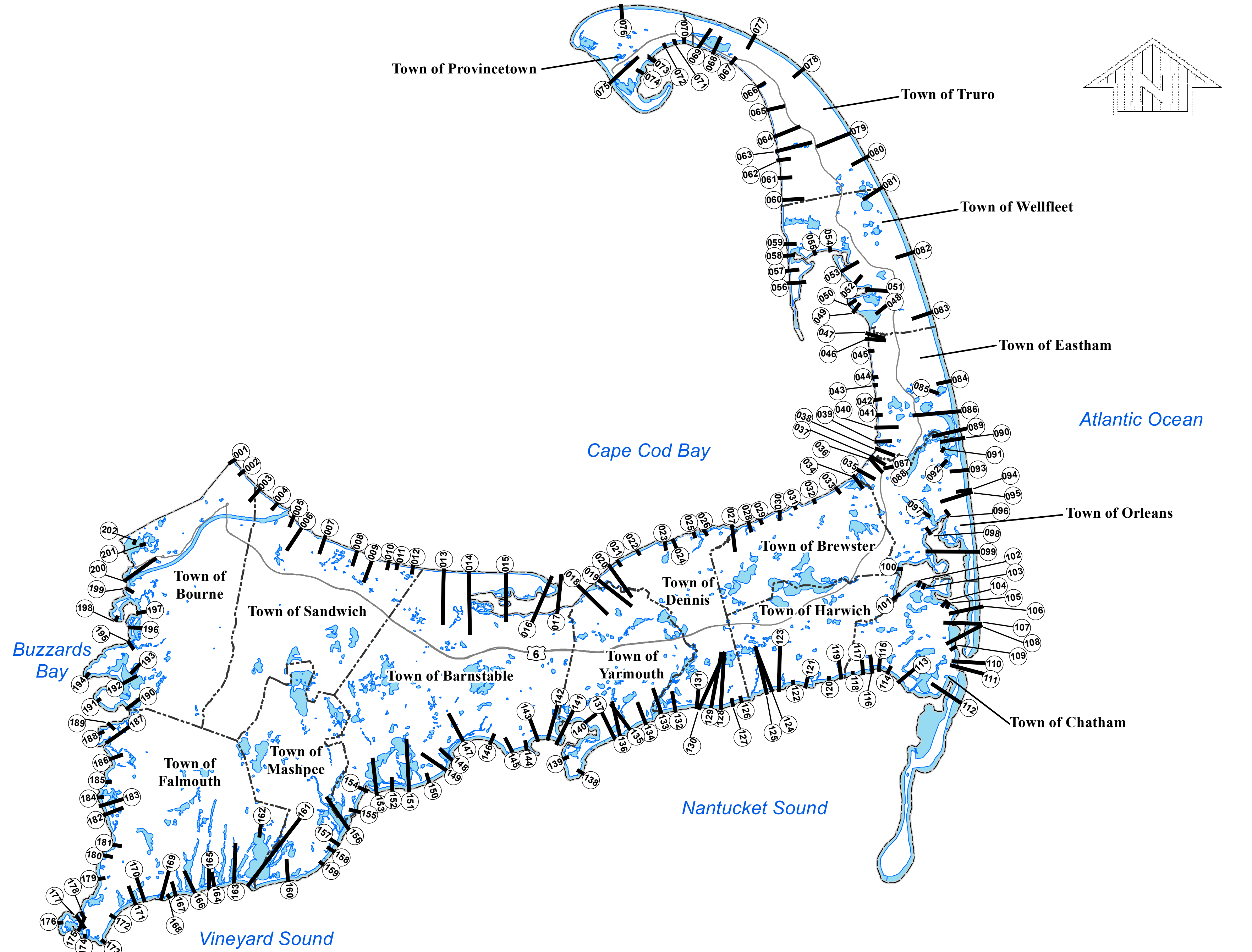

FIGURE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY

BARNSTABLE COUNTY, MA

(ALL JURISDICTIONS)

APPROXIMATE SCALE

0 5 10 15 20 25 Miles

TRANSECT LOCATION MAP

The results of the coastal analysis using detailed methods are summarized in Table 10, "Transect Data – 2013 Coastal Study," 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 10 – TRANSECT DATA – 2013 COASTAL STUDY

