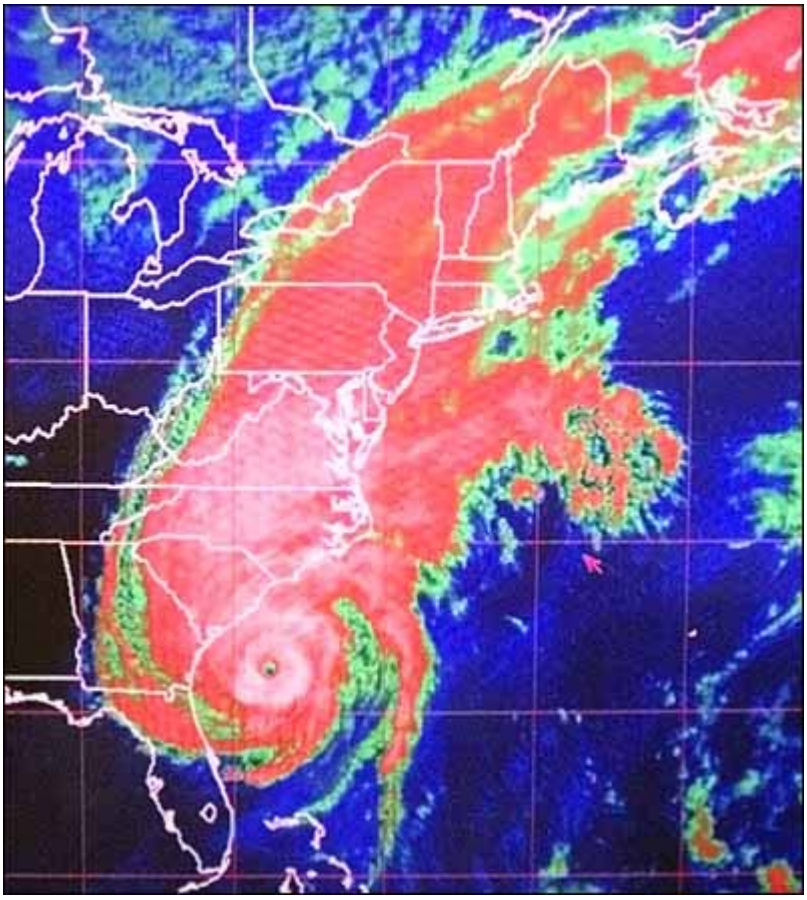
Town of Plymouth
Flood Management Plan



September 2001

Amended September 2009

Section I
Flood Management Plan

TABLE OF CONTENTS

I. Introduction

Plymouth participates in the Federal Emergency Management Agency's Flood Insurance Program. The Federal Emergency Management Agency (FEMA) provides flood insurance to homeowners and businesses located in flood and erosion prone areas. FEMA is the only source of flood insurance. It is important for the Town to participate in FEMA's Community Rating System for residents to be eligible for flood insurance. In addition, the Town maintains a program that gives policyholders a five- percent reduction in the cost of flood insurance. Plymouth has participated in this program for since 1986.

In 1996, FEMA notified Plymouth that more than 10 properties have filed multiple claims for property damaged in the past 18 years. Therefore, the Town must participate in a "repetitive loss program". This program requires yearly notification of residents in repetitive loss areas (Long Beach, Saquish, and White Horse Beach) that they are in a flood prone area and should apply for flood insurance. Flood information was mailed to hundreds of property owners in these areas and continues to be mailed each year.

The Town continues to amend the coastal Flood Management Plan to address concerns for property severely threatened by coastal erosion and coastal flooding. More aggressive and proactive goals for flood and erosion hazard mitigation are being pursued. A new area of concern, coastal bluff erosion, is now being addressed. The plan also includes an action plan identifying long- and short-range measures to better protect Plymouth's coastal residents.

In the spring of 1999, the Flood Hazard Community Planning Team (FHCPT) was assembled and appointed by the Town Manager. The FHCPT held two public hearings on March 22, 1999 and on May 19, 1999. Both meetings were well attended. A number of valuable suggestions were made. The public was also invited to submit comments in writing if they were unable to attend the public hearings. Flood management strategies were also discussed at several public meetings scheduled with various boards and committees throughout the Town. The updated Open Space and Recreation Plan identifies similar goals in preserving open areas that may promote better flood management objectives. Flood management brochures have been mailed to various citizens, civic groups and organizations, and businesses.

The Flood Hazard Community Planning Team (FHCPT) consisted of the following members:

John F. Lenox, AICP
Director of Planning & Development

Douglas Hatfield
Emergency Preparedness

Lee Hartmann

Assistant Town Manager

Richard Manfredi
Building Commissioner

Leighton Peck
Director of Public Works

In the spring of 2000 at an advertised public meeting, the draft plan was presented to the Board of Selectmen. Following that hearing, the Department of Planning and it's consultant, ENSR, finalized the Flood Management Plan. The Board of Selectmen, serving as the executive governing body of the Town of Plymouth, adopted this Flood Management Plan.

The plan includes an action plan of steps the town will take reduce losses in flood areas. This document has been prepared to qualify as Plymouth's Flood Management Plan and to be credited under the Community Rating System (CRS) of the National Flood Insurance Program (NFIP).

As part of the adoption process the Board of Selectmen appointed the following implementation group. This group is charged with implementing the recommendations outlined and developing procedures for up-dating and revising this plan.

Lee Hartmann, AICP
Director of Planning & Development

Elizabeth Sullivan
Conservation Planner

Aaron Wallace
Emergency Preparedness

Paul McAuliffe
Director of Inspectional Services

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Director of Public Works

The Town has also identified other departments and committees that will assist the implementation group and serve as contingency groups in the event of an emergency. The Fire Department and Police Department, as always, serve the public during emergencies and their influence on the plan and action steps is vital.

