Swansea, MA

Local Multi-Hazard Mitigation Plan, 2017 Update

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1.0 INTRODUCTION

1.1 Introduction

Coastal New England weather is notoriously difficult to predict, and virtually every type of weather has been and will be experienced in southeastern Massachusetts. From freezing temperatures and blizzard conditions in the winter to stifling heat and humidity in the summer, Swansea must plan for the worst. The old adage of "if you don't like the weather, wait a minute" certainly applies.

Swansea's location along the Atlantic coast is situated near the intersection of the warm-water Gulf Stream flowing north from the Gulf of Mexico and the cold-water Labrador Current flowing south from the Arctic Ocean. These ocean currents, coupled with a variable jet stream capable of bringing any combination of cold, warm, dry and moist air masses results in a constantly changing climate capable of producing any number of natural hazards.

In addition to these regional weather factors, Swansea has approximately 4.7[1] miles of shoreline directly exposed to open waves along Mt. Hope Bay. The combination of these factors results in the potential for unique natural hazards associated with ocean based storm events.

1.2 Purpose

The Federal Emergency Management Agency (FEMA) defines hazard mitigation as "any sustained action taken to reduce or eliminate the long-term risk to human life and property from (natural) hazards", such as floods, hurricanes, winter storms, tornadoes, earthquakes, etc. Hazard mitigation may include both structural measures, such as flood control structures, and nonstructural measures, such as regulations and bylaws, to prevent flooding. Local planning and mitigation efforts allow communities to evaluate existing critical infrastructure susceptible to hazards and identify improvements to reduce damage from natural disasters.

This plan is provided as an update to the Southeastern Regional Planning & Economic Development District (SRPEDD) Natural Hazard Pre-Disaster Regional Mitigation Plan prepared in 2004. The 2004 regional plan largely focused on mitigation measures to be taken by the entire area. The Town of Swansea and Comprehensive Environmental, Inc. (CEI) developed this updated Local Multi-Hazard Mitigation Plan through a FEMA grant obtained as part of the Hazard Mitigation Grant Program (HMGP) to focus specifically on the local issues affecting the Town. The plan has been developed for the entire Town with the goal of providing sustained actions to reduce or eliminate risk to human life and property damage from a natural hazard event.

Objectives of this plan are as follows:

- Describe the planning process including formation of the Local Planning Team (LPT) and input from the general public;
- Identify relevant background information on the Town, including geography, climate, land use, and infrastructure;

[1] Massachusetts Coastal Infrastructure: Inventory Assessment Project. July 6, 2009. http://www.mass.gov/eea/docs/czm/stormsmart/seawalls/south-coast/dartmouth-swansea.pdf

- Identify natural hazard risks and areas in town most likely to be impacted;
- Complete a risk assessment to profile hazard events, inventory assets, and estimate potential losses;
- Identify existing disaster mitigation measures already in place;
- Develop proposed mitigation measures and a mitigation strategy based on the risk assessment;
- Design a mechanism to keep the plan updated to reflect current conditions and establish a schedule for monitoring, evaluating, and updating the plan; and
- Define the process where Swansea formally adopts the mitigation plan.

Preparation of this Local Multi-Hazard Mitigation Plan before a major disaster occurs can help the community prevent property damage and loss of life and associated with natural hazards, save money by instituting mitigation measures to protect against natural hazards, allow funding through FEMA for post-disaster remediation, and expedite disaster recovery. The Plan will also help to reduce or eliminate repetitive flood losses.

2.0 PLANNING PROCESS

2.1 Planning Process Goals

An open public involvement process is essential to the development of an effective plan, and the most successful mitigation plans are developed after participation by a wide range of stake-holders who play a role in identifying and implementing mitigation actions. During preparation of this Local Multi-Hazard Mitigation Plan, the planning process included the following:

- An opportunity for the public to comment on the plan during the drafting state and prior to final approval;
- An opportunity for local and regional agencies, academic institutions, and other private industries to be involved in the planning process; and
- Review and incorporation of existing plans, studies, reports and information.

2.2 Local Planning Team

The LPT consisted of various Town officials, business leaders, and other interested agencies and organizations to provide critical local knowledge of the community to facilitate development of this Plan. Throughout the planning process, the LPT was modified and updated, ultimately comprising the members listed in **Table 2.1**.

Table 2.1 – Local Planning Team Members

Department / Agency	Name	Title / Position
Town Departments / Boards		
Accounting	Tracy Jo Anderson	
Board of Health	Joseph Carvalho	Chairman
Building Inspector	William McGrady	Building Inspector
Conservation Commission	Colleen Brown	Conservation Agent
Emergency Management Agency	Carl F. Sawejko	Emergency Management Agency Coordinator
Selectmen's Office	John McAuliffe	Town Administrator
Fire Department	Peter Burke Eric Hajder	Fire Chief
Highway Department	Nuno Jorge Alan Corvi	Foreman Director
Planning Board	Steve Antinelli	Town Planner
Police Department	George Arruda	Chief of Police
Water District	Robert A. Marquis	Water District Superintendent
Other Agencies and/or Organizations		
MEMA	Doug Forbes	Local Coordinator

2.3 Team Meetings

The LPT and representatives from CEI participated in a number of meetings over a 10 month period of time, during which information was provided to and input was solicited from team members. The planning process commenced with a kickoff meeting held on March 5, 2015 with representatives of MEMA. Subsequently, the LPT and representatives from CEI held the second LPT meeting on April 7, 2015 where representatives of CEI and select members of the Town reviewed general information, recent natural disasters, evacuation issues, and high hazard areas.

The meeting included a discussion outlining areas subject to inland flooding and inundation as a result of a hurricane. CEI provided background information on the planning process and solicited feedback from the LPT on the plan goals, particularly concerning high hazard areas and critical infrastructure, as well as proposed mapping.

The third meeting was held on May 12, 2015 where members of the LPT reviewed maps outlining areas subject to inland flooding and inundation as a result of a hurricane. These maps were then overlaid with critical infrastructure locations to outline important structures potentially subject to damage during a flood, which was identified as the most common natural disaster for the Town of Swansea. The LPT then outlined problems with existing evacuation routes experienced during times of emergency, as well as currently proposed measures.

The fourth meeting was held on June 2, 2015 where the LPT further reviewed hazard prone areas and reoccurring problems during a storm (i.e. dam evaluations, communication issues, potential evacuation problems, and emergency generator statuses). The LPT then discussed existing emergency shelters logistics and problems in addition to existing evacuation routes for use during an emergency situation. Future problems from new developments that could exacerbate public safety concerns, dam hazard rating, emergency generator status at emergency centers.

The fifth meeting was held on June 30, 2015 where representatives of CEI and select members from the LPT met to discuss and finalize possible evacuation routes in Town. The meeting continued with CEI and the Highway Foreman who conducted site visits to a number of historical flooding areas in Town as discussed in Section 5.0.

The sixth meeting was held September 1, 2015 where representatives of CEI and select members from the LPT discussed a number of proposed action items required at various locations within town. Many pertained to inland flooding at historically flood-prone areas, with others including dam repair, backup power supplies, and other miscellaneous items. The LPT discussed existing conditions and problems and assigned a priority ranking to each item for future implementation.

The seventh meeting was held October 13, 2015 focused on further review of proposed disaster mitigation measure action items, along with a review of a location map. The LPT discussed a preliminary prioritization plan for the mitigation measure action items.

The eighth meeting was held December 1, 2015 where representatives of CEI presented the draft Local Multi-Hazard Mitigation Plan to the LPT.

The ninth meeting was held January 5, 2016 where the LPT presented comments on the draft Local Multi-Hazard Mitigation Plan, based upon their collective review and discussion. Preliminary vulnerability assessment results (using FEMA's Hazus software) were presented and discussed; noted that the property values used in FEMA's Hazus software do not seem to reflect current conditions. CEI to investigate further and adjust vulnerability assessment as necessary.

The tenth meeting was held February 16, 2016 where CEI representatives presented the updated draft Local Multi-Hazard Mitigation Plan to the LPT, based upon their collective review and discussion. Draft report also updated to reflect current property values from the Town

Assessor's office and the adjusted vulnerability assessment. LPT provided additional comments during the meeting. Draft report was updated to reflect these additional comments; ready for public presentation and comment.

The draft Local Multi-Hazard Mitigation Plan was presented publicly at a regular Board of Selectmen meeting held on August 23, 2016. This presentation and meeting was broadcast on local cable and open to the public. Prior to and after this public presentation, the draft Local Multi-Hazard Mitigation Plan was posted on the Town's website for public comment. No public feedback was received during this public presentation and comment period.

Documentation of the LPT meetings is provided in **Appendix A**.

2.4 Planning Process

In general, the following steps were taken during the planning process.

Step 1. Outline a Local Planning Team in charge of completing this Plan;
Step 2. Define the potential natural hazards that could affect Swansea;
Step 3. Determine high hazard locations and critical infrastructure potentially affected;
Step 4. Conduct a vulnerability assessment of buildings and infrastructure;
Step 5. Outline existing hazard mitigation measures in place;
Step 6. Determine gaps in hazard mitigation preparedness;
Step 7. Define proposed hazard mitigation measures to fill these gaps; and
Step 8. Evaluate the feasibility of proposed measures and prioritize mitigation measures.

The above steps will allow implementation of proposed mitigation measures with a goal of reducing damage and improving public safety during a natural disaster.

2.5 Plan Update and Other Relevant Studies

In 2004, the SRPEDDprepared a Natural Hazard Pre-Disaster Regional Mitigation Plan for southeastern Massachusetts. The planning committee worked with all 27 communities, including Swansea to assess hazards, evaluate vulnerable areas, and recommend planning and infrastructure improvements. This Local Multi-Hazard Mitigation Plan is intended as an update to the 2004 regional plan with an emphasis on local issues that were unable to be addressed at a regional level.

During preparation of this Plan, several existing studies and documents relative to Swansea and the surrounding area were also reviewed. Preparation of this plan borrowed from the 2013 Massachusetts State Hazard Mitigation Plan and relevant local ordinances and regulations where appropriate.

In 2013, the State Hazard Mitigation Team, comprised of staff from the Massachusetts Emergency Management Agency and Department of Conservation and Recreation, updated its existing Commonwealth of Massachusetts State Hazard Mitigation Plan. This is the plan's eighth revision from its initial preparation in 1986. The planning team worked with a number of state and federal agencies to develop a plan outlining actions that should be taken by federal, state, local governments and the general public to manage the risks of natural hazards.

Various town departments and boards have implemented and updated bylaws and regulations as necessary throughout the years to control development and ensure safe construction methods that adhere to current best management practices. The Swansea Planning Board is the primary Town agency responsible for regulating development in town, through its enforcement of Zoning Bylaws. The Town Planner participated in the development of this Plan as a regular participant of the LPT (refer to meeting minutes in Appendix A), ensuring that the development of this Plan was consistent with the operational policies and historical hazards identified by the Planning Board. Bylaws and regulations are discussed further in Section 7.3.

3.0 LOCAL PROFILE

The following sections outline the local profile of the Town. Topics include:

- Area history and town historic properties;
- Natural features, including geography, climate, and waterbodies;
- Summary of the town, including land use, zoning, infrastructure and demographics; and
- Miscellaneous additional institutions vital to the community.

Additionally, expected development trends over the coming years are outlined as necessary in each section, particularly concerning land use and population growth.

3.1 History

On October 30, 1667, Pastor John Myles, Captain Thomas Willett and their neighbors petitioned the Court of Plymouth to establish a town. Swansea was the fourth town founded in Bristol County with its original boundaries extending to the border of Taunton and Rehoboth to Mount Hope Bay. The area was further reduced in 1717 when Barrington was established, in 1747 Warren was established, and 1790 when Somerset was established. In 1765 the first census revealed 1,840 people and by 1994 that number had increased to 15,100.

Swansea is a suburban/rural town founded on the premise of religious tolerance. After King Phillip's War in 1675 forges, ironworks and fishing made up most of the community's economy. Swansea's early community consisted of small villages made up of stores, cotton mills, grist and yarn mills and fishing boats. Swansea lost most of its industrial power when Fall River, Taunton and Providence became larger industrial cities but it still retained an important agriculture presence in the area. In the 1890's a street trolley connected Swansea to Fall River and Providence which spurred the development of suburban and summer homes. Currently, Swansea still has much of its agricultural land still in use.[2]

Interstate 195 (I-195) was constructed between 1958 and 1960 and brought a modern highway to the Town, running in a general northwest-southeast orientation. Swansea is still a suburban community consisting largely of suburban and summer homes and retail areas. Many early colonial homes survive to this day, indicative of Swansea's rich history.

3.2 Geography

The Town of Swansea is located in Bristol County, Massachusetts, and contains the villages of Hortonville and Ocean Grove. The following communities border the Town of Swansea: Warren RI to the southwest, Barrington RI to the west, Seekonk MA to the northwest, Rehoboth MA to the north, Dighton MA to the northeast, and Somerset to the east and southeast. Additionally, Swansea borders a portion of the Atlantic Ocean known as Mt. Hope Bay to the South. The Town occupies a total area of approximately 25.5 square miles, of which approximately ninety-one percent is land with the remaining nine percent water[3]. **Figure 1** provides a locus map of the area. Additionally, Swansea's beach along Ocean Grove Avenue acts as a barrier beach across the mouth of the Cole River.

[2] Town of Swansea http://www.town.swansea.ma.us/about-swansea
[3] Wikipediahttps://en.wikipedia.org/wiki/Swansea,_Massachusetts

Most of the Town's retail and commercial properties are located primarily along Route 6 including the location of the Swansea Mall. Other than a dense development in Ocean Grove most of the remaining residential areas in Swansea are very rural.

3.3 Climate

Swansea averages approximately 45 inches of rain per year with an average annual snowfall of 35 inches. Average temperatures range from highs in the upper 70's and low 80's during the summer months to lows in the low to mid 20's during winter months.[4] Swansea's location along the Atlantic Ocean generally keeps temperatures cooler in the summer and warmer in the winter than other nearby, inland Massachusetts communities.

3.4 Waterbodies

Mount Hope Bay is approximately 13 square miles and forms Swansea's southern border and receives flow from the Lee River, Cole River, Taunton River, and Kickemuit River. The bay opens to Narragansett Bay to the southwest and the Sakonnet River to the south, ultimately flowing into Block Island Sound and the Atlantic Ocean. Several rivers are also present in Swansea, including the Cole River, Kickemuit River, Lee River, and Palmer River, all of which flow north-south. Major lakes and ponds include the Warren Reservoir, Milford Pond, Cole River Pond, Mount Hope Pond, and Lewin Brook Pond.

3.5 Land Use and Zoning

As mentioned previously, Swansea occupies a total area of approximately 25.5 square miles, of which approximately ninety-one percent is land with the remaining nine percent water. The vast majority is zoned as Rural/Residential (RR) or lots with a minimum size of 30,000 square feet. Smaller portions of Swansea located near Route 6, Route 118 and Route 136 are zoned as Business B (BB) with minimum lot sizes of 20,000 square feet to establish a commercial base along the most heavily traveled roadways. Other sporadic areas located south of Route 6 are zoned Business A (BA) and Manufacturing (M) with a minimum lot size of 20,000 square feet for lots zoned M and no minimum requirements for lots zoned BA.

3.6 Demographics

Swansea has shrunk to a total population of 15,865 according to the 2010 US Census, down from a population of 15,901 in 2000, with a population density of approximately 690 people per square mile[5]. A total of 6,343 households are present in the Town, of which 6,079 are occupied and 264 are vacant. Of the occupied housing units, 5,177 are owner-occupied and 902 are renter-occupied. In addition to fulltime residential growth, Swansea expects a continued influx of seasonal residents during the summer months. The 2010 Census indicates that 53 housing units of the Town's total 6,079 housing units were for seasonal use[6]; however some portion of those categorized as "vacant" may well be seasonally occupied.

Swansea has experienced steady growth over the past twenty years, and is expected to continue

[4] Sperling's Best Places http://www.bestplaces.net/climate/city/massachusetts/swansea
[5] Wikipedia https://en.wikipedia.org/wiki/Swansea,_Massachusetts#Demographics
[6] US Census http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

growing over the next several decades. Projections completed by SRPEDD in the development of the 2004 SRPEDD Plan[7] indicate that Swansea is expected to reach a population of 18,114 in 2020 and 18,849 in 2025, with an average population growth of approximately 7% per decade.

3.7 Government

The Town of Swansea is governed by three Selectman and a Town Administrator. Swansea still holds open Town Meetings.

3.8 Infrastructure

Swansea contains approximately 5.27 miles of interstate highways, 19.81 miles of arterial roadways, and 13.57 miles of collector roads, and 80.92 miles of local roadways[8]. The Town is accessible via US Route 6, US Route 136, US Route 118, US Route 103, and Interstate 195, all of which run in a general east-west direction except US Route 108 and US Route 136. Three exits, Warren RI Newport RI (Exit 2) U.S. 6 to 118 Swansea (Exit 3) and Lees River Ave to 103 Somerset (Exit 4), are the major access points from Interstate 195. Massachusetts Route 138 is located just over the town border in Somerset respectively, and runs north-south. No public bus service is provided in Town.

The Town operates three water treatment facility servicing 12 municipal wells, 2 of which are inactive, and related infrastructure for drinking water such as water mains, pump stations, etc. The Town receives gas from Liberty Gas and Columbia Gas and electric service provided by National Grid, and communication services provided by Verizon and Comcast. All wastewater in Town is handled through on-site septic systems.

3.9 Historic Properties

The National Register of Historic Places is the official list of the Nation's historic places worthy of preservation, and is part of a national program to coordinate and support efforts to identify, evaluate, and protect America's historic and archeological resources. The National Register of Historic Places lists the following locations within Swansea:

- Barneyville Historic District;
- Luther's Corner Historic District;
- Hortonville Historic District;
- Swansea Village Historic District; and
- Colony Historic District;

The above historic property districts, as well as individual properties, are included in the list of Critical Infrastructure as described further in Section 6.1.

[7] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[8] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

4.0 NATURAL HAZARDS

FEMA defines a hazard as an act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing. All natural disasters pose hazards to property damage and loss of human life, and have the ability to limit access to electrical power, telecommunication services, potable water, wastewater collection/treatment and transportation. Downed trees and tree limbs may also limit emergency access and hinder cleanup efforts. Swansea must take steps to protect its infrastructure from natural disasters as much as possible, such that essential utilities and services continue when needed most.

Table 4.1 and **Table 4.2** depict major disaster declarations and emergency declarations, respectively, for Bristol County[9] through the spring of 2016.

Table 4.1 – Major Disaster Declarations for Bristol County

Date	Incident Description	Disaster Number
April 13, 2015	Severe Winter Storm, Snowstorm, and Flooding	4214
April 19, 2013	Severe Winter Storm, Snowstorm, and Flooding	4110
December 19, 2012	Hurricane Sandy	4097
September 3, 2011	Tropical Storm Irene	4028
March 29, 2010	Severe Storm and Flooding	1895
November 10, 2005	Severe Storms and Flooding	1614
April 10, 2001	Severe Storms and Flooding	1364
June 23, 1998	Heavy Rain and Flooding	1224
January 24, 1996	Blizzard	1090
August 26, 1991	Hurricane Bob	914
October 28, 1985	Hurricane Gloria	751
February 10, 1978	Coastal Storms, Flood, Ice, Snow	546

Table 4.2 – Emergency Declarations for Bristol County

Date	Incident Description	Disaster Number
April 17, 2013	Massachusetts Explosions	3362
October 28, 2012	Hurricane Sandy	3350
August 26, 2011	Hurricane Irene	3330
September 2, 2010	Hurricane Earl	3315
December 13, 2008	Severe Winter Storm	3296
October 19, 2005	Severe Storms and Flooding	3264
September 13, 2005	Hurricane Katrina Evacuation	3252
February 17, 2005	Snow	3201
January 15, 2004	Snow	3191
March 11, 2003	Snowstorm	3175
March 16, 1993	Blizzards, High Winds & Record Snowfall	3103

[9] FEMA http://www.fema.gov/disasters/grid/state/2?field_disaster_type_term_tid_1=All

Hazards associated with natural disasters typically encountered (e.g. flood events, hurricanes, winter storms) in Swansea include high winds, heavy rains and localized flooding. Natural disasters occurring less frequently (e.g. tornadoes, earthquakes, forest fires) may pose other hazards, presenting unique challenges to residents and community officials, as hazards may not have been encountered before in recent memory.

In order to outline the natural disasters and associated hazards potentially afflicting Swansea, the following sources were used:

- A review of the 2013 Massachusetts State Hazard Mitigation Plan;
- A review of the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan;
- A review of FEMA emergency declarations;
- A review of past events documented in news articles and internet sources; and
- Conversations with members of the LPT and other local stakeholders.

Based on information obtained from the sources described above, the following natural disasters and associated hazards have been identified as a threat to Swansea as shown in **Table 4.3**. Natural disasters are described in detail in the following sections. Note that tsunamis were not included within the detailed analysis, as there is no history of any tsunamis and they were determined to be of minimal risk, especially in comparison to the other natural disasters listed.

