

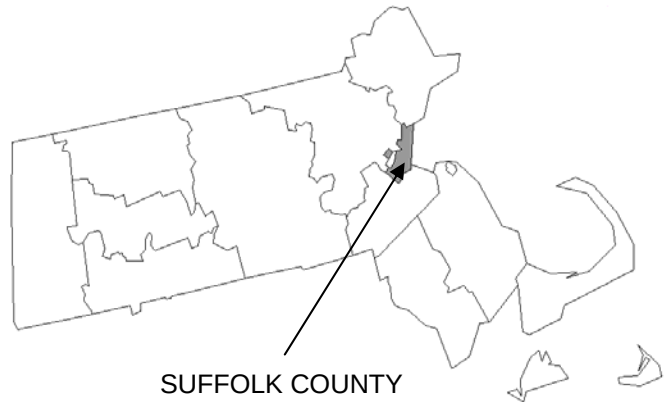
# FLOOD INSURANCE STUDY



## SUFFOLK COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

COMMUNITY NAME  
BOSTON, CITY OF  
CHELSEA, CITY OF  
REVERE, CITY OF  
WINTHROP, TOWN OF

COMMUNITY NUMBER  
250286  
250287  
250288  
250289



Effective Date: September 25, 2009

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER  
25025CV000A

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.

Selected Flood Insurance Rate Map panels for the community contain information that was previously shown separately on the corresponding Flood Boundary and Floodway Map panels (e.g., floodways, cross sections). In addition, former flood hazard zone designations have been changed as follows:

| <u>Old Zone</u> | <u>New Zone</u> |
|-----------------|-----------------|
| A1 through A30  | AE              |
| V1 through V30  | VE              |
| B               | X               |
| C               | X               |

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

Initial Countywide FIS Effective Date: September 25, 2009

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# FLOOD INSURANCE STUDY SUFFOLK COUNTY [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 Suffolk County, including the Cities of Boston, Chelsea, Revere and the Town of Winthrop; (referred to collectively herein as Suffolk 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. These criteria take precedence over the minimum federal criteria for purposes of regulating development in the floodplain, as set forth in the Code of Federal Regulations at 44 CFR, 60.3. 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.

Boston, City of:

The hydrologic and hydraulic analyses for the November 2, 1990 study represent a revision of the original October 1, 1983 analyses prepared by Harris-Toups Associates for the Federal Emergency Management Agency (FEMA), under Contract No. H-4024. The work for the original 1983 study was completed in November 1979. The hydrologic and hydraulic analyses for this updated 1990 study were prepared by Dewberry & Davis for FEMA, under Contract No. EMW-85-C-2044. This work was completed in December 1987.

|                    |                                                                                                                                                                                                                                                                                                                                    |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chelsea, City of:  | The hydrologic and hydraulic analyses for the original February 2, 1982 study were prepared by Anderson Nichols & Co., Inc., for FEMA, under Contract No. H-4524. This work was completed in May 1980.                                                                                                                             |
| Revere, City of:   | The hydrologic and hydraulic analyses for the original April 16, 1984, FIS report and the October 16, 1984, Revere FIRM (hereinafter referred to as the 1984 Revere FIS), were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772, Modification No. 5. That work was completed in April 1983. |
|                    | The hydrologic and hydraulic analyses for the August 20, 2002 revision were prepared by Roald Haestad, Inc., for FEMA, under Contract No. EMB-1999-CO-0564. This work was completed in November 2000.                                                                                                                              |
| Winthrop, Town of: | The hydrologic and hydraulic analyses for the original and revised February 15, 1984 FIS were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in January 1983.                                                                                                    |

For this countywide FIS, no new hydrologic or hydraulic analyses were performed.

Base map information shown on this FIRM was derived from digital orthophotography. Base map files were provided in digital form by Massachusetts Geographic Information System (MassGIS). Ortho imagery was produced at a scale of 1:5,000. Aerial photography is dated April 2005. The projection used in the preparation of this map was Massachusetts State Plane mainland zone (FIPSZONE2001). The horizontal datum was NAD 83, GRS80 spheroid.

### 1.3 Coordination

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

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

TABLE 1: CCO MEETING DATES FOR PRECOUNTYWIDE FISs

| <u>Community Name</u> | <u>Initial CCO Date</u> | <u>Intermediate CCO Date</u> | <u>Final CCO Date</u> |
|-----------------------|-------------------------|------------------------------|-----------------------|
| City of Boston        | April 13, 1987          | *                            | April 11, 1989        |
| City of Chelsea       | May 13, 1977            | July 27, 1980                | July 22, 1981         |
| City of Revere        | January 4, 2000         | *                            | August 28, 2001       |
| Town of Winthrop      | April 13, 1978          | December 13, 1979            | September 26, 1983    |

\* Data not Available

For this countywide revision, no initial CCO meeting was held. The results of the study were reviewed at the final CCO meetings held on December 17<sup>th</sup>, 2008 and January 14<sup>th</sup>, 2009, and were attended by representatives of FEMA, Massachusetts Department of Conservation and Recreation (DCR), CDM, Ocean & Coastal Consultants Inc. (OCC), and Suffolk County communities. All problems raised at that meeting have been addressed in this study.

## 2.0 AREA STUDIED

### 2.1 Scope of Study

This FIS report covers the geographic area of Suffolk County, MA including the incorporated communities listed in Section 1.1. The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction.

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

TABLE 2: FLOODING SOURCES STUDIED BY DETAILED METHODS

| <u>Flooding Source</u>    | <u>Description</u>                                                                  |
|---------------------------|-------------------------------------------------------------------------------------|
| Areas of shallow flooding | Along portions of Winthrop Parkway and Revere Beach Boulevard in the City of Revere |
| Atlantic Ocean            | For the entire coastline within the Town of Winthrop                                |
| Boston Harbor             | For the entire coastline within the Town of Winthrop                                |

TABLE 2: FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

| <u>Flooding Source</u> | <u>Description</u>                                                                                                                                                                                |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Broad Sound            | For its entire length within the Town of Winthrop                                                                                                                                                 |
| Charles River          | From upstream of the New Charles River Dam in the City of Boston to the City of Boston-Town of Dedham corporate limits                                                                            |
| Coastal Flooding       | For the entire coastline within the City of Revere, including its wave action from the Atlantic Ocean and the tidal portions of the Saugus, Chelsea, and Pine Rivers, as well as Belle Isle Inlet |
| Linden Brook           | From its confluence with Town Line Brook to the upstream corporate limits in the City of Revere                                                                                                   |
| Mill Creek             | From its confluence with the Chelsea River to approximately 5,400 feet upstream.                                                                                                                  |
| Mother Brook           | From its confluence with Neponset River to the City of Boston-Town of Dedham corporate limits.                                                                                                    |
| Muddy River            | From its confluence with Charles River to Willow Pond                                                                                                                                             |
| Neponset River         | From upstream of the dam at Lower Mills to the Boston-Dedham corporate limits                                                                                                                     |
| Stony Brook            | From upstream of the entrance to the Stony Brook culvert to Turtle Pond in the City of Boston.                                                                                                    |
| Tidal Flooding         | In the City of Chelsea, including its wave action from the Atlantic Ocean affecting the Island End River, the Mystic River, Boston Harbor, and the Chelsea River                                  |

TABLE 2: FLOODING SOURCES STUDIED BY DETAILED METHODS – cont'd

| <u>Flooding Source</u> | <u>Description</u>                                                       |
|------------------------|--------------------------------------------------------------------------|
| Town Line Brook        | From U.S. Route 1 to the upstream corporate limits in the City of Revere |

Portions of the Muddy River within the detailed study limits are referred to locally as the Back Bay Fens. Wherever referenced in this report, the name Muddy River shall be assumed to include the area known as the Back Bay Fens.

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

| <u>Flooding Source</u>              | <u>Community</u>          |
|-------------------------------------|---------------------------|
| Atlantic Ocean                      | Chelsea, Revere, Winthrop |
| Boston Harbor                       | Boston, Chelsea, Winthrop |
| Boston Inner Harbor                 | Boston                    |
| Broad Sound                         | Winthrop                  |
| Chandler's Pond Jamaica Pond        | Boston                    |
| Charles River                       | Boston                    |
| Chelsea River                       | Boston, Chelsea, Revere   |
| Chestnut Hill Reservoir             | Boston                    |
| Dorchester Bay                      | Boston                    |
| Island End River                    | Chelsea                   |
| Linden Brook                        | Revere                    |
| Mill Creek                          | Chelsea, Revere           |
| Mother Brook                        | Boston                    |
| Muddy River including Back Bay Fens | Boston                    |
| Mystic River                        | Boston, Chelsea           |
| Neponset River                      | Boston                    |
| Pines River                         | Revere                    |

TABLE 3: FLOODING SOURCES STUDIED BY APPROXIMATE METHODS – cont’d

| <u>Flooding Source</u>                 | <u>Community</u> |
|----------------------------------------|------------------|
| Saugus River                           | Revere           |
| Sawmill Brook                          | Boston           |
| Stony Brook                            | Boston           |
| Town Line Brook                        | Revere           |
| Unnamed Ponding Area near Genoa Street | Revere           |

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

| <u>Community</u> | <u>Case Number</u> | <u>Flooding Source</u>              | <u>Letter Date</u> |
|------------------|--------------------|-------------------------------------|--------------------|
| Boston, City of  | 04-01-013P         | Massachusetts Bay/<br>Boston Harbor | 07/09/2004         |
| Boston, City of  | 08-01-1020P        | Dorchester Bay                      | 12/05/2008         |
| Revere, City of  | 07-01-0489P        | Broad Sound                         | 09/20/2007         |

For this countywide revision, the 1- and 0.2-percent-annual-chance floodplain boundaries for the Atlantic coastline in Suffolk County were redelineated using more up to date topographic information, including MassGIS and LiDAR data, which meets the accuracy standards for flood hazard mapping (<https://www.mass.gov/mgis/> and <https://maps.csc.noaa.gov.TMC/>). No new detailed or approximate studies were performed.

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

## 2.2 Community Description

Suffolk County is located on the seacoast of the Atlantic Ocean in eastern Massachusetts. In Suffolk County there are four (4) incorporated communities. The Cities of Boston, Chelsea, and Revere and the Town Winthrop.

Suffolk County is bordered by the Atlantic Ocean on the east; by Essex County, including the towns of Lynn and Saugus, to the north; by Middlesex County, including the towns of Melrose, Malden, Everett, Somerville, Cambridge, Watertown and Newton, to the west; and by Norfolk County, including the towns of Needham, Dedham, Canton, Milton and Quincy, to the South. It is 44 miles from Providence, Rhode Island, 106 miles from Portland, Maine, and 93 miles from Hartford, Connecticut.

According to the U.S. Census, the population of Suffolk County was 689,807 in 2000. The land area of Suffolk County consists of 120.19 square miles. All communities in Suffolk County included in this FIS, along with their population and total area, are listed in Table 5, "Population and Total Area by Community."

TABLE 5 – POPULATION AND TOTAL AREA BY COMMUNITY

| <u>Community</u>  | <u>Total Area (Sq. mi)<sup>1</sup></u> | <u>Population</u> |
|-------------------|----------------------------------------|-------------------|
| Boston, City of   | 89.63                                  | 589,141           |
| Chelsea, City of  | 2.48                                   | 35,080            |
| Revere, City of   | 10.03                                  | 47,283            |
| Winthrop, Town of | 8.3                                    | 18,303            |

<sup>1</sup>U.S. Census Bureau, 2000 Census of Population and Housing (Reference 1)

Suffolk County is the hub of a larger metropolitan area, serving some 3.25 million people; the sixth largest population center in the United States.

The climate of Suffolk County is moderate and can be described as a continental climate. Summers are warm and humid, while winters are cold, windy and snowy. The hottest month is July, with an average high of 82 degrees Fahrenheit (°F) and an average low of 66°F. The coldest month is January, with an average high of 36°F and an average low of 22°F. The mean annual temperature is 50 degrees Fahrenheit (°F). The temperature ranges from an average of 29°F in January to an average of 72°F in July (Reference 2). The average annual rainfall is 42 inches. The average annual snowfall is approximately 40.9 inches (Reference 3). . There is no dry season and, on the average, no dry spell lasts more than two weeks. From June to September, rainfall usually occurs in the form of showers or thunderstorms, which produce heavy, sometimes excessive, amounts of rain. Throughout the year, the heaviest gales are usually from the northeast or east and are more common and severe during the winter. Though the coastal location on the North Atlantic moderates temperatures in Suffolk County, it also makes the County very prone to

Nor'easter weather systems, which can result in an abundance of snow and rain. (Reference 4).

Boston was originally a peninsula with great areas of salt marsh to the north, along the banks of the Charles and Mystic Rivers, and at the mouth of the Neponset River to the south. Large areas of filled land occur in the Back Bay, the West End, South Boston, Dorchester, Charlestown and East Boston. In 1910, a dam on the Charles River at Leverett Street was constructed to prevent tidal flooding of the lowlands, to cover unsightly tidal flats at the mouth of the river, and to create an aesthetically pleasing recreational pool – now known as the Charles River Basin.

However, the creation of the basin accelerated growth along its banks, which in turn resulted in the conversion of many former open spaces to developed and paved areas. This change increased the speed and amount of runoff above the existing dam, making it inadequate to carry the discharges predicted. The U.S. Army Corp of Engineers (USACE) constructed a new dam at Warren Avenue to replace the 1910 dam at Leverett Street in order to accommodate the increased run-off. The Warren Avenue bridge was removed preconstruction of the Charles River Dam Local Protection Project that was initiated back in November, 1972. The project was completed in May 1978 and it situated the new dam approximately 2,250 feet downstream of the old Charles River Dam.

The land throughout the City of Boston is densely settled, except for limited areas in the west.

The City of Revere is also densely developed and attracts both permanent and transient populations. Coastal development in Revere is a mixture of residential, commercial, industrial, and recreational. Located along the eastern shore, from Point of Pines to Elliott Circle, is Revere Beach, a popular Metropolitan District Commission recreational facility. The beach experiences severe erosion problems. A breakwater is located at the southern end of Revere Beach at Cherry Island Bar. Of the Town of Winthrop's total land area, the majority of the land is classified as urban land. Within urban land space, high density residential areas comprises more than half. (Reference 5). The recreational lands consist primarily of the beaches along the eastern shore of the town. Exposure of the beaches to the open coast has caused severe erosion. To retard erosion, a 0.4-mile long breakwater was constructed 0.2 mile off of and parallel to Winthrop Beach. Coastal development is primarily residential and recreational. Because Winthrop is long and narrow in shape, the entire town is within the Massachusetts Coastal Zone.

The coastline of the City of Chelsea is heavily developed with commercial and industrial properties, predominately related to petroleum products and storage. The Mill Creek watershed is heavily developed with commercial and residential properties.

The topography of the County is generally level, with elevations ranging from sea level to 180 feet. Occasional hills composed of glacial till, rise as high as 300 feet.

The tidal shoreline along the Atlantic Ocean is 87.7 miles in length. Most of the county was formed by glacial till; its coastline includes scattered coves, beaches, and rocky shoals. Located at the northwest boundary of Winthrop is Belle Isle Marsh, a 250-acre salt marsh that is one of the last remaining salt marshes in the Boston Harbor region.

The Charles River has its headwaters in Echo Lake in Hopkinton. It flows generally northeast, finally becoming the northern boundary of the City of Boston, before discharging into Boston Harbor. It has a drainage area of approximately 300 square miles. Mother Brook, beginning as a partial diversion of the Charles River in the Town of Dedham, flows east through the Hyde Park section of Boston, discharging into the Neponset River. Flows in Mother Brook are limited to approximately one-third that of the Charles River. Muddy River rises out of Jamaica Pond and flows north, passing through highly-developed areas of Boston and Brookline before discharging into the Back Bay Fens. The Fens then empty into the Charles River Basin. The Neponset River originates in the Neponset Reservoir in Foxborough. It flows generally northeast, becoming the southern boundary for the City of Boston before discharging into Dorchester Bay. Stony Brook originates in Turtle Pond and flows south through Stony Brook Reservation before entering the Stony Brook culvert.

Boston Harbor is bordered by the Atlantic Ocean to the east and is protected on the north by Winthrop Peninsula and to the south by Hull Peninsula. From north to south, Boston Harbor is bounded by the Logan International Airport, East Boston, Charlestown, the Mystic and Charles Rivers, the downtown area, South Boston, Dorchester, and the Neponset River. The harbor has a number of islands including Deer, Spectacle, Thompson, Long and Gallops Islands. The entire coastline is densely developed, and much of the waterfront is under redevelopment pressure. Much of the recent construction has involved the downtown waterfront area, including condominiums, offices, parks and commercial establishments.

