

*\*\*Draft Plan 06/21/04\*\**

# *TOWN OF MIDDLEBOROUGH NATURAL HAZARD DISASTER MITIGATION PLAN*

## **Chapter One: Introduction**

### *Introduction and Purpose of the Plan*

Middleborough is a rural community with great natural beauty. The landscape features cranberry bogs, natural wooded areas, and low-density residences in the outlying areas and higher density residences and businesses in the center. The New England weather means natural hazards are a fact of life in Middleborough with each season presenting its own challenge-- heavy spring rains, summer droughts, early fall hurricanes, or winter snowstorms. The intersection of these natural hazards with the man-made environment can transform these routine events into natural disasters.

This plan examines the natural hazards facing the Town of Middleborough, assesses the vulnerability of the area's residents and businesses, and makes recommendations on ways to mitigate the negative effects of typical natural hazards. The effort has drawn from the local knowledge of a group of officials and residents, and the recommendations presented are meant to be realistic and effective steps for mitigating natural hazards. Ultimately it is hoped that these actions will translate into savings – fewer lives lost, less property destroyed, and minimal disruption to essential services.

### *Development of the Plan*

In April of 2004 the Middleborough Board of Selectmen appointed a local Pre-Disaster Mitigation Planning Committee and charged them with the development of this plan. A list of the Committee members is attached. The group included representatives from: the Fire Department, Board of Health, Department of Public Works, Building Commissioner, Conservation Commission, and Planning Board. The group held four (4) public meetings to discuss and develop the plan. The Southeastern Regional Planning and Economic Development District (SRPEDD) provided mapping and technical assistance. A public hearing was held on \_\_\_\_\_ and the Board of Selectmen adopted the plan at their meeting of \_\_\_\_\_.

## **Committee Membership**

Rosemarie Correia  
Conservation Agent

Ruth Geoffrey  
Town Planner

Robert Whalen  
Building Commissioner

Jeanne Spalding  
Board of Health

Robert Silva  
Chief, Fire Department

John Healey  
Town Manager

Middleborough Town Hall ▼ Nickerson Avenue ▼ Middleborough, MA 02346 ▼ (508) 947-0928

## Chapter Two: Profile of the Community

### *Geography, Geology, Topography, and Climate*

- The Town of Middleborough is located in southeastern Massachusetts in Plymouth County and is bordered by Raynham and Taunton on the west, Bridgewater on the north, Halifax and Plympton on the northeast, Carver on the east, Rochester and Wareham on the south, and Lakeville to the southwest. Middleborough is 40 miles south of Boston and 30 miles east of Providence, Rhode Island. It has a total land area of 69.6 square miles of land area and 72.3 square miles including water bodies. making Middleborough only second to Plymouth in land area. Currently, this is the fastest growing region of New England.
- Geologists classify the southeastern Massachusetts area as part of the Northeast Coastal Lowlands/Coastal Plain region. The area is characterized by the conditions created over 12,000 years ago when massive glaciers receded. These characteristics include: low hills; highly porous soils; deposits of sand and gravel; multiple swamps, lakes, rivers and ponds; and a high water table. The glaciers left behind glacial till that contains thick deposits of both sand and gravel, lying over bedrock. There are occasionally boulders, known as glacial erratics, of different rock types that were carried from northern regions and left behind as the glaciers receded. Middleborough has rolling hills and knobby terrain with elevation changes from 0 to 200 feet above sea level.
- About half of the town is covered with wetlands, and surface waters which form an intricate network protecting and feeding the aquifer that provides drinking water for the town and beyond. The major waterways are: the Nemasket River, Fall Brook which is a tributary to the Nemasket River, the Taunton River which is fed by Purchase Brook and Puoquoy Brook, and the Weweantic River to the south. Also there are several major ponds: Woods and Tispaquin Ponds that are recreational and the Assawomsett Pond Complex that is designated for the New Bedford water supply.
- Within Middleborough there are 7,472.62 square miles of open space-conservation and recreation lands. This includes the Rocky Gutter Wildlife Management Area and Weston Memorial Forest.

- Middleborough has 17 dams covered by the Bureau of Dam Safety. Many of these facilities are smaller dams (or flumes) associated with the cranberry industry and are used to manage water supply relative to cranberry growing and harvesting. A listing of these facilities is included at the end of this Chapter.
- The Bureau of Dam Safety (BDS), a division of DCR, has jurisdictional authority over dams that meet the following criteria: dam structure six feet or higher, or impoundment of 15 acre feet<sup>1</sup> or more, or a significant downstream hazard as determined by staff review (e.g. campground, densely developed area, major thoroughfare, etc.). This includes government and privately owned dams. New regulations going into effect at the end of 2003 will require owners to register the dams and have them professionally inspected at the owner's expenses, every two years. While the monitoring of dam condition falls to the owner, be it a private or public entity, damage from dam failure may include multiple owners and even property across town boundaries.
- + Massachusetts in general has a humid climate with temperatures that average 68 to 72 degrees in the summer and about 28 to 32 degrees in the winter. The National Climatic Data Center reports the following normal temperatures by season in Middleborough:

January	26.5 Degrees F
July	71.0 Degrees F

The normal annual precipitation is 48.8 inches. The growing season, from the last killing frost in the spring to the first killing frost in the fall, runs between 180 – 200 days. The area is subject to a variety of severe weather events: hurricanes, Northeasters, thunderstorms, blizzards, tornadoes, and drought. All of these are discussed more fully in the next chapter.

***Population Characteristics and Political Structure***

- The 2000 US Census indicates that Middleborough has a total population of 19,941 in the year 2000 and is currently close to 22,000 in 2004. With a land area of 69.6 square miles the average population density is 257 persons per square mile but growing rapidly due to new construction. The median age is 31.8years, with more than half of the population in the 18-64 age group. Almost a third of the population is made up of children under the age of 17. With a total of 6,063 households, the average household size is 2.87 persons.
- Middleborough has experienced a rapid population increase over the past thirty years, and is expected to continue this growth. The figure below indicates census population figures and growth projections prepared by SRPEDD & MassHighway.

---

<sup>1</sup> Acre foot = Amount of water that fills one acre of land to a depth of one foot, approx. 300,000 galloons of water.

According to a build-out study conducted by IEP, Inc. for the Town in 1989, and described briefly in the next section of this plan, *if current zoning is unchanged, and every single buildable lot is developed for residential use, family size remains unchanged, and no additional infrastructure is provided to currently undevelopable lots, the population of Middleborough could reach 45,043 at build-out.*

New construction permits for the past few years have been on the rise due to the availability of large tracts of developable land and access to the city through the main thoroughfares and the train. The population in 2004 is pushing 22,000.

### **Past Population Trends**

The long view of Middleborough has been of a community slowly emerging from its rural roots as a low density, sparsely populated town. The town did not experience the post-war growth spurt that affected so many other communities in the 40's and 50's. Instead, Middleborough experienced a flatter growth increase that by default allowed the town to retain much of its rural character. However, the coming decades suggest a new pattern of population growth.

### **Projected Population Growth Rates**

Planners use growth rates from the recent past, tweaked by economic factors to project future growth rates. Consequently we start the discussion of projected rates with the results from the last few years.

Over the last decade, the town's population changed, from 17,867 people in 1990 to 19,950 people in 1999. This was an 11.66% increase, or little more than 1.3% annually. In the local region; i.e. , the towns surrounding Middleborough, the population grew from slightly more than 400,000 residents in 1990 to more than 435,000 residents in 1999, an increase of 35,226 or an annual change of 1% per year. The balance of the Southeast Regional Planning (SRPEDD) area, which includes mostly communities south and west of Middleborough, saw its aggregate population increase by 3.6%, with a 1999-estimated population of 556,943.