The various departments and committees that were, and remain included in the process of developing the Flood Management Plan include the following:

- ☑ Planning Board
- ☑ Parks and Recreation Department
- ☑ Water Division
- ☑ Chamber of Commerce
- ☑ Plymouth Redevelopment Authority
- ☑ Downtown-Waterfront consultants
- ☑ Harbor Master
- ☑ Rural Task Force
- ☑ Master Plan Task Force

In 2006 FEMA updated the existing Flood Insurance Rate maps for the Town of Plymouth. The revised maps were adopted at the annual Fall Town meeting in 2006 and became effective December 19, 2006.

In addition, the Town through the Board of Selectmen must adopt a "Flood Management Plan". The plan must include an action plan of steps the town will take to reduce losses in flood areas. This document is Plymouth's Flood Management Plan.

II. Floodplain Areas of Plymouth

There are two types of floodplain areas in Plymouth, inland and coastal. Inland floodplains are associated with isolated kettle ponds or with one of the six major river watersheds. Coastal floodplains are areas subject to flooding from ocean storm surges.

A 100-year floodplain is an area that on average is expected to have a 1-% chance of being flooded in any given year. For example, during the life of a 30-year mortgage there is a 30% chance that the property will be flooded. These flood areas are mapped by the Federal Emergency Management Agency (FEMA). The maps can be examined at the Office of Planning and Development at the Town Hall, 11 Lincoln Street.

In most cases the kettle pond floodplains are within a few feet of an actual water body. Kettle ponds are kettleholes created by glaciers and filled with water. The water level of these ponds is also the level of the area's water table. In other words, these ponds are exposed portions of Plymouth's aquifer. They generally do not have inlets or outlet. The level of the ponds fluctuates with the level of the aquifer. The second type of inland floodplains are floodplains associated with river systems. A river system consists of several ponds connected by a series of rivers. Plymouth's major river or river systems are the Eel River, Beaver Dam Brook, Indian Brook, Herring River, Agawam River, Wankinco River, Crane Brook and Town Brook. The watershed areas for these areas can be large. As

rainwater falls these rivers are charged with water runoff from roads, structures and adjacent hillsides. As a rain event continues, the river is not able to discharge the water as quickly as the water is entering and the level of the stream rises causing adjacent low lying areas to flood.

This type of flooding is a major concern in other communities. However, in Plymouth the potential for such flooding is minimal. Since 1978, there have no multiple damage claims for properties in these areas. Based on this information, Plymouth's Flood Management Plan will focus on the coastal locations where repetitive losses have occurred.

Plymouth has approximately 36.9 miles of tidal shoreline. Most of the coastal development has occurred on coastal banks and is therefore located outside of the floodplain. Coastal banks of 50, 100, and 150 feet are common. Plymouth's coastline is subject to flooding from storm surges caused by hurricanes and northeasters. Some of the low-lying coastal areas are protected from damage from waves, however, the buildup of stormwaters (wave upon wave) causes high flood levels throughout the coastline.

Northeasters are the primary cause of flooding in Cape Cod Bay. A northeaster travels in a northeasterly path along the Atlantic coast, collecting moisture from the ocean and sending it inland with the northeast wind. A northeaster differs from a hurricane in area effected and duration. A northeaster covers a larger area and its winds are less intense than a hurricane. It also travels at a slower rate resulting in a longer duration and prolonged wave action. A northeaster may last for several days. A hurricane can have very high winds but is fast moving and passes within several hours. In addition, northeasters often last long enough to be accompanied by one or more high tide events, which can cause severe flooding conditions. Coastal structures located above flood levels can still be severely damaged by wave run-up, wave-induced erosion, and wave-borne debris. Hurricanes have high winds, storm surges, and heavy rainfall. Hurricanes have winds in excess of 74-mph. Six to twelve inches of rainfall generally fall during a hurricane.

III. Coastal Flooding History

On February 9, 1978 the coast of Plymouth was struck by the “Blizzard of 78”. The blizzard of 1978 is an extreme example of a northeaster. The blizzard caused heavy damage along the entire Massachusetts coast. It had winds gusting to 70 miles per hour (mph), sustained wind speeds of 40-mph, and lasted over several high tides. The Blizzard of 1978 is an excellent example of a 100-year storm event. The storm generated flood levels ranging from 11.9 to 21.1 feet in exposed coastal locations. The blizzard caused $6,182,800.00 in property damage.

Several other large northeasters have occurred since 1978. The largest was on October 30, 1991, commonly referred to as the “Halloween storm” or “the perfect storm”. On that date, rainfall of 0.34 inches was reported at the National Weather Service in Taunton. A high tide of 9.4 feet occurred in conjunction with three days of 26-mph winds. A number of structures in Plymouth were damaged during this storm.

Another storm commonly referred to as the "the Blizzard of 92” occurred on December 12, 1992. This storm was not as powerful as the other storms but also caused a significant amount of damage. There was 2.47 inches of rainfall and a high tide of 9.4 feet. Wind speeds were 31- mph and 12 to 25 foot waves were reported.

More recently the Blizzard of 2005 occurred on January 23, 2005. This storm event dropped approximately 38 inches of snow in Plymouth. Wind gusts topped 80 miles an hour along the coastline.

In 2007 the “Patriot’s Day Storm” began on April 15, 2007 and lasted for 3 days. Each day the storm caused severe flooding in the coastal areas of Plymouth. Route 3A at the entrance to Plymouth Long Beach was closed due to the significant flooding and high tide event. This storm caused extensive damages to many coastal properties.