## 2.3 Principal Flood Problems

Investigations into flooding within the corporate limits of Boston have revealed that there has been severe flooding resulting in extensive damage, especially to the Charles River Basin and the surrounding lowlands. The problem is caused primarily by the difference between the established normal water level in the basin and the high tide in the harbor. In the flood of August 1955, 12.5 inches of rain coupled with a peak high tide of 8.2 feet resulted in raising the basin elevation to a record high of 6.90 feet. Over 1,750 acres, mostly highly-developed Cambridge and Boston, lying along the 8.6-mile long basin were subject to serious flooding. The 1955 hurricane, equivalent to a 1-percent-annual-chance storm, resulted in flood damage along the lower Charles River amounting to 5.5 million dollars. The same flood level in 1980 would have resulted in an estimated damage of 20 million dollars. In March 1968, 7.7 inches of rain combined with the spring thaw produced the second highest basin levels of 4.5 feet, inundating many areas along Storrow Drive. Although the peak discharge upstream was the same as the 1955 flood, the

river peak did not coincide with the tidal peaks as in the 1955 flood, and resulting damage was less extensive. Flooding problems from the 1955 and 1968 storms also occurred along the Neponset River in the Hyde Park area. Numerous private properties, automobiles and roadways were damaged as a result of the storm.

Flooding also occurs along the coastline of Boston and Chelsea and in the low-lying coastal areas of Revere and Winthrop, greatly influenced by storm surge elevations of Boston Harbor that result from severe storms. The most recent example of severe flooding was during the northeaster of February 1978, which was comparable to a 1-percent-annual-chance flood event. Elevations of flooding ranged from 8.6 to 10.1 feet, which caused one to three feet of flooding in areas such as Rows, India, Long, Commercial and Battery Wharves. Low-level flooding occurred at a number of East Boston locations such as East Boston Pier, the airport access road, and several parking lots on commercial piers. More serious damage occurred as a result of wave action. The recorded flood elevation was 9.8 feet at the New Charles River Dam, 9.5 feet at the U.S.S. Constitution, and 9.5 feet at the Commonwealth Pier gage. The 1978 northeaster caused significant damage in excess of \$15 million in the City of Revere. Other significant storms to cause flooding in Revere include the storms of December 1909 and 1959 (a flood event that had approximately 0.6- and 6.7-percent-annual-chance of occurring or being exceeded, respectively) and February 1972 (approximate recurrence of 4-percent-annual-chance).

In Chelsea, severe flooding due to poor drainage frequently occurs near Mill Creek upstream of U.S. Route 1. This area was not studied in detail because of its small drainage area. Minor flooding has been reported from residents near Mill Creek adjacent to Forbes Park (formerly Forbes Industrial Park), though no structural damage or injuries have been reported.

The heavily developed areas of Point of Pines and Oak Island, in Revere, have suffered severe damage from storms annually. The Point of Pines area is subject to coastal and riverine flooding. The encroachment of development into the Saugus River- Pines River Marsh has reduced storage capacity of the marsh and increased the flooding potential in the area. The Beachmont area, which faces the ocean and backs up to Belle Isle Marsh, experiences flooding as a result of storms and high tides.

In Winthrop, the majority of storms cause damage only to low coastal roads, boats, beaches, and seawalls. Occasionally, a major storm accompanied by strong onshore winds results in high tides and wave activity that cause extensive property damage and erosion. Some of the more significant storms in the Winthrop area include those of December 1909, December 1959, February 1972, and February 1978. The storms had approximate recurrence of 0.6-, 6.7-, 4-, and 1.1-percent annual chance, respectively. Harbors, marinas, and residential and commercial developments were damaged by the storms.

## 2.4 Flood Protection Measures

The primary flood problem within the City of Boston is in the area along the Charles River Basin. In 1910, a dam on the Charles River at Leverett Street was constructed, but with newly developed and paved areas, the dam became inadequate to carry the discharge predicted. The USACE replaced the Leverett Street dam with the new and improved Warren Avenue Dam to accommodate the growth of metropolitan Boston.

In the early 1970's the Charles River Dam Local Protection Project was initiated, thus removing the Warren Avenue Dam and replacing it with the current Charles River Dam, which provides flood protection to 2,440 acres of urban property along the banks of the Charles River. The project consisted of the construction of an earthfill and concrete dam with stone slope protection stretching between Boston and Charlestown. The dam is 400 feet long with an elevation of 12.5 feet above mean sea level. The connecting pumping station is 190 feet long and 122 feet high and contains six pumps. There are three navigation locks for commercial and recreational vessels. Two of the locks, for small recreational craft, each measure 200 feet long, 22 feet wide, and eight feet deep. The third lock, 40 feet wide, 300 feet long, and 17 feet deep, accommodates commercial vessels, large recreational boats, and the overflow of small craft during peak days.

The Baker Dam is located within the boundaries of the Dorchester/Milton Lower Mills Industrial Complex along the Neponset River and was originally built in the mid-1960's for the purpose of privately owned industrial mills. In the wake of hurricane Diane, the MDC took over the Lower Neponset, including its dams. In 1962, the MDC flood control project began, covering a stretch of the Neponset River from the freshwater limit to upstream of the Neponset Valley Parkway and CONRAIL crossing. The Baker dam was rebuilt in the same general style as the original, except the top of the dam was lowered by three or more feet to improve its discharge capacity during storm events. The average water level at Baker was also reduced by about three feet, thus providing better flood protection. This project also included channel straightening and channel and bridge modifications. These measures, in conjunction with proper operation of the floodgates on the dams, will effectively contain the 1- and 0.2-percent-annual-chance floods within the channel banks. Much of the land bordering riverine areas has been designated as parkland, thereby limiting development in floodplain areas. Flood control measures along the harbor are scattered, but include such measures as seawalls and rip-rapping.

The USACE has is currently conducting a feasibility study regarding the removal of the Baker Dam for Neponset River restoration purposes (<http://www.neponset.org/CurrentProjects.htm>). It has been recommended by the Massachusetts Riverways Program's Technical Advisory Committee to remove this dam, as it is no longer serving the purpose for which it was built.

In Chelsea, a tide gate exists on Mill Creek at the culvert under the east ramp of the U.S. Route 1 interchange with State Route 16. In 1979, the state locked the gate in

an open position to help alleviate the occasional flooding problems upstream. There are no other flood protection structures or measures in Chelsea.

In Revere and Winthrop, the MDC provides concrete seawalls and stone revetments to protect coastal highways. Other protective structures are generally built and maintained by the local municipality and private property owners to satisfy individual requirements within their financial capabilities. These structures include such backshore protection as timber and steel sheet piles, bulkheads, stone revetments, concrete seawalls, and pre-cast concrete units (Reference 6). Limited financial resources sometimes result in less than adequate protection.

### 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 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied by detailed methods affecting the county

For each community within Suffolk County, the hydrologic analyses described in their previous FIS reports have been compiled and summarized below.

##### Precountywide Analyses

Peak discharge estimates for the upper reach of the Charles River for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were based on a log-Pearson Type III analysis of the USGS gage data from the gages (no. 01104500 and no. 01103500) located at Waltham and Charles River Village, respectively (Reference 7).

As a result of the 8,400 cfs pumping capacity of the New Charles River Dam, peak discharge estimates for the Charles River Basin for floods of the selected recurrence intervals were not determined. Peak inflow hydrographs developed by the USACE were used to determine pumping curves so as to maintain basin levels near the normal elevation of 2.5 feet during the 10-, 2-, and 1-percent-annual-chance floods (Reference 8). Damage resulting from floodwaters along the Charles River Basin begins at an elevation of 3.8 feet. During a 1-percent-annual-chance event, the pumping station will control basin levels to an elevation of 3.5 feet, which is below the level at which damage will occur. For the 0.2-percent-annual-chance event, basin levels will be held to an elevation of 5.2 feet and minimal damage will result. This assumes, however, that the basin will not be drawn down and that sluicing will not be possible.

Mother Brook acts as a diversion channel from the Charles River to the Neponset River. The discharges for Mother Brook are limited by law to approximately one-third of the peak discharge for the Charles River (Reference 9).

Peak discharge estimates for the Muddy River and Back Bay Fens for floods of the selected recurrence intervals were not calculated, as the Muddy River and Back Bay Fens act as a reservoir during periods of great runoff. For this reason, hydrologic analyses were conducted to establish peak volume rather than peak discharge-frequency data. Flood volume data was developed by the USACE using unit hydrographs and rainfall-frequency analyses (References 8 and 10). This data was checked for reasonableness and incorporated into this study.

Peak discharge-frequency estimates of the Neponset River for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined for the FIS for the Town of Milton in Norfolk County and were incorporated into this study (Reference 11).

Peak discharge-frequency estimates for Stony Brook for the 10-, 2-, and 1-percent-annual-chance floods were computed using the SCS peak discharge determination methods for small watersheds (Reference 9). The 0.2-percent-annual-chance peak discharge estimate was determined by linear extrapolation of a log-Pearson Type III probability curve on the other floods.

Two high-water marks in Chelsea were obtained from the USGS. The elevation on Mill Creek upstream of Broadway Avenue in Chelsea is 8.8, and the elevation on the Chelsea River at the MDC Sewerage Division Maintenance Yard is 9.5 (Reference 12).

The Mill Creek discharges in Chelsea and Revere were obtained from a drainage study of Mill Creek prepared for the Massachusetts Department of Public Works in 1975 (Reference 13). The analysis incorporated rainfall simulation modeling, simulation of runoff, and the drainage system response to rainfall through the use of a computerized catchments model. The 0.2-percent-annual-chance discharge was extrapolated from the three calculated flow values.

### Countywide Analyses

No new Hydrologic Analyses were conducted for this countywide FIS.

Peak discharge-drainage area relationships for the flooding sources studied by detailed methods are shown in Table 6, "Summary of Discharges".

TABLE 6 - SUMMARY OF DISCHARGES

| FLOODING<br>SOURCE AND<br>LOCATION                | DRAINAGE<br>AREA<br>(SQUARE<br>MILES) | PEAK DISCHARGES (CUBIC FEET PER SECOND) |                                   |                                   |                                     |
|---------------------------------------------------|---------------------------------------|-----------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|
|                                                   |                                       | 10-<br>PERCENT<br>ANNUAL<br>CHANCE      | 2-<br>PERCENT<br>ANNUAL<br>CHANCE | 1-<br>PERCENT<br>ANNUAL<br>CHANCE | 0.2-<br>PERCENT<br>ANNUAL<br>CHANCE |
| CHARLES RIVER                                     |                                       |                                         |                                   |                                   |                                     |
| At upstream Boston-<br>Dedham corporate<br>limits | 227                                   | 2125                                    | 3102                              | 3578                              | 4850                                |
| MILL CREEK                                        |                                       |                                         |                                   |                                   |                                     |
| At confluence with<br>Chelsea River               | 1.3                                   | 600                                     | 1690                              | 2300                              | 4790                                |
| At mouth in City of<br>Chelsea                    | 1.3                                   | 600                                     | 1690                              | 2300                              | 4790                                |
| MOTHER BROOK                                      |                                       |                                         |                                   |                                   |                                     |
| At City of Boston<br>corporate limits             | 2.4                                   | 740                                     | 1210                              | 1470                              | 2250                                |
| NEPONSET RIVER                                    |                                       |                                         |                                   |                                   |                                     |
| At dam at Lower<br>Mills in the City of<br>Boston | 98                                    | 2450                                    | 3410                              | 3730                              | 4750                                |

TABLE 6 - SUMMARY OF DISCHARGES – continued

| FLOODING<br>SOURCE AND<br>LOCATION                 | DRAINAGE<br>AREA<br>(SQUARE<br>MILES) | PEAK DISCHARGES (CUBIC FEET PER SECOND) |                                   |                                   |                                     |
|----------------------------------------------------|---------------------------------------|-----------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|
|                                                    |                                       | 10-<br>PERCENT<br>ANNUAL<br>CHANCE      | 2-<br>PERCENT<br>ANNUAL<br>CHANCE | 1-<br>PERCENT<br>ANNUAL<br>CHANCE | 0.2-<br>PERCENT<br>ANNUAL<br>CHANCE |
| STONY BROOK                                        |                                       |                                         |                                   |                                   |                                     |
| At Stony Brook<br>culvert in the City of<br>Boston | 13                                    | 90                                      | 150                               | 200                               | 286                                 |

### 3.2 Hydraulic Analyses

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

Cross sections were field surveyed and located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures. All bridges, dams, and culverts in the county were field surveyed to obtain elevation data and structural geometry. In long reaches between structures, appropriate valley sections were also surveyed.

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

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

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

### Precountywide Analyses

In Boston, overbank extensions of field-surveyed channel cross sections, and additional sections needed for hydraulic continuity were taken from topographic maps at a scale of 1:1,200 with a 5 foot contour interval (Reference 14). Present culvert conditions were used and recent modifications were taken into consideration in the use of flood marks.

The overbank portions of the cross-section data for Mill Creek were obtained from topographic maps prepared by photogrammetric methods (Reference 15). The below-water sections were obtained by field measurement. All bridges and culverts were field surveyed to obtain elevation data and structural geometry.

Water-surface elevations for Stony Brook, Mill Creek, Mother Brook, Neponset River, and the upper reach of the Charles River were developed using the HEC-2 computer program developed by the USACE (Reference 16). Starting water-surface elevations for Mill Creek were based on mean high-water elevations. The storm surge elevations from the coastline were superimposed on the profile to the location on Mill Creek where backwater flooding from the coast no longer exists. Starting water-surface elevations for Stony Brook were taken from a rating curve developed at the entrance to the Stony Brook culvert.

At one location on Mill Creek, the analysis indicates that the flow would be supercritical. Because of the inherent instability of supercritical flow, critical depth was assumed at this location when establishing the profile elevations for this study.

Water-surface elevations for floods of the selected recurrence intervals along the Neponset River were obtained from a previously published report by Anderson-Nichols Co. and the FIS for the Town of Milton in Norfolk County (References 11 and 17). They were checked for reasonableness and incorporated into this study.

For the Charles River Basin, elevations were developed using inflow hydrographs in respect to the pumping capacity of the New Charles River Dam (References 8 and 18). Elevations along the Muddy River were developed using the "modified puls" method of reservoir routing in conjunction with the discharge capacity of the Charles River Basin (References 8, 10, 18 and 19). Elevations for the floods for the Back Bay Fens, the Muddy River and the Charles River Basin were developed by the USACE in their detailed analysis of the Charles River Basin (References 8 and 10).

In some locations, such as the Boston Harbor shoreline within Winthrop, water levels were computed by correlating synthetically-produced water levels with elevations obtained during historic floods (Reference 20). Historic flood damage information was also used to ensure reasonable delineation of flood-prone areas along the Revere and Winthrop shoreline (Reference 21).

The City of Revere has no qualifying bench marks within its corporate limits.

#### Countywide Analyses

No new Hydraulic Analyses were performed for this countywide FIS.

Roughness factors (Manning's "n") used in the hydraulic computations were estimated based on field inspection of flood plain areas. The channel "n" and overbank "n" values for the streams studied by detailed methods are shown in Table 7, "Manning's "n" Values":

TABLE 7- MANNING'S "n" VALUES

| <u>FLOODING SOURCE</u> | <u>CHANNEL "n"</u> | <u>OVERBANK "n"</u> |
|------------------------|--------------------|---------------------|
| Charles River          | 0.025-0.035        | 0.065               |
| Mill Creek             | 0.040              | 0.060-0.085         |
| Mother River           | 0.015-0.100        | 0.100               |
| Neponset River         | 0.035              | 0.060               |
| Stony Brook            | 0.020-0.050        | 0.100               |

### 3.3 Coastal Analyses

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

Areas of coastline subject to significant wave attack are referred to as coastal high hazard zones. The USACE has established the 3-foot breaking wave as the criterion for identifying the limit of coastal high hazard zones (Reference 22). The 3-foot wave has been determined as the minimum size wave capable of causing major damage to conventional wood frame or brick veneer structures.

A wave height analysis was performed to determine wave heights and corresponding wave crest elevations for the areas inundated by the tidal flooding. A wave run-up analysis was performed to determine the height and extent of run-up beyond the limit of tidal inundation. The results of these analyses were combined into a wave envelope, which was constructed by extending the maximum wave run-up elevation seaward to its intersection with the wave crest profile.

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 23). This method is based on three major concepts.