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])
001	8.7	9.6	9.9	10.6	14.7	VE	17
002	8.7	9.6	9.9	10.6	14.4	VE	16
003	8.2	9.1	9.5	10.5	13.6	VE	16
						AE	14-16
004	8.2	9.1	9.5	10.5	13.7	VE	15
						AE	14
005	8.4	9.4	9.6	10.7	13.7	VE	16
006	8.4	9.4	9.6	10.7	13.5	VE	16
						AE	10-15
007	8.4	9.4	9.6	10.7	13.3	VE	15
						AE	14-15
008	8.4	9.4	9.6	10.7	13.6	VE	16
						AE	14
009	8.4	9.4	9.7	10.7	13.6	VE	16
						AE	14-15

*Data not available

[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
010	8.4	9.4	9.7	10.7	14.4	VE	21
011	8.4	9.4	9.7	10.7	14.2	VE	16
012	8.4	9.4	9.7	10.7	13.6	VE	16
						AE	14
013	8.6	9.6	9.9	10.9	12.6	VE	15
						AE	13-15
014	8.8	9.8	10.1	11.1	12.7	VE	15
						AE	13-15
015	8.8	9.8	10.1	11.1	12.7	VE	15
						AE	13-15
016	8.8	9.8	10.1	11.1	11.9	VE	14
							12
017	8.8	9.8	10.1	11.1	11.1	VE	13
						AE	12-13
018	8.9	9.9	10.3	11.3	11.9	VE	14
						AE	12
019	9.0	10.0	10.3	11.5	12.2	VE	14-16
						AE	12-14

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - continued

	STILLWATER ELEVATIONS (FEET NAVD88[3])						
TRANSECT	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])
020	9.0	10.0	10.3	11.5	13.7	VE	15-16
						AE	14-15
021	9.0	10.0	10.3	11.5	12.7	VE	15
022	9.0	10.0	10.3	11.5	14.0	VE	16
023	9.0	10.0	10.3	11.5	13.1	VE	15
						AE	13
024	9.0	10.0	10.3	11.5	13.2	VE	15
						AE	13
025	9.0	10.0	10.3	11.5	14.5	VE	17
026	9.2	10.2	10.5	11.5	13.1	VE	15
027	9.2	10.2	10.5	11.5	12.5	VE	15
						AE	13
028	9.6	10.6	10.9	12.0	12.8	VE	15
029	9.6	10.6	10.9	12.0	12.8	VE	15
030	9.6	10.6	10.9	12.0	12.6	VE	15
031	9.6	10.6	10.9	12.0	12.7	VE	15

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
032	9.6	10.6	10.9	12.0	14.4	VE	17
033	9.6	10.6	10.9	12.0	12.7	VE	15
						AE	13
034	9.6	10.6	10.9	12.0	12.8	VE	16
						AE	13
035	9.4	10.4	10.7	11.8	13.3	VE	16
						AE	13
036	9.4	10.4	10.7	11.8	12.5	VE	15-16
						AE	13-16
037	9.4	10.4	10.7	11.8	15.0	VE	17
						AE	15-16
038	8.9	9.9	10.2	11.2	12.0	VE	15
						AE	13
039	8.9	9.9	10.3	11.2	12.4	VE	14
						AE	13
040	8.9	9.9	10.2	11.2	12.5	VE	15
						AE	13-14
041	8.9	9.9	10.2	11.2	13.1	VE	19

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
042	8.9	9.9	10.2	11.2	12.4	VE	15
						AE	14
043	8.9	9.9	10.2	11.2	13.0	VE	19
044	8.9	9.9	10.2	11.2	13.2	VE	14
045	8.9	9.9	10.2	11.2	13.4	VE	17
						AE	13
046	8.9	9.9	10.2	11.2	11.9	VE	14-15
						AE	13-14
047	8.9	9.9	10.2	11.2	12.6	VE	15
						AE	12-14
048	9.4	10.4	10.7	11.7	13.0	VE	15
						AE	14-15
049	9.4	10.4	10.7	11.7	12.5	VE	15
						AE	14
050	9.4	10.4	10.7	11.7	14.2	VE	24
051	9.4	10.4	10.7	11.7	12.3	VE	15
						AE	14
052	9.4	10.4	10.7	11.7	13.9	VE	18
						AE	15

*Data not available

[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
053	9.4	10.4	10.7	11.7	12.7	VE	28
						AE	13
054	9.1	10.1	10.4	11.4	13.5	VE	15
						AE	13
055	9.1	10.1	10.4	11.4	13.5	VE	16
						AE	14
056	9.1	10.1	10.4	11.4	12.5	VE	15
						AE	14
057	9.1	10.1	10.4	11.4	13.2	VE	17
058	9.1	10.1	10.4	11.4	12.7	VE	15
						AE	14
059	9.1	10.1	10.4	11.4	12.9	VE	17
060	8.9	9.7	10.2	11.0	12.4	VE	15
						AE	13-14
061	8.9	9.7	10.2	11.0	12.8	VE	16
062	7.9	8.7	9.1	10.7	11.6	VE	14
						AE	12
063	8.2	9.0	9.4	10.7	10.7	VE	13
						AE	12-13