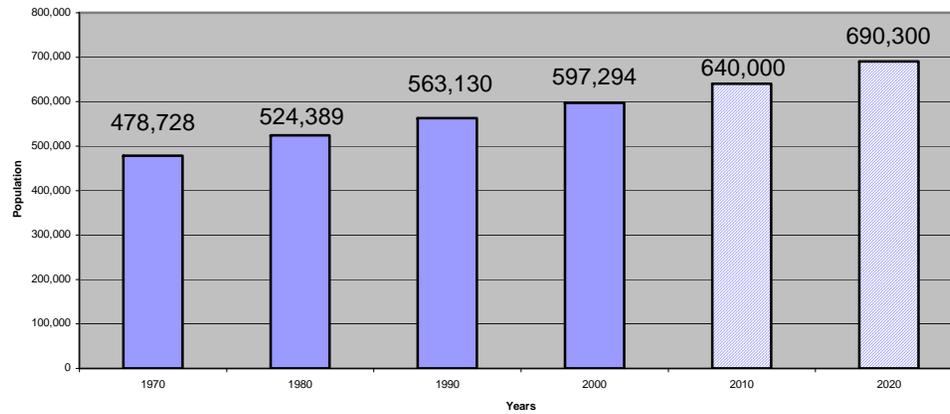
Even with this seemingly small increase, population growth rates in the entire New England region are significantly lower than those seen in Southeastern Massachusetts. The Town of Middleborough has supported this trend by experiencing growth rates that exceed the Boston metropolitan area-wide growth rates by three times the average for that area north of Middleborough. Note that regardless of this local and regional rate of change, the population growth has not kept pace with New England's economic expansion. Employers are still finding it hard to fill jobs.

Forecasts for the next five to ten years are that Middleborough's population will continue to increase, adding nearly 2,300 residents in the next ten years while averaging growth rates of 1.1%. The balance of the region is expected to experience average growth rates in the range of 0.3% to 0.9%. The resulting year 2009 forecast population will be 22,233. This represents an overall increase of people at 11.4% over the latest numbers from 1999 and a similar impact to the growth that occurred over the previous decade.

**Table 2-4: Population, Land Area, and Density by Community**

<i>Community</i>	<i>Population (1)</i>	<i>Land Area (Square Miles) (2)</i>	<i>Population Density (Persons/Square Mile) (3)</i>
Middleborough	19,941	69.36	288

**Figure 2-2: SRPEDD Region Population and Projections**



**Table 2-6 Population Projections by Community 2000-2025**

	<b>2000</b>	<b>2005</b>	<b>2010</b>	<b>2015</b>	<b>2020</b>	<b>2025</b>
<b>Community</b>	<b>U.S. Census</b>	<b>Projection</b>	<b>Projection</b>	<b>Projection</b>	<b>Projection</b>	<b>Projection</b>
Middleborough	19,941	21,222	22,107	23,420	24,583	26,003

- Consistent with national trends Middleborough has seen a steady increase in the absolute number of residents whom are over 65 years of age. This is a trend that is expected to continue as the “baby-boomer” generation ages. The number of residents over the age of 65 has increased by 5%. This population generally has a higher incidence of special needs for emergency response-- due to health afflictions and mobility restrictions—although overall this population is a healthier and more active group than they were thirty years ago. The Federal Administration on Aging notes the following as reasons the elderly are more vulnerable to disasters:
  - ✓ They have difficulty getting assistance due to progressive physical and mental impairments and other frailties that accompany aging;
  - ✓ They are slower to fill out forms for disaster notification and/or disaster relief assistance;
  - ✓ They are often at higher post-disaster nutritional risk and medication risk;
  - ✓ They are often targeted by fraudulent contractors; and
  - ✓ They may be susceptible to abuse as overall family stress levels increase in the later stages of a disaster.<sup>2</sup>
  
- Other vulnerable populations are youth and the disabled. Youth are vulnerable due to their need for supervision and guidance in times of emergency—especially groups of children under the care of a limited amount of adults. This is best assessed at the local level through critical facilities identification of childcare centers and schools. These facilities are indicated on Middleborough’s map of critical facilities and include daycare centers and schools.

### **Special Populations**

- Working in collaboration with the Greater Attleboro Transit Regional Authority (GATRA), the Middleborough Council on Aging provides transportation services for elderly and handicapped residents. The Council also provides a wide range of recreational activities and education programs for special populations. The Leonard E. Simmons Center, off Plymouth Street, serves as a multi-service center for the elderly with beautiful grounds, outdoor walkways, sitting areas and gardens. In 1996, over 500 people visited the center for recreational purposes.
  
- Within the working age population (16-64) 309 persons identified themselves as having mobility or self care limitation. 1,088 persons had some work disability and 436 were prevented from working because of a disability. Amongst persons over 65 years, 290 identified themselves as having mobility or self care limitation. These are all non-institutionalized persons with disabilities.

---

<sup>2</sup> “Disaster Preparedness for Older Americans”, 2002. Business Publishers, Inc.: Silver Spring, MD, p.1.

- The 2000 Census represents the first time that data on the disabled was collected. The Census long form allowed self-reporting by the respondent on questions that would indicate disabilities of various types:

-sensory disability,  
-mental disability,  
-going outside the home disability

-physical disability,  
-self-care disability,  
-employment disability.

Due to the ability to select more than one category, this translates into a smaller number of residents. The special circumstances of the disabled population that may affect disaster response include:

- ✓ the visually-impaired are reluctant to leave familiar surroundings;
- ✓ those with mental retardation or cognitive impairment may not understand or may become confused;
- ✓ guide dogs and other assistance animals may become disoriented in a disaster;
- ✓ proper transport techniques are required to reassure anyone being carried that they will not be dropped;
- ✓ many respiratory illnesses are aggravated by stress;
- ✓ medically-dependent individuals may not be able to communicate their needs; and all temporary shelters must meet accessibility standards.<sup>3</sup>

---

<sup>3</sup> Ibid, p.20.

- The governing body of Middleborough is a five member Board of Selectmen who also act as the Board of Health, with the legislative body being Town Meeting. The Planning Board members are elected positions. The Board of Selectmen hires a Town Manager.

## *Transportation Network*

### **Major Streets and Highways**

The town of Middleborough is well served by a number of state and local highways that provide direct access through the town and to Interstate 495. The principal roadways that provide access to the town are described below. Descriptions of the roadways include a description of geometric conditions and adjacent land uses.

#### **Interstate 495**

Interstate 495 is a circumferential limited access highway around the Boston metropolitan area. Depending on location, the highway provides two or three lanes of travel in each direction. Access to Interstate 495 is provided via four partial cloverleaf interchanges in Middleborough. These on-/off-ramps, at exits 3-6, provide direct access to Route 28, Route 106, Route 18, and Route 44 respectively. Exit 2, Route 58, approximately a quarter ¼ mile from the Middleboro town line.

#### **Route 105**

Route 105 is a state highway that provides a north-south access to Lakeville to the south and Bridgewater, Plympton and Halifax to the north. Route 105 provides one lane of travel in each direction with additional turning lanes provided at major intersections and four travel lanes at the I-495 interchange into Lakeville. Route 105 provides access to the Middleborough/Lakeville commuter rail station, located just south of the on-/off-ramps to I-495. The posted speed limit on Route 105 varies between 45 miles per hour and 25 miles per hour as the road approaches downtown Middleborough. Land use along Route 105 is a mix of office, retail, agricultural and residential uses. To the north, land use is rural/agriculture and the road serves as a major connector to Halifax, Plympton and Bridgewater.

### **Traffic and Circulation Alternatives**

The residents of Middleborough rely on their private vehicles to travel on the local roadway system and regional highway network to meet their primary transportation needs. Other than new commercial and residential subdivision roadways, there been little change in the roadway system in the past 20 years. Since the construction of I-495 and the Old Colony Middleborough railroad line, regional transportation access has improved resulting increased pressure for land development that brings an increase in travel demand. While most of Middleborough's transportation system is adequate to accommodate

current demands, there are locations in town that experience significant delays during peak periods which will be exacerbated by future land development.

Future development will generate more vehicle trips on local roadways. In the downtown area and in densely developed residential neighborhoods additional points of conflict between pedestrians and vehicles may be created. While commercial development on the western part of town will create more problems during the morning and evening peak commuter hours, new residential development in other part of town will result in more off-peak and weekend traffic to schools, shopping areas and the Town’s recreation facilities. An increase in residential population will also place more demands for parts of the transportation network used for bicycling, jogging, hiking or horseback riding. Based on these findings, the following recommended actions have been identified to help meet the future needs of the Town’s transportation system for the next generation.