First, a storm surge on the open coast is accompanied by waves. The maximum height of these waves is related to the depth of water by the following equation:

$$H_b = 0.78d$$

where  $H_b$  is the crest to trough height of the maximum or breaking wave and  $d$  is the still-water depth. The elevation of the crest of an unimpeded wave is determined using the equation:

$$Z_w = S_* + 0.7H_* = S_* + 0.55d$$

where  $Z$ , is the wave crest elevation,  $S_t$  is the still-water elevation at the site, and  $H^*$  is the wave height at the site. The 0.7 coefficient is the portion of the wave height which reaches above the still-water elevation.  $H_b$  is the upper limit for  $H^*$ . The second major concept is that the breaking wave height may be diminished by dissipation of energy by natural or man-made obstructions. The wave height transmitted past a given obstruction is determined by the following equation:

$$H_t = BH_i$$

where  $H_t$  is the transmitted wave height,  $H_i$  is the incident wave height, and  $B$  is a transmission coefficient ranging from 0.0 to 1.0. The coefficient is a function of the physical characteristics of the obstruction. Equations have been developed by the NAS to determine  $B$  for vegetation, buildings, natural barriers such as dunes, and man-made barriers such as breakwaters and seawalls (Reference 23).

The third concept deals with unimpeded reaches between obstructions. New wave generation can result from wind action. This added energy is related to distance and mean depth over the unimpeded reach.

For each coastal community within Suffolk County that has been studied prior to this countywide update, the coastal analyses described in the previous FIS reports have been compiled and are summarized below. This includes all communities within Suffolk County.

#### Precountywide Analyses

In Boston, the coastal areas for which flood elevations have been determined include the lands bordering Massachusetts Bay, Boston Harbor, and Dorchester Bay, and along the Neponset, Charles, Mystic, and Chelsea Rivers to the limits of tidal inundation. Water level fluctuations above astronomical tide levels at Boston are caused primarily by the passage of hurricanes and winter storms known as northeasters. Of these, the northeasters produce the more frequent and severe storm tides.

Extreme water levels along the Boston shoreline are caused by the combination of storm surges and high astronomical tides. Astronomical tide levels are extremely

important in the determination of total water levels as they have a mean range of 8.7 feet and a spring range of more than 11.2 feet. These ranges are considerably larger than the expected storm surges, thus making the phasing of the astronomical tide critical to the determination of total water levels.

Storm surges in the Boston area are caused mainly by onshore winds, wave setup and low barometric pressures that cause a rise in the water-surface elevation. As discussed above, these water level fluctuations are due primarily to the passage of hurricanes and northeasters through the area. The dominant surge-producing storm in the Boston area, as in most of the New England regions, is the northeaster. These storms are typically less intense than hurricanes, but they occur more frequently and are larger and slower-moving. Thus, they have a significantly greater probability of combining with a high astronomical tide causing an extreme high-water level. Hurricanes in the New England region are considerably weaker than the very destructive storms found in the Gulf of Mexico and off the southeastern coast of the United States. These factors, along with the relatively narrow continental shelf off Boston, combine to reduce the effect of the hurricanes on the tide levels at the coast.

A combined probabilistic-deterministic method was used in this study to develop the coastal stillwater flood elevations in locations where tidal gage records are not available. The probabilistic components of the study involved the determination of probabilities of occurrence of various meteorological parameters that define hurricanes and winter storms in the area. These probabilities are effectively constant over large regions and thus may be used at locations where no direct measurements have been made with any significant loss in accuracy. The deterministic component of the study involved the calculation of the storm surge that would be caused by various combinations of these meteorological parameters. The main steps involved in the determination of flood levels are as follows:

1. Determination of probabilities of occurrence of various meteorological parameters relevant to storm surge generation.
2. Development of numerical models to calculate the storm surge due to a particular set of meteorological conditions. Numerical models were developed to represent the outer coast, inner harbor and riverine areas.
3. Development of simple numerical models to allow rapid and inexpensive calculation of surge levels at various locations.
4. "Calibration" of the simple numerical model to specific locations of interest using the results of the more comprehensive numerical models.
5. Simulation of 500 years of storm tide data using a random generation of meteorological parameters based on their historical probabilities of occurrence and combination with a randomly phased astronomical tide.

6. Calculation of stillwater elevation return periods on the basis of the simulated tide data.

A total of six numerical models were developed to calculate surge levels on the open coast and inside the harbor. These models included:

WINTSRG - used to determine the open coast surge due to winter storms.

HURSRG - used to determine the open coast surge due to hurricanes.

INSRG - used to determine the surge at various locations inside the harbor due to either winter storms or hurricanes using the output of WINTSRG or HURSRG as boundary conditions.

RIVSRG - used to determine the surge at various locations along the riverine sections due to either winter storms or hurricanes using the output of INSRG as boundary conditions.

WINTSEL - used to determine the total still-water elevations due to the combination of astronomical tides and storm surges from winter storms for the development of 500 years of record.

HUSEL - used to determine the total still-water elevations due to the combination of astronomical tides and hurricane surges for the development of 500 years of record.

The development of these models is discussed in detail in the Coastal Flooding Analysis (Reference 24). Briefly, the HURSRG, INSRG, and RIVSRG models were developed based on the solution of the governing differential equations outlined by Dean. The WINTSRG model was developed to account for the special conditions caused by winter storms that control the development of open coast surge levels. These models were used to develop surge time histories due to various combinations of the meteorological parameters, which define the storms. Regression analyses were performed to determine the response of the harbor to each of the parameters while limiting the number of computer runs using the comprehensive numerical models required.

The WINTSEL and HURSEL models were developed to randomly generate winter storm and hurricane parameters respectively, and the resulting storm tides. The storm tides were calculated using simple numerical models based on the regression analyses performed using the comprehensive numerical models described above.

The numerical models were verified on the basis of historical storm records and the continuous recording from the National Ocean Survey tidal gage located on Commonwealth Pier.

Stillwater elevations were generated for return periods of 10-, 2-, 1-, and 0.2-percent-annual-chance. In addition, a number of observations on the character of the storms and the surge levels affecting Boston were made. In general, it was found that winter storms were the dominant cause of high water levels on the open coast and in the harbor. It was also found that waves contribute a significant portion of the open coast winter storm surge and that these surges can be calculated with sufficient accuracy using a steady state analysis.

The study indicated that the water levels for the specified return periods are lowest at the southeastern end of Logan International Airport and increase towards Dorchester Bay and into the Charles, Neponset, Mystic and Chelsea Rivers. It was determined that the northeast winds that caused the majority of the storm surges, forced water into Dorchester Bay and against the coast causing an increase in the water levels.

Stillwater elevations for the Charles River Basin upstream of the New Charles River Dam were obtained from a 1979 USACE report (Reference 25).

In Chelsea, storm surge elevations for the Island End River, Mystic River, Boston Harbor, and the Chelsea River were determined by FEMA. The storm surge elevations used in this study were obtained from FEMA to insure agreement between all communities being studied that are adjacent to Boston Harbor.

To calculate the storm surge and total storm tide elevations produced by historic storms in Revere and Winthrop, it was necessary to determine the storm pressure and wind fields. A computer model was developed by the study contractor to simulate these fields based on several, easily obtained, northeaster storm parameters. A detailed description of this model is presented in the report titled Development and Verification of a Synthetic Northeaster Model for Coastal Flood Analysis (Reference 26). A different model was used to simulate the wind and pressure fields of the hurricanes considered in this analysis (Reference 27).

Synoptic weather maps were searched to determine the northeasters and hurricanes that could potentially produce significant flooding in the Revere and Winthrop area. Tidal records from tide gages in the New England areas were examined to verify which historic storms produced high-water elevations. A total of 165 storms, from 1943 to 1978, were considered in the analysis for flood levels.

The flood levels associated with historic storms were simulated using a modified version of the FEMA storm surge model (References 28 and 29). Input to the model consisted of wind and pressure fields generated either by the synthetic northeaster model or a hurricane wind and pressure field model for each historic storm selected. The study area was modeled using a square grid of sufficient resolution to accurately represent the offshore bathymetry and shoreline configuration. The grid mesh covered an area from Cape Cod Bay to north of Portsmouth, New Hampshire, including Boston Harbor. Output from the model included the time history of storm-induced surge elevations in the study area. These elevations were combined

with the predicted astronomical tide for the same time period to produce total stillwater elevations for the communities in the study area. The total still-water elevation was calibrated using historic tide elevation data at Boston, Massachusetts, and Portsmouth, New Hampshire. Thus, the historic storm-induced flood levels in Revere and Winthrop could be simulated for each storm considered in the analysis.

The extent and frequency of recurrence of coastal flooding in Revere were determined by conducting a frequency analysis of annual maximum tidal heights along the coastline of Revere. Some historic storm-tide heights, consisting of an astronomical tide and a storm surge contribution, were determined by the mathematical simulation of historic northeasters and hurricanes as described above; others, for which associated storm data were not available, were obtained by a correlation analysis using tide data from Boston to Portsmouth. The data base at the Boston gage extended from 1978 discontinuously back to 1848; the shorter record at Portsmouth was lengthened by a statistical correlation with data at Boston and Portsmouth. The annual maxima of these reproduced historic stillwater elevations were fitted with a Pearson Type III distribution. The goodness of fit was tested and accepted at the 95-percent confidence level.

The analyses of the storm surge elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods for coastal water reflect the stillwater elevation due to tidal and wind setup effects. A detailed description of the methodology employed in this analysis for Revere and Winthrop can be found in the report titled, *Determination of Coastal Storm Tide Levels* (Reference 26).

The effects of wave action were also considered in the determination of flood hazard areas in Revere and Winthrop. Coastal structures which are located above stillwater flood elevations can still be severely damaged by wave run-up, wave-induced erosion, and wave-borne debris. For example, during the February 1978 northeaster, considerable damage among the Massachusetts coast was caused by wave activity, even though most of the damaged structures were above the high-water level. The extent of wave run-up past stillwater levels depends greatly on the wave conditions and local topography.

Wave heights and corresponding wave crest elevation in Revere and Winthrop were determined using the National Academy of Sciences (NAS) methodology (Reference 23). The wave run-up was determined using the methodology developed by Stone and Webster Engineering Corporation for FEMA (Reference 30).

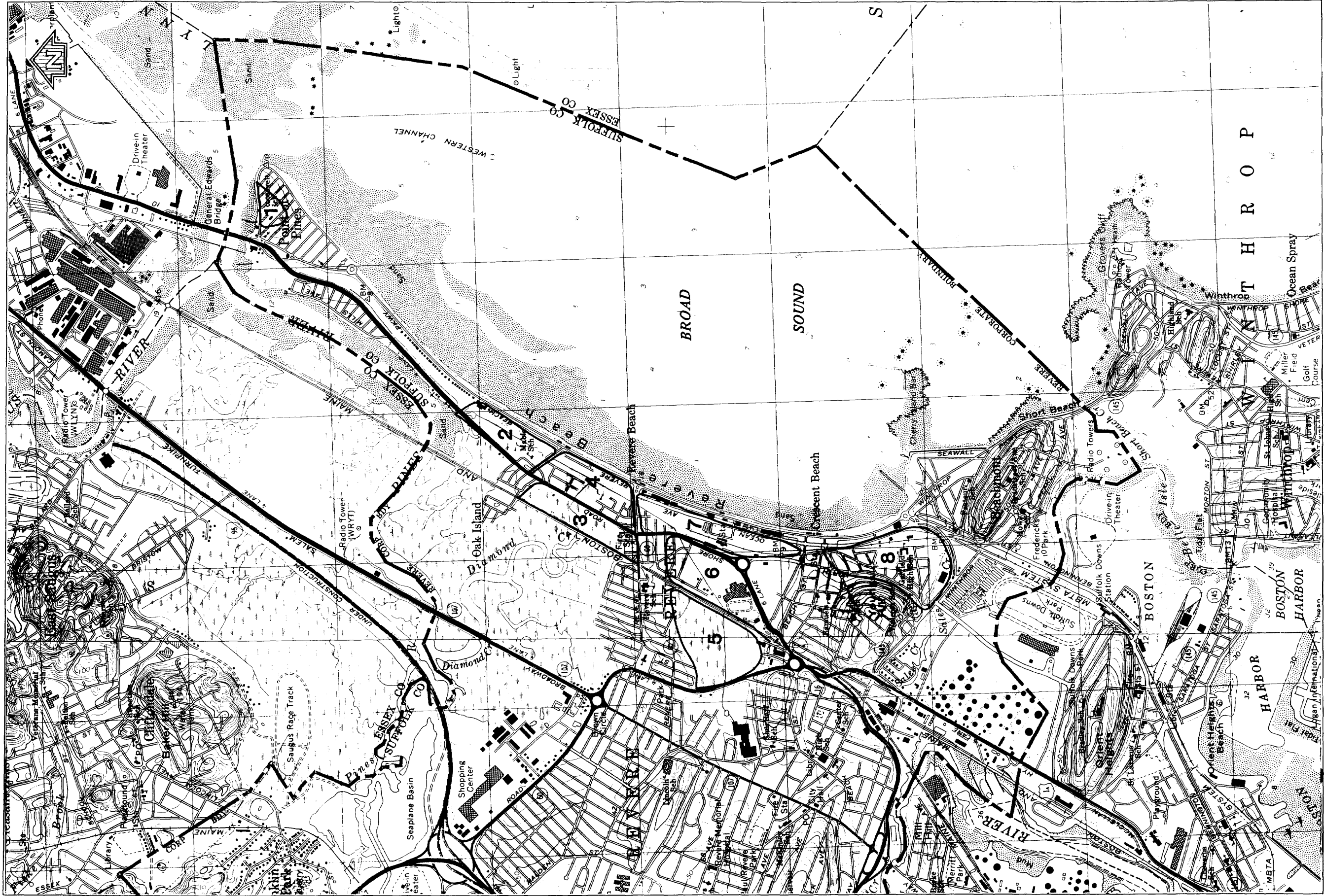
Some areas in Revere are flooded by wave overtopping of seawalls along the coast. Other areas are flooded by the Saugus and Pines Rivers. Estimating the elevation to which these areas are flooded is complicated by the following factors: the overtopping rate is a function of seawall elevation, structure slope, and exposure. Each of these factors varies along the Revere coastline. Pumping stations and tidal gates alleviate the flooding problems but, depending on maintenance, they operate with varying degrees of efficiency.

In addition, snow banks may trap floodwaters and intensify flooding. In order to establish flood elevations in these areas, the USACE made an intensive study of localized flooding in Revere (Reference 31). The USACE has used engineering methods to compute seawall overtopping rates and to determine the degree of flooding from the Saugus and Pines Rivers. The engineering studies were supported by surveys of the Revere residents concerning flooding from the February 1978 blizzard. A detailed report of flooding in the Roughans Point area has been published (Reference 31). The results of the USACE studies are incorporated into this report. Figure 1, "Area Location Map in Revere," depicts these separate areas along Broad Sound and Table 8, "Area Location Descriptions in Revere", describes each area.

TABLE 8: AREA LOCATION DESCRIPTIONS IN REVERE

| <u>Area</u> | <u>Description</u>                                                                                                     |
|-------------|------------------------------------------------------------------------------------------------------------------------|
| 1           | Between North Shore Road and Revere Beach Boulevard and South of Dix Street                                            |
| 2           | Between Revere Beach Boulevard and North Shore Road north of Oak Island Street                                         |
| 3           | Between Boston and Maine Railroad and North Shore Road and between Revere Street and Bridge Street                     |
| 4           | Between Revere Beach Boulevard and North Shore road and between Revere Street and Oak Island                           |
| 5           | Between American Legion Highway and Boston & Maine Railroad and south of Washington Street                             |
| 6           | Between Boston and Maine Railroad and North Shore Road and between Veterans of Foreign Wars Parkway and Calumet Street |
| 7           | Between North Shore Road and Ocean Avenue and between Revere Street and Beach Street                                   |
| 8           | Between North Shore Road and Revere Beach Boulevard and south of Dix Street                                            |

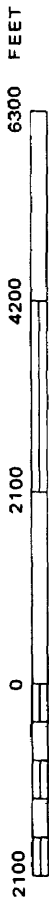
Stillwater flood elevations in the Belle Isle Inlet area in Revere and on the Boston Harbor side of Winthrop were obtained from the methods and results determined for the City of Boston (Reference 32).



FEDERAL EMERGENCY MANAGEMENT AGENCY

**CITY OF REVERE, MA**  
(SUFFOLK CO.)

APPROXIMATE SCALE



**AREA LOCATION MAP**

**FIGURE 1**

The stillwater elevations of the selected recurrence intervals are shown in Table 9, "Summary of Precountywide Stillwater Elevations."

