APPENDIX A. HAZARD MITIGATION PLANNING METHODOLOGY

To address the requirements of 44 CFR 201.4 and better understand potential risk associated with the identified hazards of concern, the Commonwealth of Massachusetts used standardized tools, combined with state and federal data and expertise to conduct the risk assessment. Our standardized tools used to support the risk assessment are described below.

HAZARDS U.S. – MULTI-HAZARD

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or Hazus. Hazus was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. Hazus was expanded into a multi-hazard methodology, Hazus-MH, with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. Hazus-MH is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

Hazus-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, Hazus-MH uses default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. Hazus-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. The guidance Using Hazus-MH for Risk Assessment: How-to Guide (FEMA 433) was used to support the application of Hazus-MH for this risk assessment and plan. More information on Hazus-MH is available at http://www.fema.gov/plan/prevent/hazus/index.shtm.

In general, both historic and probabilistic analyses were performed to develop estimated distribution of losses for the earthquake, flood, tropical storm/hurricane and nor'easter hazards. The following describes the inventory used and discusses more specifically the methodology for each of the hazards evaluated in Hazus-MH version 2.1 (Hazus-MH).

The default demographic and general building stock data in Hazus-MH 2.1 were used for the vulnerability analysis. The default demographic data is based on the 2000 U.S. Census statistics and the default aggregate building inventory is based on U.S. Census data for residential occupancies and Dun & Bradstreet for non-residential occupancies.

STATE FACILITIES

A custom table developed by DCAMM named MEMA_BDT_CAMIS.xls was used for this project. All locations were geocoded using ESRI's ArcGIS Online North America Streets 10.0 online geocoding service. Upon initial inspection of the MEMA-CAMIS spreadsheet of owned facilities, 6,422 facilities were included and of these 5,398 facilities matched via geocoding to the street, rooftop, or street name geocoding level. Out of the initial set of facilities, 916 facilities contained no address and 108 facilities would not match via coding with the address provided. After the initial geocoding of the owned facilities data, these 1,024 facilities were sent back to Massachusetts for review and to obtain additional information that would allow them to be located. Of the 1,024 facilities sent back for updating, 935 were able to be successfully located with the inclusion of additional data. This allowed for 6,333 facilities to be included in the overall analysis of state owned facilities out of the 6,422 facilities that were provided, which is 98.6% of all owned facilities.

To include the owned facilities in Hazus-MH hazard models, assumptions had to be made for specific required variables that were missing from the supplied list of owned facilities. The description of the building (DescBldg field) was provided but had to be converted into Hazus specific building types for Flood and Earthquake modeling. When a building description was provided, the flood and earthquake Hazus specific building types were assigned accordingly, for facilities were this field was not provided, the default Wood (WOOD for Flood and W1 or W2 depending on area for Earthquake) was set as a default. The occupancy class for each facility was set to a default value of GOV1 or GOV2 depending on the description of the facility. For those facilities where the number of stories was not provided, a default value of 1 for buildings that were described as sheds or other smaller structures was assigned and a default value of 2 was assigned for all other buildings. Similarly, for those buildings where an area was not indicated a default value of 2,500 square feet was assigned, unless the building was described as something similar to a shed, which in case the default value was set to 100 square feet. The values for earthquake design level (EQ_DesignLevel), first floor elevation for flood models(FL_FFElev), foundation type for flood models, and the flood design level for each of the owned facilities was not indicated in the provided spreadsheet of owned facilities. For these variables the same default value was assigned to each facility according to the following:

- Earthquake Design Level (EQ_DesignLevel) = LC (for Low Code)
- First Floor Elevation (FL_FFElev) = 3 (3 feet)
- Foundation Type (FL_Found) = 7 (slab on grade)
- Flood Design Level (FL_DesignLevel) = 0 (Unknown)

The year built was a variable collected and provided in the owned facilities spreadsheet, for facilities where this variable was missing a default year built of 1970 was assigned. For the replacement and content cost, the provided replacement value was used as both the replacement cost and the content cost needed for Hazus-MH analysis. In cases where the replacement cost wasn't provided, a 2011 RS Means cost of $133.59/sq. ft. for GOV1 buildings was used. And lastly, a CAMIS ID and an Improvement Code was provided for most facilities in the owned facilities spreadsheet. To maintain this information with each facility, these numbers were concatenated into the Hazus Comment field as *CAMIS Code; Improvement Code* in case a facility needed to be further analyzed after the risk assessment was completed.

According to DCAMM, the *User Agency* provided in the MEMA_BDT_CAMIS.xls table of state-owned facilities was populated by the 10-digit *CAMIS BLDG Code*. This column is outdated because CAMIS cannot update their code; therefore the *User Agency* may reflect old agency names or may not reflect recent changes of ownership. For example, the Department of Environmental Management (DEM) and Metropolitan District Commission (MDC) were merged and are now Department of Conservation and Recreation (DCR); however DEM and MDC were still listed as agencies. To ensure our data set and risk assessment reports the results by the proper agency, the 13 character *Improve Code* from MASSETS (characters 7 through 9 in the code) was verified with DCAMM staff and used to list the agency and fill in any blanks in the MEMA_BDT_CAMIS.xls table. There were no changes to the agencies for the State-leased data.

Please note the DCAMM building data is always being updated, changed and corrected as agencies change or modify.

There are more than 190 types of facilities in the DCAMM database that are included in the vulnerability assessment. The following list is just a short snapshot of some of the key critical facilities in DCAMM.

- Boat ramp
- Bridge
- Corrections
- Courthouse
- Dams/dam operations building
- Day care facility
- Docks/piers/marinas
- Electrical distribution/substation
- Fire station
- Fuel dispensing station
- Hospital / clinic
- Laboratory / research
- Library
- Marine & water transportation
- Military structure
- Miscellaneous
- Museum /monument
- Police station/barracks
- Pump house
- Residence/dormitory
- Salt/sand shed
- School
- Sewage treatment plant
- Telecommunications
- Water supply
- Office

Critical Facilities

All critical facilities, whether state or local, were used and obtained from MassGIS. Their data was more accurate in terms of location and more current than the default critical facility inventories in Hazus. The facility types used, in addition to those listed above, were police stations, fire stations, hospitals, emergency operation centers (state only) and schools (including pre-K through grade 12 and colleges).

Infrastructure

Hazus-MH default bridge inventory was used which includes federal, state, and locally-owned along with replacement cost values.

HAZARD-SPECIFIC METHODOLOGIES

Earthquake

Hazus-MH 2.1 was used to evaluate the Commonwealth's risk to the seismic hazard. A probabilistic assessment was performed to analyze the earthquake hazard estimated potential losses (100-, 500- 1,000- and 2,500-year mean return period losses). The probabilistic method uses information from historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census tract.

The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. For this analysis, available NEHRP soil data in portions of Franklin, Hampden and Hampshire Counties provided by the State Geologist, Mr. Stephen Mabee was incorporated into Hazus-MH 2.1 and used for all analyses. Groundwater was set as at a depth of five-feet (default setting). Damages and loss due to liquefaction, landslide or surface fault rupture were not included in this analysis. Estimated damages to the general building stock were generated at the Census-tract level.

Flood

To assess the Commonwealth's exposure to the flood hazard, an analysis was conducted with the most current floodplain boundaries. This data includes the locations of the FEMA flood zones: the 100-year flood zones or 1-percent annual chance event (including both A zones and V zones) and the 500-year flood zones or 0.2-percent annual chance event. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP. Using ArcMap, GIS software, this data was overlaid with the population, general building stock, state facility data (owned and leased), critical facilities and bridges; and the appropriate flood zone determination was assigned.

The newest FEMA FIRM or DFIRMs were used in this analysis, including preliminary DFIRMs provided by the Department of Conservation and Recreation (DCR). Where DFIRMs were not available, Quality 3 (Q3) data was used. Franklin County does not have DFIRMs or Q3 data; however a digital floodplain layer that had been developed by the Franklin Regional Council of Governments (FRCOG), which only includes the floodplain in those communities along the Connecticut River, was used for this analysis. Table A-1 summarizes the data used for this risk assessment.

TABLE A-1.
DATA USED FOR 2013 PLAN UPDATE

County	Data Used	Source
Barnstable	Q3	MassGIS – August 2012
Berkshire	Q3	MassGIS – August 2012
Bristol	DFIRM (July 7, 2009)	DCR - September 2012
Dukes	DFIRM (July 6, 2010)	DCR - September 2012
Essex	DFIRM (July 3, 2012)	DCR - September 2012
Franklin	Digital floodplain layer (1-percent flood event only) for Connecticut River (and some of the tributaries) only (there is no Q3 data for the rest of Franklin County)	DCR - September 2012
Hampden	Revised Preliminary July 13, 2012 DFIRM	DCR - September 2012
Hampshire	Q3	MassGIS – August 2012
Middlesex	DFIRM (June 4, 2010) *Shawsheen Watershed is located partially within Middlesex County The preliminary Risk MAP deliverable for Shawsheen Watershed (2011) was used in place of the data in the 2010 DFIRM database for this area.	DCR - September 2012
Nantucket	Preliminary DFIRM (July 26, 2012)	DCR - September 2012
Norfolk	DFIRM (July 17, 2012) The Town of Canton was not included in the July 17, 2012 Norfolk Countywide FIS or DFIRMs. The Q3 for the Town of Canton was used.	DCR - January 2013

TABLE A-1. DATA USED FOR 2013 PLAN UPDATE		
County	Data Used	Source
Plymouth	Physical Map Revision (PMR) to Preliminary DFIRM DB on August 16, 2012 (PMR is only for Marion, Mattapoisett and Wareham). Remainder of the county has DFIRMs from July 17, 2012.	DCR - September 2012
Suffolk	DFIRM (September 25, 2009)	DCR - September 2012
Worcester	DFIRM (July 4, 2011) The DFIRM is only available for a portion of the County (Auburn, Berlin, Blackstone, Bolton, Boylston, Charlton, Clinton, Douglas, Dudley, Grafton, Harvard, Hopedale, Lancaster, Leicester, Mendon, Milford, Millbury, Millville, Northborough, Northbridge, Oxford, Paxton, Shrewsbury, Southborough, Southbridge, Spencer, Sturbridge, Sutton, Upton, Uxbridge, Webster, West Boylston, Westborough, and Worcester); the Q3 used for the remainder of the County	DCR - September 2012

A total risk exposure was estimated for state-owned and leased buildings located in the 1- and 0.2-percent annual chance flood zones. This methodology assumed 100-percent loss to each structure and its contents if located in the defined flood hazard zones.