**DPW 2005 Report:**

<i>TOWN</i>	<i>STATE</i>	<i>UNACCEPTED</i>	<i>TOTAL</i>
<i>147.19miles</i>	<i>38.87 miles</i>	<i>12.32 miles</i>	<i>198.38 miles</i>

**SRPEDD Report:**

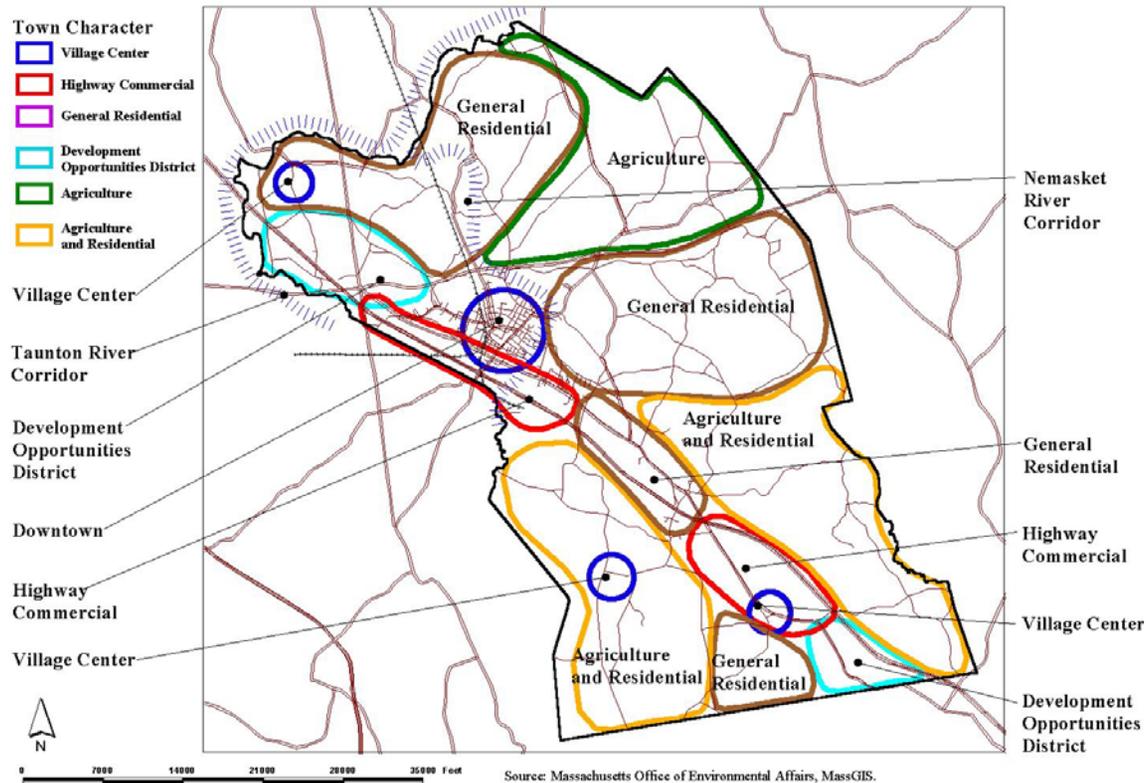
<b>Table 2-8: Roadway Mileage by Community</b>					
<i>COMMUNITY</i>	<i>Interstate</i>	<i>Arterials</i>	<i>Collector</i>	<i>Local</i>	<i>Total</i>
<b>MIDDLEBOROUGH</b>	<b>14.19</b>	<b>26.49</b>	<b>39.84</b>	<b>113.41</b>	<b>193.93</b>

Both the Town of Middleborough and MassHighway have identified locations in town that experience high accident rates and warrant improvements through roadway widening and traffic signalization. First and foremost are the proposed improvements to the Route 44 corridor between the Carver Town Line and I-495, which is in the conceptual design and environmental review phase. Proposed improvements include a combination of grade separation and at-grade intersection improvements. The Route 28 corridor also needs the implementation of recommended transportation improvements because of recent and proposed

commercial development projects. Route 105 between Route 28 and North Street needs to be reconstructed, and the Town has initiated the project, which needs support from MassHighway for funding.

***Land Use: Housing, Commerce, Industry and Agriculture.***

**Town of Middleborough Community Character Analysis**



Open land is composed of several categories, ranging from true agricultural lands to undeveloped land to undevelopable land, such as those areas consumed in regulated wetlands. The Town has notable major concentrations of open land in large parcels

and holdings in its western quadrants. This includes the “Cumberland Farms” parcel at the northern end of town, which contains of hundreds of acres of logged, but undeveloped land. It stretches through bog-filled land including Great Cedar and Little Cedar Swamps in the northeastern corner of the Town. The open space resources include both the Rocky Gutter and Forbes Swamp, which are mostly located within the Rocky Gutter Wildlife Refuge, a substantial public holding in the southeaster portions of the Town. Continuing further south, the land use maps recognize the additional clusters of private agricultural and open lands.

**Overall Land Use Observations**

Land use within the Town of Middleborough is characterized by large tracts of undeveloped and agricultural land interspersed with clusters of development. The undeveloped land includes large, relatively contiguous land areas. The developed areas include concentrations of business and residential uses around historic villages, business uses along highway and rail corridors, and residential uses within both large lots and in subdivisions that are generally distributed near the major highway and arterials that transect Middleborough. The following map is indicative of the larger patterns of land use, and is available through the Massachusetts GIS system; the more recent Middleborough GIS land use map is more useful and detailed in many ways, but is not suitable for reproduction within the limits of this report because of the extreme level of detail it provides.

*Table A1: Land Use Classifications and Areas*

(1991Data)

<b>Land Use Class</b>	<b>Area (ac. )</b>
Cropland	2,360
Pasture	2,360
Forest	27,926
Wetland	1,108
Mining	287
Open Land	1,215
Recreation: participation	83
Recreation: spectator	85
Residential: MF	74
Residential: SF Less than 1/4 ac. Lots	328
Residential: SF 1/4 to 1/2 ac. Lots	874
Residential: SF Larger than 1/2 ac. Lots	3,888
Commercial	336
Industrial	231

Urban Open	355
Transportation	787
Waste Disposal	85
Water	1,947
Woody Perennial	2,407
<b>Total Area*</b>	<b>46,738</b>

Source: Mass GIS Data;

- Residential growth has been steady for new housing including single family, condominiums, multi units and mobile homes.

	Single Family	Condominiums	Multi-units	Mobile Homes	Total
2001	115	2	1	136	164
2002	96	13	1	107	217
2003	83	53	-	147	283
2004	69	23	-	124	216

According to the Middleborough Master Plan (Update Draft in Progress):

- The estimates of future population growth and the expectations for the total number of new households in Middleborough and the rest of Plymouth County are significant in a number of ways. They reflect the impact of new transportation improvements in southeastern Massachusetts, the metropolitan area's improved economy and the relatively tighter housing market in other parts of the metropolitan area. This makes Middleborough an attractive location in the near term. The implication is that Middleborough should prepare for the change this represents to the community.
- Forecasts for the ten years suggest that Middleborough's population will continue to increase, adding nearly 2,300 residents in the next ten years while averaging annual growth rates of 1. 1%.
- Housing units are forecasted to continue to increase in Middleborough at a rate of about 80-100 units per year through 2009, so that there could be 15% more houses in Middleborough in 2009 than there were in 1999. Although

there has been a very recent increase in this rate, it is not reasonable to presume that this higher rate will necessarily continue.