TABLE 9 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS

| <u>FLOODING SOURCE AND<br/>LOCATION</u>                                         | <u>ELEVATION (feet NAVD<sup>1</sup>)</u> |                       |                       |                         |
|---------------------------------------------------------------------------------|------------------------------------------|-----------------------|-----------------------|-------------------------|
|                                                                                 | <u>10-<br/>PERCENT</u>                   | <u>2-<br/>PERCENT</u> | <u>1-<br/>PERCENT</u> | <u>0.2-<br/>PERCENT</u> |
| <u>ATLANTIC OCEAN</u>                                                           |                                          |                       |                       |                         |
| Island End River                                                                | 8.3                                      | 9.2                   | 9.5                   | 10.4                    |
| Mystic River                                                                    | 8.3                                      | 9.1                   | 9.5                   | 10.4                    |
| Boston Harbor in the City of<br>Chelsea                                         | 8.2                                      | 9.0                   | 9.4                   | 10.2                    |
| Chelsea River from Boston<br>Harbor to Eastern Avenue in<br>the City of Chelsea | 8.3                                      | 9.3                   | 9.6                   | 10.5                    |
| Chelsea River from Eastern<br>Avenue to the City of Revere<br>corporate limits  | 8.5                                      | 9.4                   | 9.8                   | 10.6                    |
| Entire Shoreline within the<br>City of Revere                                   | 8.0                                      | 8.8                   | 9.2                   | 10.0                    |
| At Broad Sound in the Town<br>of Winthrop                                       | 7.9                                      | 8.8                   | 9.1                   | 9.9                     |
| <u>BELLE ISLE INLET</u>                                                         |                                          |                       |                       |                         |
| Entire shoreline                                                                | 7.7                                      | 8.5                   | 8.8                   | 9.6                     |
| <u>BOSTON HARBOR</u>                                                            |                                          |                       |                       |                         |
| East of Logan Airport                                                           | 7.7                                      | 8.5                   | 8.8                   | 9.6                     |

<sup>1</sup>North American Vertical Datum of 1988

TABLE 9 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – cont'd

| <u>FLOODING SOURCE AND<br/>LOCATION</u>          | <u>ELEVATION (feet NAVD<sup>1</sup>)</u> |                       |                       |                         |
|--------------------------------------------------|------------------------------------------|-----------------------|-----------------------|-------------------------|
|                                                  | <u>10-<br/>PERCENT</u>                   | <u>2-<br/>PERCENT</u> | <u>1-<br/>PERCENT</u> | <u>0.2-<br/>PERCENT</u> |
| BOSTON HARBOR –<br>cont'd                        |                                          |                       |                       |                         |
| West of Deer Island                              | 7.9                                      | 8.8                   | 9.1                   | 9.9                     |
| East of Governor's Island                        | 8.0                                      | 8.7                   | 9.1                   | 9.9                     |
| Northeast of Spectacle Island                    | 8.0                                      | 8.9                   | 9.2                   | 10.1                    |
| Southeast of Castle Island                       | 8.1                                      | 8.9                   | 9.3                   | 10.1                    |
| At Long Island                                   | 8.1                                      | 9.0                   | 9.3                   | 10.2                    |
| East of Thompson Island                          | 8.2                                      | 9.1                   | 9.4                   | 10.3                    |
| Entire shoreline in the Town<br>of Winthrop      | 7.7                                      | 8.5                   | 8.8                   | 9.6                     |
| BOSTON INNER HARBOR                              |                                          |                       |                       |                         |
| Entire harbor shoreline in the<br>City of Boston | 8.2                                      | 9.0                   | 9.4                   | 10.2                    |
| BROAD SOUND                                      |                                          |                       |                       |                         |
| Area 1 in Revere                                 | 7.0                                      | 7.8                   | 8.2                   | 9.4                     |
| Area 2 in Revere                                 | 5.0                                      | 6.0                   | 6.8                   | 8.6                     |
| Area 3 in Revere                                 | 3.0                                      | 4.7                   | 5.8                   | 7.7                     |

<sup>1</sup>North American Vertical Datum of 1988

TABLE 9 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – cont'd

| <u>FLOODING SOURCE AND<br/>LOCATION</u>       | <u>ELEVATION (feet NAVD<sup>1</sup>)</u> |                       |                       |                         |
|-----------------------------------------------|------------------------------------------|-----------------------|-----------------------|-------------------------|
|                                               | <u>10-<br/>PERCENT</u>                   | <u>2-<br/>PERCENT</u> | <u>1-<br/>PERCENT</u> | <u>0.2-<br/>PERCENT</u> |
| BROAD SOUND – cont'd                          |                                          |                       |                       |                         |
| Area 4 in Revere                              | 4.6                                      | 6.8                   | 7.6                   | 9.0                     |
| Area 5 in Revere                              | 4.2                                      | 4.9                   | 5.4                   | 7.2                     |
| Area 6 in Revere                              | 5.0                                      | 7.6                   | 8.4                   | 10.0                    |
| Area 7 in Revere                              | 6.8                                      | 9.6                   | 10.6                  | 12.0                    |
| Area 8 in Revere                              | 4.2                                      | 5.6                   | 6.2                   | 7.8                     |
| CHARLES RIVER BASIN                           |                                          |                       |                       |                         |
| Immediately upstream of New Charles River Dam | 3.0                                      | 3.2                   | 3.5                   | 5.2                     |
| CHELSEA RIVER                                 |                                          |                       |                       |                         |
| Immediately upstream of McArdle Bridge        | 8.3                                      | 9.3                   | 9.6                   | 10.5                    |
| Immediately upstream of Chelsea Street Bridge | 8.5                                      | 9.4                   | 9.8                   | 10.6                    |
| Entire shoreline in City of Revere            | 8.5                                      | 9.4                   | 9.8                   | 10.6                    |
| DORCHESTER BAY                                |                                          |                       |                       |                         |
| At Old Harbor                                 | 8.4                                      | 9.3                   | 9.7                   | 10.5                    |
| West of Thompson Island                       | 8.6                                      | 9.5                   | 9.9                   | 10.7                    |

<sup>1</sup>North American Vertical Datum of 1988

TABLE 9 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – cont'd

| <u>FLOODING SOURCE AND<br/>LOCATION</u>            | <u>ELEVATION (feet NAVD<sup>1</sup>)</u> |                       |                       |                         |
|----------------------------------------------------|------------------------------------------|-----------------------|-----------------------|-------------------------|
|                                                    | <u>10-<br/>PERCENT</u>                   | <u>2-<br/>PERCENT</u> | <u>1-<br/>PERCENT</u> | <u>0.2-<br/>PERCENT</u> |
| DORCHESTER BAY –<br>cont'd                         |                                          |                       |                       |                         |
| At Neponset River                                  | 9.0                                      | 10.2                  | 10.6                  | 11.4                    |
| LINDEN BROOK                                       |                                          |                       |                       |                         |
| At the confluence with Town<br>Line Brook          | *                                        | *                     | 8.2                   | *                       |
| At the upstream corporate<br>limits                | *                                        | *                     | 8.2                   | *                       |
| MASSACHUSETTS BAY                                  |                                          |                       |                       |                         |
| At Deer and Lovell Islands                         | 8.0                                      | 8.9                   | 9.2                   | 10.1                    |
| MYSTIC RIVER                                       |                                          |                       |                       |                         |
| Immediately upstream of<br>Mystic River Bridge     | 8.3                                      | 9.1                   | 9.5                   | 10.3                    |
| PINES RIVER                                        |                                          |                       |                       |                         |
| Entire length within the City<br>of Revere         | 7.2                                      | 7.9                   | 8.2                   | 9.0                     |
| SAUGUS RIVER                                       |                                          |                       |                       |                         |
| At General Edwards Bridge in<br>the City of Revere | 7.2                                      | 7.8                   | 8.2                   | 9.0                     |

<sup>1</sup>North American Vertical Datum of 1988

\*Data Not Available

TABLE 9 – SUMMARY OF PRECOUNTYWIDE STILLWATER ELEVATIONS – cont'd

| <u>FLOODING SOURCE AND<br/>LOCATION</u> | <u>ELEVATION (feet NAVD<sup>1</sup>)</u> |                       |                       |                         |
|-----------------------------------------|------------------------------------------|-----------------------|-----------------------|-------------------------|
|                                         | <u>10-<br/>PERCENT</u>                   | <u>2-<br/>PERCENT</u> | <u>1-<br/>PERCENT</u> | <u>0.2-<br/>PERCENT</u> |
| SAUGUS RIVER – cont'd                   |                                          |                       |                       |                         |
| At confluence of Pines River            | 7.2                                      | 7.8                   | 8.2                   | 9.0                     |
| TOWN LINE BROOK                         |                                          |                       |                       |                         |
| At the confluence with Pines River      | *                                        | *                     | 8.2                   | *                       |
| At the upstream Revere corporate limits | *                                        | *                     | 8.2                   | *                       |

<sup>1</sup>North American Vertical Datum of 1988

\*Data Not Available

For Boston, Revere, and Winthrop, the methodology for analyzing wave run-up was developed by Stone and Webster Engineering Corporation (Reference 33). The wave run-up computer program operates using an ensemble of deepwater wave heights,  $H_i$ , the stillwater elevation,  $S$ , a wave period,  $T_s$ , and beach slope,  $m$ . For the City of Boston, wave heights range from 2 feet up to the significant wave height of 19 feet; the wave period equals 7 and 14 seconds. For Revere, wave heights range from 5 feet up to the significant wave height of 30 feet; the wave period equals 14 seconds.

These concepts and equations were used to compute wave envelope elevations associated with the 1-percent-annual-chance storm surge. Accurate topographic land-use and land-cover data are required for the coastal analyses. Maps of the Boston study area, at a scale of 1:1,200 with a contour interval of 5 feet were used for the topographic data (Reference 34). The land-use and land-cover data were obtained by field surveys. Maps of the study area, at a scale of 1:4,800 in Revere and 1:2,400 in Winthrop, with a contour interval of 5 feet, were used for the topographic data (Reference 35). The land-use and land-cover data were obtained by field surveys.

Wave heights and wave run-up were computed along transects located perpendicular to the average mean 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, 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.

During the course of the wave run-up analysis, shallow flooding areas were determined and delineated due to overland flow and the topography of the area.

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

Transect Descriptions for precountywide coastal analyses are shown in Table 10 below and have been re-numbered to conform to countywide standards.

TABLE 10 - PRECOUNTYWIDE TRANSECT DESCRIPTIONS

| <u>TRANSECT</u> | <u>LOCATION</u>                                                                                       |
|-----------------|-------------------------------------------------------------------------------------------------------|
| 1               | From Rice Avenue, extending southeast into Broad Sound                                                |
| 2               | From Lynnway Boulevard, extending southeast into Broad Sound                                          |
| 3               | From just south of Essex County/Suffolk County boundary, extending southeast into Broad Sound         |
| 4               | Extending east-southeast along Argyles Street, into Broad Sound                                       |
| 5               | North Shore Road, just north of Butler Circle, extending eastward into Broad Sound                    |
| 6               | From railroad tracks just east of Garfield Jr. High School, extending east-northeast into Broad Sound |

TABLE 10 - PRECOUNTYWIDE TRANSECT DESCRIPTIONS – cont'd

| <u>TRANSECT</u> | <u>LOCATION</u>                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| 7               | From northeast of Henry Street and Dolphin Avenue, extending eastward into Broad Sound    |
| 8               | From Crescent Avenue, extending east-northeast into Broad Sound                           |
| 9               | From Highland Avenue and Seawall Avenue, extending north into Broad Sound                 |
| 10              | From the Radio Tower in the northeast area of Winthrop, extending east into Broad Sound   |
| 11              | From southwest of Crest Avenue and Hutchinson Street, extending eastward into Broad Sound |
| 12              | Following Wave Way, extending into Broad Sound                                            |
| 13              | From Shirley Street at Irwin Street, extending northeast into Broad Sound                 |
| 14              | From Park Avenue and Beacon Street, extending east-northeast into Broad Sound             |
| 15              | From Prospect Avenue, extending southeast into Broad Sound                                |
| 16              | From Hale Avenue and Undine Avenue, extending east-northeast towards Broad Sound          |
| 17              | From House of Correction Cemetery, extending northeast into Broad Sound                   |
| 18              | From just south of Deer Island Reservoir, extending east into Broad Sound                 |
| 19              | Governors Island, extending east-southeast into Boston Harbor                             |

TABLE 10 - PRECOUNTYWIDE TRANSECT DESCRIPTIONS – cont'd

| <u>TRANSECT</u> | <u>LOCATION</u>                                                                         |
|-----------------|-----------------------------------------------------------------------------------------|
| 20              | From Sumner Tunnel near North Street, extending southeast into Boston Inner Harbor      |
| 21              | From Castle Island's Fort Independence, extending east into Boston Harbor               |
| 22              | From Marine Park, extending east-southeast past Pleasure Bay and into Boston Harbor     |
| 23              | From Swallow Street, extending southeast into Dorchester Bay and out to Thompson Island |
| 24              | From west side of Columbus Park, extending east-southeast into Dorchester Bay           |
| 25              | From Dorchester Ave at Linden Street, extending east into Dorchester Bay                |
| 26              | From Spectacle Island, extending northeast into Boston Harbor                           |
| 27              | From Long Island Head, extending northeast into Massachusetts Bay                       |
| 28              | From Lovell Island, extending northeast into Massachusetts Bay                          |
| 29              | From Georges Island, extending northeast into Massachusetts Bay                         |

In Table 11, "Summary of Precountywide Coastal Analyses," the flood hazard zones and base flood elevations for each flooding source is provided, along with the 1-percent-annual-chance stillwater elevation.

TABLE 11 - SUMMARY OF PRECOUNTYWIDE COASTAL ANALYSES

| FLOODING SOURCE     | STILLWATER ELEVATIONS (feet NAVD <sup>1</sup> ) |                         |                         |                           | ZONE           | BASE FLOOD ELEVATION (feet NAVD <sup>1</sup> ) |
|---------------------|-------------------------------------------------|-------------------------|-------------------------|---------------------------|----------------|------------------------------------------------|
|                     | 10-PERCENT-ANNUAL-CHANCE                        | 2-PERCENT-ANNUAL-CHANCE | 1-PERCENT-ANNUAL-CHANCE | 0.2-PERCENT-ANNUAL-CHANCE |                |                                                |
| ATLANTIC OCEAN      |                                                 |                         |                         |                           |                |                                                |
| City of Revere      | 7.2                                             | *                       | 9.2                     | *                         | VE<br>AE       | 11.2-19.2<br>9.2-12.2                          |
| BELLE ISLE INLET    |                                                 |                         |                         |                           |                |                                                |
| City of Revere      | 7.7                                             | *                       | 8.8                     | *                         | AE             | 9.2                                            |
| BOSTON INNER HARBOR |                                                 |                         |                         |                           |                |                                                |
| City of Boston      | 8.2                                             | *                       | 9.4                     | *                         | VE<br>AE<br>AE | 11.2-13.2<br>9.2-11.2<br>9.2-10.2              |
| BOSTON HARBOR       |                                                 |                         |                         |                           |                |                                                |
| City of Boston      | 7.7                                             | *                       | 8.8                     | *                         | VE<br>AE<br>AE | 11.2-23.2<br>9.2-11.2<br>8.7                   |
|                     | 7.9                                             | *                       | 9.1                     | *                         | VE<br>AE       | 11.2<br>9.2-11.2                               |
|                     | 8                                               | *                       | 9.1                     | *                         | VE<br>AE       | 11.2-14.2<br>9.2-11.2                          |