Hurricane/Tropical Storm

Hazus-MH

The Commonwealth selected historic events (tropical storm, and categories one through three) for simulation in Hazus-MH 2.1: 2011 Tropical Storm Irene; 1985 Hurricane Gloria (category one); 1991 Hurricane Bob (category two); and 1938 hurricane (category three) also known as the Great New England Hurricane of 1938. If the historic storm were not in Hazus' database, the storm's characteristics were manually defined in Hazus-MH 2.1 using best available data. The Hazus-MH 2.1 wind model was run for the entire Commonwealth to obtain building wind-only potential loss estimates.

FEMA Region IV Coastal Flood Loss Atlas

FEMA Region IV Risk Analysis Team developed storm surge inundation grids in GIS format from the National Hurricane Center's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model SLOSH Maximum of Maximums outputs, or the worst-case storm surge scenarios for each Saffir-Simpson hurricane category (1 through 4) under perfect storm conditions for the Commonwealth.

To assess the Commonwealth's exposure to hurricane storm surge, a spatial analysis was conducted using the SLOSH model provided by FEMA Region IV's Risk Analysis Team. Please note the SLOSH boundaries do not account for any inland flash flooding. Using ArcMap, GIS software, the SLOSH zones were overlaid with the population, general building stock, state facility data (owned and leased) and critical facilities; and the appropriate SLOSH zone determination (categories one through four) was assigned.

The Hurricane Category 4 SLOSH depth grids provided by FEMA Region IV were imported into the Hazus-MH flood model and the potential losses were estimated for the state-owned and leased facilities.

Nor'easter

A custom Nor'easter scenario was developed and incorporated into Hazus-MH v2.1 for this analysis. The Commonwealth selected the 1978 February Nor'easter as one of the most devastating Nor'easter events in their history. The storm's characteristics were manually defined in Hazus-MH 2.1 using best available data. Please note the maximum radius to maximum winds in Hazus-MH v2.1 is 93 and was utilized for this event.

The wind model was run for the entire Commonwealth. To obtain both wind and surge results, the near-shore wave model was run for the census blocks along the coastline. The census blocks selected for the analysis at minimum included all blocks within category one through four SLOSH zones. Initial water levels were obtained from the historic predicted normal tide levels from NOAA tide stations throughout the study region for the event. At this time, only building estimated potential losses are available from the Hazus-MH v2.1 surge model.

Severe Weather

High Winds/Thunderstorms

Massachusetts is divided into four wind zones, the limits of which are defined by the Massachusetts State Building Code Seventh Edition. The basis of these wind zones, as defined by the State Building Code, is a set of national wind data prepared by the American Society of Civil Engineers. The data can be found in a document titled, "Minimum Design Loads for Buildings and Other Structures (ASCE-7)." Generally speaking, structures should be designed to withstand the total wind load of the zone in which they are located. Refer to the State Building Code for appropriate reference wind pressures, wind forces on roofs, etc. Using ArcMap, GIS software, this data was overlaid with the DCAMM facility data; and the appropriate wind load zone determination was assigned to each facility

Tornado

The number of historic tornado touch-downs in 25 miles was updated using the NOAA Storm Prediction Center's dataset through 2011 (2012 data was not available at the time of the 2013 Plan update). To calculate density, the ArcGIS kernel density tool was used.

As was conducted in the 2010 hazard mitigation plan, tornado risk for the 2013 update is based on the probability of occurrence of past events. The density per 25 square miles indicates the probable number of tornado touchdowns for each 25 square mile cell within the contoured zone that can be expected over a similar period of record (approximately 60 years). It should be noted that the density number does not indicate the number of events that can be expected across the entire zone, but the percent probability of occurrence in the given area. To analyze how tornados could impact state facilities, critical facilities, and bridges, the DCAMM data was overlaid with the states area of greatest historic tornado density.

Extreme Temperature/Drought

Qualitative analyses were conducted for the extreme temperature and drought hazards.

Coastal Hazards

Coastal Erosion

In collaboration with the Massachusetts Office of Coastal Zone Management (CZM) the Massachusetts Department of Environmental Protection (MA DEP) wetlands spatial layer and specific wetland types (barrier beach, coastal beach, coastal dune, coastal bank, rocky intertidal shore, salt marsh and tidal flat) were identified as vulnerable to coastal erosion. In determining risk, the assets within this area were evaluated.

Shoreline change, whether erosion or accretion, is dependent upon several factors including location (e.g., open-ocean facing shore) and exposure to high-energy storm waves. The exposure and vulnerability of assets in the coastal high hazard area (or V zone), and storm surge is discussed in Sections X and X (Flood and Hurricane/Tropical Storms).

Sea-Level Rise

Projected sea-level rise inundation and depth grids were not made available in time to conduct a quantitative analysis for the Commonwealth. This coastal hazard is discussed qualitatively using available studies.

Severe Winter Weather

As part of a FEMA Hazard Mitigation Grant Program funded study, in 2010 the Northeast States Emergency Consortium (NESEC) developed regional hazard maps for snowfall for the Northeast. Using their GIS data, a figure was created to display the number of days with more than 5 inches of snow. Using ArcMap GIS software, this data was overlaid with the DCAMM facility data and critical facilities to examine exposure. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, this plan considers percentage damages (one-percent) that could result from winter storm conditions on the Commonwealth's total general building stock (structure only).

Dam Failure

Dam failure inundation maps and downstream hazard areas are considered sensitive information and were not available to conduct a quantitative risk assessment. The Commonwealth of Massachusetts' exposure and vulnerability to the dam failure hazard are discussed in a qualitative nature.

Wildfire

For the purposes of this risk assessment, the interface and intermix obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison defines the wildfire hazard area (Radeloff et al., 2011). The wildfire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. The high-, medium- and low-density interface areas were combined and used as the 'interface' hazard area and the high-, medium- and low-density intermix areas were combined and used as the 'intermix' hazard areas.

The asset data (population, building stock and critical facilities) were used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, available and appropriate GIS data was overlaid upon the hazard area. A total risk exposure was estimated for assets located in the intermix and interface zones. This methodology assumes 100-percent loss to each asset and its contents if located in the defined hazard zones. The limitations of this analysis are recognized, and as such the analysis is only used to provide a general estimate.

Landslide

In an attempt to estimate the Commonwealth's vulnerability to the landslide hazard, the Geology - Landslide Incidence and Susceptibility GIS layer from National Atlas was used to coarsely define the general landslide susceptible area (Godt, 2001). The asset data (population, building stock and critical facilities) were used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. To determine what assets are exposed, available and appropriate GIS data was overlaid upon the hazard area. A total risk exposure was estimated for assets located in the high incidence or high susceptibility zones. This methodology assumes 100-percent loss to each asset and its contents if located in the defined hazard zones. The limitations of this data set and analysis are recognized and are only used to provide a general estimate until higher resolution data is available Commonwealth-wide.

Tsunami

Tsunami inundation areas are not available for the Commonwealth. In an attempt to estimate the Commonwealth's vulnerability to the tsunami hazard, a one-mile buffer from the coast was used to define the area exposed and thus vulnerable.

APPENDIX B. BEST AVAILABLE SCIENCE

This appendix presents guidance that was provided for use in the preparation of hazard profiles for the Massachusetts State Hazard Mitigation Plan.