Table 4.3 – Natural Disasters and Associated Hazards

Natural Disaster	Potential Hazards
Floods	Coastal flooding, inland flooding
Snowstorms and Blizzards	Heavy snowfall, coastal flooding, high winds
Ice Storms	Ice buildup
Ice Dams	Inland flooding
Hurricanes	High winds, coastal flooding, inland flooding
Nor'easters	High winds, coastal flooding, inland flooding
Tornadoes	High winds
Thunderstorms	High winds, lightning, inland flooding
Earthquakes	Damaging ground movement
Forest Fires / Wildfires	Fire
Droughts	Increased fire danger, limited water
Dam Failures / Breaches	Inland flooding

4.1 Floods

Floods are an overflow of water submerging land not typically covered by water. Swansea historically experiences flooding in a number of areas multiple times a year, with flooding limited to a localized area or widespread depending on the cause. Flooding may be experienced along inland areas such as rivers and streams, and/or along coastal bays, inlets or other areas. Floods are typically associated with heavy rainfall events such as severe thunderstorms or hurricanes, and may affect (or overload) both natural resources such as rivers, or stormwater infrastructure such as catch basins and pipes. Flood damage can be widespread, and range from relatively minor in nature (flooded basements, water ponding in roadways) to extreme (severe riverbank erosion, flooded buildings and cars, etc.). In extreme cases, roadway or culvert washouts may occur, potentially limiting emergency access to portions of the town. For

example, the Palmer River and Kickemuit River flood periodically, rendering east-west travel in virtually impossible for several days. **Figure 2** shows areas subject to flooding within Swansea.

Coastal Flooding and Storm Surge

Coastal floods are typically the result of powerful coastal storms, such as hurricanes or nor'easters. These storms may bring a storm surge, or an abnormal swell of water associated with a low pressure system or high winds pushing on the ocean's surface. Storm surges are easily capable of inundating low-lying coastal areas. Typical storm surges are only a few feet of water; however major category 5 hurricanes are capable of creating a storm surges around 18 feet depending on a number of factors such as wind speed, forward speed, size, angle of approach, and local topography.[10] A storm surge coinciding with a high tide event can devastate coastal features such as piers, docks, boats, and virtually any natural or manmade infrastructure located in low-lying areas. Some recent storm events that caused major inland and coastal flooding include Hurricane Sandy on October 29, 2012 and Hurricane Irene on August 28-29, 2011. **Figure 3** shows areas subject to hurricane surge inundation.

Riverine (Inland) Flooding

Within the southeastern Massachusetts region, 17% of the land area is within the 100 year floodplain, and an additional 4% is located in the 500 year floodplain[11]. Floodplains are formed naturally as rivers and streams periodically overflow their banks and erode the surrounding areas, generally creating large, relatively flat areas adjacent to the watercourse. Throughout history, these areas have been highly sought after for their benefits, including highly fertile soil for agriculture, access to waterpower and transportation for industry, and generally easily developable land. However, this very infrastructure is at risk of flooding from rivers and streams that will inevitably seek to reoccupy the original floodplain.

Typical flooding events are the result of days or even weeks of wet weather, and may be brought on by a number of factors including prolonged heavy rains, numerous rainfall events over a short timeframe, high groundwater conditions or rapid snowmelt. Flash floods typically occur as a result of very heavy rainfall in a short period of time, typically over a period of minutes or hours. These flash floods are typically brought on by powerful, yet brief weather events such as hurricanes or summer thunderstorms; however these can also be the result of a dam breach or failure. During flood events, rivers or stream flows will greatly increase, possibly causing the waterbody to overflow its banks and damaging resources located within the natural floodplain. Actual damage will depend on a number of local factors, such as topography, river hydrology, precipitation characteristics, soil types, land use, etc. No detailed information is available specific to Swansea on past riverine flooding events.

A series of three storm events during March 2010 combined to drop approximately 15-inches of rainfall on the area, resulting in substantial flooding[12]. Route 6 was inundated at several locations, as well as Bushee Road.

[10] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[11] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[12] http://www.weather.gov/media/box/officePrograms/science/March_2010_Floods.pdf.

Flooding from Storm Runoff
Floods impacting a stormwater system may overwhelm the carrying capacity of pipes, swales and other stormwater conveyance, typically causing localized flooding in problem areas. Impacts can be exacerbated if the storm system is not properly maintained (e.g. clogged pipes, full catch basins, etc.). A number of areas are discussed further in Section 8.0, however some areas of town with these issues include Bark Street at Marvel Street and Hailes Hill Road.

Erosion
All flooding events have the potential to cause erosion. Depending on the scale of damage, erosion can be limited to a nuisance, such as eroding soil onto roadways, to catastrophic, such as the loss of a coastal seawall or river culvert crossing.

Climate Change Impacts on Flooding and Erosion
Climate change is expected to impact flooding in Massachusetts in three aspects: hydrology, sea level rise, and coastal landform transformation. It is not known that the frequency of storms will increase as a consequence of global climate change, however, there is a direct correlation between the increasing intensity of future storms and climate change. Since storm intensity is a function of sea surface temperature, as the average sea surface temperature increases due to climate change the intensity of tropical storms, hurricanes, Nor'Easters, and winter storms will likely be heightened[13].

With more intense future storms there will be more rainfall and snowfall (winter weather is expected to become warmer and wetter with 6% to 14% more precipitation). Increased precipitation will have numerous consequences on the current ecosystem: increased snowfall in the winter months will allow more storm runoff from the mountains and accelerated snowmelt will cause flooding; increased storm runoff will change the runoff and recharge patterns; and stream and river velocities, erosion patterns, channel shape and depth, sedimentation behind dams, and water quality will change. These are all potential factors that engineers and planners must account for when designing and implementing new flood protection infrastructure such as dams, floodways, culverts, levees, roads, and storm water drainage[14] .

Coastal regions are particularly sensitive to increased sea level, frequency of storms, intensity of storms, precipitation, wind speeds, and warmer oceans. As sea level rises, low-lying coastal areas will be particularly vulnerable to coastal storm hazards such as erosion and flooding. While some low-lying areas may be permanently inundated, other inland areas not currently subject to coastal storm impacts may be impacted by storm surge and other flooding events[15]. Massachusetts in particular is likely to lose beachfront and coastal land due to the rising sea level, a result of rising sea surface temperature. As stated in the Commonwealth of Massachusetts State Hazard Mitigation Plan:

> "Based on current science, the IPCC [Intergovernmental Panel on Climate Change] has estimated the sea level rise for the Massachusetts coast line to be 19 inches over the next 100 years which is an accelerated rate over what has been observed over the last 100

[13] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013
[14] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013
[15] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013

years (10 inches). The seas along the East Coast from North Carolina to New England area rising three to four times faster than the global average, and coastal cities, utilities, beaches, and wetlands are increasingly vulnerable to flooding, especially from storm surges, according to the US Geological Survey."

Climate change will also have a significant impact on coastal erosion. More intense storms will create a higher frequency of above average waves and winds which can reshape the coastline. Research also shows that due to the rising concentration of greenhouse gases in the atmosphere, the oceans are absorbing greater amounts of carbon dioxide making the ocean slightly more acidic. This may also have a significant effect for acid rain, coastal erosion, and the marine ecosystem[16].

Summary

Hazard Location:

- Coastal Flooding and Storm Surge:
  - Storm surge and wave action occurring along the coast
  - Small, localized areas to moderate area depending on the magnitude of the storm
- Riverine (Inland) Flooding:
  - General flooding occurring along rivers and streams
  - Generally small, localized areas depending on rainfall received
- Flooding from Storm Runoff:
  - Occurs at vulnerable storm sewer locations such as those with undersized pipes
  - Generally small, localized areas depending on rainfall received
- Erosion:
  - Occurs in the same vicinity as the flood event

Potential Damage (All Hazards):

- Flooded basements, buildings, parking lots, roadways, and other infrastructure
- Impassible or washed out roads

Scale / Extent:

- Coastal Flooding and Storm Surge:
  - Storm surge potentially in excess of 18 feet
- Riverine (Inland) Flooding:
  - Flooding caused by 24 hour rainfall typically ranging from 2 inches up to 7 inches (100 year storm)
  - Potentially caused by rainfall up to and in excess of 12 inches
- Flooding from Storm Runoff:
  - Flooding caused by 24 hour rainfall typically ranging from 2 inches up to 7 inches (100 year storm)
  - Potentially caused by rainfall up to and in excess of 12 inches
- Erosion:
  - Severity of erosion due to coastal flooding and storm surge increases proportional to the flood event and storm surge magnitude

[16] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013

- Severity of erosion due to inland flooding and/or stormwater runoff increases proportional to the flood event magnitude

Previous Occurrences:

- Coastal Flooding and Storm Surge:
  - See previous occurrences of Hurricanes and Nor'Easters, and Winter Storms in New England in **Tables 4.5 and 4.7**
- Riverine (Inland) Flooding:
  - Minor inland flooding occurs yearly, typically associated with strong summer thunderstorms or spring snowmelt
  - Major inland flooding occurs every few years, typically associated with heavy rainfall events in excess of 2 inches. Major inland flooding may also be associated with strong thunderstorms and minor to major hurricanes
- Flooding from Storm Runoff:
  - Minor flooding from storm runoff occurs almost yearly, typically associated with strong summer thunderstorms
  - Major flooding from storm runoff occurs every few years, typically associated with heavy rainfall events in excess of 2 inches, typically associated with strong thunderstorms and minor to major hurricanes
- Erosion:
  - Minor erosion of both inland and coastal features occurs approximately yearly from storms associated with rainfall events, hurricanes, nor'easters, etc.
  - Major coastal events occur in conjunction with coastal storms. See previous occurrences of Hurricanes and Nor'Easters
  - Major inland events have not been recorded in Swansea

Likelihood of Future Occurrences (All Hazards):

- Limited flood events occur nearly every year, typically during warmer months
- Major events occur less frequently, with moderate events occurring every several years and severe events once a decade

4.2 Winter Storm Events

Snowstorms and Blizzards

Snow storms and blizzards are also a common winter event in New England. Limited travel is expected, as well as potential disruptions to utilities and other services. Winter storms occur quite frequently, and thanks to preparation by the Town and its residents, typically amount to no more than a minor inconvenience. Though school delays and slow travel may occur, crippling winter storms are a rarity.

Blizzards bring the added dangers associated with high winds and sustained heavy snowfall, typically over a prolonged period of 12 hours to 3 days[17]. High winds (>35 mph) associated with blizzard conditions may also make travel difficult, if not impossible, due to limited visibility and drifting snow. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero[18]. Severe winter storms

[17] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[18] Commonwealth of Massachusetts State Hazard Mitigation Plan 2013

may also exacerbate coastal flooding issues, as high coastal winds can drive seawater against the coast and result in coastal flooding as described previously.

On average, Swansea receives approximately 33.4 inches of snow per year[19], contributing to an estimated roof snow load of 30 pounds per square foot[20]. According to the National Oceanic and Atmospheric Administration (NOAA), the greater Fall River area which covers Swansea has a 20% chance each year of having at least 1 snow event larger than 12 inches, and is likely to experience slightly fewer than 10 snowstorms each year of varying size[21]. To quantify potential storm impacts, NOAA's National Climatic Data Center (NCDC) is currently using the Regional Snowfall Index (RSI) for significant snowstorms which rank storm impacts on a scale from one to five. This system is different from the previously used Northeast Snowfall Impact Scale (NESIS), as the RSI also factors in societal impacts. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination of the extent and snowfall totals with population[22]. RSI values are shown in **Table 4.4**.

Table 4.4 – RSI Winter Storm Intensity

Index Category	RSI Value	Description
1	1-3	Notable
2	3-6	Significant
3	6-10	Major
4	10-18	Crippling
5	18+	Extreme

In addition to the hazards posed by all natural disasters, winter storms have the added hazards associated with cold weather for prolonged periods of time. Unlike disasters typically occurring during the summer months such as hurricanes, tornadoes and forest fires, power outages may result in extended periods of no heat. The resulting prolonged contact with low temperatures can cause causing pipes to freeze and burst, thereby damaging homes and businesses. Icy or snow covered roadways may also lead to added traffic accidents and resultant injuries. Winter storms may also pose added health problems, particularly to members of the community most susceptible to the added strain of contact with freezing temperatures such as the very young or elderly. Heart attacks while shoveling snow may also occur in susceptible individuals. Finally, the risk of carbon monoxide poisoning also rises with the presence of heavy snow events and/or windblown snow that may block heat source vents, such as boilers or wood burning appliances.

A storm in 1996 brought record snowfalls to southern New England, including 15 to 25 inches of snow in Bristol County. Estimated costs of snow removal statewide exceeded $32 million[23]. An additional storm in 2005 a three-day winter storm hit Massachusetts, dropping more than three feet of snow in parts of southern New England. Logan Airport was shut down and roadways were impassable for more than 36 hours in parts of the state. Estimated costs of snow removal

[19] Weather Underground http://www.wunderground.com/climate/local.html?id=USC00192451&var=SNOW
[20] Commonwealth of Massachusetts State Hazard Mitigation Plan 2013
[21] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[22] Commonwealth of Massachusetts State Hazard Mitigation Plan 2013
[23] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

statewide exceeded $40 million[24]. **Table 4.5** provides a list of winter storms ranked "major" or higher on the RSI in the Northeast from 1990 through 2013[25].

Table 4.5 – Major Northeast Winter Storms from 1990 through 2012

Year	Date	RSI Score	Category	Description
2013	February 6-9	9.04	3	Major
2010	February 20-28	15.853	4	Crippling
2010	February 3-7	8.438	3	Major
2010	February 2-6	7.939	3	Major
2007	February 10-15	7.316	3	Major
2003	December 3-7	9.024	3	Major
2003	February 13-17	14.452	4	Crippling
1996	January 5-8	20.281	5	Extreme
1993	March 11-14	20.465	5	Extreme

Winters with heavy snowfalls may also lead to spring flooding events as a result of snowmelt runoff, particularly if unseasonably warm conditions occur when substantial snow remains on the ground. This can lead to rapidly melting snow, potentially causing localized flooding.

Ice Storms

Ice storms occur when rain falling on tree branches and the ground freezes on contact, leading to ice buildups. These events are somewhat less common and generally occur at higher elevation areas of the state, but also have the ability to cripple access to utilities on elevated poles such as electric and telecommunications, and limit transportation as a result of downed trees and icy roadways. According to the National Climatic Data Center (NCDC), Bristol County has experienced 8 ice storms from 1971 through 2012[26], occurring most frequently in late December and early January.

Ice Jams

Ice jams can also cause hazards, either by a downstream portion of the river freezing and backing up flowing water to the north, or by the breaking up of an ice jam, causing large pieces of ice to flow downriver and possibly damage property and infrastructure. Although ice jams are possible, the United States Army Corps of Engineers Ice Jam Database does not indicate a single occurrence in Swansea over the past 100 years, and only 6 ice events have occurred in Bristol County since 1913[27]. Due to the relatively small rivers flowing through the Town and its close proximity to the relatively warm Atlantic Ocean, ice jams are not expected to occur.

Climate Change Impacts on Winter Storms

With the increasing average surface temperatures, winter storm precipitation is predicted to increase by 30%. More of this precipitation may be in the form of rain rather than snow due to higher temperatures which will affect the amount of snow cover, winter recreation, spring

[24] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[25] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[26] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[27] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

snowmelt, peak stream flows, water supply, aquifer recharge, and water quality. The change in winter precipitation and increased temperatures will also adversely affect flooding. Reduced snowfall, early snowmelt, and early spring peak flows could lead to drought and forest fires later in the summer, especially when the precipitation during the summer months is expected to have a 16% decrease.[28]

Summary

Hazard Location:

- Snowstorms and Blizzards:
  - Heavy snowfall across inland areas of town and surrounding region, with typically less near the coast
  - High winds, particularly along the coast
  - Localized coastal flooding and storm surge
- Ice Storm:
  - Widespread, capable of affecting the entire town and surrounding region
- Ice Jam:
  - Ice buildup in inland rivers

Potential Damage (All Hazards):

- Damage to infrastructure and trees associated with heavy snow and ice loads
- Power outages, limited access to communications and utilities
- Limited travel or impassible roads due to snowfall, ice, downed power lines and trees
- Prolonged cold weather, possibly causing frozen pipes and other damage
- Health hazards associated with exertion (snow shoveling) and exposure to cold
- Carbon monoxide poisoning associated with blocked heating vents

Scale / Extent:

- Snowstorms and Blizzards:
  - Snowfall anywhere from a few inches to a few feet depending on the storm
  - Typically storms drop less than a foot of snow
  - Severe storms and blizzards may drop up to and in excess of three feet of snow
- Ice Storm:
  - Can be up to 1 inch of ice covering the entire town, including electrical and telephone wires, tree branches, structures, roadways, etc.
  - Typical ice buildup of less than ¼ inch are generally not problematic
- Ice Jam:
  - Large pieces of ice potentially the width of the affected stream. As streams in Swansea are typically small, ice jams are not likely to occur

Previous Occurrences:

- Snowstorms and Blizzards:
  - Regular snowfall events occur regularly, typically around 10 times per year
  - Minor winter storms expected to occur once or twice a year

[28] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013

    - Major blizzards expected to occur less frequently, likely every two to three years as per **Table 4.5**
- Ice Storm:
    - Minor occurrences happen every several years
    - Major events happen every several decades
- Ice Jam:
    - No occurrences in Swansea during the previous 100 years

Likelihood of Future Occurrences:

- Snowstorms and Blizzards:
    - Likely to experience slightly fewer than 10 snowstorms each year of varying size
    - 20% chance each year of having at least 1 snow event larger than 12 inches
- Ice Storm:
    - Expected minor occurrences every several years
    - Expected major event every several decades
- Ice Jam:
    - Not likely to occur, perhaps once every 50 to 100 years

4.3 Hurricanes and Coastal Storms

Hurricanes and Tropical Storms

Hurricanes are typically fast-moving storms (typically lasting 6 to 12 hours[29]) with high winds in excess of 74 miles per hour and torrential rains averaging 6 to 8 inches, but possibly dropping as much as 15 to 20 inches of rainfall. Hazards also include localized flooding, coastal storm surges, and potentially tornados. Storms typically form in warm, southern waters and typically follow the US coast up to the New England area, accelerating rapidly with forward speeds as high as 47 mph. Less powerful tropical depressions and tropical storms have wind speeds of between 25 to 33 mph and 34 to 73 mph, respectively. Generally speaking, the highest winds are typically present south and east of the storm, while heavy rains are present to the north and west. Additionally, hurricanes hitting New England have an average forward speed of approximately 33 mph[30], further exacerbating damage done by internal wind speeds.

Hurricanes typically occur between June and November, though are most common in August and September when waters are warmest. Although the official hurricane season runs from June 1 through November 30, there are no records of a hurricane making landfall in New England during the first two months[31], likely due to the relatively cold waters in Long Island Sound during these months. Later months allow more time for these waters to reach higher temperatures capable of sustaining a tropical storm or hurricane.

High winds, heavy rains and coastal storm surge can be expected to cause widespread power outages, limited access to other utilities such as drinking water and telecommunications, and limited transportation. High coastal winds and storm surge could cause substantial damage to homes and businesses, and devastate coastal infrastructure such as marinas. For instance, after

[29] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[30] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[31] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

the passing of Hurricane Irene through the region as a tropical storm in late August 2011, many areas of the Commonwealth were without power for in excess of 5 days[32].

Due to New England's location as a protrusion into the Atlantic Ocean, hurricanes may pose a significant threat, both from coastal flooding and high winds. Swansea's location abutting the Atlantic Ocean makes it possible that a hurricane could make landfall directly in Swansea, thereby subjecting the Town to the highest possible winds, largest storm surge and heaviest rainfall. Damage would be particularly severe should the hurricane make landfall during high tide.

Statistically, New England can expect one major hurricanes (defined as a Category 3, 4, or 5 on the Saffir-Simpson scale as shown in **Table 4.6**) to make landfall each decade[33]. **Table 4.7** shows damaging hurricanes making landfall in New England over the past 100 years[34,]

Table 4.6 – Saffir-Simpson Hurricane Scale

Category	Wind Speeds	Expected Storm Surge
Category 1	74-95 mph	4-5 feet
Category 2	96-110 mph	6-8 feet
Category 3	111-129 mph	9-12 feet
Category 4	130-156 mph	13-18 feet
Category 5	>157 mph	>18 feet

Table 4.7 – Major New England Hurricanes

Date	Name	Intensity	Landfall?
August, 2011	Hurricane Irene	Category 2	
September 2, 2010	Hurricane Earl	Category 3	
July, 1996	Hurricane Bertha	Category 3	
August 19, 1991	Hurricane Bob	Category 2/3	Yes
September 27, 1985	Hurricane Gloria	Category 2	
September 12, 1969	Hurricane Donna	Category 2/3	
October, 1954	Hurricane Hazel	Category 3	
September 11, 1954	Hurricane Edna	Category 3	Yes
August 31, 1954	Hurricane Carol	Category 3	
September 15, 1944	Unnamed (Great Atlantic Hurricane)	Category 3	Yes
September 21, 1938	Unnamed (Great New England Hurricane of 1938)	Category 3	Yes

The last major hurricane to impact the area was Hurricane Bob in 1991. The eye of the storm tracked north-northeast between Fall River and Providence, directly over Swansea. Over 500 boats were damaged or destroyed, and storm surge reached almost six feet in nearby New Bedford. Total damage was estimated at $900 million in the area[35]. More recently, Hurricane

[32] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[33] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[34] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[35] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

Earl was the first storm threaten New England since Hurricane Bob. Although reaching Category 4 strength, the storm passed just off the coast of New England as a Category 3 storm. Damage was generally light, however one person was killed in Massachusetts.