<sup>1</sup>North American Vertical Datum of 1988

\*Data not available

TABLE 11 - SUMMARY OF PRECOUNTYWIDE COASTAL ANALYSES – cont'd

| FLOODING SOURCE        | STILLWATER ELEVATIONS (feet NAVD <sup>1</sup> ) |                         |                         |                           | ZONE | BASE FLOOD ELEVATION (feet NAVD <sup>1</sup> ) |
|------------------------|-------------------------------------------------|-------------------------|-------------------------|---------------------------|------|------------------------------------------------|
|                        | 10-PERCENT-ANNUAL-CHANCE                        | 2-PERCENT-ANNUAL-CHANCE | 1-PERCENT-ANNUAL-CHANCE | 0.2-PERCENT-ANNUAL-CHANCE |      |                                                |
| BOSTON HARBOR – cont’d |                                                 |                         |                         |                           |      |                                                |
| City of Boston         | 8                                               | *                       | 9.2                     | *                         | VE   | 13.2-27.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 9.2                                            |
|                        | 8.1                                             | *                       | 9.3                     | *                         | VE   | 13.2-20.2                                      |
|                        |                                                 |                         |                         |                           | VE   | 11.2-14.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 9.2-11.2                                       |
|                        |                                                 |                         |                         |                           | AE   | 9.2-20.2                                       |
|                        | 8.1                                             | *                       | 9.3                     | *                         | VE   | 12.2-24.2                                      |
|                        |                                                 |                         |                         |                           | VE   | 11.2-13.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 9.2-11.2                                       |
|                        |                                                 |                         |                         |                           | AE   | 9.2                                            |
|                        | 8.2                                             | *                       | 9.4                     | *                         | VE   | 14.2-24.2                                      |
|                        |                                                 |                         |                         |                           | VE   | 11.2-13.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 9.2-11.2                                       |
| BROAD SOUND            |                                                 |                         |                         |                           |      |                                                |
| City of Revere         |                                                 |                         |                         |                           |      |                                                |
| Area 1                 | 7                                               | *                       | 8.2                     | *                         | AE   | 8.2                                            |
| Area 2                 | 5                                               | *                       | 6.8                     | *                         | AE   | 7.2                                            |
| Area 3                 | 3                                               | *                       | 5.8                     | *                         | AE   | 6.2                                            |
| Area 4                 | 4.6                                             | *                       | 7.6                     | *                         | AE   | 7.2                                            |

<sup>1</sup>North American Vertical Datum of 1988

\*Data not available

TABLE 11 - SUMMARY OF PRECOUNTYWIDE COASTAL ANALYSES – cont'd

| FLOODING SOURCE        | STILLWATER ELEVATIONS (feet NAVD <sup>1</sup> ) |                         |                         |                           | ZONE | BASE FLOOD ELEVATION (feet NAVD <sup>1</sup> ) |
|------------------------|-------------------------------------------------|-------------------------|-------------------------|---------------------------|------|------------------------------------------------|
|                        | 10-PERCENT-ANNUAL-CHANCE                        | 2-PERCENT-ANNUAL-CHANCE | 1-PERCENT-ANNUAL-CHANCE | 0.2-PERCENT-ANNUAL-CHANCE |      |                                                |
| BROAD SOUND – cont’d   |                                                 |                         |                         |                           |      |                                                |
| City of Revere –cont’d |                                                 |                         |                         |                           |      |                                                |
| Area 5                 | 4.2                                             | *                       | 5.4                     | *                         | AE   | 5.2                                            |
| Area 6                 | 5                                               | *                       | 8.4                     | *                         | AE   | 8.2                                            |
| Area 7                 | 6.8                                             | *                       | 10.6                    | *                         | AE   | 10.2                                           |
| Area 8                 | 4.2                                             | *                       | 6.2                     | *                         | AE   | 6.2                                            |
| CHARLES RIVER BASIN    |                                                 |                         |                         |                           |      |                                                |
| City of Boston         | 3                                               | *                       | 3.5                     | *                         | AE   | 3.7                                            |
| CHELSEA RIVER          |                                                 |                         |                         |                           |      |                                                |
| City of Boston         | 8.3                                             | *                       | 9.6                     | *                         | AE   | 9.7                                            |
| City of Revere         | 8.5                                             | *                       | 9.8                     | *                         | AE   | 9.7-10.2                                       |
| DORCHESTER BAY         |                                                 |                         |                         |                           |      |                                                |
| City of Boston         | 8.4                                             | *                       | 9.7                     | *                         | VE   | 16.2-21.2                                      |
|                        |                                                 |                         |                         |                           | VE   | 12.2-14.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 10.2-14.2                                      |
|                        |                                                 |                         |                         |                           | AE   | 9.5                                            |
|                        |                                                 |                         |                         |                           | VE   | 14.2-24.2                                      |
|                        | 8.6                                             | *                       | 9.9                     | *                         | AE   | 9.7                                            |

<sup>1</sup>North American Vertical Datum of 1988

\*Data not available

TABLE 11 - SUMMARY OF PRECOUNTYWIDE COASTAL ANALYSES – cont'd

| FLOODING SOURCE         | STILLWATER ELEVATIONS (feet NAVD <sup>1</sup> ) |                                     |                                     |                                       | ZONE | BASE FLOOD ELEVATION (feet NAVD <sup>1</sup> ) |
|-------------------------|-------------------------------------------------|-------------------------------------|-------------------------------------|---------------------------------------|------|------------------------------------------------|
|                         | 10-<br>PERCENT-<br>ANNUAL-<br>CHANCE            | 2-<br>PERCENT-<br>ANNUAL-<br>CHANCE | 1-<br>PERCENT-<br>ANNUAL-<br>CHANCE | 0.2-<br>PERCENT-<br>ANNUAL-<br>CHANCE |      |                                                |
| DORCHESTER BAY – cont’d |                                                 |                                     |                                     |                                       |      |                                                |
| City of Boston – cont’d | 9                                               | *                                   | 10.6                                | *                                     | VE   | 13.2-15.2                                      |
|                         |                                                 |                                     |                                     |                                       | AE   | 11.2-12.2                                      |
|                         |                                                 |                                     |                                     |                                       | AE   | 10.2-24.2                                      |
|                         |                                                 |                                     |                                     |                                       | AE   | 10.7                                           |
| MASSACHUSETTS BAY       |                                                 |                                     |                                     |                                       |      |                                                |
| City of Boston          | 8                                               | *                                   | 9.2                                 | *                                     | VE   | 11.2-28.2                                      |
|                         |                                                 |                                     |                                     |                                       | VE   | 11.2-14.2                                      |
|                         |                                                 |                                     |                                     |                                       | AE   | 9.2-11.2                                       |
|                         |                                                 |                                     |                                     |                                       | AE   | 9.2-14.2                                       |
| MYSTIC RIVER            |                                                 |                                     |                                     |                                       |      |                                                |
| City of Boston          | 8.3                                             | *                                   | 9.5                                 | *                                     | AE   | 9.7                                            |
| PINES RIVER             |                                                 |                                     |                                     |                                       |      |                                                |
| City of Revere          | 7.2                                             | *                                   | 8.2                                 | *                                     | AE   | 8.2                                            |
| SAUGUS RIVER            |                                                 |                                     |                                     |                                       |      |                                                |
| City of Revere          | 7.2                                             | *                                   | 8.2                                 | *                                     | AE   | 9.2                                            |

<sup>1</sup>North American Vertical Datum of 1988

\*Data not available

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

During the course of the wave run-up analysis, shallow flooding areas were determined and delineated due to overland flow and the topography of the area.

### Countywide Analyses

No new Coastal Analyses were performed for this countywide FIS.

The transect schematic represents a sample transect that illustrates the relationship between the stillwater elevation, the wave crest elevation, the ground elevation profile, and the location of the A/V zone boundary. Figure 2, "Transect Schematic."

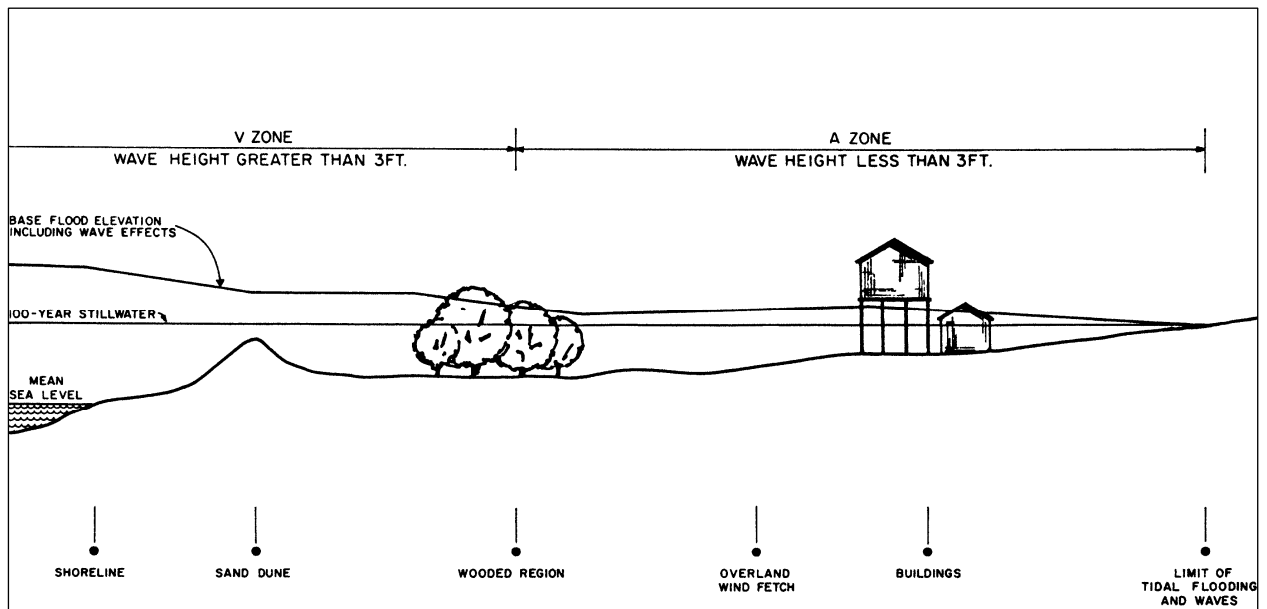


**Figure 2. Transect Schematic**

### 3.4 Vertical Datum

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

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 -0.8, and from NAVD 88 to NGVD 29 is +0.8.**

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

Vertical Network Branch, N/CG13  
National Geodetic Survey, NOAA  
Silver Spring Metro Center 3  
1315 East-West Highway  
Silver Spring, Maryland 20910  
(301) 713-3191

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 Flood Profiles and supporting data tables in the FIS report, which are shown at a minimum to the nearest 0.1 foot.

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

#### 4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The National Flood Insurance Program encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the

1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

#### 4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using topographic maps (Reference 34).

Between cross sections in Boston, the boundaries were interpolated using topographic maps at a scale of 1"=400' with a contour interval of 5 feet (Reference 7).

For Boston's tidal areas without wave action, the 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using the topographic maps at a scale of 1:1,200 with a contour interval of 5 feet (Reference 34). For Winthrop's tidal areas without wave action, the 1- and 0.2-percent-annual-chance boundaries were delineated using topographic maps at a scale of 1:2,400 with a contour interval of 5 feet (Reference 35).

For Boston's and Winthrop's tidal areas with wave action, the flood boundaries were delineated using the elevations determined at each transect; between transects, the boundaries were interpolated using engineering judgment, land-cover data, and the topographic maps referenced above. The 1-percent-annual-chance floodplain was divided into whole-foot elevation zones based on the average wave envelope elevation in that zone. Where the map scale did not permit these zones to be delineated at one foot intervals, larger increments were used (Reference 35).

In the 1984 Winthrop FIS, the boundaries were interpolated between cross-sections, using topographic maps at a scale of 1:4,800 with a contour interval of 5 feet (Reference 35).

Flood boundaries for areas in Boston studied by approximate methods were obtained from the previous October 1, 1983 FIS for the City of Boston (Reference 36). For areas in Chelsea studied by approximate methods, the boundary of the 1-percent-annual-chance flood was delineated using USGS topographic maps and a drainage study prepared for the Massachusetts Department of Public Works (References 13 and 37). In the 1984 Revere FIS, for areas of flooding studied by approximate methods, the 1-percent-annual-chance flood boundary was delineated using the topographic maps referenced above. In the Revere August 2, 2002

revision, an area of approximate flooding in the northeast corner of Revere was delineated in order to match the approximate flooding in the contiguous community of the City of Malden in Middlesex County. The delineation involved the use of topographic maps at a scale of 1:25,000 and a contour interval of 10 feet (Reference 38)

The boundaries of the 1-percent-annual-chance flood for Town Line Brook and Linden Brook in Revere have been delineated using the flood elevation of 9 ft, determined for the area downstream of U.S. Route 1. This was an elevation agreed upon by FEMA, Dewberry & Davis LLC, and Roald Haestad, Inc., after Haestad, Inc., found a flood control dike that did not meet FEMA standards. The dike was considered to be bypassed and thus the area upstream of U.S. Route 1 would be affected by coastal flooding. This area was therefore delineated to the same elevation shown for the area downstream of U.S. Route 1, which is 9 ft. The boundaries were delineated using topographic mapping at a scale of 1:480 with a contour interval of 2 feet and at a scale of 1:4,800 with a contour interval of 4 feet (References 39 and 40), and using construction drawings for developments that were constructed after the mapping was completed

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, 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 streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

#### 4.2 Floodways

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

additional floodway studies.

The floodway presented in this study was computed on the basis of equal conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the boundaries were interpolated. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown. Portions of the floodway widths of Chelsea and Revere's Mill Creek extend beyond the corporate limits. The results of the floodway computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (See Table 12).

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 12, "Floodway Data." To reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

Floodway encroachments were not determined for the Neponset River. This river is located entirely within the Neponset River Reservations. In analyzing this portion of the river using the HEC-2 program, the selected effective flow areas of the river were well inside the boundaries of the reservation. The computer was programmed not to recognize the areas of slack water beyond the effective flow limits. Therefore any encroachment up to the reservation boundary will have no appreciable effect on the river velocity or water-surface elevation. However, almost the entire land area from the banks of the Neponset River up to the 1-percent-annual-chance flood boundary has been subjected to an Order of Restriction in accordance with Chapter 131, Section 40A, of the General Laws of the Commonwealth of Massachusetts. Under this law, any permanent wetland so designated by the state cannot be built upon in any way.

The identical situation exists along the Charles River. The restricted wetlands almost completely occupy the areas inundated by the 1-percent-annual-chance flood. The areas not covered are so small that the delineation of a floodway would be useless as a functional tool to be used by the community for its floodplain management program. Therefore, no floodway has been defined for both the Neponset and Charles Rivers. Additionally, floodways were not computed for Muddy River and Stony Brook.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3, "Floodway Schematic".

In Chelsea and Revere, near the mouths of streams studied in detail, floodway computations were made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 12 for certain downstream cross sections of Mill Creek are lower than the regulatory flood elevations in that area, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

Additionally, no floodways were computed for the Town of Winthrop and no floodways extend beyond the county boundary.