BEST AVAILABLE SCIENCE

The following are sources of information representing the best available science to use in the development of hazard profiles:

- All Hazards
  - NOAA-NCDC Storm Query: http://www.ncdc.noaa.gov/stormevents/
    - □ The website is being re-organized. You can only access data from 2006 to 2011 online and then have to download the entire database to access information from 1950 to present (this database is for ALL states; but you can run queries via Access to get specific info for the planning area)
  - SHELDUS: http://webra.cas.sc.edu/hvri/products/sheldus.aspx
  - NWS: http://www.weather.gov/
  - National Atlas: http://www.nationalatlas.gov/
  - FEMA:
    - □ http://www.fema.gov/news/disasters.fema
    - □ http://www.fema.gov/library/viewRecord.do?id=6292
  - NRCC: http://www.nrcc.cornell.edu/index.html
  - U.S. Census American Fact Finder: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t
- Climate Change
  - EPA info: http://epa.gov/climatechange/
- Drought
  - Climate Division Map: http://www.esrl.noaa.gov/psd/data/usclimdivs/data/map.html
  - Climate Divisions w/ Counties: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/CLIM_DIVS/states_counties_climate-divisions.shtml
  - Drought Impact Reporter: http://droughtreporter.unl.edu/
    - □ Click on: Advanced Search—Impacts
    - □ Select State and County (and City if doing a single jurisdiction)
    - □ Select Time Interval and use the earliest date to the most recent date
    - □ Click on Search
    - □ Once you see the list of events, click on “See impact detail” and “See detail ion associated reports”
    - □ Go through this information and look for any specific information regarding the County or municipality you are researching

    - ◻ Most of the time the information found on this site is regional, but it is still a good tool to use to get an idea of the drought event
  - – NRCC Drought: http://www.nrcc.cornell.edu/page_drought.html
    - ◻ Under Data Options, select "Periods of Drought or Extreme Drought" and select the State.
    - ◻ Using the Climate Division in which the county is found in, include those drought periods and lowest PDSI in the hazard events table.
- Earthquake
  - – USGS Earthquake Archives: http://earthquake.usgs.gov/earthquakes/eqarchives/epic/
  - – USGS Hazard Maps: http://earthquake.usgs.gov/hazards/products/conterminous/
  - – USGS Did You Feel It: http://earthquake.usgs.gov/earthquakes/dyfi/
    - ◻ If you know the date of an earthquake, search for that and you will find a list of municipalities that reported having felt the earthquake
  - – NEIC: http://earthquake.usgs.gov/regional/neic/
- Flood
  - – FEMA CRS Info: http://www.fema.gov/library/viewRecord.do?id=3629
    - ◻ Use this site to see if any community in the county is a CRS community
  - – Ice Jams are included in the Flood profile
    - ◻ CRREL Ice Jam database: https://rsgis.crrel.usace.army.mil/icejam/
    - ◻ You will get a certificate error message when you first go to this site; just click on continue to site anyway
- Severe Storm
  - – NOAA Hurricane Tracker: http://www.csc.noaa.gov/hurricanes/
    - ◻ Use this site to create the historical hurricane tracker figure; use 65 nautical miles as search distance
    - ◻ Be sure to identify each of the tracked storms on the figure in the hazard profile
- Winter Storm
    - ◻ Use NOAA-NCDC Storm Query, SHELDUS, FEMA and NWS to obtain specific event information
    - ◻ Nor'easters are included in the Winter Storm profile
- Wildfire
  - – GeoMAC: http://www.geomac.gov/index.shtml
    - ◻ Use this site to get information on current and historic wildfires (select "GeoMAC Viewer")
    - ◻ Use this site to identify whether or not the county or municipality is located in the WUI (Wildland Urban Interface)

HAZARD PROFILE LAYOUT

Each hazard profile section is to be written using the following outline:

- Description—Provide definition and details about the event. This is the same for every HMP that we do; however, need to make changes based on the county/town location, what state the county/town is located in, etc.
  - If there are specific types of the hazard (for example, flood and the county/town experiences flash floods, ice jam floods and dam break floods), those need to be defined/discussed as well. Check with PM to see what the county/town wants to include.
- Extent—Describe the magnitude and severity for a particular probability event (usually the same text as in previous HMPs)
- Location—Geographic area of the county/town affected by the hazard. Typically use the same text as previous HMPs; however, make sure the info regarding state is specific to the state the county/town is located in
  - Review the county/town Flood Insurance Study for flood (look at other HMPs to see how this is done).
  - For flood, include ice jams hazard area info
- Previous Occurrences and Losses—This is where we discuss the previous hazard events using the research tools listed above.
  - NOAA-NCDC and SHELDUS paragraph—Using the NOAA and SHELDUS data, complete this paragraph
  - FEMA paragraph—Using FEMA info, complete this paragraph
  - Table—Fill out this table with hazard events that occurred in the county/town; be sure to include all FEMA disasters where the county/town was included in the disaster. Use your best judgment when filing through the events to fill out the table—if there was a lot of damage from the event, property damage/crop damage, etc.
- Vulnerability Assessment— To understand risk, assets exposed and vulnerable to the identified hazard are evaluated. This section evaluates and estimates the potential impact of the hazards on the Commonwealth's population, state facilities, critical facilities and infrastructure and economy.

GENERAL NOTES

If doing an HMP Update, need to include all events from the previous HMP. Then update from the year left off in the original HMP to the most recent date.

Provide citations. Be sure to include all websites used as well (do this right in the document or leave the website as a comment). Keep a resource page with everything used. Keeping track of information sources is important.

Best practices

Disaster Mitigation Working in Massachusetts

New Culverts Lower Flood Risks at Converse Lane

"There was no flooding on Converse Lane this March (2010), not even any puddles."

— Bob Beshara, Melrose City Engineer

City of Melrose Photo

Melrose, MA –Before mitigation, homes along Converse Lane used to flood almost every time there was any rain.

The City of Melrose took to heart the lessons of the Mother's Day Storm of 2006, when several feet of water inundated streets, school yards, and playing fields, causing damages to residences and businesses. Since then, Melrose officials have taken significant steps to reduce the risk of flooding in several areas of the city.

With financial grant assistance from the Federal Emergency Management Agency (FEMA), the city has completed drainage improvement projects at three locations where flooding proved troublesome in 2006 – at Ell Pond in the city's central core, in Ward 2 at Melrose's boundary with the Town of Wakefield, and in the Converse Lane neighborhood at the opposite (southwestern) corner of the city.

"The residents of Converse Lane had been hit by flooding too many times," said John Scenna, Deputy City Engineer and Director of the Operations and Engineering section of the city's Public Works Department. "We had to do something to give them some relief."

Historically, flooding in the Converse Lane area of Melrose has been an almost twice-a-year event. Lying just east of the Middlesex Fells Reservation (MFR), a 2,600-acre state park, the neighborhood was commonly flooded to depths of up to three feet, and occasionally much deeper, by water draining from the Reservation following even moderate rainfall.

The culverts beneath Washington Street (at the eastern boundary of the MFR) and Converse Lane could not handle all the water during the peak of the rainfall runoff. The water backed up, existing catch basins were filled to overflowing, and streets, yards, and basements would be temporarily awash. Floodwaters often covered vehicles parked on Converse Lane, and at least one house was flooded so many times that it was declared a "repetitive loss structure" by FEMA.

City of Melrose Photo

"We had to tear up streets, lawns and backyards with the least possible inconvenience to the residents," said John Scenna, Deputy City Engineer.

FEMA photo by Dale Bonza

Previously flooded neighborhood today, in photograph taken at same location. "You can't tell it was ever ripped up," said one resident.

In the Natural Hazards Mitigation Plan for the City of Melrose, completed in December 2004, flooding was recognized as a significant weather-related hazard to the city. Inadequate capacity of several of the main city culverts to transport the storm water runoff generated during large rainfall events was determined to be the immediate cause of the flooding, and the Converse Lane neighborhood was identified as one of nineteen high-flood-hazard areas in which such undersized culverts were the main cause of flooding.

In response to the conclusions of the Mitigation Plan, the city proposed replacement of the undersized culverts and construction of additional catch basins at Converse Lane. The existing 30-inch and 24-inch culverts beneath Washington Street and Converse Lane were replaced with 48-inch culverts.

Farther downstream, at the eastern end of the neighborhood, the 48-inch culvert beneath Pleasant Street that carried storm water to Spot Pond Brook was replaced with an 8-foot wide by 4-foot high concrete box culvert.

"While other drainage improvements in the city, such as those at Ell Pond and Ward 2, addressed flooding problems over larger areas, the Converse Lane project focused on a single, small neighborhood," said Scenna. "But it was no less challenging to complete, as we had to tear up streets, lawns, and backyards with the least possible inconvenience to the residents."

Did the Converse Lane project pass the test posed by the floods in March 2010? Bob Beshara, Melrose City Engineer and Superintendent of Public Works, thinks so.

"The neighborhood was a lot drier this spring than during past flood events," said Beshara, "even though this year's storm is considered the most severe to hit this area since Hurricane Diane in 1955. Thanks to the drainage improvements, there was no flooding on Converse Lane, not even any puddles. And Washington Street didn't flood either, because the new larger culvert kept up with the flow, even at the peak of the storm runoff."

Scott MacLeod, Hazard Mitigation Grants Coordinator for the Massachusetts Emergency Management Agency (MEMA), considers the Converse Lane project to be a mitigation success story, and "a best-practice model" for other communities.

Construction of the new drainage system for Converse Lane was made possible with a grant from FEMA's Pre-Disaster Mitigation Grant Program, which provides funding for hazard-mitigation planning and the implementation of mitigation projects prior to a disaster event. The Federal share of project costs was $1.08 million, leaving the remaining $400,000 the responsibility of the community.

FEMA

Federal Emergency Management Agency
Region I
Federal Insurance & Mitigation Division
99 High Street, 6th Floor
Boston, MA 02110

Telephone 617-832-4761
www.fema.gov

To learn more about FEMA mitigation grants, please contact:

Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702

Mitigation Grants Manager
Telephone 508-820-1445

www.mass.gov/mema

dcr Massachusetts

Massachusetts Department of Conservation and Recreation
251 Causeway Street, 8th Floor
Boston, MA 02114

State Hazard Mitigation Officer
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Disaster Mitigation Working in Massachusetts

New Drainage System Averts Flooding in Melrose

"The new drain system at Ell Pond saved our city."
—Ed Kelly, Director
Melrose Emergency Management Agency

Photo—City of Melrose

Water surrounds the Melrose Towers Condominiums just north of Ell Pond during the Mother's Day Flood in 2006

Despite ten days of record-breaking flooding across northeastern Massachusetts in March 2010, the City of Melrose "dodged the bullet," thanks to the new drainage system for the city's Ell Pond.