Note that no hurricane has made landfall in New England area for over 20 years. Smaller tropical storms and depressions have affected the area, generally inflicting minor damage such as some downed tree limbs, power outages, and limited damage to boating-related infrastructure. NOAA estimates that 80 to 90% of the population now living in United States coastal areas has never experienced a major hurricane[36], potentially exacerbating disruption due to limited preparation and preparedness on behalf of residents. Coupled with a significant population increase since 1954 in coastal areas, landfall of a major hurricane near Swansea could have catastrophic consequences in both dollar amounts and human tolls.

Coastal Storms or Nor'Easters

A northeast coastal storm, typically known as a nor'easter for its generally northeast trajectory and strong winds blowing from the northeast, typically occurs during late fall and early winter. Nor'easters are fairly common, with Massachusetts typically encountering a nor'easter once or twice per year in varying states of intensity. The storm typically forms either in the Gulf of Mexico or off the coast before moving up the east coast to New England.

Storms are typically large, and bring strong winds possibly exceeding hurricane-force gusts in strength, heavy rain or snow, and damaging coastal waves and surges. Storms may also remain stationary or nearly stationary for several days, potentially dropping substantial amounts of rain or snow. Although hurricanes can produce more damage, Massachusetts has historically suffered more damage from nor'easters due to the greater frequency of occurrence[37].

As with hurricanes, high winds, localized flooding, heavy rains or snow and potentially severe coastal erosion can be expected to cause widespread power outages, limited access to other utilities, and possibly temporarily limit transportation due to downed trees or heavy snow. Hazards are typically the same as those associated with hurricanes or blizzards depending on the time of year.

Climate Change Impacts on Hurricanes, Tropical Storms, and Nor'Easters

Climate change will result in increases in unstable and extreme weather due to the rise in average global temperature. According to the Massachusetts Climate Change Adaptation Report[38], large storm events, such as hurricanes, tropical storms, and Nor'Easters are likely to become more frequent and intense as a result of climate change. Research indicates that the frequency of Category 4 and 5 hurricanes is likely to double by the end of the century and the frequency of less intense storms will decrease. These changes will undoubtedly have a major impact on coastal ecosystems, communities, culture, and economies.

With the rising sea level and sea surface temperatures, the severity of storms are expected to have higher wind speeds, precipitation, and likelihood of tornado events. These severe storm

[36] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[37] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[38] Massachusetts Climate Change Adaptation Report. September 2011.

events will cause more extensive damage including downed power lines, overburdened septic systems, flooding, and transportation delays. Future storms are also more likely to cause substantial damage along coastal areas of Massachusetts; impacts may include destruction of private property and public infrastructure, sewage leaks, hazardous material spills, loss of coastal and marine businesses, and even loss of life.

Summary

Typical Hazards and Location (All Hazards):

- High winds across the entire town and surrounding region, particularly along coastal areas
- Inland flooding and erosion occurring along rivers and streams
- Coastal flooding, wave action, erosion and storm surge along the coast

Potential Damage (All Hazards):

- Wind damage to infrastructure and trees
- Power outages, limited access to communications and utilities
- Impassible roads due to flooding, downed power lines and trees
- Flooded basements, buildings, parking lots, roadways, and other infrastructure

Scale / Extent (All Hazards):

- High winds depending on the magnitude of the storm, from <75 mph to >150 mph
- Inland flooding – flooding caused by rainfall up to 7 inches (100 year storm) but potentially up to and in excess of 12 inches
- Coastal flooding and storm surge – small, localized areas to moderate area depending on the magnitude of the storm, anywhere from <4 foot storm surge to >18 feet

Previous Occurrences:

- Hurricanes:
    - Major hurricanes previously occurred approximately once every 10 to 20 years
    - Smaller hurricanes and tropical storms have previously made landfall approximately every few years
- Coastal Storms or Nor'Easters
    - See previous occurrences of Hurricanes and Blizzards

Likelihood of Future Occurrences (All Hazards):

- Hurricanes:
    - Statistically a six to thirty percent chance of a tropical storm or hurricane affecting the area each year[39]
    - Statistically one major hurricane (category 3, 4, or 5) every decade with smaller hurricanes more frequently
    - However no hurricane has made landfall in Swansea in over 20 years
- Coastal Storms or Nor'Easters
    - See previous occurrences of Hurricanes and Blizzards

[39] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

4.4 Tornadoes and Thunderstorms

Tornadoes

Tornadoes are a vortex of rapidly rotating air moving along the ground. Tornadoes typically occur during the spring, summer and fall months, usually during the afternoon. Tornadoes may occur in unusually severe thunderstorms, bringing hazards such as very high wind speeds (typically anywhere from 100 to 300 miles per hour) along a localized area, localized heavy rainfall and flooding, frequent lightning and damaging hail.

Unlike large scale disasters such as winter storms, hurricanes and earthquakes, tornadoes typically produce damage on a very limited, albeit intense scale. Although tornadoes have the capability to develop to over a mile wide and decimate an entire town, damage paths are typically limited to several hundred feet wide, causing somewhat limited destruction. However, it is not uncommon for structures suffering a direct hit to be completely destroyed.

Tornadoes may be anywhere from less than 250 feet to over two miles in diameter. Typically, tornadoes dissipate after no more than a couple miles on the ground; however have been known to stay on the ground for dozens of miles, causing substantial damage along the way. Although not commonly occurring, tornadoes have occurred in every state. In Massachusetts, tornadoes occur most frequently in and around Worcester County, however may occur wherever conditions are right. Typically, there are 1 to 3 tornadoes somewhere in southern New England per year, with most occurring in June, July or August during the late afternoon and evening hours, when the heating is the greatest[40].

According to NOAA, Bristol County is located in an area of very low probability of occurrence, with less than one tornado expected to occur every five years[41]. **Table 4.8** shows tornadoes occurring in Bristol County since 1950[42].

Table 4.8 – Tornadoes in Bristol County

Date	Strength	Fatalities	Injuries
July 23, 2008	F1	0	0
August 6, 1997	F0	0	0
September 14, 1972	F0	0	0
August 28, 1970	F2	0	0
August 2, 1970	F1	0	0
August 9, 1968	F1	0	0
August 9, 1968	F1	0	4
September 7, 1958	F0	0	0
June 9, 1953	F3	0	17

Table 4.9 defines the Fujita scale, used for rating tornado intensity based on the damage tornadoes inflict.

[40] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[41] NOAA. http://www.nssl.noaa.gov/primer/tornado/tor_hazardgraph.html
[42] TornadoHistoryProject.com. www.tornadohistoryproject.com

Table 4.9 – Fujita Scale

Scale	Wind Speed	Damage Path	Typical Damage
F0	40-72 mph	50-165 ft	Light damage. Some damage to chimneys, branches broken off trees, shallow-rooted trees pushed over, sign boards damaged
F1	73-112 mph	100-500 ft	Moderate damage. Peels surface off roofs, mobile homes pushed off foundations, attached garages may be destroyed
F2	113-157 mph	360-820 ft	Significant damage. Roofs torn off houses, mobile homes demolished, large trees snapped or uprooted
F3	158-206 mph	0.1-0.3 mi	Severe damage. Roofs and some walls torn off well-constructed houses, most trees in forest uprooted
F4	207-260 mph	0.3-0.6 mi	Devastating damage. Well-constructed houses leveled, structures with weak foundations blown away
F5	261-318 mph	0.7+ mi	Incredible damage. Strong frame houses lifted off foundations, steel reinforced structures badly damaged.

A tornado capable of significant damage has not occurred in Swansea, based upon available records since 1950. Over time, residents may have grown complacent, believing that a tornado cannot occur in Swansea. This feeling could potentially exacerbate problems, should a tornado occur.

Thunderstorms

A thunderstorm is a storm which produces lightning, typically accompanied by heavy, localized rainfall, strong winds, and occasionally hail (hailstorms). They typically occur during the spring, summer and fall months, usually during the afternoon. Thunderstorms typically form in a line or front, typically moving west-to-east ahead of a cold front. Effective January 5, 2010, the National Weather Service (NWS) modified the hail size criterion to classify a thunderstorm as 'severe' when it produces damaging wind gusts in excess of 58 mph, hail that is 1 inch in diameter or larger (quarter size), or a tornado[43].

Thunderstorms have both an updraft of rising air and a downdraft of sinking air. Extremely strong downdrafts, known as downbursts, have the potential to cause extreme straight-line wind damage, similar to that of a tornado. A small (<2.5 mile path) downburst is known as a "microburst" while a larger downburst is known as a "macro-burst." Winds exceeding 100 mph have been measured in Massachusetts from downbursts[44].

An average thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. Severe thunderstorms can be much larger and last much longer. Southern New England typically experiences about 10 to 15 days per year in which there are severe thunderstorms[45]. Thunderstorms occur quite often and typically do not pose a serious threat to the Town, however unusually severe storms may bring limited damage.

[43] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[44] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[45] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

Climate Change Impacts on Tornadoes and Thunderstorms
The number of severe weather incidents, including tornadoes and thunderstorms, has increased steadily over the past century. Weather-related disasters in the 1990s have caused 14 times more in economic losses than that of the 1950s. As the temperature increases, the likelihood of severe weather such as drought will increase; more heavy precipitation events will occur and less light precipitation events will occur[46].

Summary
Hazard Location:

- Tornadoes:
  - Very high winds across a generally narrow section of town, typically less than ½ mile wide. Exact locations are unpredictable and may occur anywhere
  - Lightning strikes across a broader portion of town. Exact locations are unpredictable and may occur anywhere
- Thunderstorms:
  - Potentially high winds across a wide swath of town and the surrounding region
  - Inland flooding occurring along rivers and streams
  - Lightning strikes across a wide swath of town and the surrounding region

Potential Damage (All Hazards):

- Wind damage to infrastructure and trees
- Power outages, limited access to communications and utilities
- Impassible roads due to flooding, downed power lines and trees
- Flooded basements, buildings, parking lots, roadways, and other infrastructure
- Lightning strikes, potentially igniting a fire

Scale / Extent:

- Tornadoes:
  - Very high winds depending on the magnitude of the storm, from <40 mph to >300 mph
- Thunderstorms:
  - Inland flooding – flooding caused by rainfall up to 7 inches (100 year storm) but potentially up to and in excess of 12 inches
  - High winds depending on the magnitude of the storm, from <40 mph to >100 mph

Previous Occurrences:

- Tornadoes:
  - Bristol County typically experiences one tornado approximately once per decade, typically magnitude F0 or F1 on the Fujita Scale, with the potential for this event to occur within the Town of Swansea
  - A tornado causing significant damage has not occurred for many years (F3 on June 9, 1953)
- Thunderstorms:
  - Thunderstorms occur on a monthly, if not weekly basis during summer months

[46] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

- There have been no recorded thunderstorms that have caused widespread severe or significant damage within Swansea

Likelihood of Future Occurrences:

- Tornadoes:
  - Swansea is located in an area of very low probability of occurrence, with less than one tornado expected to occur every five years
  - Small tornadoes may occur causing localized damage
  - A damaging tornado is unlikely to occur
- Thunderstorms:
  - Southern New England typically experiences about 10 to 15 days per year in which there are severe thunderstorms
  - Thunderstorms may be expected to occur several times a month during the late spring, summer, and early fall months

4.5 Geologic Hazards

Earthquake

An earthquake is a sudden, intense shaking of the ground caused by the sudden movement of large portions of the Earth's crust, potentially causing massive damage to buildings and infrastructure. A secondary effect potentially observed in water-saturated areas typically located near waterbodies is ground liquefaction, where water-saturated soils behave like a semi-fluid body as a result of ground shaking, potentially resulting in landslides.

As opposed to plate boundary regions along the west coast where earthquakes typically align along known geologic faults, New England's earthquakes to date have not aligned along mapped faults. Furthermore, the mapped geologic faults of New England currently do not provide any indications detailing specific locations where strong earthquakes are most likely to be centered[47]. As such, earthquakes can occur suddenly at any time, with virtually no warning. Overall, an average of six earthquakes are felt each year somewhere in New England[48] could be located nearly anywhere within the region.

The Northeast States Emergency Consortium indicates that New England experienced 1,507 earthquakes from 1638 through 2008, of which 366 were located in Massachusetts[49]. The vast majority of these earthquakes were minor in nature. Minor earthquakes, such as those less than 3.0 in magnitude on the Richter scale, occur frequently in the region, however are virtually undetectable by all but the most sensitive scientific equipment. However, between 1924 and 2008, eight earthquakes occurred within New England with a magnitude of 4.5 or greater, many of which were felt throughout the region[50].

Although the risk of a damaging earthquake is low, the potential hazard is high because of potentially devastating damage to the entire region. Nearly all critical infrastructure is

[47] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[48] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[49] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[50] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

vulnerable, including roads, bridges, utilities, communications, etc. State and federal emergency response could also be hindered by damage present throughout the region.

Swansea is located in a region with a peak ground acceleration (PGA) of approximately 0.08g to 0.10g with a 2% chance of occurrence every 50 years[51]. According to the United States Geological Survey (USGS), earthquake damage begins to occur at a ground movement level of approximately 0.10g. At this level, damage would be minor in nature. However, the probability of an event is extremely low, and according to the USGS can be expected to occur once every 2,476 years[52].

While major earthquakes are unlikely, they have occurred within the region in the past. On November 18, 1755, an earthquake estimated between 6.0 and 6.3 on the Richter scale struck just off the coast of Cape Ann, Massachusetts, reportedly damaging chimneys and homes as far away as New Haven, Connecticut. A 1990 MEMA study estimated that if a similar earthquake shook Boston today, it could result in as much as $5 billion in damage and hundreds of deaths[53]. **Table 4.10** outlines the Richter Magnitude Scale, a logarithmic scale used for documenting energy released during an earthquake.

Table 4.10 – Richter Magnitude Scale

Magnitude	Description	Typical Damage
<2.0	Micro	Micro earthquake, not felt
2.0-2.9	Minor	Generally not felt, but recorded
3.0-3.9		Often felt, but rarely causes damage
4.0-4.9	Light	Noticeable shaking of indoor items. Significant damage unlikely.
5.0-5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings
6.0-6.9	Strong	Can be destructive in areas up to approximately 160 kilometers across populated areas
7.0-7.9	Major	Can cause serious damage over larger areas
8.0-8.9	Great	Can cause serious damage several hundred kilometers across
9.0-9.9		Devastating in areas several thousand kilometers across
10.0+	Massive	Never recorded, widespread devastation across very large areas.

A major earthquake has not occurred in Swansea in recent recorded history. Although a magnitude 6+ earthquake occurred off of Cape Ann, it happened over 250 years ago and thus residents are likely not prepared to deal with the effects of an earthquake. Similar to problems associated with hurricanes and tornadoes, this feeling could exacerbate problems, should an earthquake occur.

[51] United States Geological Survey. http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/
[52] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[53] Newman, William A. and Holton, Wilfred E. *Boston's Back Bay: the story of America's greatest nineteenth-century landfill project*. University Press of New England. 2006.

Landslide
A landslide typically occurs on a section of steeply sloping ground. Landslides can involve movement of mud, soil, rocks, and other debris such as trees. Most landslides in Massachusetts are due to slope saturation. Due to the relatively flat topography of Swansea, landslides are not expected to pose a hazard to the Town and are currently estimated to be low susceptibility at less than 1.5% of the area involved[54]. Any landslides that occur will likely be minor in nature, impacting only very localized areas.

Sinkhole
A sinkhole is a depression or hole opening up in the ground surface. It can be either as a result of natural causes, or most likely in this area of the country, a result of a broken water main, or stormwater pipe. Sinkholes vary in size, however those caused by utility failure are typically not much deeper than the utility itself, typically less than twelve feet deep and up to several dozen feet wide. Any sinkholes that occur will be minor in nature, typically impacting only localized utility and transportation access.

Climate Change Impacts on Earthquakes
A correlation between global climate change and the probability of earthquakes occurring is unknown, however, some scientists believe that melting glaciers may induce tectonic activity. According to prehistoric earthquakes and volcanic activity, seismic plates may shift and volcanic activity may stimulate as a result of the earth's crust returning to its pre-glacier shape. Secondary impacts, should an earthquake occur, may worsen as a result of climate change. Soils can become oversaturated due to repetitive storms which may cause liquefaction during an earthquake event. Dams and other flood protection infrastructure may fail during a seismic event due to the heavier rainfall and increased volumes of water[55].

Summary
<u>Hazard Location:</u>
- Earthquake:
  - Damaging ground movement affecting the entire town and surrounding region
- Landslide:
  - Steep hillsides, generally not present within Swansea
- Sinkhole:
  - Could occur nearly anywhere, but typically associated with leaking water or stormwater utilities

<u>Potential Damage</u>
- Earthquake:
  - Extensive damage to buildings and infrastructure
  - Extended power outages
  - Limited access to transportation, communications and utilities
  - Fires ignited by ruptured gas lines
  - Flooding from dam failures

[54] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[55] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

- Landslide:
    - Localized damage to buildings, roadways, and utilities
- Sinkhole:
    - Localized damage to roadways and utilities

Scale / Extent:

- Earthquake:
    - Varies from undetectable (<2.0 Richter Magnitude Scale) to strong (6.0 to 6.9 Richter Magnitude Scale).
- Landslide:
    - Likely minor in nature, if occurring at all
    - Sinkhole:
    - Damage will be minor and localized

Previous Occurrences:

- Earthquake:
    - Small, undetectable earthquakes occur several times a year causing no damage
    - A major earthquake has never been recorded in Swansea
- Landslide:
    - Never occurred or documented within Swansea
- Sinkhole:
    - Never occurred or documented within Swansea

Likelihood of Future Occurrences:

- Earthquake:
    - Small, undetectable earthquakes typically occur several times a year
    - Large, damaging earthquakes are extremely rare, occurring far less than once per century and can be expected to occur once every 2,476 years
- Landslide:
    - Unlikely to occur
- Sinkhole:
    - Could potentially occur, however unlikely to be associated with natural causes

4.6 Forest Fires / Wildfires

Wildfires and forest fires are naturally occurring events, and part of a normal, healthy ecosystem. Naturally occurring fires help keep forest floors free of excessive debris buildup, thin crowded trees, encourage growth of new vegetation, and recycle nutrients into the soil. Forest fires may occur at any time of year, however typically occur during hot, dry summer months, or during windy conditions during the spring and fall. Natural ignition most frequently occurs as the result of a lightning strike. Though other natural sources are possible such as volcanic eruption or coal fires, these sources are not expected to occur in Swansea. Topography is important because it affects the movement of air (and thus the fire) over the ground surface. The slope and shape of terrain can change the rate of speed at which the fire travels. In general terms, the steeper the slope of the land, the faster a fire can spread up the slope.

There are four types of forest fires, and are typically fed by organic materials as shown in **Table 4.11**:

Table 4.11 – Forest Fire Types

Fire Type	Location	Typical Fuel
Ground	At or below ground surface	Underground roots, buried leaves or other subsurface organic matter
Surface	Ground surface	Surface leaves, grass, low-lying vegetation and underbrush
Ladder	Between the surface and canopy	Underbrush, downed logs, vines and small trees
Canopy	In the tree canopy	Tall trees, vines and branches

Though fires can be started by natural occurrences, they are most frequently ignited by humans as a result of discarded cigarettes, downed power lines, or are intentionally set. The Bureau of Fire Control estimates that nearly 98% of fires in Massachusetts are started by human carelessness[56]. Swansea has had various wildfires throughout its history varying anywhere from 25-200 acres in size. Recent forest fires in Swansea include fires behind Town Hall, around 30-40 acres, and fires near Burnside Drive.

Forest fires vary in size, however thanks to modern detection and firefighting equipment methods, fires are typically kept to a reasonably small area. The Bureau of Fire Control estimates that the average fire 100 years ago consumed approximately 34 acres, while today the average fire burns only 1.2 acres. However, large fires have occurred nearby in the past, such as the 1957 fire in Myles Standish State Forest which burned over 18,000 acres, stopping only when it reached the ocean[57]. The 2013 Massachusetts Hazard Mitigation Plan identifies the southeastern part of Massachusetts, including the southern coast of Bristol County and Swansea, to be the most susceptible area in the state to wildfires due to the availability of fuel, impacts from offshore winds, and increasing development within wooded areas[58].