- The expansion in housing will be filled by a population of households that current trends predict will be a mix of young families and retirees.
- Middleborough's average household size is 2.81 persons, which is above regional averages, indicating that a significant number of families are attracted to the way of life in Middleborough.
- While the proportion of elderly within the population has been consistent with the regional averages, this is shifting. The development of the Oak Point senior mobile home development is substantially changing the demographics of the town, which must be taken into account in planning for services in the future.
- These expected changes in the total population and in the number of households will influence budgetary decisions, land use issues and local commercial expectations. These local changes will not be solely based on the aggregate increases expected, but are also due to the relevant characteristics of the town's future population. Additional data on these aspects of the community will be discussed in the next section on Economic Development.
- The Town has a very small proportion of multi-family rental housing units; the majority are single family homes.
- Housing prices in Middleborough are relatively affordable relative to other parts of the region. The relatively low prices tends to make Middleborough a somewhat attractive housing location than other areas. However, the increases in local prices are still increasing greater than incomes.
- The Town of Middleborough does not meet goals for low income housing supply, as currently defined by the state. As a result, the Town may be subject to "Comprehensive Permit" projects that exceed zoning standards or vary

from local land use regulations, if such projects can supply additional housing meeting state goals. The Town may consider other methods to add to its approved low-income housing stock to promote diversity.

- There are many choices to and promote a wider range of housing choice within the Town by amending land use policies and other actions.

- There are four private campgrounds in Middleborough : KOA off of Plymouth and Rt. 44, YMCA on Wareham St., Camp Avoda on Gibbs Rd. and Tispaquin Family Campground on Purchase St. The Fire Department would coordinate evacuations with the campground directors.

- 

### ***Cultural and Historical Sites***

#### Historical Development Patterns: The Village Structure

The predominant land use patterns in Middleborough began with the natural conditions, and were subsequently affected by its locations within the region.

Many towns in New England grew from a single central location, and then spread outwards in a radial pattern along the roads that connected town centers to the region. The development pattern of other towns has been limited by major geographic features – clustering around a deep water harbor, or perhaps constrained within a steep-walled valley. Middleborough’s historical development pattern was quite different, and is rare. The “islands” of upland left between the wet lowlands were desirable locations for most land uses, and roads were easily built across the sandy soil if they skirted the surface waters and wetlands. So Middleborough evolved as numerous small clusters of “villages” or hamlets at the crossroads of a spiderweb-like network of roads. Some of these villages were substantial, and became concentrations for a mixture of commercial, residential and rural uses. Others were merely a convenient concentration of farms and associated residences. Each had its own name, and its history can be traced through old maps, tax rolls, and school districts. The remnants of this scattered pattern of clustered settlements is visible in many locations today, although their identity has often become obscured by time and the imposition of subsequent development. The identity of each village and the relevance of the structure is subject to interpretation, and will require more detailed investigation if they are to serve as the basis of a renewed community image. Some are quite obvious, such as the crossroads at Rock Village in South Middleborough. Some villages can be perceived through the visual clues of small greens, or in a collection

of historic buildings. For the purposes of this Master Plan, the following locations are considered as part of the relevant village fabric:

- Titicut Green (also called North Middleborough Green) – This village is centered upon the intersection of Pleasant and Plymouth Street, not far from the Taunton River. It dates from the earliest colonial times, with some of the land having been given to the townspeople by Native Americans. It was an early manufacturing center, close to gristmills, sawmills, a shipyard and an iron furnace along the nearby river. The crossroads held sites for early churches and houses for prominent families, of which outstanding examples remain. The continuity of the historic buildings and their setting mark this area.
- Eddyville – This village is centered upon the intersections of Plympton, Dedar and Carmel Streets. It surrounds a small green with an intact collection of historic buildings that recall its past. Among the historic remnants is the Eddy homestead, at the corner of Cedar and Plympton Street.
- Waterville – This village is located along Plymouth Street between Carmel and Wall Street, south of Route 44. This was primarily an early industrial district, including an early iron furnace using bog iron extracted from ponds and a sawmill.
- Middleborough Center – Middleborough Center retains the historic pattern of a mid-19<sup>th</sup> century town center, with the associated mix of civic, commercial and residential land uses in a dense and coherent pattern. It was known traditionally as Four Corners because of the crossroads that define the Center. In addition to the commercial uses that clustered in and near the Center, this area became the preferred location for the large homes of affluent residents, particularly along South Main Street.
- Rock Village – This historic cluster is located along Miller and Smith Streets in south Middleborough. Rock Village retains a number of historic structures reaching back to its commercial origins, including sawmill and manufacturing. A rocky outcrop was the site for early religious camp meetings, and gave the village its name.
- The Green – This village is located at the intersection of East Main Street and Plymouth Street, and includes an historic open space known as The Green. The historic roots of this village reach back to the 17<sup>th</sup> century; the village was the site of the First Church. Relatively few residential structures remain from early times, but the Congregational Church and Green School provide links to the past.

### Utilities

Middleborough is fortunate to be able to provide the major utilities to its residents. This is beneficial to the residents, business and the town as a cost benefit. Enhancement and expansion of gas, water supply and wastewater disposal to the outlying areas should be planned.

<i>Community</i>	<i>Electric Provider</i>	<i>Gas Provider</i>	<i>Water Source</i>	<i>Wastewater</i>
Middleborough	Middleborough Electric	Middleborough Gas	Municipal Wells	Partial Middleborough/ISDS

### *Conclusions*

The following general characteristics, drawn from this profile, are relevant to the design of a disaster mitigation strategy:

- Middleborough is a growing community and the future indicates this will continue especially as infrastructure improvements make it easier to live in Middleborough and work elsewhere
- The growth of the past two decades has brought to town many new residents who are unfamiliar with the weather and hurricane pattern of the area.
- The substantial agriculture resources of Middleborough are at risk from natural hazards.
- The rural nature and size of the community makes communication and response for emergency services more difficult.
- The presence of a large open space parcels, wildlife management area, and major undeveloped tracts make Middleborough more vulnerable to wildfires than other areas. New construction is occurring in areas vulnerable to wildfire and the Town lacks a public water supply in many of the outlying areas.
- Mobile homes are particularly vulnerable to natural hazards and Middleborough has a sizeable number of mobile homes. In addition, as a senior complex, this population is elderly with the associated response needs.
- In general Middleborough is a wet town – with swamps, bogs, ponds, streams, and rivers. Flooding is an issue in some of the residential waterway areas and can be exacerbated when natural vegetation debris collects in the many miles of connected waterways in the town.

## Chapter Three: Hazard Identification and Risk Assessment

This chapter will discuss the natural hazards and evaluate the risk they pose residents, homes and businesses. Each natural hazard is identified and profiled with information on the hazard's dimensions, history, and risk factors. Risk will be examined in terms of the likelihood of the natural hazard occurring; the geographic area that the natural hazard could affect; and the impacts that could be expected. The "likelihood" or probability of an event occurring is determined by reviewing historical events and consulting expert opinion, while GIS mapping is used to evaluate the area that could be affected. Information on the development characteristics of Middleborough from the profile chapter is used to estimate the impacts of natural hazards on critical facilities, vulnerable populations, and infrastructure.

Middleborough uses the same Hazard Index (see Table 2-1) used by the Regional Community Planning Team, to rate the categories of natural hazards in terms of likelihood, location, and magnitude of impacts. Each of these criteria was rated with a point value along a scale as indicated in Table 2-2. The Hazard Index in Table 2-1 is a gross assessment that was used to shape the focus areas of Middleborough's Mitigation Plan.

The discussion here on risk assessment draws heavily from the discussion in the Regional Plan. Maps for this section are provided at the end of the chapter.

- A. Flood Related Hazards: Regional Maps Hurricane Data: Wind and Flood Related Hazards; Flood Data: Flood Related Hazards; Nor'Easters/Blizzards: Flood and Wind Related Hazards

**The state Hazard Mitigation Plan of 1999, records flooding as the number one hazard faced within the state.**<sup>4</sup> This is not surprising given that a number of natural hazards can cause flooding including: hurricanes, Nor'easters, thunderstorms, and winter storms. Middleborough has several flooding problems with the hundred year floodplain although flooding after a hurricane may be more severe. The growth of Middleborough has meant that impervious land has become pervious, increasing the amount of runoff from normal precipitation.

**Table 3-1**

---

<sup>4</sup> Massachusetts Hazard Mitigation Plan, 1999 Update, p.10.