Runoff from several previous storms, most recently the "Mother's Day Storm" in 2006, led to flood depths as high as six feet in buildings, yards, and streets to the north of Ell Pond. This Spring, the water barely topped the banks of the pond.

"The system worked almost flawlessly," said Bob Beshara, Melrose City Engineer and Superintendent of Public Works. "The new drainage system replaced part of the existing system and enhanced our ability to move floodwaters rapidly through the city's central core area, while at the same time minimizing their impact."

Ell Pond, a natural body of water within the City of Melrose, is bordered by homes, streets, recreational fields and landscaped park strips. The 23-acre pond receives water from an 1,100-acre watershed, which includes parts of the towns of Stoneham and Wakefield. Water leaves the pond through an outlet at its southeastern corner and flows southward beneath city streets to ultimately discharge to Lower Spot Pond Brook.

The original outlet channel allowed water to begin draining from the pond only when it became nearly full, so that the water level could not be lowered in anticipation of large storms and the resulting runoff.

The Ell Pond Project changed all that, and while storm runoff can't be prevented, it can now be managed to reduce its effects. A 2001 study of flooding at Ell Pond identified alternatives for eliminating, or at least minimizing the problem. In early 2005, city officials began to seek funding for the design and construction of what became known as the “Ell Pond Project.”

With funding of $1.75 million provided by the Federal Emergency Management Agency’s (FEMA) Pre-Disaster Mitigation (PDM) program, supplemented by $1 million in city funds, construction of the new drainage system was completed in time for its first real test by the recent rainfall and accompanying floods of early 2010.

The Ell Pond drainage project consists of a control gate structure at the southeastern corner of the pond and a 3,500-foot long, 48-inch pipe that extends from the control gate to the outlet at Lower Spot Pond Brook.


FEMA photo by Michael Moore

Water enters the new drainage system through the crest gate at the southeast corner of Ell Pond

During periods of peak runoff following the storms of March 2010, the level of Ell Pond rose to as high as two feet above the top of the outlet pipe, and water was draining from the pond at a rate of 100 cubic feet (748 gallons) each second. Draining this much water this rapidly from Ell Pond reduced the extent and depth of inundation of areas around the pond compared to that in the March 2006 flood.

For instance, the West Knoll Soccer Field was flooded by 3 to 4 feet of water in March 2006; in March 2010, only the perimeter of the field was flooded. And the Cabbage Patch Park in front of the new middle school, which was covered by 2 to 3 feet of water in 2006, was not flooded at all this year.

“It’s all about water-level management,” said John Scenna, Deputy City Engineer and Project Manager for the Ell Pond work. “We can now adjust the level of the pond as conditions require, either raising it high enough to prevent wave action from eroding unvegetated parts of the shoreline or lowering it before storm runoff begins to enter. We did this in March, so the pond served as a temporary storage basin for at least part of that runoff.”

The gate that controls the level of the pond is automatically activated to maintain or adjust the water to desired, preselected elevations, but the mechanism can also be manually activated. The control gate structure incorporates a sturdy debris trapping “trash rack,” and a high, level platform that provides a safe perch from which maintenance workers can remove trees and other woody debris that become lodged against the rack.

The construction phase of the new drainage system brought a year of inconveniences – such as torn up roads and temporary water hookups – to the citizens of Melrose. The rewards for their patience, in addition to a lessening of the flood risk to the areas around Ell Pond, were amenities such as new sidewalks and street paving along the construction route, beautiful landscaping around Ell Pond, a skate park, and new baseball and soccer fields.

“The new drain system saved our city,” said Ed Kelly, Director of Melrose’s Emergency Management Agency. “During earlier floods that inundated parts of central Melrose, large areas were underwater for as long as a week to 10 days. But in 2010, much smaller areas and only scattered depressions near Ell Pond were flooded to much lower depths than in those earlier floods, and the water drained away within a few hours to a few days at most. Now that’s a success story.”

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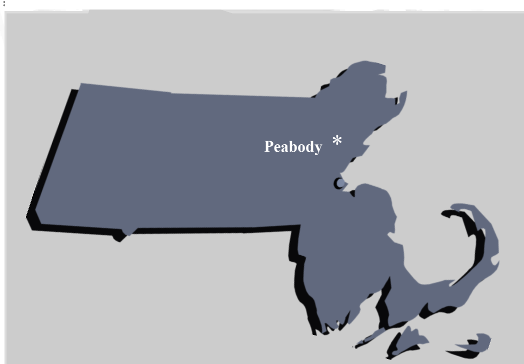
Several Small Steps Lead to Safety



"The water goes down much more quickly now…...it gives us real peace of mind."

-Chris Tighe,
Peabody Director of Emergency Management

Photo— City of Peabody

A major contributor to the high water problems in Peabody was the large amount of debris that had accumulated in the local waterways

Flooding is the most common natural disaster threatening United States residents today. While each state has its own set of hazards and risks to deal with, the majority of states count flooding as the most likely disaster citizens will have to face, and Massachusetts is no exception. In the past 20 years alone, there have been at least 16 major floods in Massachusetts, causing hundreds of millions of dollars in damages.

The City of Peabody, which lies about 15 miles northeast of Boston and three miles from the Massachusetts coast, has seen its share of those floods. Three streams – Goldthwaite, Strongwater and Proctor Brooks – converge in downtown Peabody to form the North River, which flows into the Atlantic Ocean.

"The problem with the hydrology here is that all the water is going to one place," said Chris Tighe, Peabody's Director of Emergency Management. "If we can get the water to the North River, we're going to be ok. Our best asset is low tide, when the ocean just drains all the water out of the system. The problem is, when we get back-ups, there's no place for the water to go."

In May 2006, runoff from the famous "Mother's Day Storm" inundated downtown Peabody to depths of three to four feet, in some areas reaching as wide as a half-mile across. With no convenient means of egress, in some areas the water took as long as 48 hours to recede. In assessing the aftermath of the 2006 flood, Peabody officials realized they needed to make some changes to their drainage network to lessen effects of future floods, as well as upgrade several critical systems that had been threatened.

One of the first measures Tighe undertook was to secure funds to clean out the channels of several streams running throughout Peabody. To get the money needed to accomplish this considerable task, Tighe applied to the U.S. Department of Labor for a National Emergency Grant (NEG). NEGs allow communities to temporarily increase their workforce through the employment of individuals affected by large, unforeseen economic events that cause significant job losses. Peabody qualified for such assistance and, through the Valley Works NEG Northeast Flood project, was awarded $540,000 to conduct the stream cleanup.

Beginning in November 2006, Tighe and his crew canvassed more than 10 miles of waterways, clearing out debris and refuse. They discovered early on that a major contributor to the high water problems Peabody had suffered was the large amount of garbage that had accumulated in the channels through and around the city.

"As an example, we removed a mattress that had become wedged in one of our culverts," reported Tighe. "And as soon as we pulled it out, the water level immediately dropped drastically, probably as much as two to three feet."

The clean-up project took Tighe and his team almost two years to complete and ultimately resulted in the removal of more than twenty 44-cubic yard containers of recyclables, junk and organic material.

An unexpected benefit of the streambed cleanup came when the team discovered that a culvert running beneath a railroad track had sustained major damage over the years. Though the openings appeared normal, the interior of the culvert had collapsed due to the constant vibration from passing trains. The obstructed pipe turned out to be responsible for many back-ups and the consequent flooding, and thanks to the clean-up efforts, the Peabody Department of Public Works was able to identify the problem and repair the pipe. In addition to fixing the damaged railroad culvert, Peabody has sought grant assistance from a number of sources to improve several other culverts in the city to increase the overall efficiency of their drainage network.


FEMA photo by Chris Smith

The Peabody fire station was built in the 1800s and is one of the oldest headquarters stations in the country.

Reducing future flood levels in Peabody has been only one step in the city officials' approach to mitigation. During the Mother's Day flooding in 2006, the ability of both the police and fire stations to respond to emergencies was nearly compromised. As the water rose in the basements of both buildings, it became clear that the city was in danger of losing several critical systems.

"We were within three inches of losing our 911 system," said Tighe. "The deputy police chief called and told me to get whatever I could to help, and that we were going to have to run our entire system from another community if we lost it."

In response to the risk posed by the high water, a decision was made to protect the utilities and services of both stations. To make the changes needed, Peabody officials applied for grant assistance from two of the Federal Emergency Management Agency's (FEMA) available grant programs.

The city received $225,000 from FEMA's Flood Mitigation Assistance (FMA) program [1] to redirect and upgrade the police station's electrical and 911 systems to protect them from future flood damage. In addition, a new generator was purchased, and new pumps were installed so that water levels could be managed more efficiently in future floods.

Peabody's fire station was built in the 1800s, and is one of the oldest headquarters stations in the country. In fact, the station harkens back to the days when fire trucks were pulled by horses. Like the police station, the fire department's systems had been installed in the basement. During the Mother's Day flood, the original pumps were incapable of dealing with the fast rising water.

"We had everything down there," said Joe DaSilva, a signal maintainer and electrician for the fire department. "Our electrical service, our meter, our main breakers, transfer switches and the entire communication system. In the 2006 flood, the water was about six inches away from shorting us out."

Peabody received a grant for $101,250 from FEMA's Hazard Mitigation Grant Program (HMGP) [2] to upgrade their at-risk utilities. Due to the amount of equipment that needed to be elevated, and the limited space available on the fire station's first floor, the fire department decided to use part of the grant to construct a separate, elevated room on the exterior of the station. The rest of the grant was used to purchase a new, larger generator and to transfer the fire department's remaining utilities to the new room.