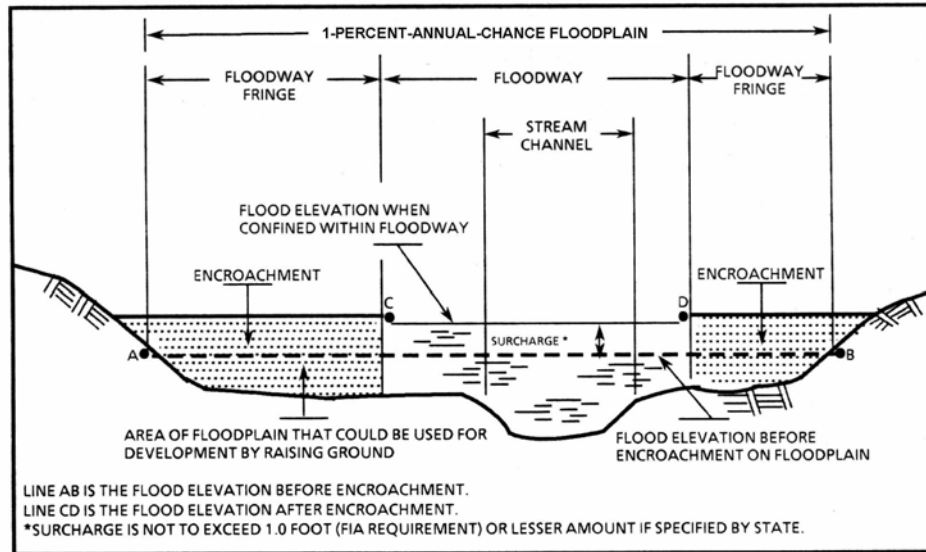


**Figure 3. Floodway Schematic**

| FLOODING SOURCE  |                       | FLOODWAY               |                                  |                                       | BASE FLOOD<br>WATER SURFACE ELEVATION<br>(FEET NAVD) |                     |                  |          |
|------------------|-----------------------|------------------------|----------------------------------|---------------------------------------|------------------------------------------------------|---------------------|------------------|----------|
| CROSS<br>SECTION | DISTANCE <sup>1</sup> | WIDTH<br>(FEET)        | SECTION<br>AREA<br>(SQUARE FEET) | MEAN<br>VELOCITY<br>(FEET PER SECOND) | REGULATORY                                           | WITHOUT<br>FLOODWAY | WITH<br>FLOODWAY | INCREASE |
| A                | 502                   | 310 / 210 <sup>2</sup> | 2561                             | 0.9                                   | 9.8                                                  | 4.1 <sup>3</sup>    | 5.1              | 1.0      |
| B                | 1447                  | 140 / 40 <sup>2</sup>  | 753                              | 3.1                                   | 9.8                                                  | 4.1 <sup>3</sup>    | 5.1              | 1.0      |
| C                | 2777                  | 120 / 100 <sup>2</sup> | 951                              | 2.4                                   | 12.5                                                 | 12.5                | 12.5             | 0.0      |
| D                | 3305                  | 80 / 60 <sup>2</sup>   | 897                              | 2.6                                   | 12.6                                                 | 12.6                | 12.6             | 0.0      |
| E                | 4572                  | 90 / 20 <sup>2</sup>   | 786                              | 2.9                                   | 13.0                                                 | 13.0                | 13.5             | 0.5      |

<sup>1</sup> FEET ABOVE CONFLUENCE WITH CHELSEA RIVER

<sup>2</sup> WIDTH/WIDTH WITHIN SUFFOLK COUNTY

<sup>3</sup> ELEVATION COMPUTED WITHOUT CONSIDERATION OF TIDAL FLOODING FROM CHELSEA RIVER

|          |                                           |               |
|----------|-------------------------------------------|---------------|
| TABLE 12 | FEDERAL EMERGENCY MANAGEMENT AGENCY       | FLOODWAY DATA |
|          | SUFFOLK COUNTY, MA<br>(ALL JURISDICTIONS) | MILL CREEK    |

| FLOODING SOURCE  |                       | FLOODWAY        |                                  |                                       | BASE FLOOD<br>WATER SURFACE ELEVATION<br>(FEET NAVD) |                     |                  |          |
|------------------|-----------------------|-----------------|----------------------------------|---------------------------------------|------------------------------------------------------|---------------------|------------------|----------|
| CROSS<br>SECTION | DISTANCE <sup>1</sup> | WIDTH<br>(FEET) | SECTION<br>AREA<br>(SQUARE FEET) | MEAN<br>VELOCITY<br>(FEET PER SECOND) | REGULATORY                                           | WITHOUT<br>FLOODWAY | WITH<br>FLOODWAY | INCREASE |
| A                | 300                   | 45              | 187                              | 7.8                                   | 43.1                                                 | 43.1                | 43.1             | 0.0      |
| B                | 750                   | 52              | 324                              | 4.5                                   | 43.4                                                 | 43.4                | 43.4             | 0.0      |
| C                | 950                   | 50              | 322                              | 4.6                                   | 43.6                                                 | 43.6                | 43.6             | 0.0      |
| D                | 1,100                 | 64              | 414                              | 3.6                                   | 43.8                                                 | 43.8                | 43.8             | 0.0      |
| E                | 1,233                 | 64              | 415                              | 3.5                                   | 43.8                                                 | 43.8                | 43.8             | 0.0      |
| F                | 1,600                 | 60              | 321                              | 4.6                                   | 43.9                                                 | 43.9                | 43.9             | 0.0      |
| G                | 2,050                 | 60              | 379                              | 3.9                                   | 44.6                                                 | 44.6                | 44.8             | 0.2      |
| H                | 2,725                 | 153             | 646                              | 2.3                                   | 45.6                                                 | 45.6                | 45.8             | 0.2      |
| I                | 4,095                 | 84              | 186                              | 7.9                                   | 48.5                                                 | 48.5                | 48.5             | 0.0      |
| J                | 5,000                 | 200             | 1445                             | 1.0                                   | 49.9                                                 | 49.9                | 49.9             | 0.0      |
| K                | 6,000                 | 147             | 1036                             | 1.4                                   | 49.9                                                 | 49.9                | 49.9             | 0.0      |
| L                | 7,130                 | 102             | 728                              | 2.0                                   | 50.1                                                 | 50.1                | 50.2             | 0.1      |

<sup>1</sup> FEET ABOVE CONFLUENCE WITH NEPONSET RIVER

|          |                                           |               |
|----------|-------------------------------------------|---------------|
| TABLE 12 | FEDERAL EMERGENCY MANAGEMENT AGENCY       | FLOODWAY DATA |
|          | SUFFOLK COUNTY, MA<br>(ALL JURISDICTIONS) | MOTHER BROOK  |

## 5.0 INSURANCE APPLICATIONS

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

### Zone A

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

### Zone AH

Zone AH is the flood insurance rate zone that corresponds to areas of 1-percent-annual-chance shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

### Zone AO

Special Flood Hazard Areas inundated by types of 1-percent-annual-chance flood shallow flooding, where depths are between 1 and 3 feet. Depths are shown within this zone

### Zone V

Zone V is the flood insurance rate zone that corresponds to the 1-percent annual chance coastal floodplains that have additional hazards associated with storm waves. Because approximate hydraulic analyses are performed for such areas, no BFEs 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 BFEs 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 500-year floodplain, areas within the 0.2-percent annual chance floodplain, and 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 BFEs 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 BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Suffolk County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 13, "Community Map History."

| COMMUNITY NAME                  |                                                                                      | INITIAL IDENTIFICATION | FLOOD HAZARD<br>BOUNDARY MAP<br>REVISION DATE(S) | FLOOD INSURANCE<br>RATE MAP<br>EFFECTIVE DATE | FLOOD INSURANCE<br>RATE MAP<br>REVISION DATE(S)     |
|---------------------------------|--------------------------------------------------------------------------------------|------------------------|--------------------------------------------------|-----------------------------------------------|-----------------------------------------------------|
| Boston, City of                 |                                                                                      | November 22, 1974      | February 11, 1977<br>June 7, 1977                | April 1, 1982                                 | October 1, 1983<br>November 2, 1990<br>July 2, 1992 |
| Chelsea, City of                |                                                                                      | June 7, 1974           | December 27, 1974                                | August 2, 1982                                | N/A                                                 |
| Revere, City of                 |                                                                                      | June 28, 1974          | February 18, 1977                                | October 16, 1984                              | August 20, 2002                                     |
| Winthrop, Town of               |                                                                                      | June 28, 1974          | None                                             | October 8, 1976                               | August 15, 1984<br>July 2, 1992                     |
|                                 |                                                                                      |                        |                                                  |                                               |                                                     |
| T<br>A<br>B<br>L<br>E<br><br>13 | FEDERAL EMERGENCY MANAGEMENT AGENCY<br><br>SUFFOLK COUNTY, MA<br>(ALL JURISDICTIONS) |                        |                                                  | COMMUNITY MAP HISTORY                         |                                                     |

## 7.0 OTHER STUDIES

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Suffolk County 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 Suffolk County.

Suffolk County is bordered by Essex County, MA to the north, Norfolk County, MA to the south, and Middlesex County, MA to the west. At the time of this revision, all of these counties were either undergoing revisions or were known to have revisions in the future. They will all be in agreement with this countywide FIS.

Due to its highly developed state, the City of Boston has been subject to numerous flood-related studies as a result of construction proposals, waterway improvements, water quality assessments and flood plain management studies.

The Charles River and the lower Charles River Basin have been extensively studied by the USACE, SCS, and C. E. Maguire, Inc., as a result of its serious flood problems (References 8, 10 and 18). Elevations for the floods of the selected recurrence intervals, discharge data, inflow hydrographs and other pertinent hydrologic and hydraulic data were adopted into this countywide FIS, as were flood elevations for the Muddy River.

Flood elevations for the Neponset River and Mother Brook were coordinated with detailed studies done in 1971 and 1973 (References 17 and 41). Elevations were coordinated with the FISs of the surrounding Cities of Quincy and Newton, and Towns of Milton, Dedham, Needham, Brookline, and Winthrop (References 9, 11, and 42-46).

Tidal elevations for Boston Harbor was coordinated with the frequency curve developed by the USACE for the tidal gage at Commonwealth Pier, and were checked with historical elevations recorded by the USGS during the flood of February 1978 (Reference 25).

The Flood Hazard Boundary and Flood Insurance Rate Maps for the 1983 Boston FIS were prepared on topographic maps of Boston provided by the Boston Redevelopment Authority (Reference 34). Although these represented the best available maps at the time, they were 15 years old, and a number of areas may have been out of date, causing inaccuracies in the flood boundary delineations. The analyses prepared for the 1990 Boston FIS, and included as part of this countywide study, included a more detailed and up-to-date coastal analysis than the FISs for Milton and Quincy (Norfolk County). Therefore, BFEs and transect data computed and shown in this countywide study may differ from the results of those previous studies. Because of the increased pumping capacity of the New Charles River Dam, the flood elevations for the Charles River Basin included in this study are lower than those computed in the Newton FIS (Middlesex County). Also, the flood boundaries delineated for the Charles River at the Boston-Newton corporate limits in this countywide study do not agree with those shown in the Newton FIS because more detailed topographic maps were used in this study than in the previously published study. Flood elevations for Mother Brook at the Boston-Dedham corporate limits are slightly higher in this study than in the Dedham FIS because of more up-to-date hydraulic analyses.

In Chelsea, a drainage study of Mill Creek was performed for the Massachusetts Department of Public Works in 1975 (Reference 13). The purpose of the study was to analyze the causes of frequent flooding at the housing project near Mill Creek upstream of U. S. Route 1. Discharges related to the drainage study were compared to discharges developed by a Massachusetts regional equation (Reference 47). The differences between the values determined by the two methods were so great that a third method was applied. A SCS method derived for small watersheds was incorporated to develop additional flow values (Reference 48). The 1-percent-annual-chance discharge determined by the SCS method was very similar to that developed for the drainage study. As the SCS method may not be appropriate for such extensively urbanized watersheds, the values from the drainage study were adopted for the hydraulic analysis in this countywide study.

In Revere, the flood water-surface elevation selected for the remapping of Town Line Brook does impact the contiguous communities of Malden and Everett (Middlesex County). The flood limits in both of the contiguous communities have also been remapped under the 2002 Revere FIS revision.

Using National Ocean Survey tide gage data, the USACE has predicted 10-, 2, 1, and 0.2-percent-annual-chance flood levels at Boston, Massachusetts, and Portsmouth, New Hampshire. The predictions compare favorably with flood levels determined for Winthrop in view of the distance between Winthrop and the National Ocean Survey gaging stations.

## 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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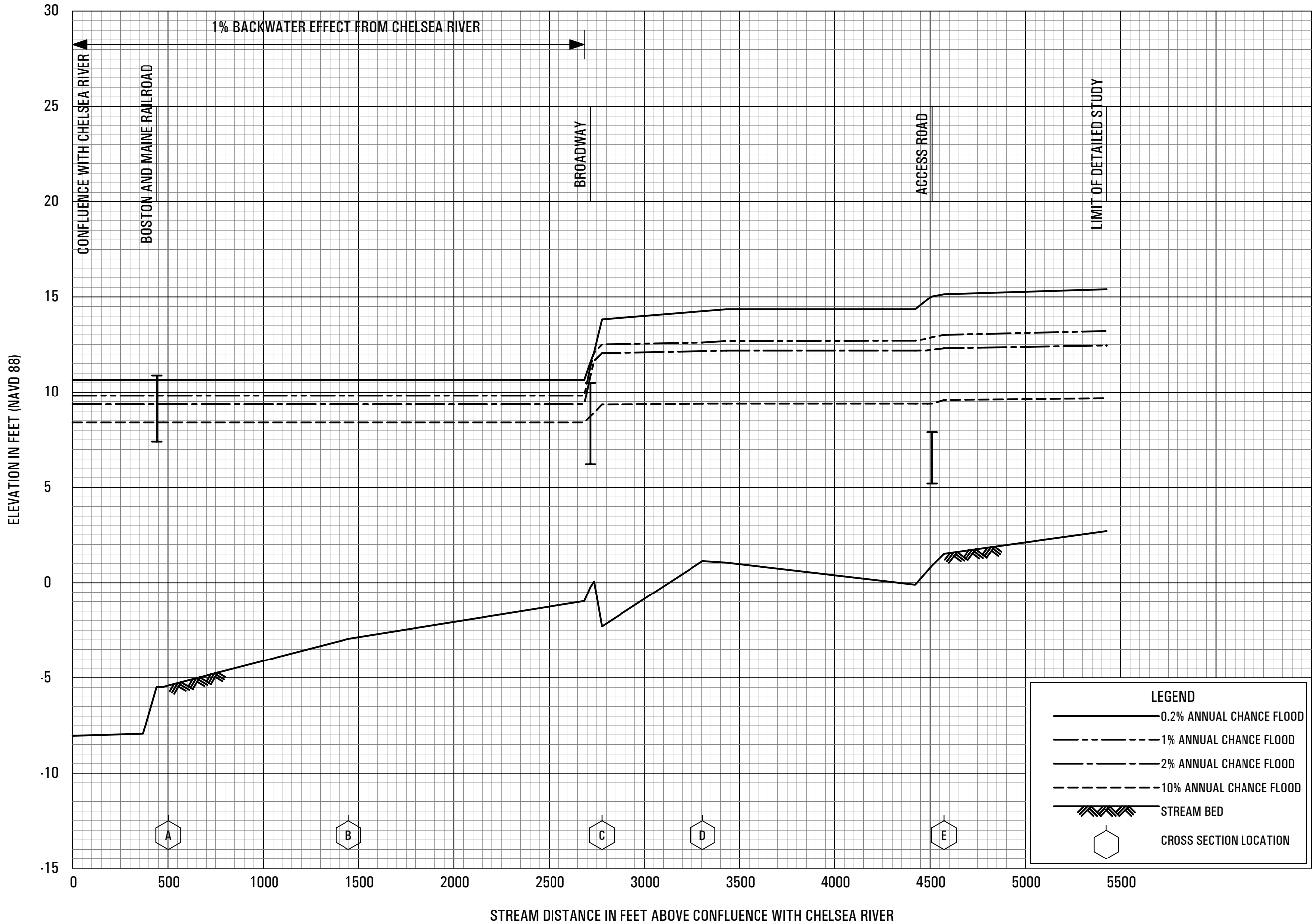










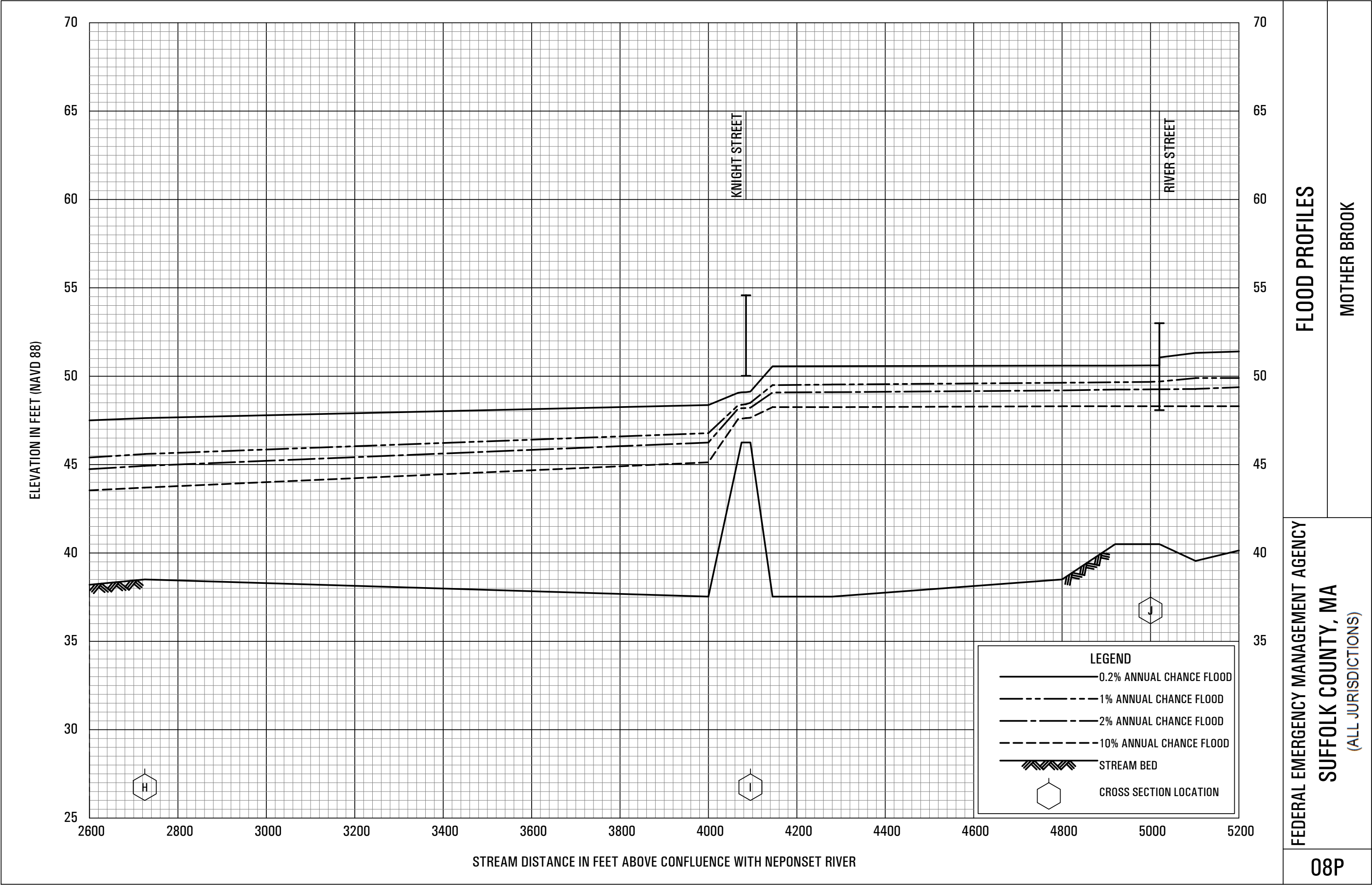


FLOOD PROFILES

MILL CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY  
SUFFOLK COUNTY, MA  
(ALL JURISDICTIONS)