<b>Natural Hazard</b>	<b>Likelihood/ Frequency</b>	<b>Impact Area Assessment</b>	<b>Severity/Magnitude</b>	<b>Hazard Index</b>
<b>FLOOD RELATED HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Riverine/Coastal Erosion/Dam Failures</li> <li>➤ Thunderstorms/Winter Storms</li> <li>➤ Coastal Storms/ Nor'easters</li> <li>➤ Hurricanes</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts. Rank #1
<b>WIND RELATED HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Hurricanes</li> <li>➤ Coastal Storms/ Nor'easters</li> <li>➤ Winter Storms</li> <li>➤ Downspouts/Tornadoes</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts. *Rank #2
<b>FIRE-RELATED HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Drought</li> <li>➤ Wildfires/Urban Fires</li> <li>➤ Flooding</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts. *Rank #1
<b>GEOLOGIC HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Earthquakes/Landslides</li> <li>➤ Sink Holes/Subsidence</li> </ul>	Possible (1)	Small (1)	Limited (1)	3 Pts. Rank #3
<i>(Source: State of North Carolina Emergency Management Agency)</i>				* equally ranked

Table 3-2



## Hurricanes

While New England is not the area of the United States most burdened by hurricanes, the Atlantic coast of the United States can expect to see an average of 2 major hurricanes every 3 years<sup>5</sup> and New England can expect one major landfall in each decade.<sup>6</sup> This is in part due to the geography of Massachusetts—its projection easterly into the Atlantic places it in the typical path of storms that originate in Cape Verde or the Bahamas. Hurricanes are tropical storms that obtain wind speeds of 74 miles per hour or greater and are accompanied by heavy rainfall. Since hurricanes are formed at sea, storm surge is a concern when hurricanes make landfall. The National Weather Service reports, “southern New England has been affected by forty-one such storms since 1900, 12 of which made landfall with significant impact.”<sup>7</sup> Table 2-3 reflects the history of these events. The tracks of storms that made landfall within the region are reflected on the map, *Hurricane Data: Wind and Flood Related Hazards*. It should be noted, however, that these paths are neither indicators of future behavior nor the full representation of hurricane impacts in the region. The heaviest areas of hurricane damage are on the eastern side of landfall, as the storm moves in a large counter-clockwise spinning spiral. **The most damaging storms have made landfall and tracked to the west of this region-** including the major 1938 unnamed hurricane that made landfall in Milford Connecticut and the 1954 Hurricane Carol that made landfall in Old Saybrook, Connecticut. Mapping the paths of hurricanes that made landfall in the region since 1860 shows that eight hurricanes, of varying intensity, crossed the region. The inset tells a more complete story about hurricane damage, by indicating those hurricanes that made landfall as far west of the region as the Rhode Island border. Figures 2-1 and 2-2 indicate the frequency of hurricane events in southern New England during the past hundred years. While it looks highly likely that southeastern Massachusetts will experience a hurricane, flooding in Middleborough from the hurricane is “likely”.

**TABLE 3-3 History of southern New England Hurricanes**

	NAME	DATE	INTENSITY
<i>Twelve significant tropical cyclones impacted southern New England, 1900-1999. Storm intensity at landfall is given by the Saffir/Simpson scale or TS for tropical storm.</i>	Unnamed	7/21/1916	CAT 1
	Unnamed	9/21/1938	CAT 3
	Unnamed	9/14-15/1944	CAT 3
	Carol	8/31/1954	CAT 3
	Edna	9/11/1954	CAT 3
	Diane	8/18-20/1955	TS
	Donna	9/12/1960	CAT 2
	Belle	8/9-10/1976	CAT 1
	Gloria	9/27/1985	CAT 2
	Bob	8/19/1991	CAT 2
	Bertha	7/12-13/1996	TS
	Floyd	9/18/1999	TS

*Source:* Vallee, D. “A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England. [Available at: [www.erh.noaa.gov/er/box/tropical\\_cyclones.htm](http://www.erh.noaa.gov/er/box/tropical_cyclones.htm)]

<sup>5</sup> Jarrel et al, 4.

<sup>6</sup> Vallee, D. “A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England. [Available at: [www.erh.noaa.gov/er/box/tropical\\_cyclones.htm](http://www.erh.noaa.gov/er/box/tropical_cyclones.htm)], p.2.

<sup>7</sup> Vallee “A Centennial Review”,p 1.

Figure 3-1

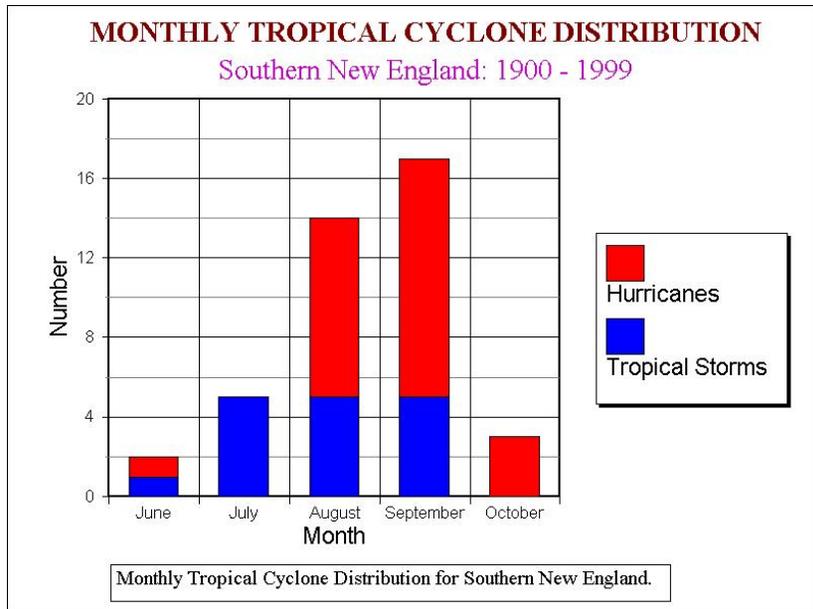
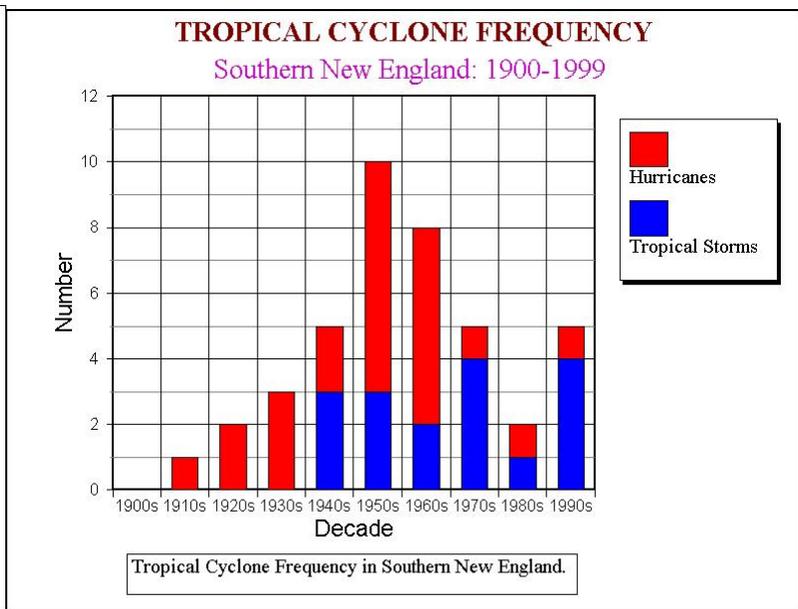


Figure 3-2



Vallee, D. "A Centennial Review of Major Land Falling Tropical Cyclones in Southern New England" Available at: [www.erh.noaa.gov/er/hox/tropical\\_cyclones.htm](http://www.erh.noaa.gov/er/hox/tropical_cyclones.htm) 1 p 2.

Strength	Wind Speed (mph)	Pressure (millibars)	Storm Surge (feet)
Category 1	74-95	>980mb	4-5 ft.
Category 2	96-110	965-979mb	6-8 ft.
Category 3	96-113	945-964	9-12 ft.
Category 4	131-155	920-944	13-18 ft.
Category 5	>135	919	18 ft.
Tropical Cyclone Classification			
Tropical Depression		20-34 kt or 23-39 mph	
Tropical Storm		35-64 kt or 40-73 mph	
Hurricane		65+ kt or 74+ mph	

In assessing the magnitude or severity of damage from a hurricane in southeastern Massachusetts, consideration must be given to the timing of the event. Hurricanes that make landfall during high tide will have much greater storm surge and thus flood larger areas. In addition, hurricane season runs from June 1 to November 30, a period that includes the summer population swells experienced by several southeastern Massachusetts communities. The timing of the storm relative to other weather events also has a bearing on the

overall impact of the hurricane. If a hurricane follows another hurricane or a major rain event, the effects can be magnified as flooding is greater, and weakened or loosened trees are more susceptible to toppling.