In addition to these most recent storms Plymouth has experience a number of significant storm events. The following table describes several of Plymouth's largest storms.

Historic Storms affecting Plymouth

Date	Water level	Description
August 15, 1635	Water levels rose 20 feet.	This hurricane was the first storm recorded in New England. It was described by William Bradford.
February 24, 1722	Water levels rose 15 feet, 4 inches above low water.	This storm was a northeaster.
January 1, 1778	Unknown	Known as the "Magee Storm", it occurred during the highest tides reported in the previous 50 years.
April 17, 1851	Water levels rose 14 feet, 9 inches above mean low water.	Known as the "Monot's Gale", it caused extensive coastal flooding.

Date	Water Level	Description
April 12-24 1888	Unknown	The "Blizzard of 88", northeaster, produced extremely high tides.
November 26, 1898	Water levels rose 14 feet above mean low water.	Known as the "Portland Gale", it was one of the most destructive storms to hit Plymouth. It had wind speeds of 60 to 80 mphs. The steamship Portland was lost off the coast during this storm.
December 26, 1909	Water levels rose 5 feet above mean low water.	This storm was a northeaster.
March 3-4 1927	Unknown	A petigrean spring tide with on-shore winds of 21 to 49 mph.
September, 1938	Water levels rose 5 feet above mean high water.	This hurricane claimed 187 lives and caused major flooding throughout New England. Wind speeds of 186 mph were recorded.
February, 1940	Unknown	This storm was a northeaster.
April 21, 1940	Water levels rose 13 feet, 8 inches above mean high water.	This storm lasted for 31 hours and had winds in excess of 30 mph. The event occurred during a perigean spring tide.
September 14-15, 1944	Unknown	This hurricane had 80 to 104 mph winds.
November 28-30, 1945	Water levels rose 12 feet, 5 inches above mean low water.	This storm had sustained on-shore winds combined with a perigean spring tide. There was significant damage to shorefront property. Coastal erosion of 15 feet was reported.

Date	Water Level	Description
August 31 – September 1, 1954	Unknown	Known as Hurricane Carol, it had winds in excess of 100 mph. It caused significant damage along the south shore.
September 11, 1954	Unknown	Known as Hurricane Edna, it also had wind speeds in excess of 100 mph and also caused significant damage.
December 29, 1959	The water level rose 15 feet above mean low tide and was 2.5 feet above normal in Boston.	This storm had east-northeast winds of 25 mph with strong gale forces. Its tidal flooding engulfed many coastal areas, battering seawalls.
September 12-13, 1960	Unknown	Hurricane Donna.
November 28, 1967	Unknown	This storm is another example of high-sustained offshore winds occurring with a perigean spring tide.
January 8-9, 1978	Unknown	This storm occurred during higher than normal tides. It caused flooding and severe coastal erosion.
February 6-7, 1978	The water level rose 10.3 feet above normal in Boston.	The "Blizzard of 78" was a northeaster with record snow fall, flooding, and erosion. An estimated $180,000,000 of damage occurred. It was the most destructive storm of recent times.

Date	Water Level	Description
October 30, 1991	Unknown	Known as the “no-name” storm, the “Halloween” storm and “the perfect” storm.
December 12, 1992	Unknown	The Blizzard of 92.

Source: A Guide to Coastal Hazards, Volume 1, Massachusetts Coastal Zone Management.

IV. Planning Process

This Flood Management Plan focuses on the areas of Town where flooding occurs most frequently. The Plan was prepared by the Office of Planning and Development and adopted by the Board of Selectmen. Prior to adoption, the Board of Selectmen held a public hearing on May 16, 1999. This plan was revised and updated on October 1, 2007. The plan was again revised and updated on ??????????

Repetitive Losses

The Federal Emergency Management Agency has identified twenty-four properties as having been damaged two or more times in the last 18 years. The damage occurred on 13 dates. All of the properties are located in low-lying coastal areas. All of the events are not described due to the number. However most of the filings is a result of two large coastal storms.
The largest number of losses, twenty-one, were reported on October 30, 1991. Eleven losses occurred on December 12, 1992. Two of the events occurred on February 6 and 7 of 1978. These losses are a result of the “Blizzard of 78” (a 100-year storm) and should not be included in the repetitive loss list.

Given the localized nature of the damage, this plan focuses on the 100-year coastal floodplains located along Saquish Beach, Plymouth Beach, and White Horse Beach. There are four other isolated areas (Hedge Road, Water Street, Sea View Drive, and the Ship Pond area) where repetitive losses were filed. Single properties were damaged in the Hedge Road, Water Street, Sea View Drive areas. Three properties were damaged in the Ship Pond area.

As required by FEMA, the residents of these repetitive loss areas will be sent information on flood protection measures each year. The purpose of the information is to remind property owners of the potential hazards associated with coastal storms and the steps that can be taken to minimize financial and property losses that often occur when a large coastal storm strikes Plymouth.

Potential Future Losses

Approximately 230 dwellings are located on the barrier beaches in Plymouth and most of these are in the floodplain, thus vulnerable to storm damages. Approximately 425 dwellings are located at the top of coastal banks and not in the floodplain. However, approximately 298 of these dwellings, or 70%, have some form of protection afforded by coastal engineering structures (e.g., stone revetments) at the base of the coastal banks. The remaining 135 dwellings or 30% do not have structural protection. Though "unprotected", a majority (70%) of the dwellings (90) are greater than 100 feet landward of the top of bank, are not in danger of erosion or are protected by a well-vegetated coastal bank. There are currently (2000), 35 dwellings within 100 feet of an eroding, unprotected coastal bank and the setback distances of these residential structures are listed below. Several dwellings are within 100 feet of the bank on Gurnet Point and Saquish Neck but their setbacks and location were not specifically measured. These dwellings and the dwellings listed below have been identified on the Town's Coastal Hazard Mitigation Maps.