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
064	8.2	9.0	9.4	10.7	11.4	VE	13
						AE	12-13
065	8.2	9.0	9.4	10.7	11.9	VE	15
066	8.2	9.0	9.4	10.1	12.2	VE	14
067	8.2	9.0	9.4	10.4	11.7	VE	14
						AO	2
						AE	12
068	8.2	9.0	9.4	10.4	13.0	VE	15
						AO	1
						AE	13-15
069	8.2	9.0	9.4	10.4	11.8	VE	14
						AE	12-13
075	7.2	8.0	9.2	12.5	11.5	VE	14
						AE	9-12
076	7.2	8.0	9.2	12.5	12.2	VE	16
						AE	12
077	6.9	8.2	9.1	11.6	13.0	VE	15
							14-15
078	6.9	8.2	9.1	11.6	13.8	VE	16

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
079	7.0	7.9	9.1	12.4	13.4	VE	16-17
						AE	14-15
080	7.0	7.9	9.1	12.4	13.4	VE	16
081	6.3	7.5	9.1	13.4	13.5	VE	16
082	6.7	7.5	9.1	13.6	14.2	VE	16
083	6.7	7.5	9.1	13.6	12.9	VE	16
084	6.7	7.5	9.1	13.6	13.2	VE	15
						AE	14
085	6.7	7.5	9.1	13.6	9.6	VE	12
086	6.7	7.5	9.1	13.6	12.6	VE	15
						AE	13
087	5.7	7.6	9.2	13.7	10.3	VE	13
						AE	10-12
088	5.7	7.6	9.2	13.7	10.0	VE	12
						AE	10
089	5.7	7.6	9.2	13.7	13.1	VE	15
						AE	11-13

*Data not available

[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
090	5.7	7.6	9.2	13.7	12.8	VE	13-15
						AE	11-13
091	5.6	7.5	9.2	13.6	10.8	VE	13
092	5.6	7.5	9.2	13.6	9.9	VE	12
						AE	10-11
093	5.6	7.5	9.1	13.6	13.1	VE	15
						AE	13-14
094	5.6	7.5	9.1	13.6	12.6	VE	13-14
095	5.6	7.5	9.1	13.6	12.7	VE	15
						AE	14-15
096	3.9	5.9	11.4	14.2	11.7	VE	12
097	4.1	6.1	11.8	14.4	12.9	VE	16
098	3.9	5.9	11.4	14.2	13.8	VE	30
099	5.1	7.6	9.1	13.6	13.3	VE	15-16
						AE	13-14
100	3.8	5.8	11.0	14.1	12.8	VE	18
101	8.8	12.4	13.9	17.0	15.7	VE	18

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
102	5.8	8.6	10.8	14.1	12.7	VE	28
103	5.8	8.6	10.8	14.1	12.5	VE	19
104	3.8	5.8	10.1	14.1	10.9	VE	13
						AE	11-12
105	3.8	5.8	10.1	14.1	11.9	VE	26
106	3.8	5.8	9.1	14.1	13.8	VE	19
						AE	14
107	5.1	7.6	9.1	13.6	12.8	VE	15
108	5.1	7.6	9.1	13.6	12.7	VE	15
						AE	13
109	5.8	8.6	9.5	14.1	10.8	VE	22
110	5.1	7.6	9.1	13.6	13.4	VE	19
111	5.1	7.6	9.3	13.6	12.3	VE	18
112	5.1	7.6	9.1	13.6	12.7	VE	15
						AE	11-13
113	4.9	7.5	9.1	13.9	11.3	VE	15
						AE	11

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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	4.9	7.5	9.1	13.9	11.5	VE	15
115	4.9	7.5	9.1	13.9	11.1	VE	14
						AE	11
116	4.9	7.5	9.1	13.9	11.9	VE	13-14
						AE	11-12
117	4.9	7.5	9.1	13.9	10.8	VE	13
118	4.9	7.5	9.1	13.9	10.9	VE	13
119	4.9	7.5	9.1	13.9	11.3	VE	13
						AE	11-12
120	4.9	7.5	9.1	13.9	10.8	VE	14
121	4.9	7.5	9.1	13.9	10.9	VE	13
						AE	12
122	4.9	7.5	9.1	13.9	11.6	VE	16
123	4.9	7.5	9.1	13.9	10.9	VE	13
						AE	11-12
124	4.9	7.5	9.1	13.9	11.4	VE	14
						AE	11-13
125	4.9	7.5	9.1	13.9	10.8	VE	13
						AE	11-13