The severity of an event considers the potential for loss of life, property damage, and critical facility or business interruption. **Most experts anticipate that the next major New England hurricane will have severe impacts because present residents are unaware of the serious danger and major property investment has increased the value of structures in the region.** Given that the last major storm event was nearly twelve years ago, there is concern that those who have re-located to the area during this period or come of age during this period, are unaware of the real danger posed by a powerful hurricane. NOAA (National Oceanic and Atmospheric Administration) estimates that 80-90% of the population now living in United States coastal areas has never experienced a major hurricane.<sup>8</sup> This lack of firsthand knowledge can cause lax response to warnings and poor or little preparedness.<sup>9</sup> When residents are slow to respond to warnings the severity of impacts can be expected to be greater.

The new population has come with increased residential construction. Given the rating categories within severity of impacts (see Table 2-2), “**limited**” described, as “complete shutdown of critical facilities for more than one week, up to 25% property damage, and injuries but no permanent disabilities” appears to fit the severity of damages Middleborough could expect. Of course, a powerful storm on a particular tract could inflict much greater damage.

### **Nor’easters, Winter Storms, and Thunderstorms**

**The Massachusetts Hazard Mitigation Plan reports that while hurricanes strike the area with much more force than Nor’easters, the state suffers more damage from Nor’easters because they are a more frequent occurrence.**<sup>10</sup> Nor’easters are a common winter event in New England (1-2 each year<sup>11</sup>) and they bring high winds and sustained rains. They are more problematic in part because they have a longer duration – 12 hours to 3 days, versus 6 to 12 hours for hurricanes. Many southeastern Massachusetts communities will have flooding associated with the heavy precipitation of Nor’easter storms. Problems can be exacerbated when the rains fall and the melting of snow and ice is added to the flow. The large chunks of ice that are freed can clog drainage passages and increase localized flooding. This flooding can affect private residences, businesses, and public infrastructure such as roadways and storm drains.

---

<sup>8</sup> “Hurricanes: Unleashing Nature’s Fury”, August, 2001, ARC 5030, NOAA/PA 94050, p.8.

<sup>9</sup> Jarrell, J. “The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 – 2000. NOAA Technical Memorandum NWS TPC-1, [Available at [www.aoml.noaa.gov/hrd/Landsea/deadly/index.html](http://www.aoml.noaa.gov/hrd/Landsea/deadly/index.html)], p. 8.

<sup>10</sup> Massachusetts Hazard Mitigation Plan, 1999, p.11.

<sup>11</sup> Ibid.

The hazard map for Middleborough, *Nor'Easters & Blizzards* indicates the snowfall pattern. The majority of Middleborough falls within a band of lower average annual snowfall 24.1 to 36 inches per year, with approximately the northern fourth classified in the higher snow band of 36 – 48 inches of snow each year. According to NOAA, the greater Providence area (covering the western section of southeastern Massachusetts) has a 20% chance each year of having at least 1 snowfall amounting to 12 inches or more, and is likely to experience 9.88 snowstorms each year. The greater Boston area (covering the northern/central area of southeastern Massachusetts) has a 33% chance each year of having at least 1 snowfall amounting to 12 inches each year and is likely to experience 10.33 snowstorms annually.<sup>12</sup> Middleborough is most accurately placed within the Boston area. While melting snow adds to flooding, snowfall also presents a non-flooding hazard as access to critical facilities may be compromised by large amounts of snowfall. Variations on this hazard are a snowstorm in combination with rain that produces a very heavy wet snow or ice storms both of which weigh down trees and power lines.

As a community with the outlying area without access to the public water supply, the loss of power in Middleborough results in many homeowners that lack a back-up generator being without running water. In February of 2004, the American Meteorological Society initiated a rating scale for winter storms. The Category 1- 5 scale is intended to be used to assess damage rather than predict impacts. Snowstorms are difficult to predict and small temperature fluctuations mean the difference between snow and rain. The scale that includes by increasing intensity- notable, significant, major, crippling and extreme storms- assesses the amount of snow, area affected, and population impacted.<sup>13</sup>

<b>Category</b>	<b>Cat 1 Notable</b>	<b>Cat 2 Significant</b>	<b>Cat 3 Major</b>	<b>Cat 4 Crippling</b>	<b>Cat 5 Extreme</b>
<b>Snow Depth</b>	4-10 inches	10+ inches	10-20 inches	20+ inches	10, 20, or 30 inches
<b>Area</b>	Size of RI	Southern New England	1-3 times NY State	Northeast	Northeast
<b>Population Affected</b>	10 million	10-20 million	20-40 million	50 million	60 million

*(Source: American Meteorological Society)*

<sup>12</sup> <http://www.erh.noaa.gov/box/climate/snow-climate.html>

<sup>13</sup> Allen, Diane. “Snow Watchers now rate the effects from 1-5.” *The Boston Globe*, March 17, 2004, p.B4.

## Riverine Flooding and Dam Failures

As indicated by the Critical Facility and Flood map, the 100-year floodplain areas in Middleborough are located along river corridors. Further evaluation should be undertaken to assess whether this land area is the rear portion of developed lots, wetland areas or in any other way restricted from development. Much of this area may be associated with bogs.

The Massachusetts Bureau of Dam Safety reports that the region's dams, like the other parts of New England infrastructure, are an aging infrastructure that is expensive to repair. Routine maintenance is necessary to control the growth of trees and keep the area clear so defects can be detected. In addition to aging, the region's dams are often doing work beyond their original design. The increase in impervious surfaces leads to increased flows in some streams and rivers and thus greater demands are placed on the dams. In 2003, a dam in a north shore community "overtopped" after heavy precipitation. When this happens the dams can fail quickly as the earthen structures are subject to erosion pressures. The Riverways Program within the Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE), has been studying the larger environmental costs of both operational dams and dam failures. Dam failures may cause loss of life and property downstream, but they may also degrade the environment. Many dams act as a holding area for contaminated sediments. With a dam failure, these sediments are released and can damage wildlife and the ecology of the river system. An associated cost of dam failures is the potential for such destruction to affect fish ladders or culverts for directing water. The Riverways program is looking to develop an assessment tool for evaluating dams for all aspects of safety, including environmental safety.

In summary, flooding due to a variety of causes (hurricanes, Nor'easters, thunderstorms, winter storms, dam failure) is **highly likely** in Middleborough and would affect a large geographic area and population base thus having an **impact of medium** degree. The **severity** of the impacts on persons, property, and public infrastructure can be expected to be significant but **limited**.

### **B. Wind Related Hazards: Regional Maps Hurricane Data: Wind and Flood Related Hazards; Tornado Data: Wind Related Hazards; Nor'Easters/Blizzards: Flood and Wind Related Hazards;**

A number of the storm events discussed under "Flood Related Hazards", also represent wind hazards to the region. Hurricanes and Nor'easters typically have high winds that can topple trees, knock out power lines, and carry dangerous debris. Consistent with

flooding, the occurrence of these storm events can be expected to be “**highly likely**”, that is the frequency of 1-2 times each year means that southeastern Massachusetts communities need to be prepared for high wind events. Wind has primary and secondary impacts. That is, property damage may occur as roofs are blown off or power lines blown down, but this is often followed by secondary impacts as the debris from one structure is blown into another structure or vehicle, and downed power lines cause fire or electrocution.

The Middleborough map *Hurricane & Tornado* reflects the 100-year wind exposure zones defined by the American Society of Civil Engineers (ASCE) construction standards. The wind exposure standard is used to determine the construction needed to withstand an average wind gust lasting 3 seconds at 33 feet off the ground.