While modern fire detection, prevention and extinguishing techniques have minimized damage from fires, it has also led to excessive vegetation growth in forests, meaning that there is excess fuel available, should a fire occur. Vegetated material that once would have been periodically consumed during natural fire events now stands crowded into the same area, potentially increasing the severity of a fire should one occur. Global warming has also increased the damage potential of a wildfire by raising average temperatures and increasing drought-like conditions.

Climate Change Impacts on Forest Fires/ Wildfires

Climate can influence the wildfire system in a number of ways including fire behavior, ignition, fire management, and vegetation fuel. Increasing average surface temperatures by cause more frequent hot dry spells and climate change may also increase wind speeds, conditions which are

[56] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[57] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.
[58] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

ideal for intense and fast moving fires which are much harder to contain. Summer temperatures are expected to rise 2°C to 5°C and precipitation in the summer is expected to decrease about 15%. These conditions will exacerbate forest fire and wildfire intensity and frequency in the future[59].

Summary

Hazard Location:

- Fires typically occurring in wooded areas, though could spread to developed areas

Potential Damage:

- Damage to trees and other vegetated areas
- Limited damage to homes and other infrastructure
- Health concerns due to noxious smoke

Scale / Extent:

- Varies from minor (<1 acre consumed) to substantial (>1,000 acres consumed)

Previous Occurrences

- No information is available specific to Swansea, however no major fires have been documented within the Town
- Minor fires can occur throughout the course of the year, however are quickly extinguished before burning more than one acre

Likelihood of Future Occurrences:

- Minor wildfires causing little damage may occur somewhat frequently due to human carelessness or lightning strikes, however large, damaging fires are rare

4.7 Extreme Temperatures and Drought

Extreme Cold

Extreme cold events are generally characterized by the ambient air temperature dropping to approximately 0-degrees Fahrenheit or below[60]. While generally not an issue for people with adequate shelter or during normal periods when electricity and heat is available, risks are much higher when extreme cold coincides with another extreme weather event, such as a blizzard or other high wind event resulting in loss of power. Should sufficient heat be unavailable, risks are much higher. Additionally, the user of space heaters, fireplaces, candles, and/or generators can pose an elevated risk of fire and/or carbon monoxide poisoning. Car exhaust can also pose a risk if operated within an enclosed area lacking adequate ventilation. Secondary effects can be an elevated risk of automobile accidents due to icy roads.

[59] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[60] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

Extreme Heat

Temperatures that are 10ºF or more above the average high temperature for the region and last for several hours are defined as extreme heat[61]. Because this can translate to a 50-degree day in the winter being classified as "extreme heat", a better definition for extreme heat would be a heat wave, generally defined for the Northeast as three or more consecutive days above 90-degree Fahrenheit temperatures. Heat waves cause more fatalities in the U.S. than the total of all other meteorological events combined[62]. Other applicable definitions for extreme heat are an excessive heat warning or heat advisory, issued by the NWS when daytime heat indices of 105 degrees Fahrenheit for 2 or more hours, or between 100 degrees and 104 degrees Fahrenheit for 2 or more hours, respectively.

Air quality is also impacted by extreme heat events. The Air Quality Index (AQI) is an index for reporting daily air quality that indicates how clean or polluted the air is and when associated health effects might be a concern. Daily AQI values range from 0 to 500, where values below 100 are generally considered satisfactory. When AQI values exceed 100, air quality is considered to be unhealthy, first for sensitive groups of people then for everyone as values get higher. AQI values over 300 indicate hazardous air quality. The NWS issues air quality alerts for public notification and provide recommendations for reducing risks associated with poor air quality as needed[63].

Drought

Drought is an extended period of time where a region experiences a notable reduction in available water supply typically caused by a lack of precipitation, and can be related to either surface water or groundwater sources. Though most droughts in Massachusetts last only a matter of months, it is possible for drought conditions to extend over a period of years due to reduced rainfall and snowfall accumulations contributing to lower groundwater and surface water levels.

According to the 2002 Massachusetts Drought Management Plan, Massachusetts communities generally receive enough precipitation to support typical residential and business water demand[64]. However, during period of reduced rainfall or drought, communities frequently implement water use regulations to restrict non-critical water use, such as outdoor watering, in order to maintain adequate water supplies for drinking, washing and firefighting activities.

Drought can cause significant environmental and financial impacts, such as failed agricultural crops, limited availability of drinking water, heavy erosion once rainfall returns, and ecosystem damage to plants and animals. Drought can also be a major factor in the propagation of forest fires. Less water in the ground and vegetation translates to more easily combustible fuel for a fire. Drought can also reduce water available to fight a forest fire, making it that much more difficult to extinguish.

[61] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[62] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[63] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[64] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

Most droughts affecting Swansea have typically started with dry winters, leading to reduced spring snowmelt. The most severe drought on record in the northeastern United States was during the summer from 1961 through 1969[65]. No information is available specific to Swansea.

Climate Change Impacts on Drought

Climate change is a shift in long-term weather patterns, and includes alterations in typical temperature, precipitation, wind, and more. Massachusetts' climate is rapidly changing, the ambient air temperature and sea surface temperature have risen by about 1.8° and 2.3° Fahrenheit, respectively, since 1970[66]. Massachusetts will continue to experience accelerated warming in the next several decades[67]. Winter snowfall is also expected to decrease which will result in a smaller and earlier spring melt and drier later in the summer. These conditions are ideal for longer and more intense droughts.

Summary

Hazard Location:

- Droughts would affect the entire town and surrounding region

Potential Damage:

- Limited access to drinking water and water for firefighting

Scale / Extent:

- Varies from somewhat minor to major, depending on how much and when precipitation is received
- Can last from a matter of weeks to years
- Minor droughts may only require enforcement of outdoor watering restrictions,
- Major events could cause loss of agricultural crops, drinking water shortages, widespread ecological damage to plants and animals, and increased fire risk

Previous Occurrences

- No information is available specific to Swansea, however droughts severe enough to cause significant environmental and financial impacts have not been recorded in town
- Minor droughts, severe enough to enforce outdoor watering restrictions, occur nearly every year

Likelihood of Future Occurrences:

- Minor droughts are expected to occur often, though major droughts are rare

4.8 Dam Failures / Breaches

According to FEMA, a dam is an artificial barrier constructed for the purpose of storage or control of water. Dam failure can occur either catastrophically by sudden, rapid, and uncontrolled release of impounded water, or slowly via a partial breach or overtopping of limited water quantities. Dams can fail for one or a combination of the following reasons:

[65] Massachusetts Department of Conservation and Recreation. http://www.mass.gov/dcr/watersupply/rainfall/reports/2012/0612%20Comp%20estimate%20web.pdf

[66] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013

[67] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013

- Overtopping caused by floods that exceed the capacity of the dam;
- Deliberate acts of sabotage;
- Lack of maintenance;
- Structural failure of the dam or foundation; and
- Piping and internal erosion of soil in embankment dams.

Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure (34 percent of failures);
- Foundation defects due to settlement, slides, or other instability (30 percent of failures);
- Failure due to piping and seepage (20 percent of failures); or
- Failure due to problems with conduits and valves (10 percent of failures[68]).

According to the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan, Swansea has 7 dams, however the DCR Office of Dam Safety and Army Corps National Inventory of Dams has provided a list of the following dams located within Swansea as shown in **Table 4.12**.

Table 4.12 – Dams within Swansea

Dam Name	Location	River	Owner	Ownership Type
Swansea Print Works Dam	Ledge Road	Lewin Brook into Lees River	Brightledge LLC	Private
Cole River Pond Dam	Wood Street	Cole River	Wightman	Private
Warren Reservoir Dam	Reed Road	Kickemuit River	Bristol County Water Authority	Quasi-Public
Milford Pond Dam	Milford Road	Cole River	Town of Swansea	Public
Swansea Dam (Montaup #5 Dam)	Main Street	Lewin Brook	Town of Swansea	Public
Coles River Dam Route 6 (Montaup #3 Dam)	GAR Highway	Cole River	Town of Swansea	Public
Upper Lewin Pond Dam	Lewin Lane	Lewin Pond	Town of Swansea	Public

Note that Swansea has never had a dam breach in recent recorded history (approximately 100-years). However, the Upper Milford Pond Dam is a critical structure, as the Town has previously had problems with the outlet control structure.

The Office of Dam Safety (ODS), a division of the Massachusetts Department of Conservation and Recreation (DCR), has jurisdictional authority over dams that meet the following criteria: dam structure six feet or higher, or impoundment of 15 acre feet or more, or a significant downstream hazard as determined by staff review (e.g. campground, densely developed area, major thoroughfare, etc.). This includes government and privately owned dams[69].

[68] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.
[69] SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan. 2004.

Dam Safety Regulations became effective on November 4, 2005, and require owners to register the dams and have them professionally inspected. Dam hazards are classified into three categories: high hazard; significant hazard; or low hazard[70], and must be inspected every 2, 5, and 10 years, respectively. Descriptions are as follows:

- High Hazard Potential – dams located where failure will likely cause loss of life and serious damage to homes, industrial or commercial facilities, important public utilities, main highways or railroads;
- Significant Hazard Potential – dams located where failure may cause loss of life and damage homes, industrial or commercial facilities, secondary highways or railroads or cause interruption of use or service of relatively important facilities; and
- Low Hazard Potential – dams located where failure may cause minimal property damage to others. Loss of life is not expected[71].

Climate Change Impacts on Dam Failures/Breaches

Since climate change has a large effect on the hydrograph of a river or stream, it will likewise have significant effects on designing dams. A dam can lose some or all of its margin of safety, or freeboard, if the hydrograph changes, forcing operators to release a greater volumes of storm water earlier in the storm cycle to maintain the required freeboard. A larger volume of water downstream of dams may cause flooding. Though climate change will likely not result in catastrophic failure of dams, the probability of design failures such as increased discharges from spillways will likely increase[72].

Summary

Hazard Location:

- At each dam situated along rivers or streams, 12 locations within town
- Impact depends on the size of the dam, however generally small, localized areas

Potential Damage:

- Erosion, flooded buildings, parking lots, roadways, and other infrastructure
- Impassible or washed out roads

Scale / Extent:

- Minor dam failure could release a wall of water up to 1 foot high, typical of privately owned dams in Swansea
- Major dam failure could release a wall of water greater than 6 feet high, typical of larger high hazard and significant hazard dams in town.

Previous Occurrences:

- A dam failure within Swansea has never occurred

Likelihood of Future Occurrences:

- Possible, however a damaging failure is unlikely

[70] Massachusetts Office of Dam Safety. http://www.mass.gov/dcr/pe/damSafety/index.htm
[71] Massachusetts Office of Dam Safety. http://www.mass.gov/eea/agencies/dcr/conservation/dam-safety/
[72] Commonwealth of Massachusetts State Hazard Mitigation Plan. 2013.

4.9 Natural Hazard Indexing Methodology

As discussed previously, Swansea faces a number of potential natural hazards. A Hazard Identification matrix was developed that rates natural hazards based on the following three items:

- Likelihood of Occurrence – the probability that a hazard will occur;
- Geographic Scale – location and/or size of the area affected; and
- Impacts – expected damage and disruptions to be expected.

Specific hazards were then assigned a point value for each of these items based on the expected severity of the hazard. Point values and descriptions for each category are shown in **Table 4.13**. This information was then used to establish a Hazard Index for each type of natural hazard and associated risk level based on the total score as shown in **Table 4.14.** Hazards associated with the highest index value were determined to have the greatest potential impact to Swansea. The entire scoring matrix is provided as **Table 4.15**.

Table 4.13 – Hazard Identification Criteria

Score	Category	Description
Likelihood of Occurrence		
3	Highly Likely	50% to 100% probability in the next year
2	Likely	Between 10% and 50% probability in the next year
1	Possible	Between 1% and 10% probability in the next year
0	Unlikely	Less than 1% probability in the next year
Geographic Scale		
3	Large	More than 50% of the town affected
2	Medium	10% to 50% of the town affected
1	Small	Less than 10% of the town affected
Impacts		
3	Catastrophic	Multiple deaths & injuries possible, >50% property severely damaged Complete shutdown of facilities for 30 days or more
2	Critical	Multiple injuries possible, <50% to >25% property severely damaged Complete shutdown of critical facilities for at least 1 week
1	Limited	Minor injuries only, <25% to >10% property severely damaged Complete shutdown of critical facilities for more than one day
0	Minor	Very few injuries, if any, only minor property damage Shutdown of critical facilities and services for 24 hours or less

Table 4.14 – Risk Level

Hazard Index Score	Risk Level
8-9	Extremely High
6-7	Very High
5	High
4	Moderate
3	Low
1-2	Very Low

Table 4.15 – Natural Hazard Index

Natural Hazard	Likelihood of Occurrence	Geographic Scale	Impacts	Hazard Index Score[1]	Risk Level
Floods					
Coastal Flooding	3 Highly Likely	2 Medium	3 Catastrophic	8	**Extremely High**
Riverine Flooding	3 Highly Likely	2 Medium	1 Limited	6	Moderate
Flooding from Storm Runoff	2 Likely	1 Small	1 Limited	4	Moderate
Erosion	2 Likely	1 Small	0 Minor	3	Low
Winter Storm Events					
Snowstorms and Blizzards	3 Highly Likely	3 Large	1 Limited	7	Very High
Ice Storm	3 Highly Likely	3 Large	1 Limited	7	Very High
Ice Jam	0 Unlikely	1 Small	1 Limited	2	Very Low
Hurricanes, Tropical Storms, and Nor'Easters					
Hurricanes and Tropical Storms	3 Highly Likely	3 Large	2 Critical	8	**Extremely High**
Coastal Storms or Nor'easters	3 Highly Likely	3 Large	2 Critical	8	**Extremely High**
Tornadoes and Thunderstorms					
Tornadoes	0 Unlikely	2 Medium	2 Critical	4	Moderate
Thunderstorms	3 Highly Likely	1 Small	1 Limited	5	High
Geologic Hazards					
Earthquakes	0 Unlikely	3 Large	0 Minor	3	Low
Landslides	0 Unlikely	1 Small	1 Limited	2	Very Low
Sinkholes	0 Unlikely	1 Small	0 Minor	1	Very Low
Other Hazards					
Extreme Temperatures & Drought	2 Likely	3 Large	0 Minor	5	High
Forest Fires / Wildfires	1 Possible	2 Medium	1 Limited	4	Moderate
Dam Failures	0 Unlikely	1 Small	3 Catastrophic	4	Moderate

[1]Possible 9 points, 9 being high, 1 being low.

5.0 VULNERABILITY ASSESSMENT

The following sections provide an overview of Swansea's vulnerability to the various natural hazards outlined previously. Based on these hazards, the following sections outline the most likely source of damage and provide an estimate of damage in dollars that may result from each natural hazard. Where possible, tools available through FEMA, such as FEMA's Hazus-MH hazard simulation software simulation and *Understanding Your Risks: Identifying Hazards and Estimating Losses*[73] document, were used to estimate dollar amounts.

To determine potential damages, FEMA Hazus-MH software was first used to obtain property value data. For those hazards affecting a limited area of Swansea such as flooding, only those structures located within hazard-prone areas were evaluated. For hazards capable of affecting the entire town, such as earthquakes, an assessment was made based on a percentage of buildings damaged within the entire Town. **Table 5.1** provides a summary of property values, or replacement values, in the study region, Swansea, based on the MassGIS Data.

Table 5.1 – Property Values within Swansea

Zone	Number of Properties	Total Building Value	Average Building Replacement Cost
Residential	6,118	$952,729,000	$156,000
Commercial	182	$164,150,000	$902,000
Industrial	18	$4,863,000	$270,000
TOTAL	**6,318**	**$1,122 Million**	

Note: dollar amounts based on property values obtained from MassGIS data.

The majority of disasters affect either the entire town (earthquakes, snowstorms, thunderstorms, etc.), or a small yet difficult to determine section (tornadoes, fires, landslides, sinkholes, etc.) Due to the unpredictability of some hazards, inability to protect the location and/or severity of the hazard, or inability to quantify impacts in a reliable manner, vulnerability dollar amounts may range substantially.

These vulnerability assessments represent a worst-case scenario, as it is likely that a portion(s) of the building would remain usable, most notable being the foundation. Additionally costs do not include the replacement cost of land, as it is assumed that all structures may be rebuilt at the same location. This assumption may not apply for storm events that cause severe erosion along coastal properties.

5.1 Floods

Coastal and Riverine Flooding

Flooding is associated with high water levels and may impact inland streams and/or coastal waters. Flooding may be caused by a number of factors, including heavy rainfall, excessive snowmelt, storms such as hurricanes or nor'easters, or any number of other factors.

[73] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

To quantify structures vulnerable to floodwaters and corresponding flood damage, FEMA's Hazus-MH software was used to run a flood simulation and gather direct economic loss information. The flood model in the Hazus-MH software incorporates data from the USGS National Elevation Dataset (NED) that includes topographical data related to expected flood elevations. Shorelines and land features for coastal states and territories are derived from the U.S. Census Bureau, 2000 TIGER dataset. Hydrologic calculations, population density, runoff coefficients and soils data are derived from the "Compilation of GIS Data Layers for Flash Flood Forecasting" published for the National Weather Service and default river reaches and watersheds are derived from the National Operational Hydrologic Remote Sensing Center data.

After running a flood analysis for several different scenarios, the Hazus-MH software provided building and property values for potentially affected locations. The total building values of approximately $500 million within flood-prone areas represent approximately 45% of the total building value of the town as outlined in Table 5.2. Coastal or riverine flooding may cause damage to the above structures in varying amounts depending on flooding severity. Minor floods will likely cause minimal to no damage, while severe floods could damage or destroy a large number of these structures, particularly those located near the coast.

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[74], two story buildings with basements as typical to Swansea have an approximate 50% damage rate for any flood event over 8 feet. Infrastructure damage could also be extensive, and include damage to roads, utilities, bridges, culverts, etc. Smaller events have a correspondingly smaller damage percentage, however even a relatively moderate flood can inflict substantial financial damages to affected properties.

Table 5.2 provides a vulnerability assessment of potential flooding losses to buildings, transportation systems and agricultural systems based on several different flood scenarios according to the Hazus-MH software flood simulation.

Table 5.2 – Flooding Vulnerability Assessment

Flood Scenario	Direct Losses to Buildings	Direct Losses to Transportation	Total Damage
10-year	$35,302,000	$2,270	$35.3 million
25-year	$90,820,000	$5,680	$90.8 million
50-year	$105,169,000	$11,360	$105.2 million
100-year	$184,388,000	$22,720	$184.4 million

Note: dollar amounts based on property values obtained from MassGIS and Hazus-MH software data.

Flooding from Stormwater Runoff

Flooding due to stormwater runoff will likely occur in conjunction with riverine flooding as a result of heavy precipitation. Typically, stormwater flooding affects a localized area associated with a single outfall or culvert, and as such damages are generally minimal in comparison to other major disasters. A worst-case scenario may involve flooding of several major businesses, typically causing less than $1 million in damages, but potentially up to $5 million depending on the extent of damage and which business or businesses are affected.

[74] State Board of Building Regulations and Standards, 8th addition, 780 CMR, 1604.11, Table 1604.11.

Erosion
Erosion is also typically associated with other flood events, including coastal, riverine, or stormwater. Impacts are often limited to localized areas and typically do not affect structures. An exception is severe coastal erosion; however this would be quantified under a more severe disaster such as a hurricane. Erosion damage is typically minimal in comparison to other hazards, generally less than $0.1 million, however may exceed $1 million should a major roadway, bridge or culvert be washed out.

5.2 Winter Storm Events

Snowstorms and Blizzards
Damage from snowstorms is typically caused by heavy snowfall loads on roofs, utility lines, and trees, causing damage from resultant collapse. Per the Massachusetts State Board of Building Regulations and Standards, Swansea's ground snow load is equivalent to 55 pounds per square foot[75]. However, most "damage" will be from economic impacts as a result of residents being unable to get to work and town expenditures for snow removal. Blizzards, however, have the added impacts of high winds and wave action along the coast. Corresponding damages can be much more severe, and closer to the monetary damages associated with nor'easters. As with many other hazards, damage from snowstorms varies with intensity. Minor snow storms occur quite regularly, with little damage apart from the occasional vehicle accident. **Table 5.3** outlines the potential damage expected during snow storms of varying intensity.

Table 5.3 – Snowstorm Vulnerability Assessment

Snowstorm Severity	Typical Expected Damage	Total Damage
Notable	Light snow, travel unaffected, virtually no damage	$100,000
Significant	Moderate snow, travel lightly affected, little damage	$500,000
Major	Heavy snow, travel impacted, light damage	$1,000,000
Crippling	Very heavy snow, travel difficult, light damage	$2,000,000
Extreme	Substantial snow, travel impossible, moderate damage	$4,000,000

The table above refers to damages caused by snow alone, as well as costs of snow removal. The vast majority of snow storms cause less than $2 million in damages. Note that damage from very intense blizzards may be closer in dollars to that assumed for nor'easters, as evidenced by damage caused from high winds and wave action along the coast (as much as $50 million). In general, high winds and wave action cause far more damage than snow alone.