In March 2010, a series of major rainstorms over a short period caused record-setting floods throughout Massachusetts. Several communities in the eastern and central parts of the state received as much as 12 inches of rain, and major flooding was reported on many rivers and streams.

While Peabody still had to contend with high water and some flooding in March 2010, the situation they faced was much easier to handle thanks to the efforts taken following the 2006 Mother's Day Storm. Neighborhoods and private homes that previously would have been inundated did not flood. In the past, many of these houses would have had as much as six feet of water in their basement, but this year some had less than a foot, and most were not flooded at all.

"The water goes down much more quickly now," said Tighe. "Instead of taking two days, it goes down in one cycle of the ocean. If we hadn't made these drainage improvements, our streets would have been closed for a longer period, possibly as long as 48 hours or more. And there would have been a lot more damage. In addition, the upgrades we made to the police and fire stations' systems allowed us to keep operating with no interruption of service. It gives us real peace of mind."

1. *Flood Mitigation Assistance (FMA) grants provide funds to assist States and communities to implement measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program.*
2. *The Hazard Mitigation Grant Program (HMGP) allows local governments to apply to their State government for federal grant assistance to implement long-term hazard mitigation measures after a major disaster declaration.*

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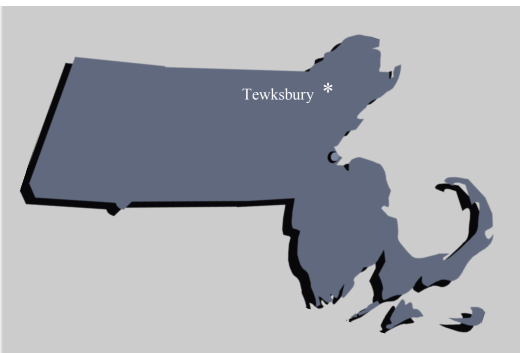
New Culvert Works: No Flooding at East Street



> "East Street remained open to traffic throughout the flood. For a while, it was the only direct route into and out of town."
> - Brian Gilbert, Superintendent of Public Works, Tewksbury, MA

Photo courtesy of Coughlin Environmental Services

Upstream side of new culverts at East Street during stormwater runoff in March 2010

Flooding and the closure of East Street, just east of the town center in Tewksbury, Massachusetts, has been an annual – and in some years an even more frequent – event.

Yet, when heavy rains in March 2010 brought record-breaking flows to streams across eastern Massachusetts, the floodwaters of Strongwater Brook topped out below the East Street roadway, thanks to recent improvements in the drainage system there.

"The backup of floodwaters at the East Street-Strongwater Brook crossing has long been a problem," said Brian Gilbert, Superintendent of Public Works in Tewksbury. "So it was good to finally get that resolved last summer (2009)."

Over the past several decades, flooding along the Shawsheen River and its tributary, Strongwater Brook, has overtopped stream crossings on major through streets in Tewksbury. Parts of the town were temporarily isolated, requiring the detour of traffic to alternate routes that quickly became congested, which also severely limited access for emergency response vehicles.

In an effort to mitigate the extent and duration of the disruptions caused by flooding of at least one of these streets, town officials proposed to install new, larger culverts at the East Street-Strongwater Brook crossing.

Prior to the reconstruction of the crossing, the brook passed through two old granite culverts, each with an opening of approximately 3 feet by 4 feet. During periods of high flow, the old culverts could not carry all the water, which then backed up and eventually overtopped the roadway.

The two new concrete box culverts, each 5 feet high by 10 feet wide, together provide an opening four times larger than the old culverts. As extra insurance against future flooding across East Street, the existing roadway was raised by three feet, so that it is now higher than the elevation of the 1-percent-annual-chance flood (known as the 100-year flood) at the crossing.

Because this reach of Strongwater Brook lies within a wetland, proposed drainage improvements had to consider wetlands issues. These include the maintenance of natural water levels and velocities, their fluctuations during periods of low flow, and the accommodation of high flood flows.

This dual requirement was resolved by incorporating two features into the design and installation of the new culverts. First, the bottoms of the culverts were set at one foot below the natural channel of the brook and then backfilled to establish a natural channel within the culverts. Secondly, the culverts were sized so that during a flood, water would back up and be temporarily stored in the large wetland area on the upstream side of the roadway. Under such conditions, the water would rise above the tops of the culverts, but not high enough to overtop East Street.

"Completion of the culvert upgrade on East Street last summer made it a lot easier on us during this spring's (2010) floods," said Gilbert. "While Main and Shawsheen Streets were flooded and temporarily closed, East Street remained open to traffic throughout the flood. For a while, it was the only direct route into and out of town."

Photo courtesy of Coughlin Environmental Services

Views to west along East Street at the Strongwater Brook Crossing under non-flood and flood conditions before culvert upgrade

Drainage improvements at East Street and Strongwater Brook were made possible by a grant from the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP). The HMGP provides 75 percent of the total cost of implementing long-term hazard mitigation measures following major disaster declarations.

For the East Street culvert upgrade project, HMGP provided $281,250 of the total cost of $375,000. The $93,750 remainder of the project cost was the responsibility of the Town of Tewksbury.

Evidence of a former railroad crossing that coincides with the present-day East Street crossing of Strongwater Brook can still be seen at the site, lending a sense of history to the project. A small part of the granite block abutment for the rail crossing is exposed on the downstream side of East Street, and pieces of granite from the old culverts and the abutment have been placed for erosion protection on the embankments on both sides of the street adjacent to the new culverts.

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High Marks for Building Higher: Hull's Freeboard Incentive Program

"Our community is in the top three highest number of repetitive-loss properties in the Commonwealth."

Anne Herbst
Hull's Conservation Administrator

Photo by Christopher Smith

Even prior to the introduction of the town's incentive program, many coastal residents of Hull have understood the need to build their homes up higher.

The Town of Hull, MA sits on a three-square-mile strip of land on the Nantasket Peninsula, extending into Massachusetts Bay. Despite its small size, it has one of

the largest population densities in the Commonwealth, averaging 11,000 year-round and swelling to 20,000 or more in the summer seasons. The high density has resulted in near-total development of all available land-space in the town.

Being on the bay, Hull is subject to frequent inundation from storms. Even mild wave action from seasonal storms called "Nor'easters" can cause significant damage to local properties, despite the protection of coastal banks and dunes, or even man-made defenses such as revetments and sea-walls. To date, the largest of these such storms, the Blizzard of 1978, filled the streets of Hull with water reaching depths of several feet, causing major damage to hundreds of buildings and homes throughout the town. Many of those same homes damaged in the Blizzard of '78 sustained considerable damage from a number of storms and floods over the years.

"Our community is in the top three highest number of repetitive-loss properties in the Commonwealth," said Anne Herbst, Hull's Conservation Administrator. "In the 30 years since the '78 Blizzard, we've had 23 coastal storms resulting in three or more flood claims to over 200 residential structures."

Because of restrictions in the Massachusetts building codes, local communities are unable to enforce stricter codes and ordinances than the state requires. This has resulted in towns and cities like Hull having to come up with creative forms of incentives to encourage the adoption of enhanced building techniques, such as the incorporation of freeboard. Put simply, freeboard is the practice of elevating a structure's lowest floor, either during or after its construction, to a level higher than predicted flood levels for that area's base flood elevation (BFE). Many communities throughout the United States encourage, or even require, the use of freeboard of at least one foot higher than their local BFE.

In September 2009, with the encouragement of Herbst, based on research she had undertaken, Hull's Board of Selectmen unanimously approved a new program available to new and existing residential structures. For those who elect to incorporate two-feet of freeboard into the construction, they will receive a $500 credit towards their permitting costs.

"Since we couldn't legally require people to build two feet higher, we had to find other alternatives" said Herbst. "So, we were looking into ways to move people in that direction, and this was considered to be a real attention grabber."

For those people who participate in the incentive program, there are a number of benefits beyond the $500 credit to their permit costs. The first, and most obvious, is the peace of mind a homeowner will have knowing their home has a greater safety margin above possible future flood levels. Another financial boon from such a program, is the substantial savings that such a homeowner will see in their flood insurance costs. On average, an increase of two feet of freeboard in a V-zone will potentially result in flood insurance savings of almost 50%. For those structures built in an A-zone that incorporate the two feet of freeboard, the savings can be even greater.

The Town of Hull was recently selected as a recipient of the National Oceanic and Atmospheric Administration's (NOAA) 2010 Walter B. Jones Memorial Award for Excellence in Local Government. The award was presented to Hull in recognition of the town's efforts in coastal hazard management, with specific focus on their freeboard incentive program.

While the program is still new, and has only recently begun to spark interest with Hull's citizens, Herbst is confident that as word spreads, more and more people will consider participating. As residents who choose to elevate their house start seeing the benefits of such actions, their neighbors and friends will take notice.

Photo by Christopher Smith

One of the first homes in Hull to participate in the freeboard incentive program.

"We're starting to get great feedback on this program," said Herbst. "We've received calls from other municipalities around the country interested in establishing their own incentive program. And it's really starting to grab the interest of our residents. They're taking note that in this troubled financial climate, the town is willing to rebate money in order to encourage residents to protect their property and their lives. The rebate may not be large compared to the cost of elevating a home, but it encourages people to take flood risks more seriously than they otherwise would."

V and A Zones: the V-Zone is referred to as the Special Flood Hazard Area (SFHA) with three of more feet of coastal wave action, and that will be inundated by a flood event having a 1-percent chance of being equaled or exceeded in any given year, and is also known as the 100-year flood plain. The A-Zone is an area still within the SFHA, but is considered at lower risk of flooding.