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - continued

	STILLWATER ELEVATIONS (FEET NAVD88[3])						
TRANSECT	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])
126	4.9	7.5	9.1	13.9	11.9	VE	14
127	4.9	7.5	9.1	13.9	12.1	VE	15
128	4.9	7.5	9.1	13.9	10.8	VE	13
						AE	10-12
129	4.9	7.5	9.1	13.9	11.9	VE	15
						AE	10-12
130	4.9	7.5	9.1	13.9	10.4	VE	12-14
						AE	10-12
131	4.9	7.5	9.1	13.9	11.1	VE	13
						AE	11-12
132	4.9	7.5	9.1	13.9	10.4	VE	13
						AE	10
133	4.9	7.5	9.1	13.9	10.6	VE	13
						AE	11
134	4.9	7.5	9.1	13.9	10.9	VE	13
						AE	11
135	4.9	7.5	9.1	13.9	11.1	VE	13
						AE	11-13

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
136	4.9	7.5	9.1	13.9	10.7	VE	13-14
						AE	11-13
137	4.9	7.5	9.1	13.9	10.8	VE	13-14
						AE	11-13
138	4.9	7.5	9.1	13.9	11.8	VE	15
139	4.7	7.8	9.4	14.2	11.3	VE	13
140	4.7	7.8	9.4	14.2	11.1	VE	13
						AE	11
141	4.7	7.8	9.4	14.2	10.9	VE	13
						AE	11-12
142	4.7	7.8	9.4	14.2	12.2	VE	14
						AE	11-13
143	4.7	7.8	9.4	14.2	11.1	VE	13-15
						AE	11-13
144	4.7	7.8	9.4	14.2	11.3	VE	13-14
						AE	11
145	4.7	7.8	9.4	14.2	11.7	VE	14-15
						AE	12-13
146	4.6	7.9	9.7	14.5	12.1	VE	14-16
						AE	12

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
147	4.6	7.9	9.7	14.5	11.9	VE	14-16
						AE	12-13
148	4.6	7.9	9.7	14.5	11.6	VE	14-16
						AE	12
149	4.6	7.9	9.7	14.5	12.8	VE	16
150	4.5	8.1	10.1	14.9	12.9	VE	15
						AO	2
						AE	13
151	4.5	8.1	10.1	14.9	11.9	VE	14-15
						AE	12-13
152	4.5	8.1	10.1	14.9	12.4	VE	14-16
153	4.5	8.1	10.1	14.9	11.4	VE	14-16
154	4.5	8.1	10.1	14.9	12.3	VE	15-16
						AE	12
155	4.5	8.1	10.1	14.9	12.4	VE	17
156	4.5	8.1	10.1	14.9	11.4	VE	14-17
						AE	11
157	4.5	8.1	10.1	14.9	12.7	VE	16
						AE	12

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - continued

	STILLWATER ELEVATIONS (FEET NAVD88[3])						
TRANSECT	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])
158	4.5	8.1	10.1	14.9	11.9	VE	14
						AE	12
159	4.5	8.1	10.1	14.9	14.3	VE	23
160	4.5	8.1	10.1	14.9	11.7	VE	14
						AE	12
161	4.5	8.1	10.1	14.9	11.3	VE	13-14
						AE	10-13
162	4.5	8.1	10.1	14.9	13.0	VE	20
						AE	11
163	4.5	8.1	10.1	14.9	11.7	VE	14
						AE	12-13
164	4.5	8.1	10.1	14.9	11.6	VE	14
						AE	12
165	4.5	8.1	10.1	14.9	13.2	VE	15
						AE	13
166	4.5	8.1	10.1	14.9	12.4	VE	15
						AE	13-14
167	4.5	8.1	10.1	14.9	13.0	VE	15
						AE	13-14