Ice Storms
Damage inflicted by ice storms can vary greatly, depending on the intensity and timing. Minor ice storms with ice buildup of less than a quarter inch will likely result in little damage. Alternatively, ice storms with buildup greater than one-half inch can result in substantial damage from tree limbs falling onto structures, vehicles, power lines, and other infrastructure. FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[76] does not include any standard loss estimation models for estimated ice storm damage, however **Table 5.4** outlines the potential damage expected during ice storms of varying intensity.

[75] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[76] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

Table 5.4 – Ice Storm Vulnerability Assessment

Ice Buildup	Typical Expected Damage	Total Damage
<¼"	Minimal damage expected, travel dangerous	<$100,000
¼" to 1"	Some tree branches downed, power outages likely, some roadways blocked	$10,000,000
>1"	Substantial trees and tree limbs downed, major extended power outages, blocked roadways	$20,000,000

Swansea has not experienced a damaging ice storm in recent history, however a worst-case scenario could exceed $20 million in damages.

Ice Jams

Damage from ice storms will result from large pieces of ice damaging structures or infrastructure such as roadways and culverts. Alternatively, ice jams could force water to backup and cause flooding, however this would be covered under flooding damages. To date, no ice jams have occurred within Swansea and expected damages are essentially $0, however a worst-case scenario could involve damages of up to $3 million, should a roadway culvert be destroyed.

5.3 Hurricanes and Coastal Storms

Hurricanes and Tropical Storms

Damage inflicted by hurricane strength winds and storm surge will depend on the category of hurricane and corresponding hazards. Although hurricane wind speeds may exceed 157 miles per hour, the Massachusetts State Board of Building Regulations and Standards assigns Swansea a design basic wind speed (three second gust speed) is equivalent to 110 miles per hour[77], or approximately equivalent to a Category 2 hurricane. The majority of buildings in Swansea are single family homes, most of which are of wood frame construction typical of this area of the country. A much smaller percentage of homes are mobile or pre-constructed houses, typically less tolerant of wind loads. The remaining structures are constructed from brick, concrete, steel, or other material typical of municipal, commercial and industrial building construction.

The Hazus-MH software hurricane model was used to simulate the damages that would occur during various hurricane intensities should one occur in Swansea. The hurricane model in Hazus-MH is derived from Nation Land Cover Data (1992) and uses historic storm and probabilistic storm sets using the Atlantic Basin Hurricane Database (HURDAT) which encompasses historic the period 1886-2001. The potential property damage expected and number of buildings damaged in Swansea during hurricanes of varying intensity based on FEMA's Hazus-MH software can be seen below in **Table 5.5.**

[77] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

Table 5.5 – Hurricane Vulnerability Assessment

Return Period	Building Damages	Business Interruption	Total Damages
10-year	$68,000	$0	$68,000
20-year	$1,410,000	$15,000	$1,425,000
50-year	$6,868,000	$476,000	$7,344,000
100-year	$15,738,000	$2,056,000	$17,794,000
200-year	$33,382,000	$6,065,000	$39,447,000
500-year	$74,688,000	$16,433,000	$91,121,000
1000-year	$114,644,000	$26,306,000	$140,950,000

Note: dollar amounts based on property values obtained from MassGIS and Hazus-MH software data.

As shown above, hurricanes are one of the most destructive hazard with a reasonable chance of occurrence within Swansea. Although a category 5 storm (approximately equivalent to a 1000-year storm) making direct landfall would be devastating with potentially over $140 million in damages, a more realistic scenario is a category 3 storm (approximately equivalent to a 200-year storm) making direct landfall, with potential damages in excess of $37 million.

Coastal Storms or Nor'Easters

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[78], communities should contact the State Coastal Zone Management Program, or the Massachusetts Office of Coastal Zone Management (CZM), to determine the annual long-term erosion rate for the area. In 2014, the Massachusetts Legislature established a Coastal Erosion Commission to investigate and document levels and impacts of coastal erosion in Massachusetts. The commission recently released a draft report on January 2015 outlining average erosion rates for a number of Massachusetts Towns. Although the report does not provide a rate specific to Swansea, erosion rates for several nearby towns in Bristol County are provided, including Westport and Dartmouth. Per the report, these communities are experiencing a long-term average erosion rate of -0.8 feet per year[79]. However, these towns are located along Buzzards Bay, with coastlines exposed to the Atlantic Ocean, whereas Swansea is comparatively sheltered by Mount Hope Bay and Narragansett Bay. Therefore, Swansea's erosion rate is likely somewhat lower, although the above rate can be considered a worst-case scenario. Note that this is an average rate, and does not include the effects of large, single-event storms such as a major hurricane or nor'easter. These storms can cause substantial coastal erosion over a period of hours or days, sometimes greatly exceeding erosion experienced over a typical period of years or decades.

Damage due to coastal storms is comparable to that inflicted by a weak hurricane, typically a category 1 or category 2 equivalent. Potential monetary damages may range from less than $10 million to over $20 million depending on severity of the storm. Damages will vary depending on storm intensity and timing.

[78] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[79] Massachusetts Coastal Erosion Commission, Volume 1 – Report and Recommendations. Draft. January 7, 2015.

5.4 Tornadoes and Thunderstorms

Tornadoes

Damage from tornadoes is due almost exclusively to high winds in a localized area, although minor damage may also result from hail, heavy rains and lightning. As with other disasters, damage ranges depending on the severity of the occurrence. However, unlike other hazards that typically affect a large area of town (blizzard, hurricane, etc.) a tornado is limited to a relatively narrow swath. As such, the location of occurrence is also important, as a potentially minor tornado occurring in a heavily developed area can cause far more damage than a major tornado occurring in a sparsely developed location.

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[80], Swansea is located in Wind Zone II (160 mph), and also within a hurricane-susceptible region[81]. As outlined in the above document, there are no standard loss estimation models or table for tornadoes, as the potential strength and path are highly variable. Therefore, tornado losses should be estimated based on past occurrences. As outlined earlier, Swansea has not experienced a damage-causing tornado, with most storms in Bristol County consisting of F0 or F1 tornadoes. Therefore, damage estimates from larger tornadoes are difficult to determine, however **Table 5.6** provides a worst-case dollar estimate for each potential storm.

Table 5.6 – Tornado Vulnerability Assessment

Tornado Category	Typical Expected Damage	% of Buildings Damaged	Total Damage
F0-F1	Light damage. Some roof and garage damage, mobile homes moved	1%	$11,217,000
F2-F3	Significant damage. Roofs torn off, mobile homes demolished, large trees snapped or uprooted	5%	$56,087,000
F4-F5	Devastating damage. Houses leveled, damage to well-constructed buildings, cars thrown	15%	$168,261,000

Note: dollar amounts based on property values obtained from MassGIS and Hazus-MH software data.

As shown above, even a minor tornado can cause substantial financial damage should it occur in a heavily developed area. However, tornadoes rarely occur within Swansea and the vast majority that occur in the area do very little damage. Due to rarity of occurrence and inability to determine where a tornado will occur, vulnerability to a "typical" tornado is impossible. Percentages and dollar values are based on a worst-case scenario, with a tornado affecting the most densely developed areas of town.

Thunderstorms

Similar to tornadoes, thunderstorm damage is typically caused by high winds, with lesser damage caused by heavy precipitation and hail. Damage is typically less than that inflicted by a tornado; however thunderstorms generally affect a much larger area than a tornado. Thunderstorm damage is typically similar to the damages inflicted by a very weak tornado, with

[80] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[81] FEMA Wind Zones in the United States http://www.fema.gov/graphics/library/wmap.gif.

damages estimated at less than $1 million. Additional damages may also result from flooding as outlined earlier in this section.

5.5 Geologic Hazards

Earthquake

Damage from earthquakes is caused by moderate to severe shaking of the ground. As with other disasters, damage ranges depending on the severity of the occurrence. Due to the rarity of a major earthquake occurrence, most structures within town are not constructed to a high seismic design level. Therefore, an earthquake occurrence of a damaging level has the potential to inflict substantial damage across the community.

As outlined earlier, Swansea has never experienced a damage-causing earthquake, with virtually all earthquakes occurring in the area of barely detectable magnitude. Even an earthquake of less than 4.0 is rare, and will typically cause $0 in damage. For planning purposes, an earthquake of 0.10g with a reoccurrence interval of once every 2,476 years may be considered a "typical" worst-case scenario. Damage for this earthquake is estimated to affect 2% of buildings, assumed to be a worst-case scenario for unreinforced masonry construction as outlined in FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[82] totaling up to $22.4 million. Larger earthquakes will affect more structures and have a correspondingly higher damage total, however are considered extremely rare, occurring less than once every several thousand years.

An earthquake simulation was completed using the Hazus-MH software with an epicenter in the center of Swansea to simulate a worst-case scenario to illustrate potential property damage. The earthquake simulation used an arbitrary earthquake occurring at a depth of 10 km and with a 5.0 and 8.0 moment magnitude to provide a range between a "typical" and extreme event. **Table 5.7** below displays the property damages associated with these potential earthquakes.

Table 5.7 – Earthquake Vulnerability Assessment

Mag-nitude	Buildings Damaged	Direct Losses to Buildings	Direct Losses to Transportation	Direct Losses to Utilities	Total Damage
5.0	2,300	$112,728,044	$22,802,000	$353,000	$135,883,044
8.0	6,318	$1,456,483,600	$126,930,000	$49,634,000	$1,633,047,600

Note: dollar amounts based on property values obtained from MassGIS and Hazus-MH software data.

The building losses displayed above are greater than just the replacement values for the building as they include capital stock losses (structural damage, non-structural damage, contents damage, inventory loss) and income losses (relocation loss, capital related loss, wages loss, and rental income loss). Transportation losses include highway bridges damage only, and do not include smaller roadways and culverts. Utility losses include pipeline damage to potable water, waste water, and natural gas.

An earthquake with a moment magnitude of 5.0 could cause damages equivalent to that of a category 5 hurricane. An earthquake with a moment magnitude of 8.0 could cause near-complete destruction, in part because infrastructure in New England is typically not designed or

[82] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

constructed to withstand large magnitude seismic activity. In addition to the infrastructure devastation, casualties and injuries would total upwards of 1,500 people according to Hazus-MH software scenario. Fortunately, substantially damaging earthquakes are considered extremely rare for this area, occurring less than once every several thousand years.

Landslide

Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[83], the best predictor of future landslides is past landslides, as they tend to occur in the same places. As such, there are no standard loss estimation models. As outlined earlier, landslides typically occur at areas of steeply sloping ground, and Swansea topography is generally flat. Additionally, Swansea has never experienced a landslide, and the likelihood of occurrence is minimal. Should one occur, damages will depend on the location of occurrence, and will typically be minimal, likely be less than $1 million.

Sinkhole

As with landslides, Swansea has never had a damaging sinkhole. Should one occur, it will likely be associated with a utility line failure and not due to natural causes. Sinkhole damages will likely be less than $1 million.

5.6 Forest Fires / Wildfires

The USDA and United States Forestry Service classify Swansea as located within an area of Very Low or Low risk of wildfire hazard. Per FEMA's *Understanding Your Risks: Identifying Hazards and Estimating Losses*[84], there are no standard loss estimation models for wildfires. However, this document further classifies areas of light fuel with shallow sloped areas as having a Moderate Fire Hazard. As wildfires typically occur in localized, sparsely developed areas, damages are typically light compared with those that take place in either highly developed areas or over a large area. Most fires will cause damages less than $1 million, however may potentially exceed $5 million depending on size and location.

5.7 Extreme Temperatures and Drought

Damages due to drought are difficult to determine, and actual damage to structures and infrastructure is typically minimal. However, damage to crops and other water-sensitive features can be extensive depending on drought timing and duration. Unlike most other disasters that are over in days at most, droughts can last years. Should an extended drought occur, droughts lasting years can have substantial financial consequences. Although extended droughts are possible, most droughts are fairly brief with little to no damaging impacts.

5.8 Dam Failures / Breaches

Damages from dam failures will be caused by a sudden release of water along an inland waterway, likely to roadway infrastructure or buildings in close proximity to the affected stream. Damages will directly relate to the size and location of the dam that failed. Many dams in Swansea are small and located in remote areas. Damages from the failure of one of these will be minimal, potentially limited to the cost of replacing the dam if desired. However, failure of a major dam, such as those listed as High Hazard or Significant Hazard can cause substantial

[83] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.
[84] FEMA Understanding Your Risks, Identifying Hazards and Estimated Losses. 2001.

damages comparable to localized inland flooding. Damages from a dam failure are difficult to quantify, however could exceed $20 million, similar to a minor to moderate flood event.

5.9 Vulnerability Summary

The following table provides a summary of the above vulnerability assessment for Swansea. Note that the following dollar amounts are for planning purposes only and should not be used as a comprehensive assessment in the event of a natural disaster.

Table 5.8 – Vulnerability Summary

Natural Hazard	Potential Hazard Damage		
	Low	Moderate	High
Floods			
Flooding	$0 to $100 Million	$100 to $200 Million	>$200 Million
Flooding from Storm Runoff	Up to $5 Million		
Erosion	Up to $1 Million		
Winter Storm Events			
Snowstorms and Blizzards	$0 to $1 Million	$1 to $3 Million	>$3 Million
Ice Storm	$0 to $10 Million	$10 to $20 Million	>$20 Million
Ice Jam	Up to $3 Million		
Hurricanes and Nor'Easters			
Hurricanes	$0 to $25 Million	$25 to $140 Million	>$140 Million
Coastal Storms or Nor'easters	$0 to $5 Million	$5 to $20 Million	>$20 Million
Tornadoes and Thunderstorms			
Tornadoes	$0 to $20 Million	$20 to $100 Million	>$100 Million
Thunderstorms	Up to $1 Million		
Geologic Hazards			
Earthquakes	$0 to $100 Million	$100 to $1,000 Million	>$1,000 Million
Landslides	Up to $1 Million		
Sinkholes	Up to $1 Million		
Other Hazards			
Forest Fires / Wildfires	Up to $5 Million		
Drought	Unknown		
Dam Failures	Up to $20 Million		

6.0 HIGH HAZARD AREAS

The Local Planning Team has evaluated areas of the Town that are particularly vulnerable to the hazards associated with a natural disaster as discussed in Section 4.0. The following sections outline areas at the highest risk of adverse impacts from hazards, as well as the potential impacts at each location. As many hazards such as earthquakes and winter storm events can affect the entire town, this section has been tailored to localized events, particularly those associated with flooding and/or coastal storm surge.

6.1 Critical Infrastructure

Critical infrastructure is essential to the health and welfare of the Town and is especially important following hazard events. Critical infrastructure includes buildings and infrastructure such as emergency operations centers and shelters, critical municipal buildings, transportation features, utilities and communications infrastructure, water and wastewater facilities, etc. The Local Planning Team developed a list of critical infrastructure and facilities as provided in **Appendix B**. Only a portion of critical infrastructure facilities are located within high hazard areas such as floodplains, however due to the importance of these facilities, special care must be taken to ensure continued operation even during disaster events.

During the planning process, it became apparent that the list of critical infrastructure was extensive, making it impractical to respond to the needs of all facilities during or immediately after an emergency. Therefore, the LPT prioritized critical infrastructure into the following "tiers" based on priority of importance, and shown on the respective figure:

- Tier 1 – Emergency Response and Utilities (**Figure 4**);
- Tier 2 – Municipal and Community Centers (**Figure 5**); and
- Tier 3 – Other (**Figure 6**).

Tier 1 facilities are the most critical and include facilities such as police, fire and medical services, water infrastructure, public works facilities, and other important utilities. This infrastructure is necessary to maintain a minimal level of service to provide necessary utilities and emergency services to residents. Every feasible opportunity should be taken to ensure that these facilities remain functional and accessible at all times.

Tier 2 facilities are also important and include large municipal, public, semi-public and other gathering places servicing a proportionally large group of people. Infrastructure includes town offices and other municipal buildings, schools, nursing homes, and other miscellaneous buildings.

Tier 3 facilities are generally less critical, however still important to the community as a whole. Infrastructure includes smaller preschool and kindergarten facilities, daycare facilities, animal shelters, historic properties, parks and cemeteries.

6.2 Hazardous Material Sources

Facilities storing large quantities of hazardous or other regulated materials such as oil deserve special consideration due to the potential environmental contamination possible in the event of a natural disaster. The Massachusetts Board of Fire Prevention Regulations requires facilities to

register the storage of flammable materials with the local fire department. **Appendix C** provides a list of facilities storing more than 500 gallons of flammable materials as registered with Swansea Fire Districts. Products stored are typically oil and fuel that could cause a fire or environmental hazard in the event of a disaster.

6.3 Repetitive Loss Properties

Nationally, approximately one-fourth of all National Flood Insurance Program (NFIP) claims (almost $9 billion) since 1978 have been paid to "repetitive loss properties," which, in turn, represent only 1.3% of all policies[85]. Repetitive loss scenarios are as follows:

- Repetitive loss – Properties experiencing two or more losses of at least $1,000 each within any 10 year period since 1978; and
- Severe repetitive loss – Single or multifamily residential properties experiencing 4 or more claims each exceeding $5,000, or properties with 2 separate claims with the cumulative dollar amount exceeding the market value of the property. Either scenario must have at least 2 claims occurring within 10 years of each other.

Repetitive loss properties are those for which two or more losses of at least $1,000 each have been paid under the NFIP within any 10 year period from 1978. FEMA reports that a total of 8 residential properties in Swansea have experienced repetitive losses through March 2015. Losses occurred in 1985, 1987, 1991, 1992, 2001, 2003, 2005, 2006, 2007, 2010, and 2012, with each property experiencing two events.

6.4 High Hazard Areas

The Local Planning Team has established a number of areas in the Town as being prone to hazards associated with natural disasters. Areas were selected based on the local knowledge offered by Town personnel, as well as mapping efforts conducted through the use of GIS and Flood Insurance Rate Maps (FIRMs).

Although these areas are subject to hazards such as wind, fire, earthquakes and snow, these types of hazards have the potential to affect the entire town. High hazard areas were selected because they experience localized damage associated with flooding problems. A description of each high hazard area is provided in the following sections, as well as expected causes and potential mitigation issues. The following areas and associated concerns were identified during the planning process as high hazard areas:

1. Bushee Road at Kickemuit River (March 2010 Flood);
2. Route 6 and Stephen French Road (March 2010 Flood);
3. Milford Road at Cole's River (March 2010 Flood);
4. Burnside Road (undersized Culvert Pipes for Kickemuit River);
5. Lynnwood Road (undersized Culvert Pipes for Kickemuit River);
6. Pearse Road at Duck Pond;
7. Hortonville Road and Hailes Hill Road;
8. 40B Development Projects at Coles River Fun Center (low lying area); and
9. 40B Development Projects at Kickemuit River near Colletti Lane (low lying area).

[85] National Flood Insurance Program Community Rating System (NFIP/CRS). "Strategic Plan Evaluation Repetitive Loss Strategy. June 2011. http://crs2012.org/uploads/docs/other/repetitive_losses_final.pdf

Bushee Road
Bushee Road just south of Smoke Rise Circle (southern intersection) has two concrete box culverts, estimated at 4-feet high by 10-feet wide, and periodically floods. One culvert is visibly blocked with sediment and in need of cleaning. Additionally, the upstream area is heavily vegetated and requires periodic thinning/removal by the respective utility owners. Bushee Road is often used as an evacuation route for Warren, RI, however this area can be inundated during evacuation events.

Route 6 and Stephen French Road
Route 6 near the police station periodically floods, causing the road to become inundated. This area can also back floodwaters up to Stephen French Road, causing further flooding.

Milford Road
Milford Road has previously flooded during the March 2010 flood event, resulting in closure of the road at the culvert near Cole River.

Burnside Road
Burnside Road at the Kickemuit River crossing has undersized culverts, periodically causing a road closure on Bushee Road. Previous flooding has ponded to a depth of approximately 6-inches deep, flowing at high velocity down Ash Road and then to Smoke Rise Circle before flowing out to Bushee Road. The downstream headwall has settled and is possibly blocked by sediment and debris.

Lynnwood Road
Lynnwood Road at the Kickemuit River crossing has undersized culverts, periodically causing a localized road closure. This location has two corrugated metal culverts approximately 60-inches in diameter. The bottom one-third of each culvert is blocked by sediment, and portions of the pipes are corroded.

Pearse Road
Pearse Road periodically floods along the water. Bristol, RI evacuates through Route 136, however typically cannot evacuate through Pearse Road and instead have to detour down Long Lane. Note that a culvert replacement is scheduled to occur in the summer of 2016 as outlined in Section 8.0. Southern areas of Pearse Road are typically the problem areas, whereas areas north of Wilbur Avenue are okay.