FLOOD PROFILES

MOTHER BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

SUFFOLK COUNTY, MA

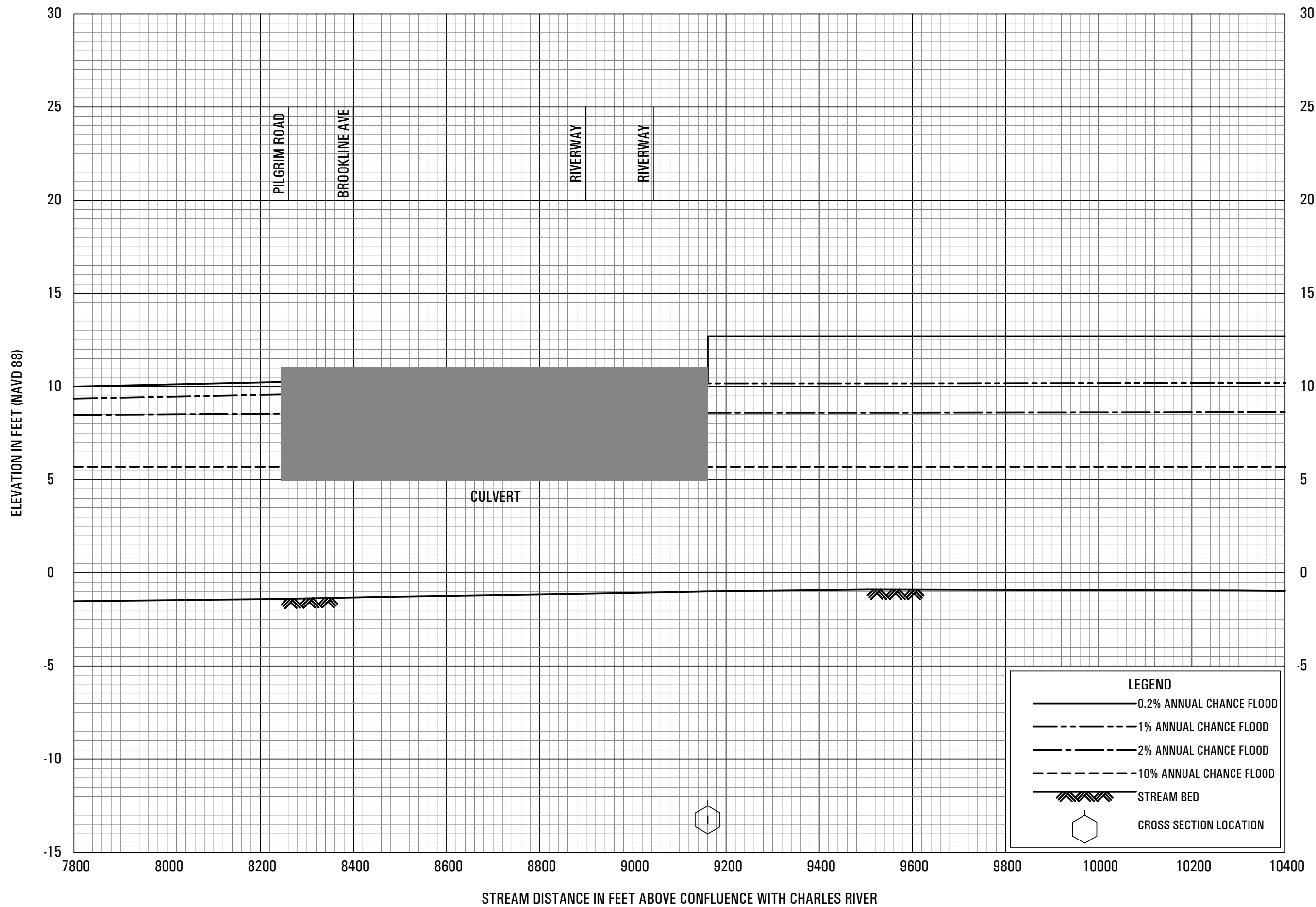
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## FLOOD PROFILES

**MUDDY RIVER**

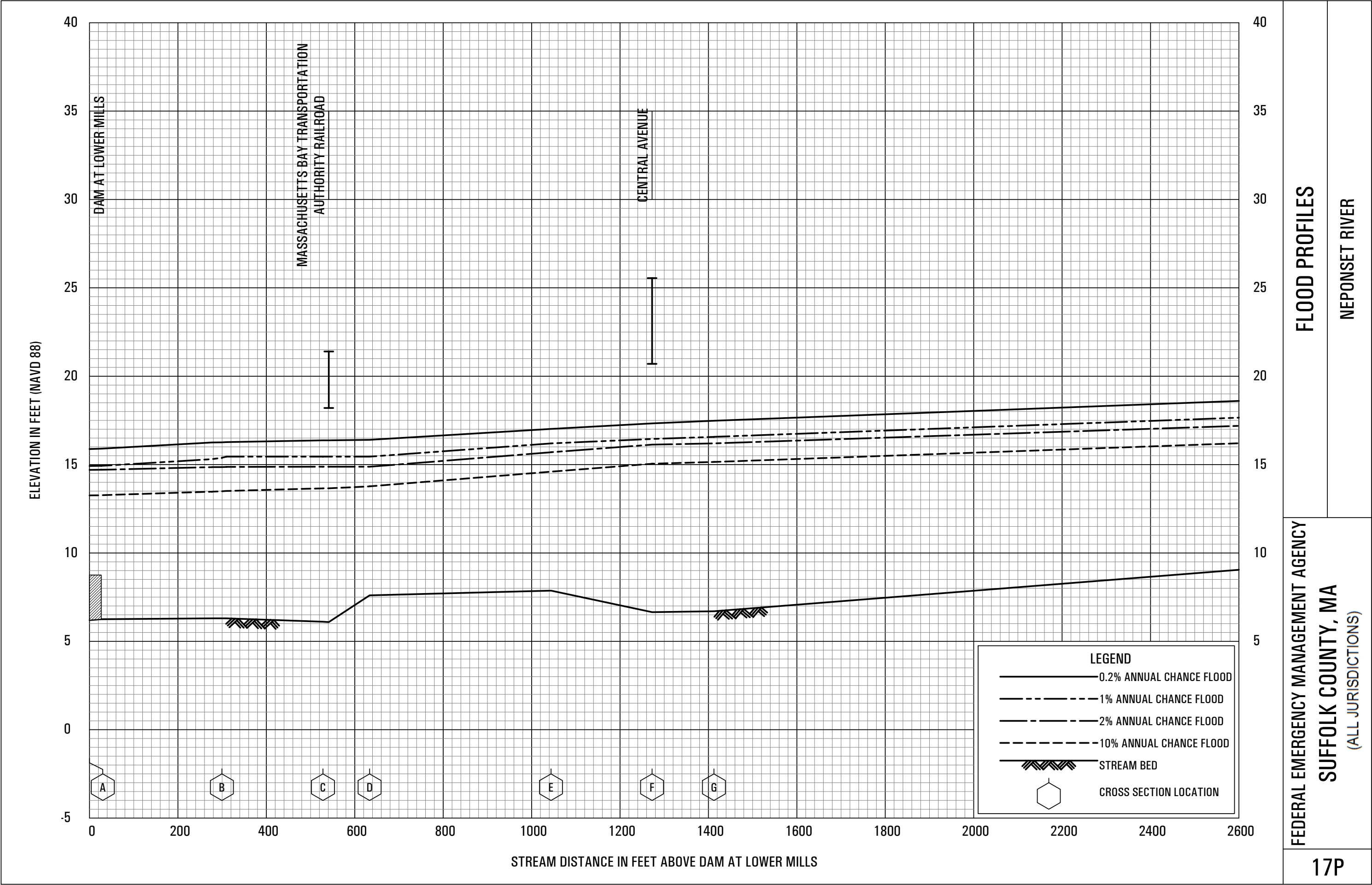
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**SUFFOLK COUNTY, MA**  
**(ALL JURISDICTIONS)**

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FLOOD PROFILES

NEPONSET RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

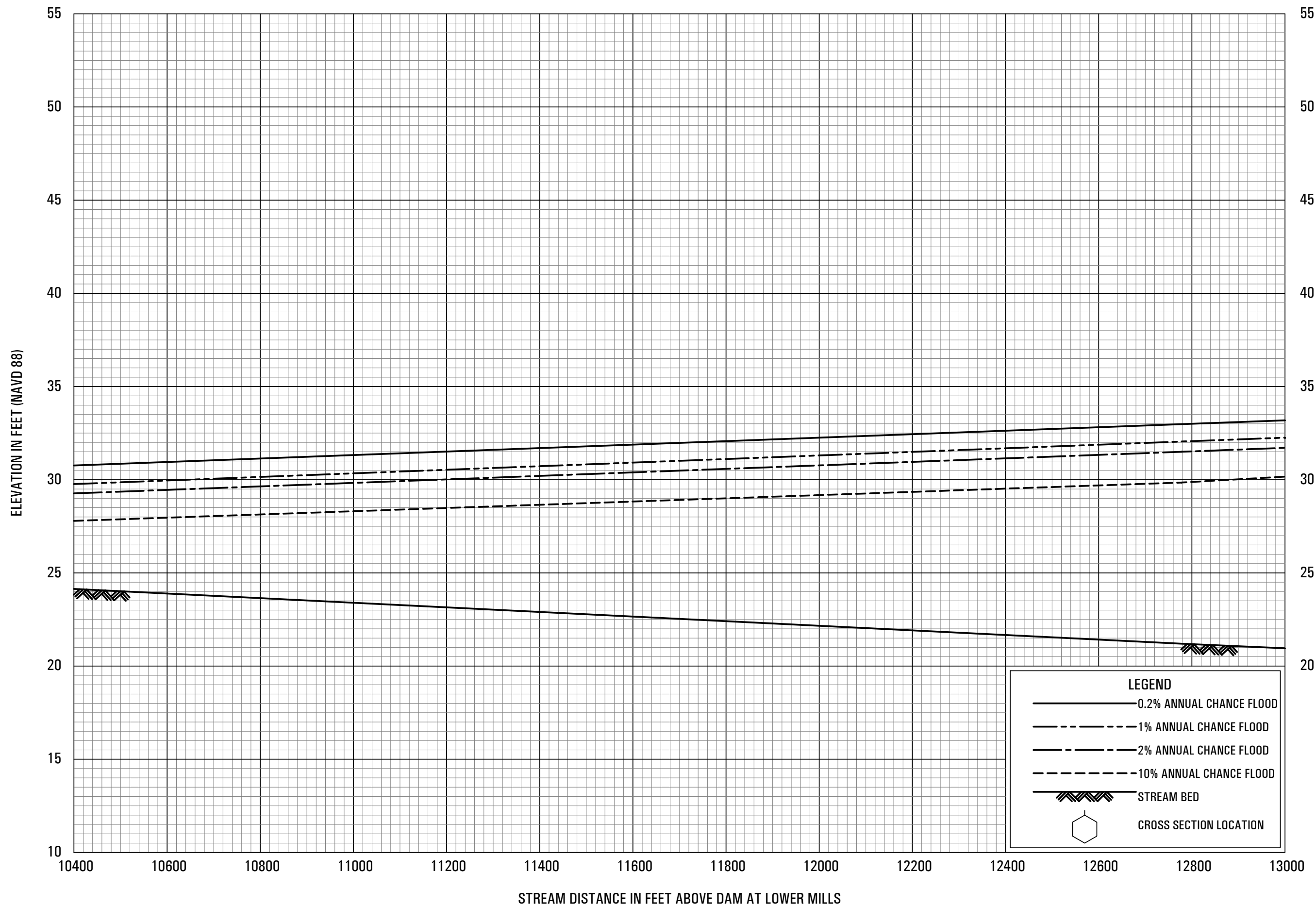
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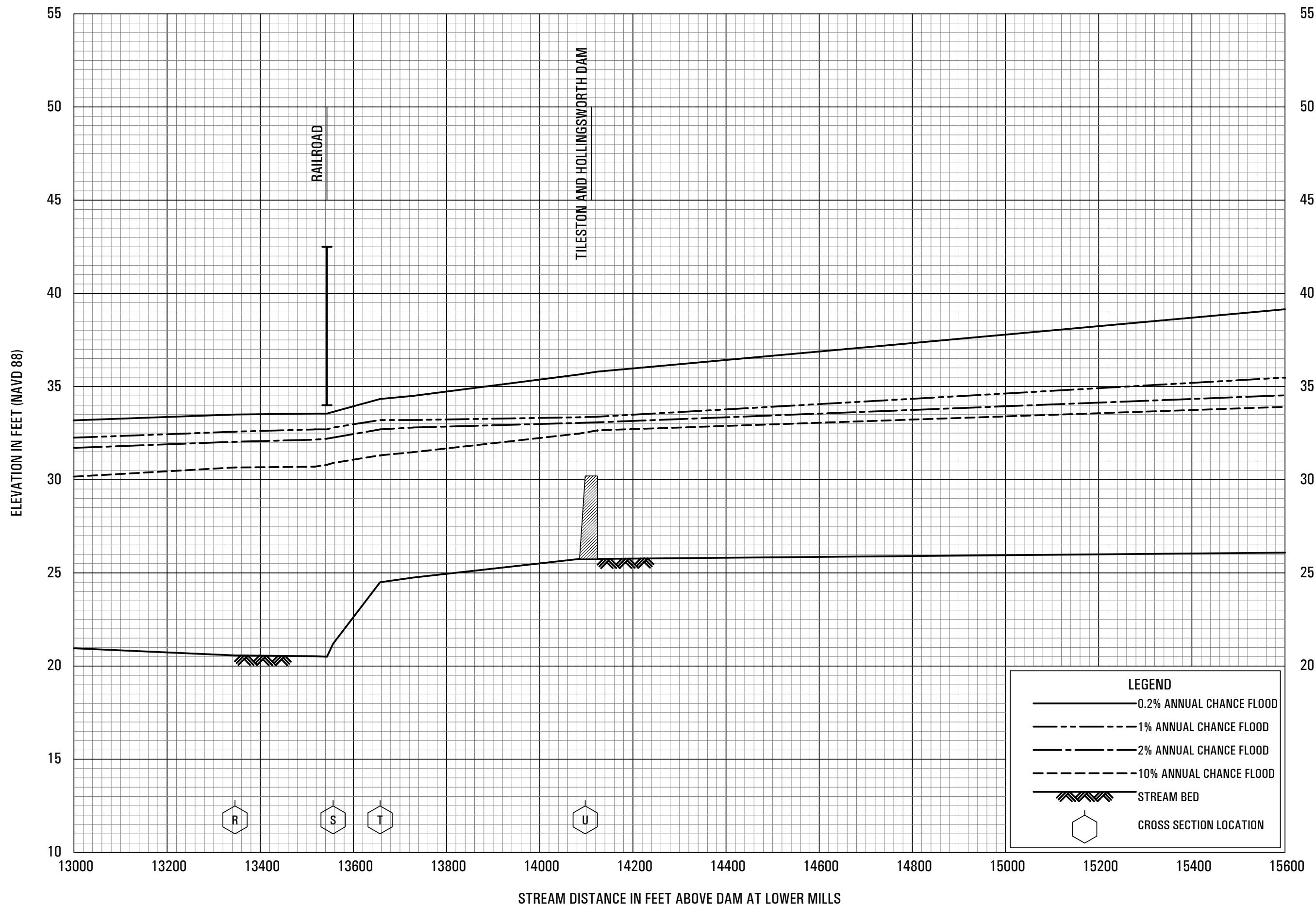
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**FEDERAL EMERGENCY MANAGEMENT AGENCY**