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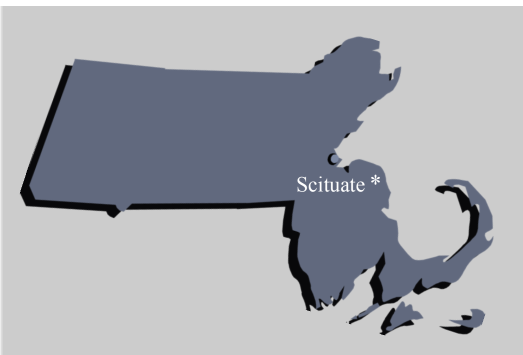
Get 'em Up: Scituate's Grant Committee Gets Homes in the Air



"Instead of being able to do three or four houses with one grant, we would be able to do ten."

Laura Harbottle
Scituate Town Planner

Photo by Christopher Smith

One of the 44 houses in Scituate that has undergone the elevation process.

Sitting on the Massachusetts Bay, the small seacoast town of Scituate, MA has seen its share of storms and floods. Most long-time residents would likely say that the Blizzard of '78 was the worst, when the tremendous waves from a record Nor'easter filled the streets of the town with several feet of water, and over 300 homes were destroyed, and many others severely damaged. Then there was the No-Name Storm of 1991, when an additional 100 local homes were destroyed, again by wave action pouring in from the Bay.

In 1997, town employee Joan Francis began investigating the possibility that federal grant assistance might be available through the Commonwealth of Massachusetts. The Federal Emergency Management Agency (FEMA) offers several grant programs to state and local governments to mitigate homes and buildings in order to prevent future damage. Mitigation actions can take the form of installing safety measures such as hurricane shutters, upgrading culverts to improve water flow, or utilizing building materials such as hurricane clips to strengthen the overall stability of a structure. Another popular form of mitigation, especially in coastal communities, is elevation, or the raising of a building above expected future flood levels.

"Our Board of Selectmen decided to form a committee to research all sorts of grants," said Neil Duggan, Scituate's building commissioner and zoning enforcement officer. "As we started looking into the flood mitigation grants, we realized we needed to concentrate on those, because a lot of townspeople started coming to our meetings, and asking questions about them."

The first grant Scituate was awarded was for $249,004, which allowed the town to elevate 14 homes. The grant came from FEMA's Flood Mitigation Assistance (FMA) program, which provides funds to states and communities to incorporate measures to reduce or eliminate long-term risks of flood damages to structures insured under the National Flood Insurance Program (NFIP). Seeing the success of their first grant application, the Scituate grant committee began applying for additional assistance on an almost yearly basis.

Typically, federal grant assistance provides up to 75% of the cost of a mitigation project, such as a structural elevation, leaving the remaining portion of the costs the responsibility of the individual homeowner or, in some cases, the applying community. Scituate's grant committee sought the means to get more for their money, making the elevation assistance available to more homeowners by reducing the amount of grant funds awarded per home to 40-50%, instead of the usual higher figure. This allowed them to elevate more homes with the awarded federal money.

"We were looking to spread the wealth, as it were," said Laura Harbottle, Scituate's Town Planner, and the person who took over the grant program in 2006. "We saw lowering the amount each homeowner would get from the grant as a chance to get more homes raised. Instead of being able to do three or four houses with one grant, we would be able to do ten."

Prior to 2006, the town applied for four FMA grants, totaling $725,347. Since taking over management of the program in 2006, Harbottle has continued the aggressive pursuit of additional grant money, applying for another two FMA grants, as well as assistance from FEMA's Hazard Mitigation Grant Program (HMGP), which provides funds to states or communities to perform mitigation actions during the recovery period following a presidentially declared disaster.

In addition to the FMA and HMGP grants, a third form of assistance that Scituate has sought came from FEMA's Severe Repetitive Loss (SRL) grant program. SRL grants provide funding to reduce or eliminate the long-term risk of flood damage to residential structures insured under the NFIP. To qualify for an SRL grant, a structure must have had at least four separate flood insurance claims filed for it that total over $5,000 each, or for which two separate claims have been filed that cumulatively exceed the market value of the structure itself. In both cases, at least two of the claims must have occurred within a 10-year period.

Throughout the years since Scituate's grant committee began their campaign to help their fellow residents protect their homes, the town has received more than $1 million in mitigation grant funds to elevate homes above future flood levels. In total, thanks to the committee's efforts, the eager participation of Scituate's homeowners, and grant money provided by FEMA and the Commonwealth of Massachusetts, 44 homes in the town of Scituate have been successfully elevated.

The committee didn't stop at structural elevations, however. Recognizing that not everyone who was at risk from flooding would be able to afford the full amount of their portion of the elevation costs, the decision was made to add utility elevations to the mix.

"Neil encouraged us to include the utilities," said Harbottle. "We knew there would be people who wouldn't be able to afford a complete elevation, but who would definitely benefit from having their utilities raised. That way, even if they did get water in their home, their furnace, or hot water heater, or their electrical panel box would not be destroyed."

Photo by Christopher Smith

Impressive elevations like this protect coastal residences against flood damage.

The utility elevations were included in the applications for grant assistance, but listed separately from the structural projects. For those that elected to elevate their utilities, the portion of the grant awarded to them was 75% of the cost of the project, up to a maximum of $10,000. The remaining 25% then fell to the homeowner to cover. In addition to the 44 homes that have undergone the full elevation process, eight homeowners in Scituate have used grant money to raise their utilities.

While Scituate has been fortunate in not experiencing significant flooding in recent years, Duggan is convinced that the elevations have been a major reason they have seen less damage. Borrowing a philosophy from the arena of public safety, he believes that it is difficult, if not impossible, to fully quantify that which is prevented.

"From a public safety perspective, this is one of the best approaches for protecting coastal structures," said Duggan. "For every house we get up, that's one less we have to worry about the next time there's a big storm, which will happen. The key to making this work is having dedicated government workers, from the federal side, through the state, and down into the local levels. You need qualified volunteers; your Board of Selectmen, your town administrators. They have to be willing to work those extra hours. We don't do it for the extra pay, because there is none. We do it out of a sense of duty to our fellow citizens."

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Securing the Steele Building

> "We didn't have to evacuate in the March 30 storm. It made it all worthwhile."
>
> Ann St Pierre
> Executive Director,
> Melrose, MA Housing Authority

Photo by Christopher Smith

The Julian Steele Building in Melrose, MA has suffered through at least four major floods since its construction in the 70s.

The Julian Steele Apartments in the City of Melrose, MA is a nine story building consisting of 155 residential units serving as a sustainable community for elderly and disabled individuals. Built in the early 1970s, the Steele Building was constructed prior to the enforcement of today's more stringent building codes, resulting in half of the ground floor being built below-grade and exposed to repeated flood risks. While all of the residential units are above Melrose's Base Flood Elevation (BFE,) the lower portion of the structure, which contains the building's critical facilities, laundry room and maintenance shop, were all left at the mercy of numerous floods throughout the years.

Ann St. Pierre has been the Executive Director for the Melrose Housing Authority since 2005. One year after taking the job, over the days leading up to Mother's Day, 2006, Ms. St. Pierre and her staff watched nervously as a constant downpour caused the water levels in Melrose to steadily rise. Finally, on March 15, she received a phone call that the Melrose Fire Department and Emergency Services were on site at the Steele Building, and proceeding to evacuate the residents.

"By the time I got there, they had already started moving people out," said Ms. St. Pierre. "The maintenance staff had shut off the elevators under orders from the fire department, so they had to carry a lot of the residents down the stairs. We're talking about elderly and disabled people; people in wheelchairs. It was a hazard for everyone involved."

The residents of the Steele Building were bussed away to stay at a hotel for the next five days. During that time, Ms. St. Pierre returned to the building to review the damage. Approximately three feet of water had entered the structure's lowest floor, destroying the building's snow-blowers, as well as some lawn-care and security equipment. In addition, the laundry machines, elevator and boiler had to be taken off-line, dried out and repaired. The water had also come within inches of shorting out the building's backup generator.

With assistance from employees of the Federal Emergency Management Agency (FEMA), Ms. St. Pierre learned how to fill out the application to recoup some of the losses suffered in the 2006 Mother's Day flood. At the same time, she was also informed that money was possibly available through FEMA's Public Assistance 406 Hazard Mitigation program to perform upgrades to the Steele Building that would reduce or even eliminate future flood damage.

"We had a retired engineer, Michael Casavoy, who was a volunteer on the Melrose Housing Authority Design and Selection committee, write up our mitigation plan," said Ms. St. Pierre. "He was very familiar with floods and flood mitigation. That had been his area of expertise when he was working in the private sector, so he did the whole design for us."

Mr. Casavoy knew that because the lowest part of the building was below grade, there would always be some risk of flooding during periods of high water. The design for the mitigation called for measures to not only keep water out of the threatened areas, but to also quickly deal with any water that did happen to get into the building. To this end, Mr. Casavoy recommended the installation of flood dams at several key points throughout the structure, including doorways, windows and garage doors. In addition, they treated the exterior of the building up to three feet in height with water-proofing paint, and sealed and water-proofed the interior floors and walls. An 18 inch barrier, or moat, was also installed around the backup generator to keep water from shorting out the building's power supply.

To deal with water that did enter the building, Mr. Casavoy recommended the installation of two new ejection pumps, one of which was positioned in the bottom of the elevator shaft, to swiftly lower water levels, pumping the water out into the drains at street level. Backflow preventers were also installed in the building's drains on the lowest level, ensuring that sewage backups could not occur.