Important to the determination and prediction of flood-related erosion damages is an assessment of the erosion rates in Plymouth and along the coastal bank sections of Town, specifically. From shoreline change data mapped over a 147-year period (MCZM), a fairly low rate of erosion has been determined (Eskandary and Leatherman, 1997). Statistics produced from the data show 33% of the coastline is stable (up to $\pm$ 0.5 feet/year), 41% has had less than 1.5 feet of erosion/year, 19% has had between 1.5-3.5 feet of erosion/year, 2% has had greater than 3.5 feet of erosion/year, and 5% have accreted. These are measurements of the Mean High Water position. If one considers erosion of the coastal banks, located at higher elevations, a more dramatic picture is revealed. Low frequency storms (i.e., 10- to 100-year) are needed to erode the coastal banks and as much as 10-15 feet of the base can be eroded during a storm.

As sediment is removed at the base, gravity pulls down sediment at higher elevations as the face of the bank seeks an angle of repose or equilibrium. Primarily as a function of bank height, the top of the bank may recede immediately during the storm (for low banks) or weeks, months and years later (for high banks).

The recession may occur steadily, several inches at a time or episodically, several feet at a time. Predicting erosion rates for the top of a coastal bank is difficult to do with any certainty.

If one assumes a maximum erosion rate of 1.5 feet per year, since 74% of the shoreline in Plymouth erodes at this rate and that the top of coastal banks erodes at an equivalent rate, there is currently one home is in danger within 1-5 years, two homes will be in danger within 6-10 years, there are no homes in imminent danger, and 26 homes will be in danger within the next 60 years.

V. Floodplain Development

A. Regulations

In 1986, FEMA delineated the areas of Town susceptible to flooding on Flood Insurance Rate Maps. Plymouth regulates development in these floodplains through its zoning and wetlands bylaws. Since 1989 there has been no new dwellings constructed in the floodplain area. In addition, the Town limits the expansion of existing structures in these areas.

Repetitive flood claims account for 33 percent of all flood insurance claims. Therefore, this management plan focuses on the repetitive loss areas of Town. The main areas of concern are Plymouth Beach, Saquish/Gurnet Point and White Horse Beach. Of the twenty-four repetitive loss claims, eighteen occurred in these areas.

With the addition of flood-related erosion areas (i.e., coastal banks) and the effort to update the Flood Management Plan, several new steps are taken to evaluate the existing level of protection, identify gaps in the protection efforts, and recommend additional measures to reduce damages by improving the protection measures. The following existing protection matrices reflect actions being taken at the local, state and federal levels.

Local Existing Coastal Protection Matrix

TYPE OF EXISTING PROTECTION	DESCRIPTION	AREA COVERED	EFFECTIVENESS AND/OR ENFORCEMENT	IMPROVEMENTS OR CHANGES NEEDED
Floodplain District Zoning Bylaw (Section 401.18 FP)	All new construction shall be located landward of the reach of mean high tide	100-year floodplain as shown on Flood Insurance Rate Map dated July 2, 1992	Enforced by Building Inspector and Conservation Commission - rated good	Continue to enforce bylaw Update reference to July 2, 1992 date
Floodplain District Zoning Bylaw (Section 401.18 FP)	The placement of mobile homes in the floodplain district is prohibited	100-year floodplain as shown on Flood Insurance Rate Map dated July 2, 1992	Enforced by Building Inspector - rated good	Continue to enforce measure.
Coastal Flood Management Plan (6/96 revised 9/23/96)	Focuses on repetitive losses, policy that prohibits new development and discourages expansion of existing development.	Three developed barrier beaches: Plymouth Beach Squish/Gurnet White Horse Beach	Good awareness document. Not storm tested yet.	Amend plan to acknowledge erosion-prone coastal bluff areas. Adopt recommendations
Wetland Bylaw Article #27 Rules and Regulations 4/23/90	Regulates development through approvals (with Orders of Conditions) or denials	Within the 100-yr floodplain, wetland resource areas and 100-feet from any wetland resource area	Enforced by Conservation Commission - rated good	Add new regulations 1. +1 foot to FIRM elevations. 2. 50' setback from coastal banks.

State Existing Coastal Protection Matrix

TYPE OF EXISTING PROTECTION	DESCRIPTION	AREA COVERED	EFFECTIVENESS AND/OR ENFORCEMENT	IMPROVEMENTS OR CHANGES NEEDED
State Building Code (780 CMR 2102.3)	New or substantially improved residential structures shall be designed and constructed to minimize flood damage.	100-year flood zones (A, A1-30, AE, AO and AH) as shown on FIRM dated July 2, 1991	Enforced by Building Inspector to minimize FIRM standards - rated good	Continue to enforce this code.
State Building Code (780 CMR 2102.4)	New or substantially improved residential structures shall be designed and constructed to avoid flood damage by elevating on piles or columns	100-year flood zones (V1-30 and VE) as shown on FIRM dated July 2, 1992	Enforced by Building Inspector to minimize FIRM standards - rated good	Continue to enforce this code.
State Wetlands Protection Act Regulations (310 CMR 10.00)	Protect natural resource areas, which safeguard property owners from coastal storms.	From salt marshes and coastal beaches to coastal banks and dunes, within 100 feet of these areas, and the entire 100-year floodplain.	- local enforcement by Conservation Commission, State enforcement by DEP Southeast Region - rated good	State should add performance standards for "land subject to coastal storm flowage" in regs.
"Chapter 91" Waterways act Regulations (310	Ensures structures are sound and located in areas, which minimize	Historically filled tidelands and any area seaward of	- enforcement at the state level - rated good	Continue to enforce regulations

CMR 9.00)	dangers to private and public property, to fishermen and users of waterways.	mean high water to the 3-mile limit.		
State Environmental Code Title 5 Regulations (310 CMR 15.00)	Prohibition of new septic systems and conditional approval of replacement systems.	Velocity zones (V1-30 and VE) of beaches, dunes and barrier beaches	- enforced by Board of Health and Conservation Commission - rated good	Continue to enforce Code
Executive Order No. 181 on Barrier Beaches, 1982	No new development	Velocity zones or primary dunes on barrier beaches	- enforced by State DEP - rate good	Continue to enforce this protective measure.