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
168	4.5	8.1	10.1	14.9	13.8	VE	16
169	4.5	8.1	10.1	14.9	13.3	VE	15
						AE	13-15
170	4.5	8.1	10.1	14.9	11.7	VE	15-16
						AE	12-13
171	4.5	8.1	10.1	14.9	11.7	VE	15-16
						AE	12-13
172	4.5	8.1	10.1	14.9	12.6	VE	15
173	4.5	8.1	10.1	14.9	13.9	VE	16
174	4.5	8.1	10.1	14.9	13.3	VE	15
175	4.5	8.1	10.1	14.9	10.8	VE	15
						AE	12-14
176	7.0	10.6	12.1	15.7	15.7	VE	18
						AE	16-17
177	7.0	10.6	12.1	15.7	14.4	VE	16
						AE	13-14
178	7.0	10.6	12.1	15.7	15.0	VE	23

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - continued

	STILLWATER ELEVATIONS (FEET NAVD88[3])						
TRANSECT	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])
179	8.3	11.7	13.1	16.3	15.8	VE	18-20
						AE	15
180	8.3	11.7	13.1	16.3	17.7	VE	25
181	8.3	11.7	13.1	16.3	15.0	VE	17-20
						AE	15
182	8.3	11.7	13.1	16.3	15.7	VE	18-21
						AE	16-18
183	8.3	11.7	13.1	16.3	15.3	VE	18-21
						AE	15-17
184	8.3	11.7	13.1	16.3	16.1	VE	19-20
						AE	17
185	8.3	11.7	13.1	16.3	15.2	VE	17-20
						AE	16
186	8.3	11.7	13.1	16.3	15.4	VE	19
						AE	15-16
187	8.3	11.7	13.1	16.3	14.5	VE	17-18
						AE	15-17
188	8.3	11.7	13.1	16.3	15.9	VE	18

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - 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])
189	8.3	11.7	13.1	16.3	14.4	VE	17
						AE	14
190	8.3	11.8	13.2	16.4	14.7	VE	17-20
191	8.3	11.8	13.2	16.4	15.3	VE	17-20
						AE	17
192	8.7	12.2	13.7	16.8	14.8	VE	17-20
193	8.7	12.2	13.7	16.8	14.3	VE	16
194	8.7	12.2	13.7	16.8	17.1	VE	20
						AE	17
195	8.7	12.3	13.9	17.0	15.1	VE	17
						AE	15
196	8.7	12.3	13.9	17.0	15.9	VE	18-22
197	8.7	12.3	13.9	17.0	14.9	VE	18
						AE	15
198	8.7	12.3	13.9	17.0	18.3	VE	22
199	8.7	12.3	13.9	17.0	14.5	VE	17-18
						AE	15

*Data not available
[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 1988

TABLE 10 – TRANSECT DATA – 2013 COASTAL STUDY - continued

STILLWATER ELEVATIONS (FEET NAVD88[3])

TRANSECT	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])
200	8.7	12.3	13.9	17.0	16.5	VE	18-20
						AE	16-17
201	8.7	12.3	13.8	17.0	15.3	VE	20
202	8.7	12.3	13.8	17.0	16.5	VE	19

*Data not available
[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 1988

3.3 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. Previously, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

Unless otherwise stated, all flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD 88. 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 NGVD 29 by applying a standard conversion factor. The conversion factor from NGVD 29 to NAVD 88 is -0.9 (NGVD – 0.9 = NAVD 88).

For information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

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

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

The BFEs shown on the FIRM represent whole-foot rounded values. For example, a BFE of 102.4 will appear as 102 on the FIRM and 102.6 will appear as 103. Therefore, users that wish to convert the elevations in this FIS to NGVD 29 should apply the stated conversion factor to elevations shown on the 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.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

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

4.1 Floodplain Boundaries

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

The coastal flood hazard data was performed for open water flooding source of Cape Cod Bay in the community of Provincetown (Reference 40) and for open water flooding sources within the communities of Barnstable, Bourne, Brewster, Chatham, Dennis, Eastham, Falmouth, Harwich, Mashpee, Orleans, Provincetown (Atlantic Ocean), Sandwich, Truro, Wellfleet, and Yarmouth (Reference 58).

To provide a national standard without regional discrimination, the 1-percent-annual-chance (100-year) flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance (500-year) flood is employed to indicate additional areas of flood risk in the community. For tidal areas without wave action, the l-percent-annual-chance and 0.2-percent-annual-chance boundaries were delineated using 2 foot contour intervals developed from LiDAR data (Reference 58). For the tidal areas with wave action, the flood boundaries were delineated wing the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used.

The approximate studied areas were delineated using the previous FISs for all communities of Barnstable County. The shallow flooding areas in the Town of Eastham were delineated using aerial maps (Reference 60).