On March 15, 2010, following several days of constant rain, Melrose flooded again. Unfortunately, not all of the mitigation measures had been completed in time, and some water was able to enter the building. Luckily, enough of the protections on Mr. Casavoy's list were in place, and Ms. St. Pierre feels confident that the damage was significantly reduced because of it. By the time Melrose flooded again on March 30 (to the highest levels recorded to date), all of Casavoy's suggested mitigation measures were completed, and the Steele Building suffered no water damage whatsoever.

"We didn't have to evacuate during the March 30 storm," concluded Ms. St. Pierre. "It made it all worthwhile. We may still bring everyone down to the first floor as a precaution, but now we don't have to shut off the electricity, or the elevators, because this mitigation is working. These measures were never intended to fully solve the problem of the Julian Steele Building from ever flooding again. They were intended to give the Melrose Fire Department and the Housing Authority the time to evacuate the building safely if necessary, and that's well worth it."

Photo by Melrose Housing Authority

These three foot high door dams must be installed manually prior to flood events, and prevent water from entering through doorways, windows and garage doors.

FEMA

Federal Emergency Management Agency
Region I
Federal Insurance & Mitigation Division
99 High Street, 6th Floor
Boston, MA 02110

Telephone 617-832-4761
www.fema.gov

To learn more about FEMA mitigation grants, please contact:

Massachusetts Emergency Management Agency
400 Worcester Road
Framingham, MA 01702

Mitigation Grants Manager
Telephone 508-820-1445

www.mass.gov/mema

dcr Massachusetts

Massachusetts Department of Conservation and Recreation
251 Causeway Street, 8th Floor
Boston, MA 02114

State Hazard Mitigation Officer
Telephone 617-626-1406

Reducing Future Flood Damage in Massachusetts:

Mitigation measures to make your home safer and stronger after a flood

There are three major causes of flooding in Massachusetts, each affecting different areas of the state. In the 1990s, coastal storms and hurricanes were seen as the most common source of floods, while more recently flooding has been attributed to intense rainfall causing many of the rivers and streams to overflow. The final piece of the puzzle stems from storm water and local drainage issues, which can swiftly and unexpectedly present serious problems for affected communities.

Regardless of the cause of a flood or the resulting damage, you can take steps to reduce your risk of damages and loss of life from future floods. Taken together, these steps are called *hazard mitigation*, which is defined as actions taken to reduce or eliminate long-term risk to people and property from natural hazards and their effects.

Following a flood, you will have many decisions to make about rebuilding or making repairs to your flood-damaged property. These decisions will affect you, your family, and your community.

A great deal of information is available for you to consider, including suggestions on changes you can make to a building and property to increase your protection against future events. Ideally, mitigation steps are taken before a disaster happens. However, the availability of post-disaster financial assistance is often what makes it possible to take those steps.

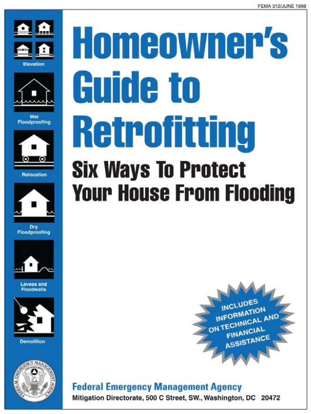
This fact sheet briefly outlines some flood mitigation options and resources that may be available to you, your business, and your community through information and funding support from the Federal Emergency Management Agency (FEMA).

No matter what decisions you make, don't forget to coordinate with your local officials to ensure you obtain all necessary permits and approvals for any work you intend to do on your house, commercial building or property.

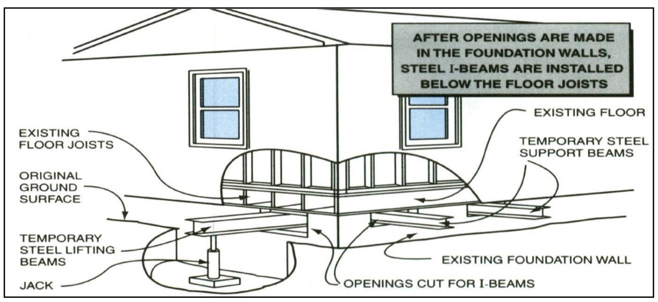
Making your home safe from floods: Five ways to RETROFIT

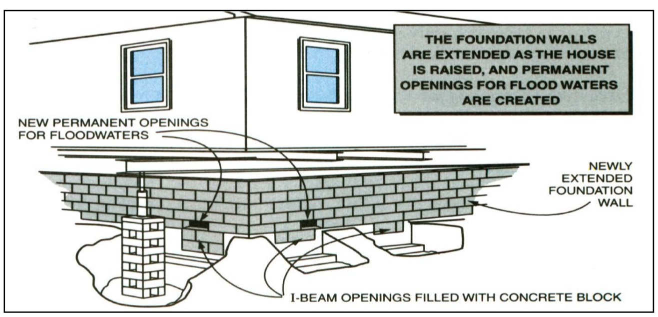
What is Retrofitting?

RETROFITTING means making changes to an existing building to protect it from flooding or other hazards such as high winds and earthquakes.



FEMA PUBLICATION 312
Home Owner's Guide to Retrofitting: Six Ways to Protect Your House From Flooding, provides information that will help you decide whether your house is a candidate for retrofitting.





Basic Steps in Elevating a Building:

1	Have appropriate professionals disconnect all utilities.
2	Hire a professional house mover to disconnect your house from the existing foundation, jack it up to the new height and provide a temporary foundation.
3	Build a temporary access stair to meet the new height.
4	Build a new, permanent foundation.
5	Have the house mover lower the house onto the new foundation and connect the anchor bolts.
6	Have the utilities permanently reconnected.

Elevation: Raising your house so that the floor of the lowest living space is above the Base Flood Elevation, which is determined in studies conducted by FEMA.

Relocation: Moving your house to a new, safer location.

Dry Floodproofing: Sealing your house to prevent floodwaters from entering.

Demolition: Razing your house and rebuilding on the same property or buying a house elsewhere.

Wet Floodproofing: Using vents or breakaway walls to reduce structural damage by allowing floodwaters to flow through uninhabited parts of a building.

The ultimate retrofit? Move your home away from a flood-prone area.

NFIP Explained

What is the National Flood Insurance Program?

The National Flood Insurance Program (NFIP) is a federal program enabling property owners to purchase flood insurance. If your community adopts and enforces floodplain management regulations that meet minimum federal requirements, the federal government makes flood insurance and flood disaster assistance available in your community.

BILLERICA, MA -- A resident wades through a flooded area on Elsie Avenue.

If you live in an area that has been designated as "high risk" for flooding, your home has a 26 percent chance of being damaged by a flood over the life of a 30-year mortgage.

Why you need Flood Insurance

The Risk is Real

You can live miles away from water and still be the victim of flooding. Nearly 1 in 4 flood insurance claims is paid on policies in low-to-moderate-risk areas. It doesn't take a major body of water, or even a major storm, to cause a flood. Anything from a broken sewer line to a slow-moving rainstorm can cause flooding. In high-risk areas, your home has a 26% chance of being damaged by a flood over the life of a 30-year mortgage.

Flood Insurance is Affordable

A large number of private insurance companies nationwide offer affordable flood insurance backed by the federal government. Policies are available to home, condo, apartment and business owners, as well as renters.

If you live in a low-to-moderate-risk area, affordable coverage may be available to insure your home and its contents against flooding, which causes more than $2 billion damage in the U.S. every year.

How Do I Purchase Flood Insurance?

Flood insurance is available in more than 20,000 communities nationwide. Only a small number of municipalities in Massachusetts have not joined the National Flood Insurance Program (NFIP). To find out if your community participates in the program call **800-427-4661.**

If your community is a participant, you can purchase flood insurance for your property from any insurance agent. If your agent is not familiar with the program, you can call 800-720-1093 to find an agent in your area who is.

The Challenge with Mold and Mildew

A problem that often arises after a home is flooded is the development of mold and mildew. These microscopic organisms can begin to grow on virtually any damp surface within 24 to 48 hours. They can damage and eventually destroy the material they grow on, and can also cause mild to severe respiratory, nervous system, and other health problems.

If your home has been inundated by a flood, or if wet or damp conditions have resulted from sewage backup, plumbing or roofing leaks, or overflows from sinks, showers, or bathtubs, mold and mildew will begin and continue to grow until you eliminate the source of the moisture, dry out the area, and deal with the mold and mildew problem.

A FEMA booklet, "Dealing with Mold and Mildew in Your Flood Damaged Home," will help you determine the severity of your mold problem and provide steps you can take to eliminate the problem. This booklet is available in a printable document online.

You can download your own PDF copy of **FEMA Publication 606** from http://www.fema.gov Enter "mold and mildew" to go to the correct site.

Federal Mitigation and Recovery Assistance May Be Available

FEMA

For States and Local Governments:

Funding is available from FEMA through one or more Hazard Mitigation Assistance (HMA) programs. These funds enable states and communities to implement mitigation measures before, during, and after recovery from a disaster.

Hazard Mitigation Grant Program (HMGP) – Assists implementation of long-term hazard mitigation measures following major disaster declarations.

Pre-Disaster Mitigation (PDM) – Provides funds on an annual basis for hazard mitigation planning and implementation of hazard mitigation projects.

Flood Mitigation Assistance (FMA) – Provides funds on an annual basis for measures that can reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

Severe Repetitive Loss (SRL) – Provides funds on an annual basis to reduce the risk of flood damage to residential structures insured under the NFIP that are qualified as severe repetitive loss structures.