Hortonville Road and Hailes Hill Road
This area has several locations subject to flooding. Areas typically have corrugated metal culverts in deteriorated or otherwise poor condition causing periodic flooding during storm events. One or more culverts may be blocked, partially contributing to flooding concerns.

Section 7.0, Existing Disaster Mitigation Measures and Section 8.0, Planned Disaster Mitigation Measures provide more detail on the above areas as well as proposed structural controls to help mitigation hazard impacts.

7.0 EXISTING DISASTER MITIGATION MEASURES

Swansea has implemented a number of existing hazard mitigation measures in response to previous disaster situations. Existing measures primarily include regulations and bylaws to protect existing structures and future development, however other measures are also in place. Existing mitigation measures are discussed in the following sections.

7.1 Emergency Management Agency

Swansea has established a local Emergency Management Agency as a component of the Fire Department to coordinate response between federal, state, local, and private resources during disaster events. The agency also helps develop plans for responding to disaster events, assists in training and preparedness exercises, and assists members of the public before, during, and after emergencies.

7.2 Federal and State Regulations

Development in Swansea must adhere to all applicable Federal and State regulations, as set forth by the appropriate agency. Agencies include, but not limited to:

- United States Environmental Protection Agency (EPA);
- United States Army Corps of Engineers (ACoE);
- Federal Emergency Management Agency (FEMA);
- Massachusetts Department of Environmental Protection (MassDEP);
- Massachusetts Department of Fire Services (DFS); and
- Massachusetts Department of Public Safety (DPS).

All development in town is subject to the minimum requirements set forth by federal and state regulatory agencies. Local regulations and bylaws may be developed that outline more stringent requirements. Applicable local regulations and bylaws are discussed in the following section.

7.3 Local Regulations and Bylaws

Swansea currently has a number of bylaws and regulations in place. Bylaws and regulations provide for water quality and resource area protection in an effort to maintain the health and stability of wetlands, marshes, and other environmentally sensitive areas. These areas provide critical water storage during flood events that help alleviate potential property damage and loss of life. Applicable local bylaws and regulations include:

- Zoning Bylaws (2014); and
- Wetland Protection Bylaw (1988).

Town agencies, including the Building Inspector, Conservation Commission, and Planning Board enforce existing local regulations, as well as state and federal regulations set forth by the Massachusetts Department of Fire Services, Massachusetts Department of Public Safety, Environmental Protection Agency, Army Corps of Engineers, Federal Emergency Management Agency, and Massachusetts Department of Environmental Protection. If existing bylaws and regulations prove ineffective, or additional measures are developed that better protect infrastructure and the environment, changes should be adopted to maintain adequate protection.

Note that the Massachusetts State Building Code, enforced locally by the Building Inspector, contains many standards governing proper construction methods and techniques. Many of the standards are in place to help ensure buildings and other structures can withstand natural hazards such as high winds, heavy rains, snow loads, and high waters. The Building Department requires that permits be obtained for many construction-related projects, and permits must be obtained before occupying the building.

Swansea also has a standardized building numbering system where each digit represents ten feet of linear distance traveled, with numbering increasing east to west and generally radiating out from Route 6. Specifically, locations north of Route 6 increase from south to north, with the exception of Gardners Neck Road where numbering begins at Main Street and increases going south. Location south or Route 6 increase from north to south, with the exception of Maple Avenue where numbering begins at Old Warren Road and increases going south. This building numbering system helps emergency response personnel find the appropriate location in an efficient manner.

Zoning Bylaws

The Zoning Bylaws contain several relevant sections, including sections regulating inland flooding and flood plain districts, and an aquifer protection district. Additional information is provided below.

Section 7 – Inland Flooding and Flood Plain District

The "Floodplain Overlay District" is a district designed to protect structures located in areas subject to flooding. The Floodplain District is based on a compilation of FIRMs and Flood Boundary and Floodway maps issued by FEMA. These maps do not taken into account wave velocity or sea level rise. The purposes of the Floodplain District are to ensure public safety, eliminate new hazards to emergence response officials, prevent occurrence of public emergencies from water quality, contamination, and pollution due to flooding, avoid the loss of utility services, eliminate costs associated with response and cleanup of flooding conditions, and reduce damage to public and private property from flooding waters.

All uses shall comply with Massachusetts General Law, Chapter 131, Section 40, addressing the removal, fill, dredging or altering of land bordering waters, Massachusetts State Building Code, addressing floodplain and coastal high hazard areas, Massachusetts Department of Environmental Protection (MassDEP) Wetlands Protection Regulations, Inland Wetlands Restrictions and Coastal Wetland Restrictions, and the Swansea Conservation Commission Wetlands Protection Bylaw. Additionally, the following design standards apply:

- Encroachments are prohibited in the regulatory floodway which would result in any increase in flood levels with the community during the occurrence of the base flood discharge;
- All new construction within Zone VE must be located landward of the reach of mean high tide; and
- Subdivision proposals must minimize flood damage, ensure all public utilities and facilities are located and constructed to minimize or eliminate flood, and that adequate drainage is provided.

Section 16 – Aquifer Protection District

The purpose of the Aquifer Protection District is to promote the health, safety, and general welfare of the community by ensuring an adequate quality and quantity of drinking water, preserve and protect existing and potential sources of drinking water supplies, conserve natural resources in Town, and prevent temporary and permanent contamination of the environment. There are 3 Aquifer Protection Districts as follows:

- Area 1 – MassDEP Approved Zone I. A 400 foot radius extending in all directions from each public water supply well, and include all the land within the radius;
- Area 2 – MassDEP Approved Zone II. The recharge area associated with a public water supply well after 180 days of continuous pumping, at approved yield with no recharge from precipitation. Area 2 is equivalent to Zone II as defined in 310 CMR 22.02; and
- Area 3 – Recharge and Potential Groundwater Development Areas. The potential groundwater development areas and areas providing recharge to Area 2.

Many uses that could involve storage or handling of hazardous wastes, petroleum products, solid waste, human or animal waste products or chemicals are prohibited in aquifer protection district areas that could potentially be damaging to the environment, the Town's drinking water sources and public health, should a release occur.

Wetland Protection Bylaw

The Wetland Protection Bylaw and accompanying Rules and Regulations contain design standards to ensure proper design and construction of sites to minimize flooding and other damage.

Article 37 – Swansea Wetlands Protection Bylaw

Swansea has enacted a Wetlands Protection Bylaw to protect the wetlands, related water resources and adjoining land areas. Regulated areas and activities include public or private water supplies, groundwater, erosion and sedimentation controls. Per these bylaws, removal, filling, dredging, and/or billing within 100 feet of the following resource areas is regulated: freshwater wetland, coastal wetland, marsh, wet meadow, swamp, bank, beach, dune, lake, river, pond, stream, estuary, ocean, and any land subjected to flooding or inundation by groundwater, surface water, tidal action or storm surge.

Swansea has also developed accompanying rules and regulations in support of the bylaw. These regulations establish performance standards governing work within resource areas and associated buffer zones. Regulations also mandate that disturbed areas within buffer zones be stabilized against wind and water erosion during construction. Additionally, appropriate stormwater controls and standards must be implemented to control flooding.

7.4 Backup Power Supplies

Emergency generators are also available for many municipal facilities, including the Police Station, Fire Stations, Highway Department with fuel depot, and much of the water supply infrastructure. Additionally, the evacuation center will be equipped with an emergency generator in the near future. The Town generally tests backup generators, either utilizing automatic test methods or manual weekly tests such as on those located at schools and the police station. Backup power supplies are listed in **Appendix D**.

The Town owns several portable generators that they deploy to critical residents (i.e. individuals with critical medical equipment) ahead of predicted severe storm events. Finally, Swansea is in the process of requiring permanent installation of emergency generators at gas stations in Town to ensure operation during power outages. This will be required for all future facilities, as well as two facilities currently under construction.

7.5 Emergency Shelters and Mutual Aid

Swansea has established the following emergency shelters for use in the event of a natural disaster:

1. Primary – Joseph Case High School, 70 School Street
2. Alternate – Brown Elementary School, 29 Gardner's Neck Road
3. Alternative – Council on Aging, 260 Ocean Grove Avenue

Typically, the Joseph Case High School is the only emergency shelter opened and has never reached full capacity in the past. The Gardner Elementary School and the Council on Aging could both be used as an alternative emergency shelter if people within the town are unable to get to the high school because of hazardous conditions nearby (i.e. flooding).

The neighboring town of Somerset has also established an evacuation center at the high school with trailers and cots for residents to use if needed. The nearest Red Cross Evacuation Center is located in Fall River, however typically residents will not travel that far from home, instead going to the local high school if needed.

7.6 Evacuation Routes

It is assumed that a major evacuation would most likely be triggered by a hurricane, and thus most affected people will be traveling from the southern coastal areas to the northern major roadways. People will likely be funneling towards Route 6 and Interstate 195, and to a lesser extent Routes 103, 118, and 136 to travel north, west or east as these are the major conveyance roads in the area. Primary evacuation routes are shown in **Figure 7**.

Accordingly, Town personnel have established major evacuation routes that generally run north/south to convey residents away from major bodies of water along the southern edge of the town. Priority routes for maintaining traffic flow are as follows:

1. Gardners Neck Road for evacuation of the Ocean Grove area;
2. Pearse Road to connect Wilbur Ave (Route 103) with Route 6. Note this route is typically passable from areas between Route 103 and Route 6, however sometimes has problems south of this area at the culvert crossing of an unnamed tributary of Cole River;
3. Bushee Road for evacuation of the Warren, Rhode Island area. Note this route historically floods from Kickemuit River culvert along Burnside Road; and
4. Seaview Avenue and Pearse Road for evacuation of the Seaview Avenue area. Note this route historically becomes impassible through Pearse Road at Duck Pond, and instead residents must detour down Barton Avenue and Long Lane into Warren, Rhode Island.

Isolated problem areas have been noted during previous evacuation orders:

- No one leaves Seaview Ave area when there is a suggested storm evacuation; Fire Department and Police Department previously have gone through Warren, RI to access Seaview Ave to rescue residents in emergency. Homes on Seaview Ave required to have a generator because of frequent flooding problems; and
- Residents of Ocean Grove Ave do not typically evacuate during suggested evacuation.

Additional isolated problem areas during storm events include:

- Ocean Grove;
- Old Providence Road at Palmer River crossing, becomes completely isolated ; and
- Little Neck.

7.7 Structural Upgrades

Southern areas of Pearse Road are typically the most affected. The Pearse Road culvert is scheduled to be replaced in the summer of 2016. This area will be raised higher to account for sea level rise for areas adjacent to the water.

The Hollister Road and Warren Avenue area historically floods, however has been better since a detention pond was installed. The Town will continue to watch this area to evaluate any worsening conditions.

7.8 Public Outreach

Swansea has implemented several programs as a means of reaching out to the public prior to and during an emergency. The Town routinely distributes information via the local cable channel broadcast by Swansea Public Access Television which has also been used to convey information to the general public during and after natural disasters. Information typically includes closed roadways, power company response estimates, etc.

Swansea uses the town website as a means of conveying information to the public. The website includes links to all Town departments, as well as applicable contact information. The website also provides links to applicable emergency agencies, such as Police, Fire, and emergency services. Swansea has also implemented a system to keep residents informed during disaster events via its E-Alerts system.

7.9 National Flood Insurance Program

Swansea currently participates in FEMA's NFIP. Per FEMA's Local Multi-Hazard Mitigation Planning Guidance document, the NFIP has three basic aspects:

1. Floodplain identification and mapping – adopt flood maps depicting hazards;
2. Floodplain management – adopt and enforce floodplain management regulations; and
3. Flood insurance – require property owners to purchase insurance in exchange for floodplain management regulations that reduce future flood damages.

Floodplain Identification and Mapping
Flood Hazard Boundary Maps (FHBMs) were established on February 28, 1975, with flood insurance rate maps following on August 15, 1977. The FIRMs were amended several years ago with an effective date of July 7, 2009[86].

Floodplain Management
Swansea has implemented a Floodplain District as regulated under the zoning bylaws to protect existing and future infrastructure located in flood-prone areas. The Town will update its bylaws as necessary to reflect any changes to flood-prone areas. Updates may be required after FHBMs and/or FIRMs are updated.

Flood Insurance
Swansea currently has 438 insurance policies in force, with a total insurance value of $96,920,000[87] as of March 31, 2016. Loss statistics for January 1, 1978 through March 31, 2016 are shown below[88] in **Table 7.1**.

Table 7.1 – Swansea Loss Statistics

Total Losses	Closed Losses	Open Losses	Closed Without Payment Losses	Total Payments
145	98	0	47	$662,223.75

Ongoing Compliance
As part of ongoing NFIP requirements, Swansea tracks development within flood hazard areas as identified on community FIRMs to ensure new buildings and substantial improvements are properly elevated above applicable floodplains. For properties located within FIRM Zone A, the elevation of the lowest floor, including a basement, must be documented, as well as any flood-proofing performed on the structure. Similarly, for properties located within FIRM Zones V1-30, VE, and V, the elevation of the lowest structural member of the lowest floor must be recorded.

Swansea will also work with nearby communities to establish mutual aid agreements to address administering the NFIP following a major storm event as outlined further in Section 7.3, action item 17.

7.10 Existing Disaster Mitigation Measures Matrix

The matrix below outlines the following information for each existing disaster mitigation measure:

- Existing Protection Measure;
- Description;
- Implementing Department or Agency;
- Staffing;
- Existing Funding;

[86] Federal Emergency Management Agency. http://coop.fema.gov/cis/MA.pdf
[87] FEMA National Flood Insurance Program. http://bsa.nfipstat.fema.gov/reports/1011.htm#MAT
[88] FEMA National Flood Insurance Program. http://bsa.nfipstat.fema.gov/reports/1040.htm#25

- Effective Area covered;
- Applicable Hazards;
- Effectiveness; and
- Improvements or Changes Needed.

"Staffing" and "Existing Funding" columns also indicate whether or not existing levels are adequate or not, depicted under the "(Adequate?)" description in parentheses by "(Yes)" or "(No)" for Town items, or "(Unknown)" for agencies outside Town regulation such as State and Federal agencies. Town-controlled items not identified as adequately staffed and/or funded by a "(Yes)" have additional information provided under the "Improvement or Changes Needed" column.

Finally, the "Improvement or Changes Needed" column also indicates whether any additional funding sources are needed, depicted under the "(Funding Sources)" description in parentheses. Items not in need of additional funding sources are shown as "(N/A)", or Not Applicable, generally because no changes are needed at this time and existing funding sources are adequate. Should additional funding be required, potential sources are outlined in parentheses under the "Improvement or Changed Needed" column, such as "(Town general fund and operating budgets)".

Table 7.2 – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
Emergency Management Agency	Agency in charge of coordinating response efforts between agencies during an emergency	Emergency Management Agency	Emergency Management Agency Director and Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	No changes needed at this time (N/A)
Federal and State Regulations	Regulations and agencies designed to protect infrastructure, the environment, and public safety	EPA, ACoE, FEMA, MassDEP, DFS, DPS, etc.	Agency Staff (Unknown)	State and Federal taxes (Yes)	Entire town	All hazards	Effective	No changes needed at this time
Zoning Bylaws, Section 7 – Inland Flooding and Flood Plain District	Bylaws designed to protect public safety, reduce damage, and lower cleanup costs in areas subject to flooding during hurricanes by regulating development and requiring permits	Swansea Planning Board, Highway Dept.	Planning Board Members, Highway Dept. Director and Personnel (Yes)	Town general fund and operating budgets (Yes)	Flood prone land overlay district	Flood-related hazards	Effective	No changes needed at this time (N/A)
Zoning Bylaws, Section 16 – Aquifer Protection District	Bylaws designed to protect groundwater supplies from contamination by limiting uses involving hazardous materials near public wells	Swansea Planning Board and Zoning Bylaw Enforcement	Planning Board Members (Yes)	Town general fund and operating budgets (Yes)	Aquifer protection overlay district	Drought, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Wetlands Protection Bylaw, Article 37 – Wetlands Protection Bylaw	Bylaws designed to protect wetlands and other sensitive water resource areas by controlling or prohibiting alterations that could affect the environment	Swansea Conservation Commission	Conservation Commission Members (Yes)	Town general fund and operating budgets (Yes)	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Wetland Protection Bylaw Regulations	Regulations governing new construction to ensure proper drainage system sizing, stormwater treatment, peak flow accommodation, groundwater protection, and wetland protection	Swansea Conservation Commission	Conservation Commission Members (Yes)	Town general fund and operating budgets (Yes)	Resource areas and areas within regulated buffer zones	Riverine flooding, erosion, thunderstorms, flooding from storm runoff	Effective	No changes needed at this time (N/A)
Backup Power Supplies	Emergency generators to maintain water service in the event of a power outage. Emergency generators also available for other critical facilities and centers of operations. The town also has several portable generators for deployment in advance of severe storm events. Finally, the Town is in the process of requiring installation of permanent emergency generators at all gas stations within town limits as part of future construction requirements.	Swansea Highway Dept., School Dept. and Swansea Water District	Highway Dept. Director and Personnel, School Department Staff, Water District Personnel (Yes)	Town general fund and operating budgets (Yes)	Emergency shelters, select water infrastructure	All hazards	Effective	Continue use, testing, and repair of backup power supplies. (Town general fund and operating budgets)

Table 7.2 (continued) – Existing Disaster Mitigation Measures Matrix

Existing Protection Measure	Description	Implementing Department or Agency	Staffing (Adequate?)	Existing Funding (Adequate?)	Effective Area Covered	Applicable Hazards	Effectiveness	Improvement or Changes Needed (Funding Source)
Emergency Shelters and Mutual Aid	Emergency shelters provided for use during a natural disaster. Primary shelter: Joseph Case High School. Alternate shelters: Gardner Elementary School, Council on Aging	Swansea Emergency Management Agency	Director of Emergency Management Agency Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	No changes needed at this time (N/A)
Evacuation Routes	Maintain trouble-spots on evacuation routes, including Gardners Neck Road, Pearse Road, Bushee Road, and Market Street	Swansea Emergency Management Agency	Director of Emergency Management Agency Staff, Highway Dept. Director and Personnel (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	See Section 8.0, Planned Disaster Mitigation Measures (N/A)
Structural Upgrades	Structural upgrades along low areas of Pearse Road to alleviate periodic coastal inundation	Swansea Highway Department	Highway Dept. Director and Personnel (Yes)	Town general fund and operating budgets, FEMA funding (Yes)	Coastal area along Pearse Road	Coastal flooding, hurricanes	Unknown	No changes needed at this time (N/A)
	Detention pond off Hampden Lane near Hollister Road and Warren Avenue to alleviate periodic flooding of Hampden Lane (sole access to the Hampden Cove subdivision).				Immediate area near Hollister Road and Warren Avenue	Riverine flooding	Pending future monitoring	Continue monitoring area for flooding (Town general fund and operating budgets)
Public Outreach	Provide information to the public during an emergency via the local cable television channel and local radio station	Swansea Public Access Television, Webmaster	Department Staff (Yes)	Town general fund and operating budgets (Yes)	Entire town	All hazards	Effective to date	No changes needed at this time (N/A)
	Electronic methods include town website and E-Alerts system.						Effective to date	See Section 8.0, Planned Disaster Mitigation Measures (N/A)
National Flood Insurance Program	Swansea is enrolled in FEMA's NFIP, which in part identifies floodplain areas, manages floodplains, and requires flood insurance by affected residents.	Swansea Planning Department	Planning Board Members (Yes)	Town general fund and operating budgets, FEMA funding assistance (Yes)	Areas identified in FEMA FIRMs	Flood-related hazards	Effective	Update FEMA maps, record applicable structural elevations within flood-prone areas, establish mutual aid agreements (Town general fund and operating budgets, FEMA funding assistance)

8.0 PLANNED DISASTER MITIGATION MEASURES

Although the Town has implemented a number of existing hazard mitigation measures as discussed in Section 7.0, additional measures should be considered to protect Town infrastructure in the event of a disaster.

8.1 Goal Statements

During Local Planning Team meetings, responsible personnel discussed existing areas of hazard protection as discussed in Section 7.0 that require expansion and/or improvement to better protect the Town of Swansea. The team then developed goals and objectives to reduce impacts and losses due to hazards associated with natural disasters. The team agreed that the primary goal is as follows, consistent with the 2004 SRPEDD Natural Hazard Pre-Disaster Regional Mitigation Plan:

- Reduce the loss of life, property, infrastructure, and cultural resources from natural disasters.