Middleborough is in the 100 mph zone. The ASCE standards are only used for high-rise structures, but the mapped zones indicate wind patterns as determined through readings and modeling. These patterns are consistent with the general regional weather patterns that indicate inland areas have less severe winds than coastal areas.

Occasional contributors to wind hazards are tornadoes. Since 1950, the southeastern Massachusetts region has experienced 15 tornadoes. Table 3-7 lists the dates and intensity of the event as determined by the tornado Fujita Scale, which is detailed in Table 3-8. Within this region, tornadoes tend to be more likely in the months of May – September and the hours of 3 – 6PM. The National Weather Service reports that despite technological advances in equipment, the warning window for a tornado is still only about 2 minutes. In addition, this warning is very general, typically covering an area as large as a county.<sup>14</sup> Massachusetts ranks nationally as 35<sup>th</sup> in occurrences of tornadoes for the period 1950 – 1995, but 16<sup>th</sup> in fatalities and 12<sup>th</sup> in property damages based on these same events.<sup>15</sup> Massachusetts can expect on average, three tornadoes per year through out the state.<sup>16</sup> Tornadoes and other natural hazards that bring high winds, can affect the entire southeastern Massachusetts region. Thus all populations are vulnerable, but given that 38% of tornado fatalities are in mobile homes<sup>17</sup>, mobile home park residents are a more vulnerable group than the general population. The higher fatalities does not reflect the fact that mobile home parks are more likely to be hit by a tornado, but rather that if hit mobile homes are more vulnerable to damage.

Middleborough has three senior mobile home parks containing approximately 800 units with another 700 permitted in one park at buildout.

---

<sup>14</sup> Interview with Glenn Field, July 2003.

<sup>15</sup> [http://nebraskaweather.unl.edu/severe/USspc\\_state\\_tornado\\_information\\_alpha\\_2.htm](http://nebraskaweather.unl.edu/severe/USspc_state_tornado_information_alpha_2.htm)

<sup>16</sup> <http://www.ncdc.noaa.gov/img/climate/severeweather/small/avgt5095.gif>

<sup>17</sup> <http://nebraskaweather.unl.edu/severe/USstornfacts.htm>

<b>Table 3-7 Tornadoes 1950 – 1995 Bristol &amp; Plymouth Counties</b>		
<b>Bristol County</b>	<b>Date</b>	<b>F-Scale</b>
	June 9, 1953	F3
	September 7, 1958	F0
	August 9, 1968	F1
	August 9, 1968	F1
	August 2, 1970	F1
	August 28, 1970	F2
	September 14, 1972	F0
<b>Plymouth County</b>	<b>Date</b>	<b>F-Scale</b>
	September 7, 1958	F0
	July 4, 1964	F1
	June 9, 1965	F0
	November 18, 1967	F2
	August 9, 1968	F1
	September 16, 1986	F1
	July 10, 1989	F1
	July 10, 1989	F0

<b>Table 3-8 Fujita Tornado Damage Scale</b>		
<b>SCALE</b>	<b>WIND (MPH)</b>	<b>TYPICAL DAMAGE</b>
<b>F0</b>	< 73	Light Damage: Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged
<b>F1</b>	73-112	Moderate Damage: Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
<b>F2</b>	113-157	Considerable Damage: Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground
<b>F3</b>	158-206	Severe Damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
<b>F4</b>	207-260	Devastating Damage: Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
<b>F5</b>	261-318	Incredible Damage: Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yds); trees debarked; incredible phenomena will occur.

In summary, wind damage due to a variety of causes (hurricanes, Nor'easters, winter storms, tornadoes) is **highly likely** in Middleborough, and would affect a large geographic area and population base thus having an **impact of medium** degree. The **severity** of the impacts on persons, property, and public infrastructure can be expected to be significant but **limited**.

### **C. Fire-Related Hazards: Regional Map Forest Vegetation and Wildfire Data: Fire Related Hazards**

Wildfires are a natural part of the southeastern Massachusetts ecosystem. Fires keep the forest floor clean of debris, encourage the growth of grasses that serve as wildlife feed, and ensure that trees have plenty of room to grow. Natural fires, recurring in a cyclical manner, can recycle nutrients and create a diversity of natural habitats. In these ways, wildfires that occur in isolated areas can be a positive force. Increasingly, however, development is encroaching into isolated areas and wildfires present a danger to human life and manmade facilities. **Forest fires that were in remote areas are now forest fires in people's backyards.** The dual issues of human suppression of forest fires and human encroachment into forest areas, has increased the risks associated with wildfire. Portions of southeastern Massachusetts are classified as "pine barrens". These are areas where the vegetation is predominately pitch pine with an understory of scrub oak and black huckleberry. Not only is this vegetation highly flammable, the ecosystem of the pine-barrens relies on periodic fire to perpetuate the barrens.<sup>18</sup>

The dispersion of growth into rural and undeveloped areas described in the Profile Chapter is consistent with the national phenomenon documented in discussions of the Wildlands/Urban Interface. The Wildlands/Urban Interface is getting attention because as development (particularly low-density residential development) pushes into flammable vegetative areas the threats of wildfires increase.

---

<sup>18</sup> Barbour, Henry et al, "Our Irreplaceable Heritage: Protecting Biodiversity in Massachusetts" 1998, p.46-7(NHESP & MA Audubon).

<b>Vegetation Type</b>	<b>Acres</b>	<b>Percent of Total*</b>
Pitch Pine/Scrub Oak	120,332.00	23 %
Northern Hardwood	41,423.49	8 %
Red Maple Dominant	19,191.91	4 %
Oak/Maple Birch	3,908.96	1 %
Open Meadow	7,283.46	1 %
Forested Wetlands	56,101.70	11 %
Mixed Hardwood Pine	42,023.78	8 %
Suburban Forest	92,233.93	18 %
Water Bodies/Beaches/No Vegetation	132,883.69	26 %

The Middleborough map, *Wildfire* indicates vegetative coverage of the region that can be used to assess flammability. Pitch pine/scrub oak vegetation is resinous and waxy, characteristics that make it the most highly flammable vegetation in the region. The red areas on the Forest Vegetation Map are pitch pine/Scrub oak vegetation.

The types of injuries that wildfire can cause include: loss of life, loss of property, and environmental damage. Fighting fires relies on having adequate access to the area and sufficient water

### **Drought**

Drought is the main factor that determines the intensity of a wildfire season - the less moisture present in trees and vegetation, the more likely they are to ignite and the hotter they will burn. Table 3-11 indicates the amount of time it takes for vegetation to dry after rainfall, to reach its point of flammability.

<b>Size of Fuel</b>	<b>Hours Post Rain to Reach Flammability</b>
¼" diameter or less	1 hour
¼ – 1" diameter	10 hours
1 - 3" diameter	100 hours

4 – 7" diameter	1,000 hours
8" + diameter	10,000 hours
<i>Source: MA Bureau of Fire Control.</i>	

Beyond its role as a factor leading to wildfire, drought also has impacts on public safety for all firefighting activity, agricultural production, and economic vitality of large users such as golf courses or industrial processes. According to the December 2001 Draft Massachusetts Drought Management Plan, Massachusetts generally has enough precipitation to support the demands residents and businesses place on water. Periods of drought are not unheard of though, with the 1960s and more recently 1999 – 2000 and 2002 being notable times of water stress in the southeastern region.<sup>19</sup>

#### **D. Geologic Hazards – Regional Map Earthquake Data: Geological Related Hazards**

The hazards that present the least risk to southeastern Massachusetts are geologic hazards such as earthquakes and landslides. The United States Geological Service (USGS) categories the region as one of low risk for earthquakes, although small-scale earthquakes (under 3 on the Richter scale) are common in the region. The Weston MA Observatory of Boston College tracks earthquake activity throughout New England and reports that recent earthquakes in the vicinity of this region include an April 1996 3.5 Mn magnitude in Swansea; a July 11, 2002, 3.0 Mn magnitude in Martha’s Vineyard; and a February 23, 2004 2.0 Mn magnitude in Dartmouth.