Federal Existing Coastal Protection Matrix

TYPE OF EXISTING PROTECTION	DESCRIPTION	AREA COVERED	EFFECTIVENESS AND/OR ENFORCEMENT	IMPROVEMENTS OR CHANGES NEEDED
National Flood Insurance Program; Flood Plain Management Standards (44 CFR)	Regulates new and substantial improvement construction	100-year floodplain as shown on the FIRM dated July 2, 1992.	- Community Assistance Program visits 1992 and 1996 - rated good	Continue to implement the program. Complete remapping effort.
Coastal Barrier Resources Act	Prohibits the issuance of flood insurance and discourages new residential development.	On federally designated barrier beaches on Long Beach	- Enforced by FEMA - rated good	Continue to enforce this measure

B. Critical Facilities

Fifteen critical facilities have been identified in Plymouth (see below). Ten of these facilities are located in the 100-year floodplain. Four are located in the 100-year floodplain. Four are located in critical hazard areas (i.e., V-zones), however, three are recreational beaches. Portions of three coastal roads may be impassible during a flood event.

Critical Facilities in the 100-year Floodplain

Critical Facilities	Flood Zones				
	A	AE	AO	VE	X
Long / Plymouth Beach				√	√
Wastewater Treatment Facility (Haz. Mat.)					√
Habormaster Office				√	
Town Hall					√
Fire Station					√
Warren Avenue			√		
Boston Edison Nuclear					

Power Plant (Haz. Mat.)					√
Taylor Avenue				√	
White Horse Beach				√	
Indian Brook School					√
Day Care Center					√
Ellisville State Park		√		√	
Red Brook Lane		√			

B. Historic Development

Plymouth Beach

Plymouth Beach is a 3-mile long barrier beach. It begins at the opening to Eel River on Warren Avenue and extends northwesterly. Long Beach is only a few hundred feet wide. The beach is part of Plymouth Harbor's protective barrier. Historically a number of storms have caused extensive damage to the natural and man-made features of the beach. There are approximately 15 dwellings located on this barrier beach. In addition, a hotel, small take-out and larger sit-down restaurant, town bathhouse, and guardhouse are located on the beach.

In 1832, Dr. James Thacher described Plymouth Beach in 1770 "as well remembered by persons now living" as follows. "Plymouth Beach ... is a natural barrier to the wharves against the sweeping surges of the ocean. Originally, the beach consisted of sand hills and hollows, covered with beach grass, excepting an area of about 80 rods in breadth, which was a thick forest. The inner side of the beach was covered with plum and wild cherry trees, and the swamp with large pitch pine and beech wood, with a large quantity of white grapevines attached to the trees. In the center of the hollow, was a spot about fifty feet square, that was a firm green sward, shaded by four beech trees, from which were suspended numerous vines with clusters of grapes, in their proper season... The point of the beach extended to the spot where the stone pier now (1832) stands, and not far from the point was a house of entertainment for mariners, as the harbor was a famous anchorage, and sometimes near one hundred vessels were seen riding in the Cow Yard."

Thacher also notes that "our ancestors were well aware of the importance of the beach as security to the harbor, and we find in 1702 a penalty of five shillings imposed on anyone who shall fell trees of set fires on the beach."

Plymouth was concerned about the condition of the beach throughout the 1700. Action was taken at several town meetings to repair breaches in the beach.

During the "Gale of 1778" the brig Arnold was lost off Plymouth Beach with the loss of almost all on board. The storm widened two existing breaches in the beach.

According to Thacher, the Gale of 1784 occurred in November and was "accompanied by the highest tide ever known" It carried away a part of the woods on the east side and overflowed the valley and the swamp killing all the trees.

In 1805 and 1806 the condition of the beach deteriorated. The tides swept over the beach and boats could pass through the breaches. One of the breaches reached a depth of nine feet. A stone wall was erected along the breach but was demolished by ocean surges.
In 1824, extensive repairs were made to the beach. Approximately 14,997 tons of stones were placed along the beach to minimize erosion.

In April of 1851, a severe gale combined with high tides caused considerable damage to the southern part of the beach.

By the late 1800's the beach became a recreation area. More than fifteen summer cottages existed as well as a three story pavilion offering rooms and serving meals.

On November 26 and 27, 1898, the "Steamer Portland Gale" hit the Plymouth area. The storm produced blinding snow and 80 M.P.H. winds. The fleet of vessels in the Cow Yard either sank or were washed ashore. Heavy surf rolled across the beach for over a mile, undermining the cottages. The Old Colony Memorial reported that "At Plymouth Beach the destruction was complete, over a mile of the sand ridge being cut down to a sand bar. Every cottage was wrecked, all but on of the seventeen being swept away, and the Columbus Pavilion being represented by a small part of the original structure. The sand filled Eel River full inside the beach, and the surf cut a new passage from the stream straight out to the sea... The Warren Avenue and Eel River bridges were ruined."