In addition, the following objectives were established by the Local Planning Team to minimize the impacts of natural disasters on residents, businesses and infrastructure:

- Reduce or eliminate preventable damage to buildings and infrastructure;
- Identify and prioritize structural mitigation projects based in part on feasibility and cost effectiveness;
- Maintain adequate access to public utilities such as electricity, drinking water, and communications during and after a natural disaster;
- Maintain an adequate Level of Service (LOS) on all roadways during and after natural disasters, particularly on major roadways;
- Maintain communication between private citizens, businesses, utility companies, and town, regional, state, and federal agencies before, during and after a natural disaster;
- Provide residents adequate protection during natural disaster events;
- Improve public education to inform residents in advance of a disaster on what may happen, particularly regarding rare natural disasters such as hurricanes;
- Incorporate disaster mitigation actions into local plans, regulations and structural improvement projects;
- Identify funding sources to implement mitigation items; and
- Make improvements to existing practices based on experience gained during disaster response and recovery.

8.2 Planning Process

In order to identify, evaluate and prioritize specific mitigation actions and projects to reduce the effects of a natural disaster, the LPT used the STAPLEE method as developed by FEMA as follows and as provided in **Appendix E**:

- **S**ocial – Determine if measures are acceptable to the public and nearby community;
- **T**echnical – Evaluate whether measures are technically feasible;
- **A**dministrative – Review staffing, funding and maintenance needs for implementation;
- **P**olitical – Evaluate local and state political support for the measure;
- **L**egal – Determine if local, state or federal laws allow for implementation;

- **E**conomic – Ensure the local community budget can support project implementation; and
- **E**nvironmental – Ensure the local environment is protected at all times.

8.3 SRPEDD Proposed Mitigation Actions

The 2004 SRPEDD Plan outlined a number of proposed mitigation actions identified during the planning process conducted prior to the release of the 2004 plan. It is important to note that this was a regional plan prepared over 10 years ago targeting the entire area, and few mitigation actions are specific to Swansea. As the plan is over 10 years old and no updates have occurred, many of the mitigation measures have either been enacted or are out of date. The schedule also no longer applies. However, the following table outlines items that were identified in the plan as the responsibility of "Local Communities" and progress made since plan release.

Table 8.1 – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2016 Plan Update Progress
Objective 3: Identify implementing body and pursue funding that builds local capacity and supports grant-writing for the mitigation actions identified in the regional and local PDM plans.			
Consider use of SRPEDD municipal assistance hours for technical assistance	Ongoing	Part of annual budget – 40 hours total per community per year.	Swansea has utilized municipal assistance hours to date, however, this potential resource for implementing mitigation planning measures could be more fully utilized.
Objective 4: Increase communication/coordination between federal, state, regional, county, municipal, private, and non-profit agencies in the area of pre-disaster mitigation. In particular, coordinate planning around prisons, colleges, and large employers.			
Develop or use existing town websites.	Ongoing	May need funding or use student labor.	Swansea utilizes its website for this purpose as outlined in Section 7.9.
Objective 5: Maintain and enhance working relationships with the utilities including the annual meetings with emergency personnel, and satellite spaces within each community for temporary emergency headquarters.			
This exists – local communities need to maintain this relationship.	Ongoing	No funds needed, space exists.	Swansea currently has working relationships with all utilities in the community as outlined throughout this Plan. No further updates required.
Coordinate this action with Homeland Security planning and implementation actions. Review Cable capabilities.	2005	Homeland Security funding may be available to address this concern.	Swansea has implemented improved hazard warning systems since preparation of the 2004 Plan as outlined in Section 7.0.

Table 8.1 (continued) – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2016 Plan Update Progress
Objective 6: Improve hazard warning systems and notification to vulnerable populations.			
Share ideas on successful ways of tracking vulnerable populations through SRPEDD, DCR, MEMA newsletters such as Visiting nurses, self-identify card with tax bill, or COA coordination.	Ongoing	Plugs into existing program	Improvements to inter-departmental communication are ongoing, consistent with the timeline/timeframe provided by the 2004 Plan. No further updates required.
Objective 7: Combat complacency and foster appropriate individual responsibility for mitigating disaster impacts by educating all parts of the community including: school children, elderly, employers, school administrators, and municipal employees.			
Use all existing websites – town and SRPEDD.	Ongoing	Uses existing channels.	Swansea utilizes its website for this purpose as outlined in Section 7.0. No further updates required.
Display pre-disaster mitigation plan mapping series at local libraries and at major regional events.	2005	May need small stipend to complete, possible PDM project.	Upon completion of this 2015 updated plan, updated maps will be made available at various public venues, as well as on the website for download as outlined in Section 10.4.
Objective 8: Promote use of full range of federal and state resources related to disaster mitigation such as educational materials, training, and National Weather Service forecasts.			
Set a goal of 5 communities certified as "Storm Ready" by 2010. (Right now Taunton is only community certified.)	2004-2010	Interest and commitment	Swansea is committed to being "Storm Ready" and could pursue certification as a "Storm Ready" community if Town personnel desire at a later date.
Objective 10: Find funding to review and update the regional and local disaster mitigation plans on a five year cycle.			
Fund staff time to convene process and review and update plan.	Future	Funding will be needed to complete this work.	Once adopted, this Hazard Mitigation Plan will be updated every five years as outlined under Section 10.0. Funding will come from general departmental operating budgets.
Objective 11: Incorporate disaster mitigation actions into appropriate local and regional plans – Master Plan, Open Space Plan, Transportation Plan, and Capital Programming.			
SRPEDD educate communities as they update all of these plans; local representatives also indicate a need for this. Annexes should identify connections.	Ongoing	Done within other planning process funded with local or state funds as available.	Section 10.2 outlines measures to incorporate future disaster mitigation actions. Additionally, several disaster mitigation actions have already been included in existing planning mechanisms as outlined in Section 10.3.

Table 8.1 (continued) – 2004 SRPEDD Plan Mitigation Actions

Action	2004 Timeline	2004 Needed Resources	2016 Plan Update Progress
Objective 12: Integrate disaster mitigation concerns into transportation projects (e.g. drainage improvements, underground utilities, etc.).			
SRPEDD and local representatives need to speak about these concerns during project development.	Ongoing	Coordination with project planning processes.	A number of proposed transportation and drainage structural improvements are proposed as detailed under Proposed Mitigation Action #'s 1 through 9.
Objective 14: Identify PDM actions that are consistent with the objectives of other interest groups, and reach out to collaborate on achieving these initiatives. (For example conservation or environmental groups that support wetlands protection, river corridor acquisition, or reducing runoff.)			
Local representatives must identify these common goals especially through the Open Space or Master Plan planning process	Ongoing	Staff time and interest.	Planning documents solicit input from the public and public interest groups. Common goals and projects are identified during the planning process and incorporated into the final product.
Objective 20: Ensure that each community has a Unified Incident Command program in place, with special attention to communities that have federal, state, or county facilities within their borders.			
Support efforts to get training funds and to integrate this training in other programs	Ongoing	Funding for training is needed.	Swansea coordinates response through the Emergency Management Agency (EMA). No further updates required.

8.4 Swansea Proposed Mitigation Actions

Proposed mitigation actions developed during the LPT planning process have been divided into the following categories:

- Structural Projects – Construction projects to reduce hazard impacts;
- Property Protection and Public Safety – Modifications to existing infrastructure to protect property and people from a hazard;
- Planning and Prevention – Regulatory modifications to bylaws and regulations to prevent damage and preserve or restore natural resources;
- Communications and Awareness – Actions to better communicate information before and during a disaster.

Structural Projects

The following structural projects are proposed as a way to alleviate potential flooding damage to buildings and infrastructure within Swansea. Project locations are shown on **Figure 8**.

- Action Item 1 – Alleviate Flooding at Intersection of Bark Street and Marvel Street
  Swansea is exploring ways to alleviate flooding at the intersection of Bark Street and Marvel Street. This area has three 24-inch culverts, generally in good condition, however the adjacent development site has incomplete stormwater controls causing periodic

flooding during storm events.

- Action Item 2 – Alleviate Flooding on Baker Road
  Swansea is exploring ways to alleviate flooding concerns on Baker Road. The problem area has an existing corrugated metal culvert approximately 5-feet in diameter. The culvert is in poor condition and in need of replacement.

- Action Item 3 – Alleviate Flooding on Old Providence Road
  Swansea is exploring ways to alleviate flooding concerns on Old Providence Road. This coastal problem area is low-lying and periodically floods, isolating nearby residents. This area is also the location of an intake station for the water treatment facility.

- Action Item 4 – Alleviate Flooding on Hailes Hill Road
  This area has three locations that are subject to flooding. One area has an existing 30-inch corrugated metal culvert that floods periodically due to heavy runoff generated from Hortonville Road. A second area is located near house number 57. This area has two existing metal culverts, 18-inch and 12-inch in diameter. This area floods during storm events, possibly due to undersized culverts. Additionally, both culverts flow thorough deteriorated headwalls in need of repair. A third area is located in the vicinity of the Dillon Lane intersection. This area has an existing 18-inch corrugated metal culvert with a collapsed headwall that is in need of replacement. This area also floods during some storm events, possibly due to a blocked culvert.

- Action Item 5 – Address Flooding on Locust Street
  This area has two locations that are subject to flooding. The first area is a box culvert located near house number 235. Although this structure appears to be adequately sized, there are privately-owned dams located upstream and downstream, possibly contributing to flooding in this area. A second area is a culvert located near the power line crossing. The culvert was recently replaced, however periodically floods possibly due to a blockage. The area is also overgrown with vegetation.

- Action Item 6 – Alleviate Flooding on Old Warren Road
  Swansea is exploring ways to alleviate periodic flooding concerns on Old Warren Road near Cypress Drive. This stream crossing consists of two 30-inch concrete culverts under the road with an additional 30-inch HDPE culvert downstream that discharges stormwater runoff along Old Warren Road.

- Action Item 7 – Alleviate Flooding along the Kickemuit River
  This area has three locations subject to flooding of the Kickemuit River. The first area is located near the stream crossing at Bushee Road. This location has two concrete box culverts, estimated at 4-feet high by 10-feet wide and periodically floods. One culvert is visibly blocked with sediment and in need of cleaning. Additionally, the upstream area is heavily vegetated. The second area is located near the crossing at Lynnwood Road. This location has two corrugated metal culverts approximately 60-inches in diameter. The bottom one-third of each culvert is blocked by sediment, and portions of the pipes are corroded. The third area is located near the crossing at Burnside Drive. This location has

two corrugated metal culverts approximately 42-inches in diameter. The downstream headwall has settled and is possibly blocked by sediment and debris.

- Action Item 8 – Alleviate Flooding on Seaview Avenue
  Swansea is exploring ways to alleviate periodic flooding concerns on Seaview Avenue. This area has an undersized 8-inch culvert that leads to flooding during storm events.

- Action Item 9 – Alleviate Flooding on Stephen French Road
  Swansea is exploring ways to alleviate periodic flooding concerns on Stephen French Road, at its crossing of the Kickemuit River, recognizing the flows in this area are dictated primarily by any releases from the Warren Reservoir which is under the control of the Bristol County Water Authority. This area has an undersized culvert that leads to roadway flooding during storm events. If the roadway is impassable due to flooding, the entire length of Buckingham Drive (after its transition from Stephen French Road) is isolated and inaccessible. Anticipate replacement with concrete box culverts similar in capacity to those for Action Item 7.

Property Protection and Public Safety

The following proposed disaster mitigation measures should be explored in an effort to preserve and protect existing infrastructure and preserve public safety in the event of a natural hazard event.

- Action Item 10 – Install Backup Generator at Council of Aging
  The Council of Aging facility, currently used as the backup evacuation center, is not currently equipped with a backup power supply. This facility should be equipped with an emergency power supply in case it is required during disaster events.

- Action Item 11 – Address Pets during Emergency Evacuations
  During previous evacuation events, very few people have typically evacuated. Although reasons vary, one reason is that affected residents do not want to leave pets behind and the Swansea emergency shelter cannot accommodate pets. Additionally, the animal shelter is currently at capacity and cannot accommodate pets on a temporary basis. The Town should explore other options, such as reaching out to veterinary clinics or private shelters for assistance accommodating pets during disaster events. Alternatively, a portable kennel trailer could be located at the evacuation center to accommodate pets near displaced owners.

- Action Item 12 – Rehabilitate the Upper Lewin Dam (Swansea Dam) on Main Street
  The Upper Lewin Dam at Main Street in Swansea is currently in need of repair. Problem areas include displaced riprap apron at the base of the spillway, irregularities along the spillway crest, cracked concrete approach slab, seepage through the spillway and dam walls, masonry joints in need of repointing, and an inoperable low level outlet. Swansea recently received a grant of $459,000 for the repair and restoration of the Swansea Dam, located on Main Street near the intersection of Gardners Neck Road and Hortonville Road. This project is anticipated to include rebuilding the stone face of the dam and abutments that have been compromised and could be breached during a disaster event.

The town will contribute a match of approximately $150,000 for dam repair.

- Action Item 13 – Repair Control Structure on the Upper Milford Pond Dam
  Additional upgrades are required at the Upper Milford Pond Dam. In June 2015 the flood control gate was vandalized, causing damage to the steel framework and theft of the metal sluice gate. Without the sluice gate control, approximately 5-feet of water could flood Milford Road during storm events. The Town performed temporary fixes over the summer of 2015, however a permanent repair will be required as outlined under Action Item 14. Additionally, a portable hand-operated winch is currently used to operate the lifting mechanism. This should be replaced with a permanent and lockable lifting mechanism as part of upgrades performed under Action Item 14.

- Action Item 14 – Upgrades to the Upper Milford Pond Dam
  The Upper Milford Pond Dam is currently in need of repair. Problem areas include thick brush and tree growth along the upstream slope, seepage and leakage through the primary spillway, a sinkhole and shifting crest stone on the primary spillway, a timber spillway gate not properly seated on the spillway invert, rotting stringers on the spillway control structure, and poor conditions downstream of the auxiliary spillway. Permanent repairs are estimated to cost between $430,000 and $1,235,000.

- Action Item 15 – Repair Backup Generator at the High School
  The Joseph Case High School is currently used as the primary evacuation center. The backup generator is in need of a new head gasket and is currently not functioning. This unit should be repaired in case it is required during disaster events.

- Action Item 16 – Repair Verizon Distribution Manholes
  Existing manholes at various locations in Town (i.e. on Route 6 near Maple Avenue) serve as distribution points for Verizon utilities. These manholes periodically flood (and freeze during the winter), thereby knocking out telephone service to a large majority of the town. These manholes should be repaired, however is the responsibility of the private utility. Alternatively, the Town should consider alternatives for their critical emergency communication systems (fiber optic, wireless, microwave), such as the recent transition of the Police Station to a microwave communication system.

- Action Item 17 – Address Boat Moorings
  Previous coastal storms have caused boats to come loose during storm events causing boats to drift aimlessly, potentially colliding with other boats and structures such as bridges or other property. Overall, there are a minimal number of boat moorings and most are located within the Town marina, which has its own established policies and procedures for maintenance/upgrade of moorings. The Town will should consider development of a minimum standard to improve boat tie-down, as well as provide public education to properly secure boats (moored or on land) before storm events.

Planning and Prevention

The following proposed disaster mitigation measures should be explored in an effort to preserve natural resources for added environmental protection.

- Action Item 18 – Create Comprehensive Plan on Emergency Generators
  Swansea currently relies upon the various departments (i.e. Fire Department, Police Department, Highway Department, Swansea Water District) to test and maintain their respective emergency generators. However, past disaster events have highlighted the lack of emergency power at critical private businesses, such as gas stations. The Town should consider implementing requirements through the Planning Board review process to require new (or redeveloped/reconstructed) gas stations to have permanently installed emergency generators with automatic transfer switches.

Communications and Awareness
The following proposed disaster mitigation measures should be explored in an effort to improve communications before and during a disaster event.

- Action Item 19 – Work with Carriers to Provide Adequate Backup Power at Cell Towers
  Current emergency backup supplies at cell phone towers are limited to batteries which typically last approximately 24-hours. In the event of a long duration disaster event, backup power may be insufficient. The Town should work with carriers to ensure adequate power supply at all times. This may include purchasing emergency generators for use during a disaster event.

- Action Item 20 – Implement Improved Mass Communication System
  Swansea has a mass communication system capable of reaching residents in times of emergency, but is often limited by a general transition from land lines to cell service as the primary communication mode for residents. The Town should work with MEMA and FEMA to implement a system that is more capable of reaching residents before and during disaster events. Town residents and businesses encouraged to subscribe to CodeRED (Bristol County and Plymouth County), but participation is voluntary. Town is currently investigating mass communication system that is GPS based and would connect automatically with any phones (landline or cellular) that are physically located at that time within the identified geographic area.

8.5 Proposed Disaster Mitigation Measures Matrix
The matrix below outlines the following information for proposed disaster mitigation measures:

Table 8.2 – Proposed Disaster Mitigation Measures Matrix

Proposed Protection Measure	Area Covered	Applicable Hazards
Action Item 1 – Alleviate Flooding at Intersection of Bark Street and Marvel Street	Intersection of Bark Street and Marvel Street	Riverine flooding
Action Item 2 – Alleviate Flooding on Baker Road	Cole River culvert crossing	Riverine flooding
Action Item 3 – Alleviate Flooding on Old Providence Road	Palmer River culvert crossing	Coastal flooding, hurricanes
Action Item 4 – Alleviate Flooding on Hailes Hill Road	Lewin Brook culvert crossing	Riverine flooding

Table 8.2 (continued) – Proposed Disaster Mitigation Measures Matrix

Proposed Protection Measure	Area Covered	Applicable Hazards
Action Item 5 – Address Flooding on Locust Street	Cole River culvert crossings	Riverine flooding
Action Item 6 – Alleviate Flooding on Old Warren Road	Cole River tributary culvert crossing	Riverine flooding
Action Item 7 – Alleviate Flooding along the Kickemuit River	Culvert crossings at Bushee Road, Lynnwood Road, and Burnside Drive	Flood-related hazards
Action Item 8 – Alleviate Flooding on Seaview Avenue	Tributary to the Cole River culvert crossing	Coastal flooding, hurricanes
Action Item 9 – Alleviate Flooding on Stephen French Road	Kickemuit River tributary culvert crossing	Riverine flooding
Action Item 10 – Install Backup Generator at Council of Aging	Council of Aging	All hazards
Action Item 11 – Address Pets during Emergency Evacuations	Joseph Case High School and Council of Aging	All hazards
Action Item 12 – Rehabilitate the Upper Lewin Dam (Swansea Dam) on Main Street	Upper Lewin Dam, Main Street	Flood-related hazards, dam failure
Action Item 13 – Repair Control Structure on the Upper Milford Pond Dam	Upper Milford Pond Dam, Milford Road	Flood-related hazards, dam failure
Action Item 14 – Upgrades to the Upper Milford Pond Dam	Upper Milford Pond Dam, Milford Road	Flood-related hazards, dam failure
Action Item 15 – Repair Backup Generator at the High School	Joseph Case High School	All Hazards
Action Item 16 – Repair Verizon Distribution Manholes or Switch to Alternative Emergency Communication Systems	Various locations	Flood-related hazards
Action Item 17 – Address Boat Moorings	Coastal areas with boat moorings	Coastal storm events
Action Item 18 – Create Comprehensive Plan on Emergency Generators	Entire town	All hazards
Action Item 19 – Work with Carriers to Provide Adequate Backup Power at Cell Towers	Entire town	All hazards
Action Item 20 – Implement Improved Mass Communication System	Entire town	All hazards

8.6 National Flood Insurance Program

As outlined earlier, Swansea participates in FEMA's NFIP. In order to maintain compliance with the NFIP requirements, FIRMs will be periodically updated as necessary to reflect the most up-to-date information possible concerning flood plain locations and flooding hazards. The Floodplain Overlay District as regulated under the zoning bylaws will also be updated as needed to reflect any changes in the floodplain and other vulnerable areas as a result of altered stormwater drainage, natural stream channel deviations, global warming, etc.

The Town will continue to evaluate and track flood damage to buildings and infrastructure in town, particularly for repetitive loss structures, to determine if any additional measures are required to reduce or prevent damage. Bylaws and/or regulations will also be updated as needed to improve flood protection.

8.7 Prioritization and Implementation of Mitigation Actions

Effective implementation of the proposed mitigation actions outlined in Section 8.3 is critical to minimizing damage from future natural hazards. Measures should be prioritized to make the best use out of limited resources as outlined in sections below. Implementation of mitigation actions will be directed and enforced by the appropriate agency and will take place over several years depending on a number of factors such as urgency, need, funding sources, etc.

To facilitate prioritization, proposed mitigation measures were first separated into those to be performed in-house by assorted Swansea agencies, and those requiring additional outside funding and planning. The LPT then reviewed each of the identified mitigation measures and prioritized improvements based in part on the STAPLEE criteria outlined in Section 8.2 and Appendix E.

In-House Mitigation Actions

Most of the following action items can be accomplished by the Town for little or no cost as part of ongoing improvements and updates to its existing measures, plans and procedures. Several structural projects already in progress are also listed below. Proposed protection measures have been loosely prioritized as high, moderate and low priority and include the following information:

- Priority grouping / ranking;
- Town department / board responsibility;
- Potential funding sources; and
- Estimated timeline to completion.