In the Town of Bourne, approximate floodplain boundaries for Great Herring Pond were taken from the previous printed FIS for the Town of Plymouth (Plymouth County) and delineated using topographic maps (References 61 and 62). For the remaining flooding sources studied by approximate methods, the 1-percent-annual-chance floodplain boundaries were taken from the previously printed FIS for the Town of Bourne (Reference 2).

In the Town of Sandwich, the flooding sources studied by approximate methods, designated as Zone X, are subject to 1-percent-annual-chance flooding with average depths of less than 1 foot, or where contributing drainage area is less than 1 square mile. Please note, however, that not all of the areas designated Zone X were studied by approximate methods; some of the areas were studied by detailed methods.

The coastline shown on the maps should not be associated with a particular elevation. This line is the shoreline at the time of the aerial photography from which the maps were prepared. The coastline shown on the maps is not mean sea level.

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM (Exhibit 1). On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, AO, and VE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

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

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the

1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. No floodways were calculated in Barnstable County.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS by detailed methods. In most instances, whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, and to areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 1-percent-annual-chance flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains where applicable.

This countywide FIRM presents flooding information for the geographic area of Barnstable County, as outlined in Section 1. Previously, FIRMs were prepared for each incorporated community identified as flood-prone. Historical data relating to the maps prepared for each community are presented in Table 11, "Community Map History."

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Barnstable, Town of	February 7, 1975	None	April 3, 1978	October 1, 1983 August 19, 1985 July 2, 1992
Bourne, Town of	June 29, 1973	None	June 29, 1973	July 1, 1974 January 2, 1976 May 7, 1976 June 5, 1985 July 15, 1992 August 9, 1999
Brewster, Town of	March 15, 1974	October 15, 1976 December 6, 1977 October 1, 1983	June 19, 1985	June 4, 1987 July 2, 1992 May 17, 1993
Chatham, Town of	May 31, 1974	February 7, 1978	August 1, 1980	October 1, 1983 April 17, 1985 January 16, 1992 July 20, 1998
Dennis, Town of	July 26, 1974	None	October 6, 1976	October 1, 1983 July 3, 1986 July 2, 1992
Eastham, Town of	March 22, 1974	August 13, 1976 October 1, 1983	July 3, 1986	July 2, 1992

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Falmouth, Town of	May 18, 1973	None	May 18, 1973	July 1, 1974 August 8, 1975 July 29, 1977 September 30, 1977 December 16, 1980 October 1, 1983 May 15, 1986 July 15, 1992 April 16, 1993
Harwich, Town of	July 19, 1974	October 22, 1976	September 30, 1980	May 15, 1985 December 3, 1991
Mashpee, Town of	August 2, 1974	None	September 15, 1978	October 1, 1983 June 5, 1985 May 17, 1990 July 2, 1992
Orleans, Town of	May 31, 1974	March 4, 1977 October 1, 1983	September 4, 1986	December 3, 1991 July 2, 1992
Provincetown, Town of	March 2, 1973	None	March 2, 1973	July 1, 1974 April 9, 1976 June 19, 1985 July 15, 1992

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

BARNSTABLE COUNTY, MA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE(S)	FLOOD INSURANCE RATE MAP EFFECTIVE DATE	FLOOD INSURANCE RATE MAP REVISION DATE(S)
Sandwich, Town of	January 14, 1977	March 28, 1978	June 18, 1980	October 1, 1983 July 3, 1985 August 5, 1991 July 2, 1992
Truro, Town of	April 20, 1973	None	April 20, 1973	July 1, 1974 December 12, 1975 July 3, 1985 July 15, 1992
Wellfleet, Town of	May 31, 1974	December 3, 1976	June 19, 1985	July 2, 1992
Yarmouth, Town of	October 18, 1974	None	May 2, 1977	October 1, 1983 June 17, 1986 July 2, 1992

TABLE 11

FEDERAL EMERGENCY MANAGEMENT AGENCY

BARNSTABLE COUNTY, MA (ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction included in this countywide Barnstable County FIS has been compiled in this FIS. Therefore, this FIS supersedes all previously printed FIS reports, FIRMs, and/or FHBMs for all of the incorporated jurisdictions within Barnstable County listed in Section 1 and should be considered authoritative for the purposes of the NFIP.

FISs have been prepared or are in the process of being prepared for the adjacent county of Plymouth, Massachusetts, and it is in agreement with this FIS.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA Region I, 99 High Street, 6th Floor, Boston, MA 02110.

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