In 1899, the federal government restored the Eel River to its original course and repaired the beach and installed a rip rap dike.

After 1898, several cottages were reconstructed. The pavilion was never rebuilt.
The April first and second, 1958 northeaster created waves that broke over the beach and stone breakwater. The sand and gravel parking area was severely eroded and the Eel River was blocked.

Source: Pilgrim Society Notes, Pilgrim Society, August 1958, No. 8.

Today approximately 15 cottages are located on the Beach. The beach is accessed by a narrow gravel road. The beach area does not have telephone, electric or public water service. There has been no new construction of dwellings over the past few decades. The exiting dwellings have been maintained and used mainly as seasonal cottages.

Saquish and Gurnet

Saquish and Gurnet are part of a single barrier beach that extends southward from Marshfield. Access to the area is gained via four-wheel drive vehicles from the Powder Point Bridge in Duxbury or from Marshfield.

Saquish and Gurnet have been part of Plymouth since they were granted to the Town by Sir Edmond Andros, governor of New England in 1638. The Town owned the land for over 50 years. In 1690 it was granted to Ephraim and George Morton. In 1768 a lighthouse was built. In 1776, Fort Andrews was constructed. Saquish and Gurnet remained sparsely developed throughout the 1700's.

The area began to be developed during the 19th century. An 1879 map shows at least one school and a boarding house. A second fort, Fort Standish, was constructed during the Civil War. A life saving station was constructed in 1874.

The greatest amount of development occurred during the late 19th century and the early 20th century. The Powder Point Bridge and the Old Colony Railroad Station in Duxbury made this area more accessible during this time. At the turn of the century the area was a summer resort that attracted people from all over the Boston area. Numerous dwellings existed in 1903. The majority of homes that existed in 1903 have since disappeared. The scattered homes that now stand were constructed during the mid 20th century. The remote location and difficult access have prevented further development and the year round use of dwellings.

Like Plymouth Beach, Saquish does not have telephone, electric or public water service. There has been no new construction of dwellings over the past few decades. The exiting dwellings are used mainly as seasonal cottages.

Source: The Public Archaeology Laboratory, Inc., Pawtucket, RI

White Horse Beach

White Horse Beach (Taylor Avenue) was not developed until the early 20th century. Development expanded from Taylor Avenue to the surrounding coastal areas. As of 1830 there were no roads or buildings in the vicinity of White Horse Beach. The area remained undeveloped until the late 1840's when the building of a railroad opened the area to summer use. In 1874, a large farm and a few other buildings existed in the area. The area was heavily developed during the latter part of the 19th century. In 1903 approximately 70 buildings were constructed in this area. The development continued through the early part of the 20th century.
Hundreds of dwellings exist in this area today, the majority of which are located in the floodplain area. These homes are located on small non-conforming lots with poor access.

Source: The Public Archaeology Laboratory, Inc., Pawtucket, RI

C. Future Development

The development of all three areas occurred prior to the establishment and enforcement of modern zoning laws. Access to these areas is difficult and sometimes impossible. Since the adoption of the new zoning laws few if any new dwellings have been constructed. In addition, written policy (the zoning bylaw) and informal policies have discouraged and in most cases prevented the expansion of existing dwellings in these areas. At this time, the Town has no plans to improve access or provide additional services to these areas.

VI. Flood Management Goals

After several meetings with the Flood Hazard Community Planning Team (FHCPT) as a whole and individually, meetings with residents individually and at Town sponsored public hearings, the plan specifically identified the following general Flood Management Goals.

1. Goals for the Repetitive Loss Areas of the Town of Plymouth are as follows:

   A. Minimize Loss of Life and Property

B. Increase Community Awareness of Flood Issues

C. Discourage Future Development in Flood Prone Areas

D. Preserve and Protect Natural Areas Located in and adjacent to the Floodplain.

2. Goals for the Potential Future Loss Areas of the Town of Plymouth are as follows:

A. Reduce loss of life, disruption and damages associated with coastal flooding and flood-related erosion.

B. Preserve and restore natural resources and functions in area susceptible to coastal flooding and flood-related erosion.

C. Regulate development in flood-related erosion areas through the Floodplain section of the Zoning Bylaw and the Conservation Wetlands Bylaw.

VII. Recommendations and Actions

The following actions were evaluated based on their level of acceptability **(see Appendix B - 2000 STAPLEE Evaluation)** and recommended for implementation:

1. Adopt three changes in the Local Wetlands Bylaw:

a) No new or substantial construction shall occur within 50 feet of the top of an eroding coastal bank;

b) A natural, vegetated buffer shall be preserved within 25 feet of the top of an eroding coastal bank; and,

c) New and substantial construction shall be built to the 100-year flood elevation plus one (1) vertical foot.

2. Maintain coastal hazard mitigation maps and other data/information that document flood and erosion hazards.

3. Whenever possible and feasible the Town will apply for Hazard Mitigation Grants. The Town's decision will be based in part on the availability of staff resources. Generally, it is expected that any requirements for matching funds will be the responsibility of the property owner. In certain limited cases if feasible the Town may consider funding or providing in-kind support for a project.

4. Provide “Keep-off” signage along fragile dunes and dangerous coastal banks.
5. The zoning of these areas calls for 20,000 to 25,000 square foot lots with direct frontage on acceptable roads. Few lots in these areas can comply, thereby preventing future development in these areas. The Town should continue to prohibit new construction in these areas.

6. Whenever possible and feasible the Town should acquire additional open space located in or adjacent to the floodplain.

7. Traditionally, the Town has discouraged the expansion of existing structures in the White Horse Beach, Plymouth Beach and Saquish areas. The Town should continue this policy and discourage the expansion of existing structures in these areas.