To get information online, go to http://www.fema.gov/government/grant/hma/index.shtm

For more information on the specific criteria for each HMA program, contact your local community official, State Hazard Mitigation Officer, or the FEMA staff at a Disaster Recovery Center.

FEMA

For individuals and households:

When disaster strikes, FEMA's **Individuals and Households Program (IHP)** provides money and services to people in the disaster area when their property has been damaged or destroyed and the losses are not covered by insurance. While some money is available through IHP, most disaster aid from the Federal government is in the form of loans from the Small Business Administration, and must be repaid. IHP provides the following types of assistance:

Temporary Housing – A place to live for a limited time. Money is available to rent an alternate place to live. Government provided housing may also be made available when local rental properties are not available.

Repair – Money is available to repair damage that is not covered by insurance. The goal is to make the home safe, sanitary, and functional.

Replacement – Money is available to homeowners to replace a home destroyed in a disaster but not covered by insurance.

Permanent Housing Construction – Direct assistance or money for the construction of a home. This type of help is available only in insular areas or remote locations, specified by FEMA, where no other type of housing is available.

Other Needs – Money is available for expenses incurred because of the disaster, such as medical, dental, replacement of personal property, transportation, moving and storage, and other expenses that are authorized by law.

For additional information call **800-621-FEMA (3362),** TTY 800-462-7585 for people with speech or hearing disabilities from 7 a.m. to 10 p.m. Multilingual assistance is available. For information online, go to http://www/fema/gov/media/fact_sheets/individual-assistance.shtm

SBA

The U.S. Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, businesses of all sizes, and certain private, non-profit organizations to repair or replace real estate, personal property, machinery and equipment, inventory and business assets that have been damaged or destroyed in a declared disaster. Businesses also may apply for loans for loss of income as a result of the disaster.

If your loan application is approved, you may be eligible for additional funds to cover the cost of improvements that will protect your property against future damage. Examples of improvements include: structural elevation, storm shutters, flood-proofing of a basement, or reinforcing garage doors. Mitigation loan money would be in addition to the amount of the approved loan, but may not exceed 20 percent of the total amount of disaster damage to real estate and/or leasehold improvements as verified by SBA to a maximum of $200,000 for home loans.

For additional information, contact the SBA Help Line at **1-800-659-2955** or SBA staff at the nearest Disaster Recovery Center. To get information online, go to http://www.sba.gov/services/disasterassistance

DAWG HAUS

Disaster Avoidance With Good Home Attenuating Unionization System.

As a part of the recovery process from the March 2010 Flood several Massachusetts home building stores such as Home Depot and Lowe's coordinated with the Federal Emergency Management Agency (FEMA) Hazard Mitigation Group to focus attention on smart building techniques.

FEMA assisted staff at the stores in the construction of this "dawg haus" model. The concept of this model is to provide a user-friendly, and visual, example of everyday mitigation construction techniques and materials.

The models are constructed to demonstrate strong and safe building practices. Key to the design is the incorporation of a strap-and-connector system that ensures proper load path construction in a structure. While the construction resembles a traditional dog house, the unusual spelling is actually an acronym for Disaster Avoidance With Good Home Attenuating Unionization System.

"Think of a house like a box," said Cris Nery, a FEMA Hazard Mitigation Engineer. "When you push on one side of a box, all the pressure is transferred to the other side. If any part of the box fails, the whole thing collapses. But if the box is properly secured on all sides, then pressure from one side will not allow the box to move. It's really pretty simple, but it can make all the difference in the world."

Construction of this "dawg haus" took about one week and was donated by the H**ome Depot.**

EXAMPLE PAST BEST-MANAGEMENT PROJECTS

BANK STABILIZATION PROJECT

The Town of Becket, faced with a roadway in jeopardy of erosion, developed a plan to permanently stabilize this roadway through an environmentally sensitive bank stabilization structure. Brooker Hill Road was collapsing into adjoining Shaker Mill Brook and was in serious danger of additional failure. One lane of the road had collapsed, causing the road to be reduced to one lane, one-way. This put a hardship on residents, emergency response vehicles, and traffic to the elementary school. Tourism also had been hurt by the restrictions on this road, which connects one side of town to the other, putting a strain on the economic development and growth of North Becket Village. Becket applied for and received a grant from FEMA to help fund the project costs, which totaled $259,383. FEMA provided a grant for $186,348 through the Pre-Disaster Mitigation Competitive (PDM-C) Grant Program. The success of the project was dependent on the intergovernmental coordination and cooperation among the various town departments, MEMA, DCR, the National Park Service and FEMA. The project site involved a sensitive design because Shaker Hill Brook, a tributary of the Westfield River, is a Nationally Designated Wild and Scenic River. The National Wild and Scenic Rivers System was created by Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. The project, completed in September 2008, provides permanent stabilization to the affected portion of Brooker Hill Road through the placement of a slope retention system made of an interlocking retention wall. Not only does this system provide a sound technique for solving road erosion, it also allows for native vegetation to grow which adds to the stability of the slope and its natural characteristics. Most significantly, the project has allowed the roadway to re-open as a two-lane, two-way road, which greatly enhances the safety of residents, and the elementary school children, and restore adequate emergency response time to at least pre-disaster conditions. It will also allow for continued tourism in the area, which will help in the economic growth of the town.

TOWN OF DRACUT COMPLETES A SEWER LIFT STATION PROJECT

The Town of Dracut, concerned over the ongoing potential for flooding of the sewer lift station at 150 Turtle Hill Road, developed a solution that would enable the town to mitigate a potential public health risk. During normal operations, sewage is pumped up from the neighborhood to the station. If the lift station were to be flooded, operations would cease. Houses in this neighborhood would become threatened by a risk of sewage back-up which ultimately could lead to a significant public health issue if the lift station was inoperable for an extended period of time. Dracut applied for and received a grant through the HMGP to offset the majority of the project costs required to fund this risk mitigation project. The total cost of the project was $48,000. This sewer lift station currently services 311 residences. At full build-out, it would service 415 residences. The lift station was originally built to a half-foot above the base flood elevation of 121 feet. The lift station was still threatened by flooding from nearby Beaver Brook, because the flood hazard appears to have increased since the original Flood Insurance Study was published; therefore the station required additional protection. If this pump were to sustain flooding in excess of the base flood elevation, the pump and related electrical components could fail. That failure could cause sewage to back up into homes, causing a significant risk to public health. The project consisted of building a 12-inch thick concrete wall surrounding the station. The wall is centered on one-foot thick, two-foot wide footings. The wall is 10 feet total in height, with 6’6” below grade, and 3’6” above grade, to prevent floodwaters from damaging the electrical components. The floodwall is providing an additional 3 feet of protection above the existing base flood elevation. There is a 4-foot wide service opening to allow access to the station. The opening will be closed with stop logs, already stored at the site, when the lift station is at risk of flooding. The project was completed in November of 2008. This neighborhood was vulnerable to the potential impact of a failed sewer lift station before this wall was installed. Now there is an increased level of protection to this pump station and related electrical components as well as the homes serviced by this sewage pump.

HARWICH COMMUNITY CENTER SHUTTER PROJECT

In times of emergency the Harwich Community Center, located at 100 Oak Street, serves as a Red Cross Shelter. Additionally, it houses Channel 18, the local access cable network. In order to ensure that the shelter workers and residents are as safe as possible during an emergency, the town of Harwich decided to invest in hurricane panels that could be installed to protect the building and its occupants. Harwich applied for and received a grant through FEMA's Hazard Mitigation Grant Program. The total project cost was $53,900. The project consists of the installation of corrugated polycarbonate resin hurricane shutter panels. By protecting the windows from high velocity wind damage and flying debris, it enhances the integrity of the building, and insures the safety of the local residents and workers utilizing it as a shelter. These shutters protect not only the windows and doors they cover, but also the people and equipment inside the building. Once a window or door has been breached by hurricane winds tremendous pressure is brought to bear on interior walls and upward pressure on the building's roof. This can lead to roof failure, which exposes the entire contents of the building to the storm. Shutters are a first line of defense against a hurricane. Studies show that engineered storm shutters are more effective and safer to use than plywood panels. The shutter panels are "see-through," therefore everyone can remain safely inside and still monitor the situation outside. Having hurricane panels at the Harwich Community Shelter provides a safe place for residents and workers to ride out the storm.

INSTALLATION OF BACK FLOW PREVENTERS

Town of Framingham was faced with recurring flooding on Auburn Street and the Auburn Street Extension causing repetitive damage to the town and private properties as a result of the Sudbury River backing up at these locations into the town's storm water drainage system. In order to mitigate this problem, the town decided to install two backflow preventers, a component of which is a "duckbill" style check valve. This valve allows liquids to flow in a single direction. These valves are used in situations where the direction of liquid flow must not be allowed to reverse itself. At the first installation, located at 18 Auburn Street, a 24" duckbill style backflow preventer was installed over and around a 24" reinforced concrete outfall pipe. The installation required the assistance of an excavator as the preventer weighed 220 pounds. At the second location, 18 Auburn Street Extension, a 12" duckbill style backflow preventer was installed around a 12" reinforced concrete outfall pipe. The preventer weighed 50 pounds and was installed by hand. However, due to continued high water conditions, the contractor first installed a cofferdam to remove water from the immediate site of installation. A cofferdam is an enclosure within a water environment constructed to allow water to be removed for the purpose of creating a dry work environment. The total cost of the project was $16, 387. Framingham was successful in receiving a Flood Mitigation Assistance grant from FEMA for $12, 290. The mitigation grant award included final design, permitting, and construction.