The PGA zones are based on modeling data that indicates areas where there is a 10% chance in the next fifty years of an earthquake exceeding the PGA for that zone. PGA is a measurement that compares the shaking of the ground with the force of gravity. While the likelihood of a powerful earthquake in the region is low, the actual risk is high because of how old the buildings are and because few structures have been built to withstand earthquakes. Critical infrastructure such as bridges and dams would be vulnerable. Overall the likelihood of a geological hazard in the region is considered to be **possible** but the type of event would be such that the impacts would be **small** and the severity **limited**, because earthquakes in the area are typically very small.

**(add: there is a distinctive fault line which runs through a significant area in south Middleborough)**

---

<sup>19</sup> Working Draft: Massachusetts Drought Management Plan, p4, December 21, 2001.

<b>Table 3-11 Richter Scale</b>	
M= 1-3	Recorded on local seismographs, but generally not felt
M= 3-4	Often felt, no damage
M= 5	Felt widely, slight damage near epicentre
M= 6	Damage to poorly constructed buildings and other structures within 10's km
M= 7	"Major" earthquake, causes serious damage up to ~100 km
M= 8	"Great" earthquake, great destruction, loss of life over several 100 km
M=9	Rare great earthquake, major damage over a large region over 1000 km

## Chapter Four: Existing Protection Matrix Town of Middleborough

<b>Table 3-1: Hazard Index</b>				
<i>Natural Hazard</i>	<b>Likelihood/ Frequency</b>	<b>Impact Area Assessment</b>	<b>Severity/ Magnitude</b>	<b>Hazard Index</b>
<b><i>FLOOD RELATED HAZARDS</i></b> <ul style="list-style-type: none"> <li>➤ Riverine</li> <li>➤ Coastal</li> <li>➤ Erosion</li> <li>➤ Dam Failures</li> <li>➤ Thunderstorms</li> <li>➤ Winter Storms</li> <li>➤ Coastal Storms/ Nor'easters</li> <li>➤ Hurricanes</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1

<b>WIND RELATED HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Hurricanes</li> <li>➤ Coastal Storms/ Nor'easters</li> <li>➤ Winter Storms</li> <li>➤ Downspouts</li> <li>➤ Tornadoes</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1
<b>FIRE-RELATED HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Drought</li> <li>➤ Wildfires</li> <li>➤ Urban Fires</li> <li>➤ Flooding</li> </ul>	Highly Likely (3)	Medium (2)	Limited (1)	6 Pts.* Rank #1
<b>GEOLOGIC HAZARDS</b> <ul style="list-style-type: none"> <li>➤ Earthquakes</li> <li>➤ Landslides</li> <li>➤ Sink Holes</li> <li>➤ Subsidence</li> </ul>	Possible (1)	Small (1)	Limited (1)	3 Pts. Rank #4
<b>OTHER</b>				* equally ranked

The following table lists mitigation actions by category that the Town of Middleborough presently has in place.

**EXISTING PROTECTION MATRIX: TOWN OF MIDDLEBOROUGH**

<i>Category of Protection Measure</i>	<i>Description</i>	<i>Area Covered</i>	<i>Effectiveness and/or Enforcement</i>	<i>Improvements or Changes Needed</i>
<b>Capital Improvement Planning/ Structural Improvements</b>	Capital Improvement Planning Committee in place. Prepares CIP on an annual basis covering a 5-year cycle.	Town-wide	Funding on as possible basis. FY 05 requests total \$681,132.	The town struggles to fund CIP items and maintain a sufficient operating budget.
	Route 44 improvements - including changing stormwater from ditch drainage to closed system with water quality treatment	Route 44	NA	NA
<b>Regulations/ Bylaws/Codes</b>	Local Wetlands Bylaw	Town-wide	Effective	None
	Local roadways sufficient width for fire response equipment	Town-wide	Effective – Planning Board and Fire Department work together to ensure site plans and regulations are adequate for emergency response purposes.	None
	Zoning upland requirements for residential lots- a minimum of 70% of lot must be upland (residential lot minimum is 60,000 sq.ft.).	Town-wide	Each residential lot must have adequate upland area – this protects floodplain areas by giving the resident enough useable land area for building and landscaping, i.e. prevents encroachment in floodplain/wetland areas.	None

	Subdivision Regulations-underground utilities required	Town-wide	Enforced.	None
	Soil Conservation Regulations-regulations that could impact sedimentation build up in waterways as a result of run-off from sand and gravel operations.	Town-wide	Adequate.	
<b>Operations, Administration, and Enforcement</b>	Tree Maintenance	Town-wide within public street ROW	As funding permits within G & E workload	More funds
	Inter-department Emergency Coordination through Local Emergency Planning Committee	Town-wide	Meets on as needed basis.	
	Disaster Warning System	Town-wide	Cable TV; siren system,	None
	Maintenance of Drainage Facilities	Town-wide	On an as needed basis, routine annual program followed as permitted within the Highway Department workload.	None
	Winter Road Clean-up	DPW	Snow removal, tree removal as needed in response to storms.	None
<b>Planning</b>	Comprehensive Plan -completed 2003	Town-wide	No mention of disaster mitigation	
	Open Space Plan –draft 2004	Town-wide	No mention of disaster mitigation	
<b>Education &amp; Training</b>	Regular Training run on nuclear evacuation; hazardous materials, etc.	Town-wide	Effective	None

	Wide range of materials available at town hall on preparedness.	Town-wide	Adequate	Try to widen distribution – consider mailing with tax bill or utility bill.
--	---	-----------	----------	---

## Chapter Five: Proposed Pre-Disaster Mitigation Actions Town of Middleborough

The following table represents recommended mitigation actions. Some of these activities will require grant funding, others will require the cooperation of other agencies. The Town of Middleborough will make a good faith effort to implement these actions within the constraints of the local budget, staff resources, and new demands from state and federal agencies.

### PROPOSED MITIGATION ACTIONS: TOWN OF MIDDLEBOROUGH

<i>Category of Protection Measure</i>	<i>Action</i>	<i>Responsible Parties</i>	<i>Timeline</i>	<i>Resources Needed</i>
<b>Capital Improvement Planning/ Structural Improvements</b>	(1) Correct repetitive flooding problem at Woloski Park  Requires new box culverts and raising roadway bed for 700 feet. Corrective measure to prevent existing flooding issues that necessitate maintenance and repair each spring.	DPW	Ongoing request until funded.	Pursue grant funding in combination with Chapter 90 monies – total cost estimated at \$250,000
	(2) Construct “dry-hydrants” to assist wildfire fighting. Middleborough is a rural community without a water supply in outlying areas and with a high wildfire risk. Dry hydrants provide additional water supplies for fighting fires. Town-wide but in particular high-risk areas near state forest.	Fire Dept	Submit as needed until funded.	Pursue grant funding or CIP funding as budgeting allows

	<p>(3) Equip fire vehicles with GPS to assist with monitoring vegetation and responding to wildfire threats. Global Positioning System (GPS) would permit better coordination and tracking of conditions.</p>	<p>Fire Department with Emergency Mgt.</p>	<p>Ongoing request until funded.</p>	<p>Pursue grant funding for equipment.</p>
--	---	--	--------------------------------------	--

<b>Regulations/ Bylaws/Codes</b>	(6) Adopt Floodplain zoning. Needed for consistency with NFIP regulations	Planning Board/Bldg Commissioner/ Town Meeting	Return in 2005	Try to revise to be acceptable and educate before Town Meeting.
<b>Operations, Administration, and Enforcement</b>	None			
<b>Planning</b>	(7) Comprehensive Plan- No mention of disaster mitigation. At next re-write add cross-references to this plan.	Planning Board	At re-write – 5 years.	Part of the process.
	(8) Open Space Plan- At next re-write add cross-references to this plan.	Planning Board	At re-write – 5 years.	Part of the process.

	(9) Update Pre-Disaster Mitigation Plan on a regular 5 year cycle – coordinate with CEM update and Open Space update	Emergency Mgt Director	Ongoing	Limited amount of work – if looks to be excessive can apply to MEMA for funding.
<b>Education &amp; Training</b>	(10) Expand education efforts with a targeted mailing. Work with neighboring communities on developing appropriate materials. Pursue joint application with other towns for funds to prepare updates materials.	Emergency Mgt.	Within next 5 years	Pursue grant funds in a regional application.