8. Currently, information on the location of buildings and flood zones is difficult to interpret. The Town is proceeding with the development of Geographic Information System (GIS) mapping program. A GIS will improve the Town and property owner's ability to determine which structures are located within a flood zone. If a GIS is not developed the Town should explore other low cost methods to improve the accuracy of flood zone information.

9. As required by FEMA, the Town should continue to implement outreach programs. Increased awareness of the flooding potential will help to convince property owners of the need for flood insurance. The outreach programs will also advise and encourage owners to retrofit their structures. Retrofitting structures will minimize damage when the next flood occurs.

10. The Town periodically provides information to local insurance companies describing FEMA's flood insurance program. This information is provided to the Town by FEMA at no cost. This information educates insurance companies and homeowners about the hazards associated with flooding and the availability of federal flood insurance. The Town should continue to provide this information.

11. As required by FEMA, the Town should continue to mail information on flooding and flood insurance to property owners located in or adjacent to the areas where repetitive losses have occurred.

12. Plymouth's Public Library currently maintains a series of books and pamphlets relating to floods and flood insurance. The community should be made aware of the availability of this information. As new documents are published by FEMA, copies should be added to the library's collection.

13. Plymouth in conjunction with the Boston Edison Company maintains an elaborate emergency and flood warning system. Annual emergency exercises are conducted. In the case of a flood, this system will provide important public information and assistance as needed.

VIII. Summary

In summary, a number of repetitive losses have been filed in the Town. All of the repetitive losses have been a result of coastal storms. These losses have mainly occurred in three areas, Plymouth Beach, White Horse Beach, and the Saquish - Gurnet area. Access and public services to this area are extremely limited. Therefore, the Town prohibits new development in these areas and discourages the expansion of existing structures. The Town will continue to discourage development in these areas.

Future losses will occur along coastal banks or bluffs as a result of flood-related erosion. Historical shoreline changes indicate a wide range of erosion and accretion conditions throughout the Town. A majority (74%) of the shoreline in Plymouth has a long-term gradual erosion rate of less than 1.5 feet/year. Yet, storm - or flood - related erosion occurs at much higher rates and, depending on the height of a coastal bank, the top may not recede for days, weeks or years later.

The most effective way to minimize the loss of life and property in these areas is to educate the community:

- On the dangers associated with coastal storms,
- On the need for flood insurance, and
- On the options available to minimize the potential for property damage.

IX. Glossary

Barrier Beaches - a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish, or salt water or a marsh. A barrier beach may be joined to the mainland at one or both ends.

Coastal Bank - The seaward face or elevated side of any landform, other than a coastal dune, which lies on the landward edge of a coastal beach or wetland.

Floodplain - Any normally dry land area that is susceptible to being inundated by water from any natural source. These areas are generally low land adjacent to water bodies, rivers, or the ocean.

Hurricanes - A storm with high winds (in excess of 74 M.P.H.), storm surges, and rainfall in the six to twelve inches. There are five categories of hurricanes.

Category 1 - Winds between 74 and 95 M.P.H. with a storm surge of 5 to 7 feet. It will cause some damage to trees, piers, small crafts, and buildings.

Category 2 - Winds between 96 and 110 M.P.H. with storm surges of 8 to 10 feet. It will cause some damage to roofs and windows. A considerable amount of damage to trees, piers, small crafts can be expected.

Category 3 - Winds between 111 and 130 M.P.H. with storm surges of 11 to 12 feet. It will cause some damage to roofs and windows. Some structural damage to smaller buildings. A considerable amount of damage to trees, piers, small crafts can be expected. Waves and floating debris will damage buildings.

Category 4 - Winds between 131 and 155 M.P.H. with storm surges of 13 to 18 feet. It will cause extensive damage to roofs and windows. Additional structural damage to smaller buildings can be expected. A considerable amount of damage to trees, piers, small crafts can be expected. Waves and floating debris will damage buildings.

Category 5 - Winds over 155 M.P.H. with storm surges over 18 feet. Some buildings will be completely destroyed. Major damage to structures within 15 vertical feet of sea level and within 500 yards of shore.

Perigean Spring Tide - A high tide that occurs when the moon is at its closest point to the earth. These are the tides with the greatest fluctuation.

Storm Surge - A local rise in sea level along the coast due to the stress of winds and reduced atmospheric pressure.

Swash - A rush of water up the beach face following the breaking of a wave.

Section II

NFIP/CRS Planning Process

The following section describes the process in which the Town of Plymouth coordinated the update of its Flood Management Plan and how the process relates to the NFIP/CRS standards for developing such a plan.

STEP A – Organize to prepare the plan
STEP B – Involve the Public
STEP C – Coordinate with other Agencies
STEP D – Assess the Hazards
STEP E – Assess the Problem
STEP F – Set Goals
STEP G – Review possible Activities
STEP H – Draft an Action Plan
STEP I – Adopt the Plan
STEP J – Implement, Evaluate and Revise

Step A – Organize to prepare the plan

Staff Resources
The planning department is the principal staff support for development of the CRS Activity 510 (Floodplain Management Planning). The planning department coordinates other Town departments, committees, businesses and residents.

Planning Committee
The planning committee is a group of individuals made up of department heads, citizens, committee members and others. The Flood Hazard Community Planning Team (FHCPT) was assembled and appointed by the Town Manager.

Meetings
The focus of flood management in Plymouth is an important topic, specifically with coastal flooding which accounts for the majority of repetitive losses. The Town holds both formal and informal meetings to discuss this subject. The committee meets throughout the year.

The main focus of the group is to gain a consensus on various topics, set goals and agree on achieving attainable actions through both a creative and legal process.