**SUFFOLK COUNTY, MA**

(ALL JURISDICTIONS)

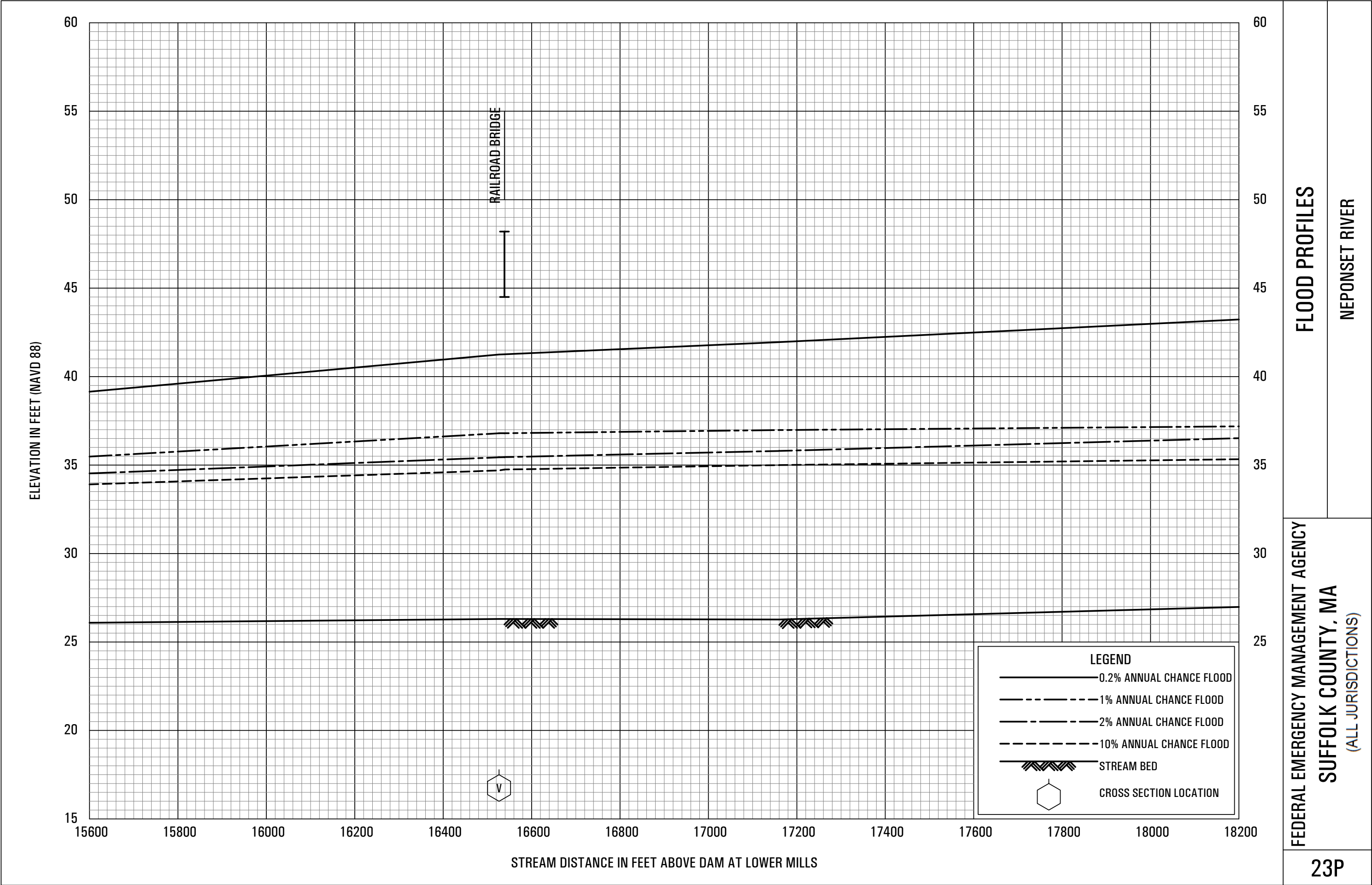
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# FLOOD PROFILES

# NEPONSET RIVER

**FEDERAL EMERGENCY MANAGEMENT AGENCY  
SUFFOLK COUNTY, MA  
(ALL JURISDICTIONS)**



FLOOD PROFILES

NEPONSET RIVER

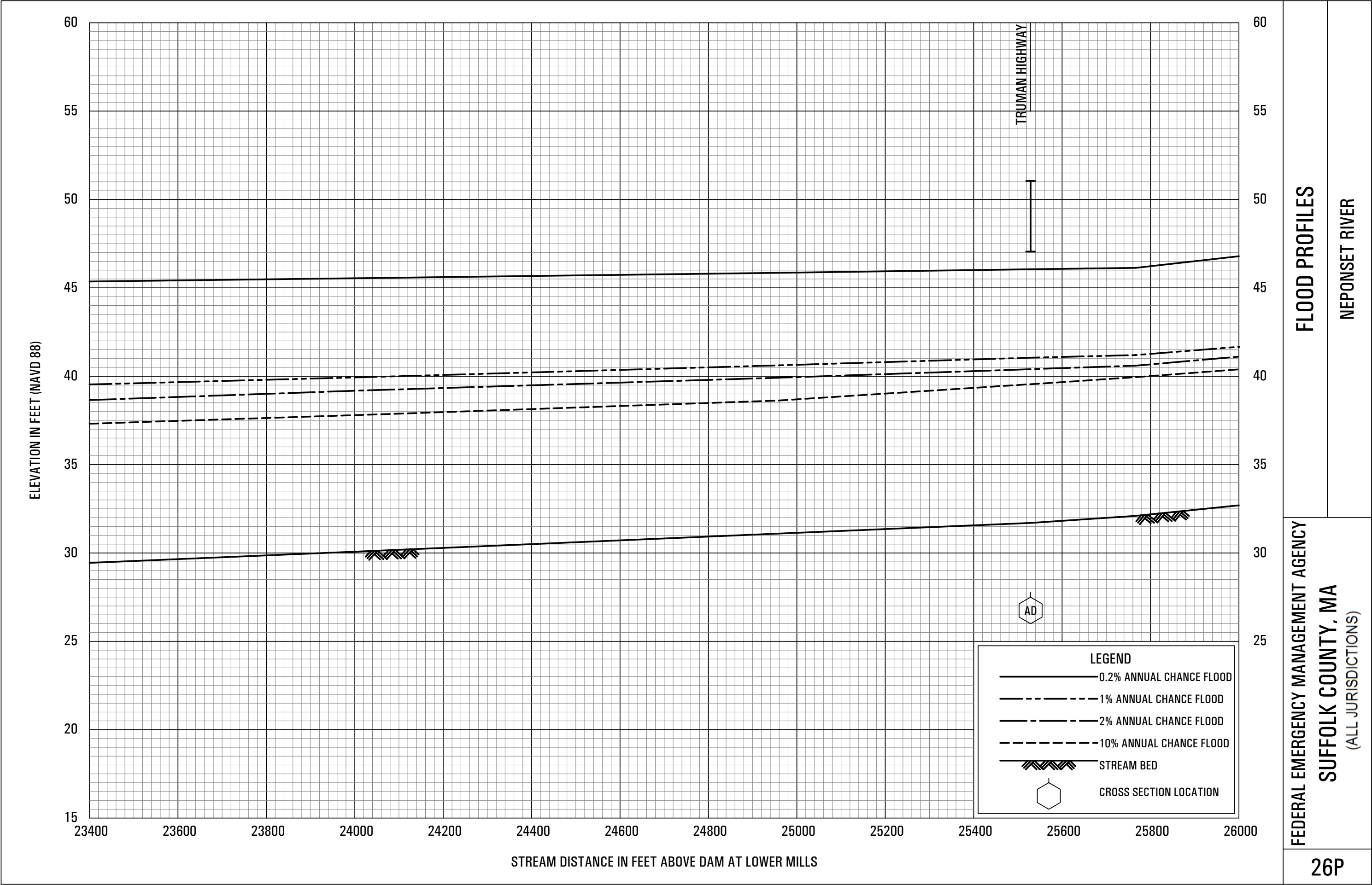
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SUFFOLK COUNTY, MA

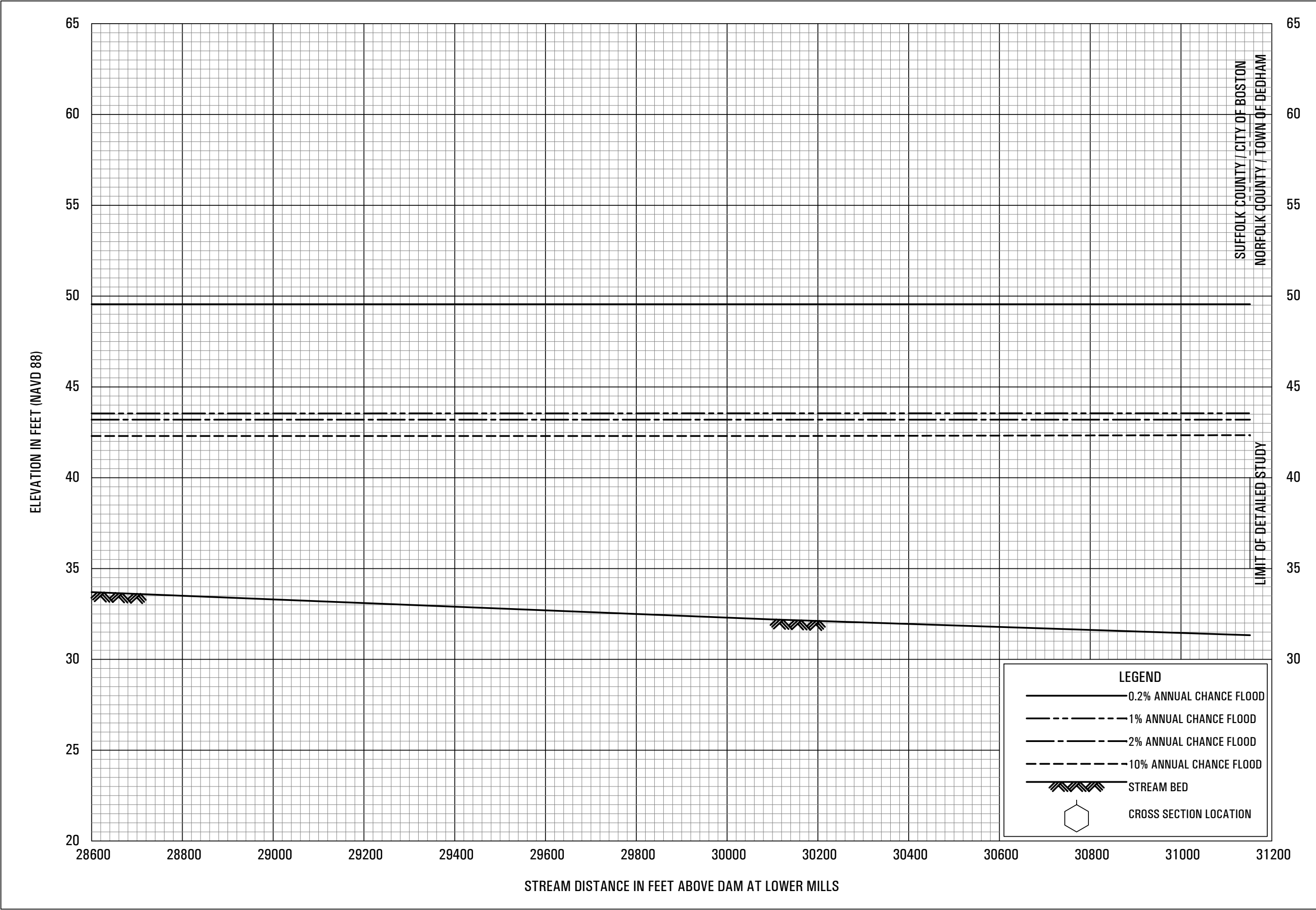
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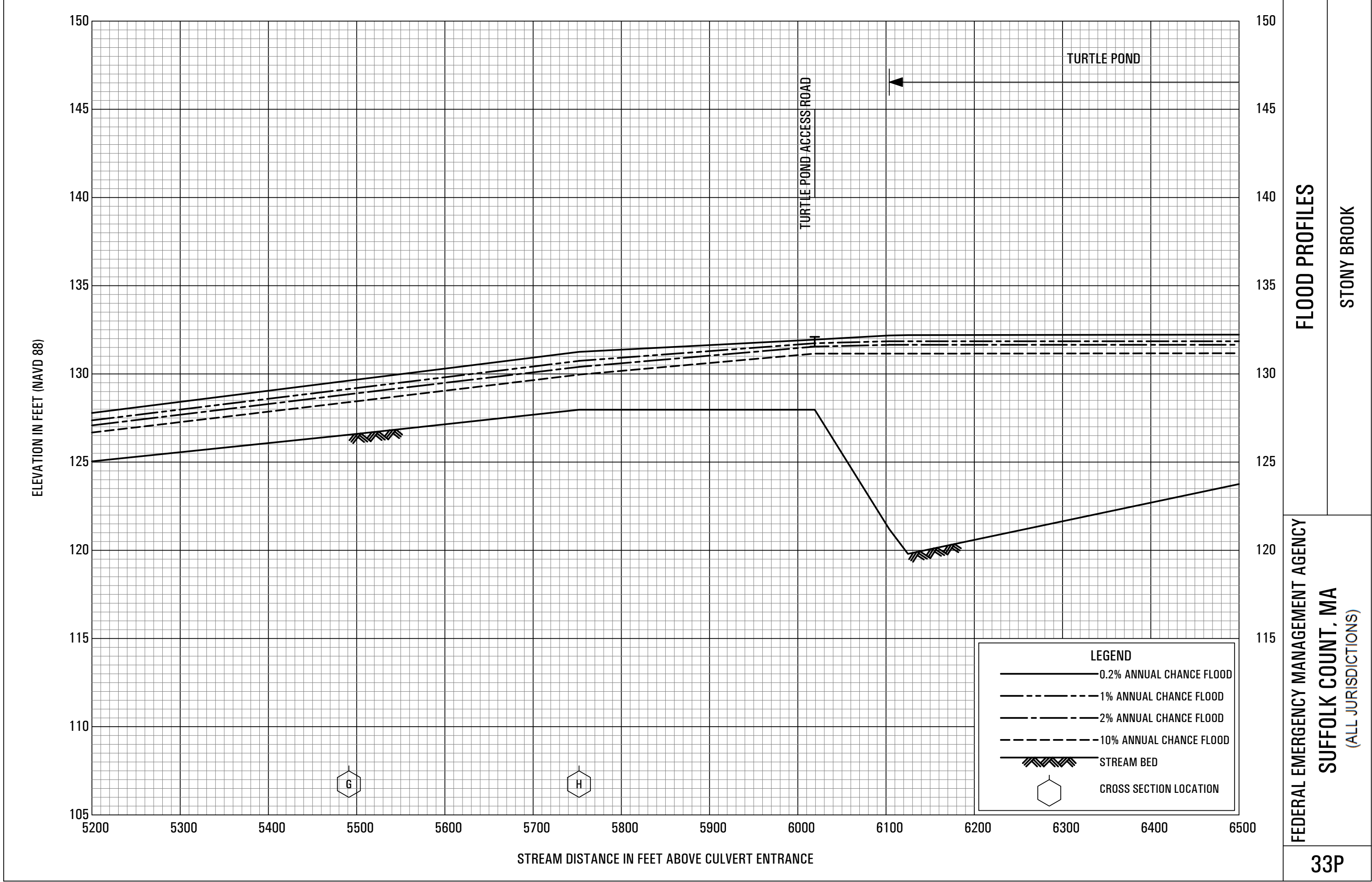












FLOOD PROFILES

STONY BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY  
SUFFOLK COUNT, MA  
(ALL JURISDICTIONS)