Step B – Involve the Public

There were residents; specifically those living in areas most affected, at every level in development of the plan. It was the severity of the major storm events in the early 1990's that compelled the residents to push for action by the Town. The mixed group of citizens were unquestionably well represented and participated in the establishment of defining the problems, goals, and solutions.

Homeowners
Homeowners and businesses affected by repetitive losses are continually updated and involved in the Town's flood management coordination. Specific mailings go out annually to residents listed under repetitive loss.

Conservation Groups/Neighborhood Groups/Associations
The focus of flood management in Plymouth is critical. The Town, as represented by various boards and commissions, holds both public and informal meetings on a variety of flooding topics. Typically the flood management team or conservation commission will meet with groups in the fall and spring.

Lending Institutes/Real Estate/Developers
A mailing to bankers and other lending institutes, real estate brokers, and insurance

agencies is done annually to inform them of various state and federal programs, timely topics regarding flood mitigation and prevention, as well as other topics closely related to safety and protection against flood emergencies.

Step C - Coordinate with other Agencies

Who to involve

The planning department is the centralized staff to manage flood management within Plymouth. The Town Planner is the specific coordinator of the program. As a division head, the Town Planner is responsible for coordinating all other town departments and organizations, including the Parks & Forestry Division, Conservation Commission, Engineering Division, Building Department, etc.

The Flood Hazard Community Planning Team (FHCPT) was coordinated through the Department of Planning and Development. Both the Director of Planning and the Town Planner shared the responsibilities of holding meetings. There were meetings held with particular individuals, specific group meetings, public hearings, and meetings with divisional heads. The process was designed to review the positive and negative past and present policies, programs and regulations, and to develop better solutions in the future. Several meetings were held to emphasize on the development of the plan as well as to gain suggestions and recommendations from the public and municipal leaders for establishing the recommended actions.

Step D – Assess the Hazards

The Base Flood

The Town's consultant, ENSR, is staffed by professionals that spent several man-hours collecting and reviewing data associated with the coastal flooding problems. ENSR reported back to the Town on several occasions to support the development of the plan and its recommendations, as well as to present their findings to the general public.

ENSR also held several "fly-overs", which was coordinated through the Airport Commission, to survey the coastal areas and associated tributaries that are "known flood hazards". ENSR supplied several aerial photographs and color orthophotos, which was assembled with assistance from FEMA, MassGIS, MCZM, and MIT.

A map illustrating the HURRICANE SURGE INUNDATION MAPPING for Plymouth was produced by the Emergency Preparedness, in conjunction with the US Army Corp of Engineers, FEMA, and MassGIS. The map outlines the location of emergency shelters, fire and police stations, Red Cross shelters, medical facilities, and other public facilities available during emergencies. The

plan also depicted Hurricane Surge Inundation Areas by hurricane categories and FEMA 100-year flood zones.

Step E – Assess the Problem

The structures immediately impacted by flooding include mostly residential structures, although there are some commercial properties and public facilities they have been impacted in the past. The plan outlines both repetitive loss areas, which includes both residential and commercial properties, as well as public facilities that are within the 100-year flood plain.

The Department of Public Works (DPW) has described a variety of culverts, bridges and roadways they are impacted during heavier storm events. The DPW maintains a list of those specific locations.

The Conservation Commission maintains records of properties located in and near 100-year floodplains. A member of the Conservation Commission sits on the Land Use & Acquisition Committee and notifies the committee when property located in and near floodplains are available for the Town to acquire.

Step F – Set Goals

The goals are clear within the Town of Plymouth. The areas impacted the most have been identified as the first priority and there is clear consensus on addressing those specific areas. The second priority is not to neglect the second "tier" or less impacted flooding areas, and that our regulations and bylaws should address those specific concerns as well.

Step G – Review Possible Activities

The committee developed its overall flood management goals into two general goals: 1) address repetitive loss and 2) prevent future loss. The goals are intended to address the past, present and future. The goals are general in design and are proposed as a logical foundation in which the recommendations and actions are created. The goals are established to be permanent, while the action steps are continually being expanded and altered as objectives are being met.

The balance of the recommendations and actions apply a multi-level approach to developing a broad plan. As actions are implemented and new ones are created as the plan is updated, new and creative solutions are formed. As public sponsored programs are created and/or changed, the actions outlined in the plan can be amended to incorporate specific community goals.

The general "goals" of the plan are intended to create a balanced program.

Step H – Draft an action plan

The Floodplain Management Plan was drafted with the help of ENSR Consulting. The principal planner working with the Town of Plymouth was Stan Humpries. Mr. Humpries collected data and studied areas in which concentrations of repetitive losses had occurred. Mr. Humpries also coordinated with the town on achieving the priorities established by the Town, the Committee, and the residents of the community. ENSR sponsored a public hearing and served as the moderator for the meeting. Additional input was sought from several other department heads, civic groups and organized boards and committees. The recommendations for action were created on the principle of the past, present and future mitigation measures in Plymouth.

"Appendix C" identifies the breakdown of specific steps and who will accomplish those steps.

Step I – Adopt the plan

The Plan was adopted by the Board of Selectmen, the governing body of the Town of Plymouth. A unanimous vote was given in support of the plan.

Step J – Implement, evaluate and revise

The plan has been adopted and is in place and serves as the prevailing document for supporting the goals and objectives outlined for the community. The committee will be implementing the plan over the next several years. The planning team will continue to monitor and evaluate the plan as necessary, and will coordinate the Floodplain Management Plan amendments in the years ahead.

APPENDIX

A. Copy of Public Hearing on Flood Management Plan

B. Copy of Floodplain Bylaw