Many of these items may be mixed and matched, particularly if performed by different agencies. Prioritization is provided as a guideline only and timelines do not represent a definitive schedule.

Table 8.3 – Prioritization of In-House Mitigation Actions

Proposed Protection Measure	Responsibility	Implementation Timeframe
Very High Priority		
Action Item 15 – Replace Backup Generator at the High School	School Department or Emergency Management Agency	Funds approved; installation pending
High Priority		
Action Item 11 – Address Pets during Emergency Evacuations	Emergency Management Agency	Continuous yearly updates, by 2021.
Action Item 13 – Repair Control Structure on the Upper Milford Pond Dam	Highway Department	Temporary Fix completed in 2015
Moderate Priority		
Action Item 5 – Alleviate Flooding on Locust Street (two locations)	Highway Department	Continuous yearly updates, by 2021.
Low Priority		
Action Item 1 – Alleviate Flooding at Intersection of Bark Street and Marvel Street	Highway Department	Continuous yearly updates, by 2021.
Action Item 3 – Alleviate Flooding on Old Providence Road	Highway Department	Continuous yearly updates, by 2021.
Action Item 7C – Alleviate Flooding on Bushee Road, through coordinated maintenance/clearing.	Highway Department and Property Owners	Continuous yearly updates, by 2021.
Action Item 10 – Install Backup Generator at Council of Aging	Emergency Management Agency	Continuous yearly updates, by 2021.
Action Item 16 – Repair Verizon Distribution Manholes or Switch to Alternative Emergency Communication Systems	Verizon (non-town entity)	Continuous yearly updates, by 2021.
Action Item 17 – Address Boat Moorings	Harbormaster, Building Inspector	Continuous yearly updates, by 2021.
Action Item 18 – Create Comprehensive Plan on Emergency Generators	Emergency Management Agency	Continuous yearly updates, by 2021.
Action Item 19 – Work with Carriers to Provide Adequate Backup Power at Cell Towers	Cell providers (non-town entities)	Continuous yearly updates, by 2021.
Action Item 20 – Implement Improved Mass Communication System	Emergency Management Agency, FEMA	Continuous yearly updates, by 2021.

Property and Structural Mitigation Actions

Many measures classified as Property Protection or Structural Projects require will require additional consideration and design. These items have been classified separately, as projects will likely be implemented one at a time following a more specific order. The following matrix provides the following information for proposed property and structural action items:

- Priority ranking;
- Proposed protection measure
- Town department / board responsibility;
- Estimated project cost;
- Potential funding sources; and
- Estimated timeline to completion

Project costs are approximate and assumed to represent a general range for a project of this type based on LPT and in-house knowledge. Timelines are provided as an estimate of project duration, including obtaining funding sources, design, permitting and construction.

Table 8.4 – Prioritization of Property and Structural Mitigation Actions

Proposed Protection Measure	Responsibility	Project Cost[1]	Potential Funding	Timeframe
High Priority				
Action Item 4 – Alleviate Flooding on Hailes Hill Road	Highway Department	$400,000 to $600,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 7A – Alleviate Flooding along the Kickemuit River **(**Burnside Drive)	Highway Department	$300,000 to $500,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 8 – Alleviate Flooding on Seaview Avenue	Highway Department	$300,000 to $500,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 9 – Alleviate Flooding on Stephen French Road	Highway Department	$300,000 to $500,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 12 – Rehabilitate the Upper Lewin Dam (Swansea Dam) on Main Street	Highway Department	$210,000 to $450,000	Local Funding & FEMA Grant	Project Bid; Installation Pending
Action Item 14 – Upgrades to the Upper Milford Pond Dam	Highway Department	$430,000 to $1,235,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.

Table 8.4 (continued) – Prioritization of Property and Structural Mitigation Actions

Proposed Protection Measure	Responsibility	Project Cost[1]	Potential Funding	Timeframe
Low Priority				
Action Item 2 – Alleviate Flooding on Baker Road	Highway Department	$300,000 to $500,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 6 – Alleviate Flooding on Old Warren Road	Highway Department	$300,000 to $500,000 TBD	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.
Action Item 7B – Alleviate Flooding along the Kickemuit River (Lynnwood Road)	Highway Department	$300,000 to $500,000	Local Funding & FEMA Grant	Continuous yearly updates, by 2021.

[1]Project cost is approximate, and is only intended to provide a scale of magnitude for estimating purposes.

9.0 PLAN ADOPTION

At the conclusion of planning efforts conducted by the Local Planning Team, the final Local Multi-Hazard Mitigation Plan was reviewed and informally approved by all applicable Town departments, boards, and other agencies identified as members of the LPT. The plan was endorsed by the Swansea Select Board, who intends on formally adopting the completed Plan after it has been reviewed and approved by the various regulatory agencies. The Plan was then sent to the State Hazard Mitigation Officer (SHMO) of the Massachusetts Department of Resource Conservation, the Massachusetts Emergency Management Agency (MEMA) and the FEMA for review and approval.

Upon receiving final approval from MEMA and FEMA, the Plan will undergo final review and local approval by the Swansea Select Board. Proof of final approval will be included in **Appendix F**. Following final adoption, the Plan will be implemented as outlined in Section 10.0.

10.0 PLAN MAINTENANCE PROCESS

As required by FEMA, this Plan must include a plan and maintenance process to ensure the plan remains active and relevant to the current conditions of the Town. The process must identify the following items:

- Plan Monitoring, Evaluation and Updates – Method and schedule for monitoring, evaluating and updating the plan at least once every five years;
- Incorporation of Mitigation Strategies – Explanation of how local governments will incorporate mitigation strategies into existing mechanisms; and
- Continued Public Involvement – Requirements that public participation continue throughout the plan maintenance process.

10.1 Plan Monitoring, Evaluation and Updates

As required by FEMA, the written plan will be evaluated and updated at least once every five years by the departments, boards, agencies and other organizations listed under the Local Planning Team. In the interim, select members of the LPT will conduct annual reviews to track implementation progress and update areas as necessary. Should a major disaster occur in the interim, the plan may be evaluated or updated if Town personnel feel that the plan failed in some way, or imminent changes are required to better respond to a disaster situation. As necessary, LPT member departments and/or organizations may be added or deleted to obtain the most accurate and applicable information possible.

Evaluations and updates will take place in much the same way as development of this original plan. The process will include meetings of the LPT, review of goals and objectives, updating community profile information, review and modification of potential hazards to the Town, review of existing hazard-prone areas and the addition of any new areas, updating existing and planned hazard mitigation measures, and an evaluation as to the effectiveness of the plan to date.

10.2 Incorporation of Future Mitigation Strategies

Mitigation strategies outlined in this Plan will be incorporated into existing mechanisms such as plans, bylaws and regulations as feasible. Existing planning mechanisms include:

- Plans:
  - Master Plan;
  - Capital Improvement Plan;
  - Open Space Plan; and
  - Emergency Management Plan.
- Bylaws and Regulations:
  - General (earth and soil removal, water use, waterways, etc.);
  - Zoning (waterfront district, floodplain district, etc.);
  - Subdivision Regulations;
  - DPW) Construction Specifications; and
  - Wetland Protection Bylaw Regulations.

Updates to the above planning mechanisms will occur as these documents themselves are periodically updated, unless a major change is required in the meantime as identified by applicable personnel. This Plan update will be distributed to all applicable Town departments

and boards to solicit potential input into planning mechanisms. Plan updates, including applicable mitigation measures, goals and objectives will be the responsibility of Town departments, boards, agencies and/or personnel in charge of implementation and enforcement.

10.3 Previous Incorporation of Future Mitigation Strategies

Since the preparation of the 2004 SRPEDD Plan, several items have been incorporated into local bylaws and regulations. These items were identified by Town personnel during routine updates and incorporated as needed:

- Floodplain District: mapping updated October 20, 2009
- Aquifer Protection: updated May 2015.
- Waterfront Overlay District: updated November 6, 2006 and November 13, 2010.

Additionally, Swansea has implemented improved hazard warning systems since preparation of the 2004 Plan as outlined in Section 7.9. As further updates are made, this section will be updated.

10.4 Continued Public Involvement

During the periodic five year update process, the Local Planning Team will hold at least one public workshop or similar meeting to solicit feedback from the general public on the progress made to date. Concerned citizens will also be invited to make any additional recommendations for improving the Plan. All events will be publicly advertised in the local newspaper and/or similar method. Copies of the Plan will be provided in public places such as the Town Hall and/or Swansea Public Libraries. The Plan will also be made available to the general public via the Town's website for download.

Figure 1

Locus Map

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Figure 2

FEMA National Flood Hazard Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

SEEKONK
REHOBOTH
DIGHTON
SOMERSET
BARRINGTON
WARREN
BRISTOL
FALL RIVER

Warren Reservoir
Palmer River
Cole River
Lee River
Taunton River

Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

FEMA National Flood Hazard Layer

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

Data Source:
MassGIS and
Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

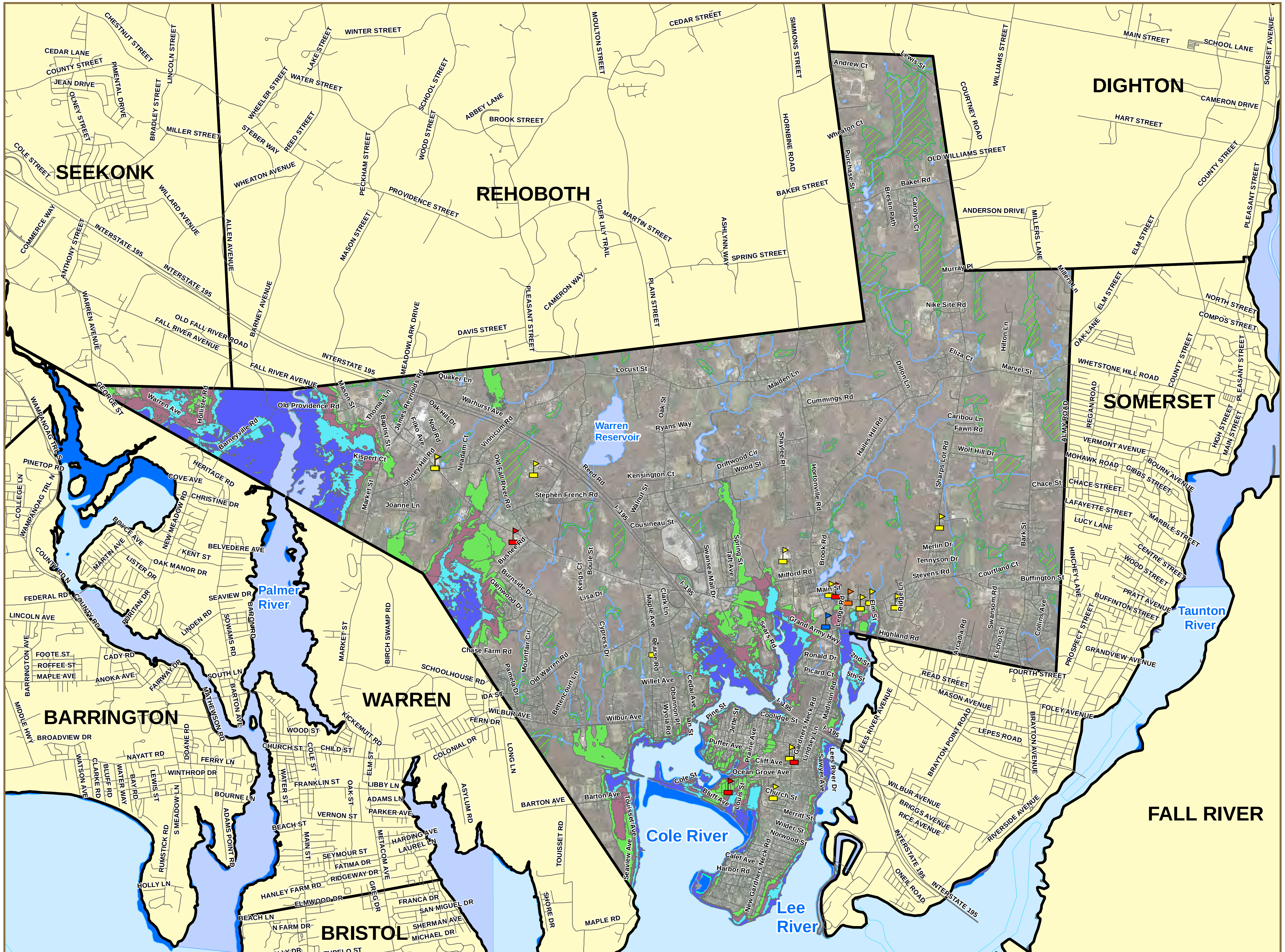

Figure 3

Hurricane Surge Inundation Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Surge Inundation Zones

Hurricane Category

- 1
- 2
- 3
- 4

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS and
Town of Swansea

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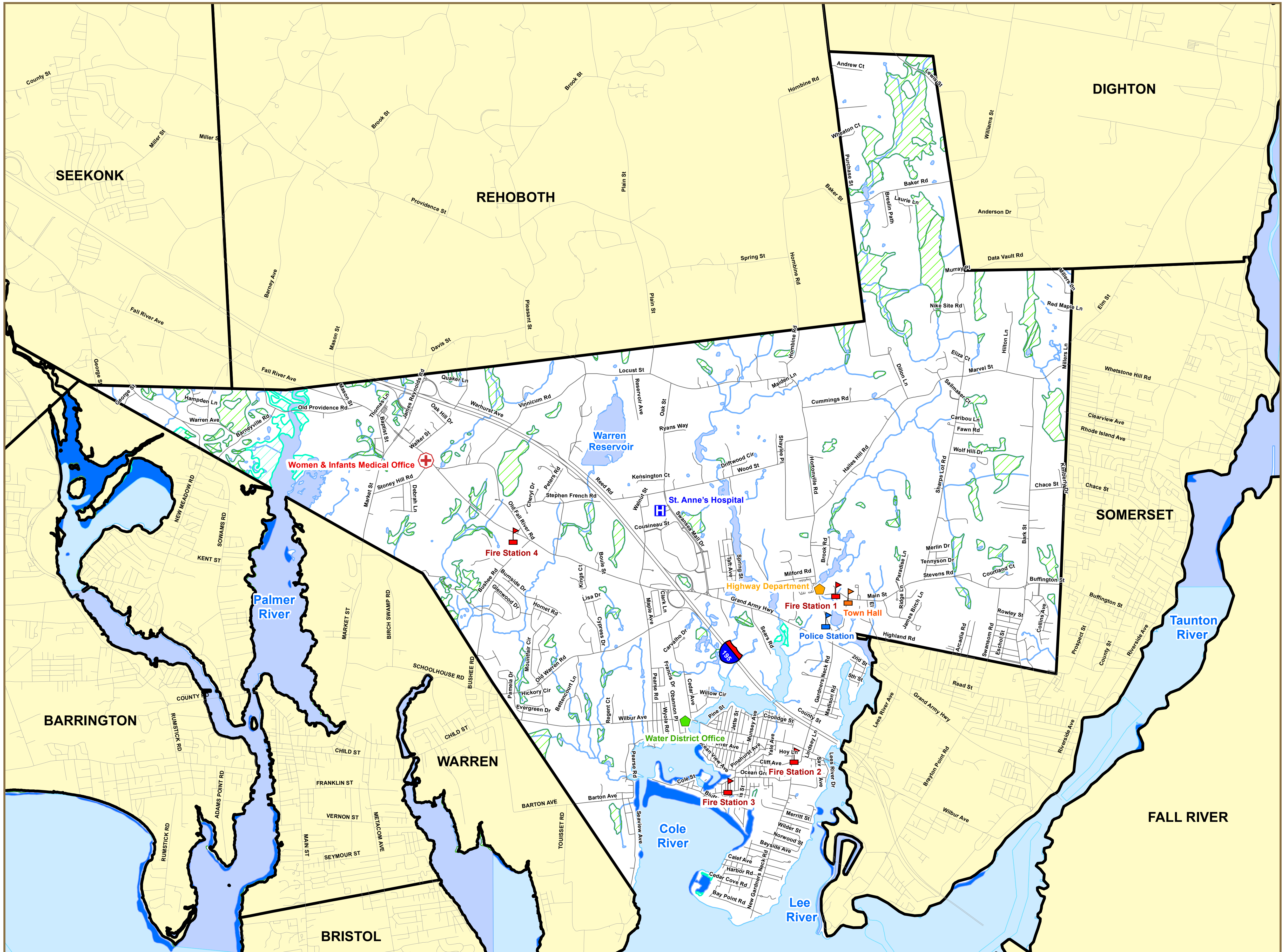

Figure 4

Tier 1 Critical Infrastructure

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Stations
- Police Station
- Town Hall
- Highway Garage
- Water District Office
- Women & Infants Medical Office
- St Anne's Hospital
- Town Boundary

Hydrography

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS, RIGIS and
Town of Swansea

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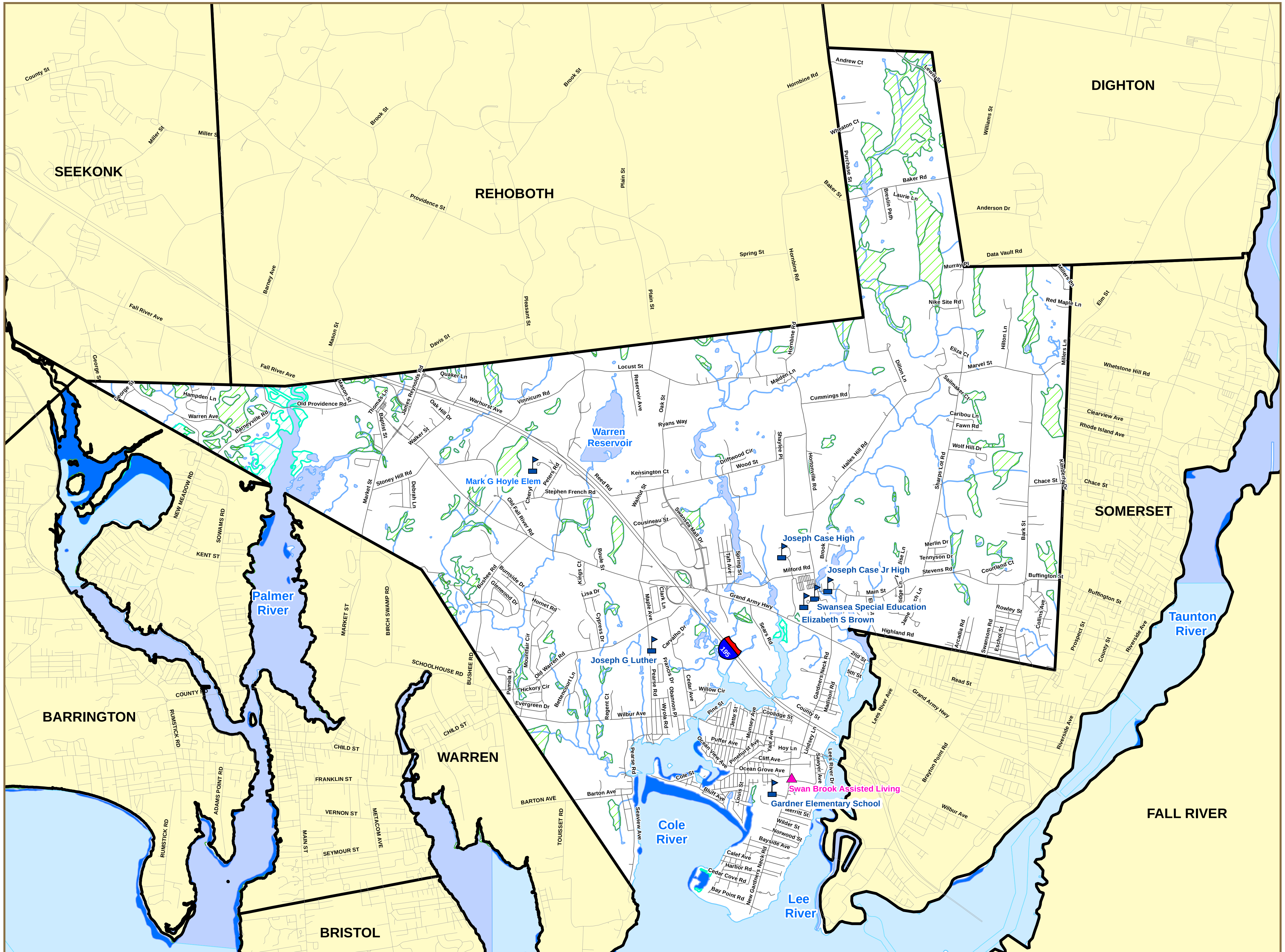

Figure 5

Tier 2 Critical Infrastructure

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

School

Elderly Care Facility

Swan Brook Assisted Living

Town Boundary

Hydrography

Bay, Ocean

Tidal Flats, Shoals

Salt Wetlands

Lake, Pond

Wetland

Stream, Brook

Data Source: MassGIS and Town of Swansea

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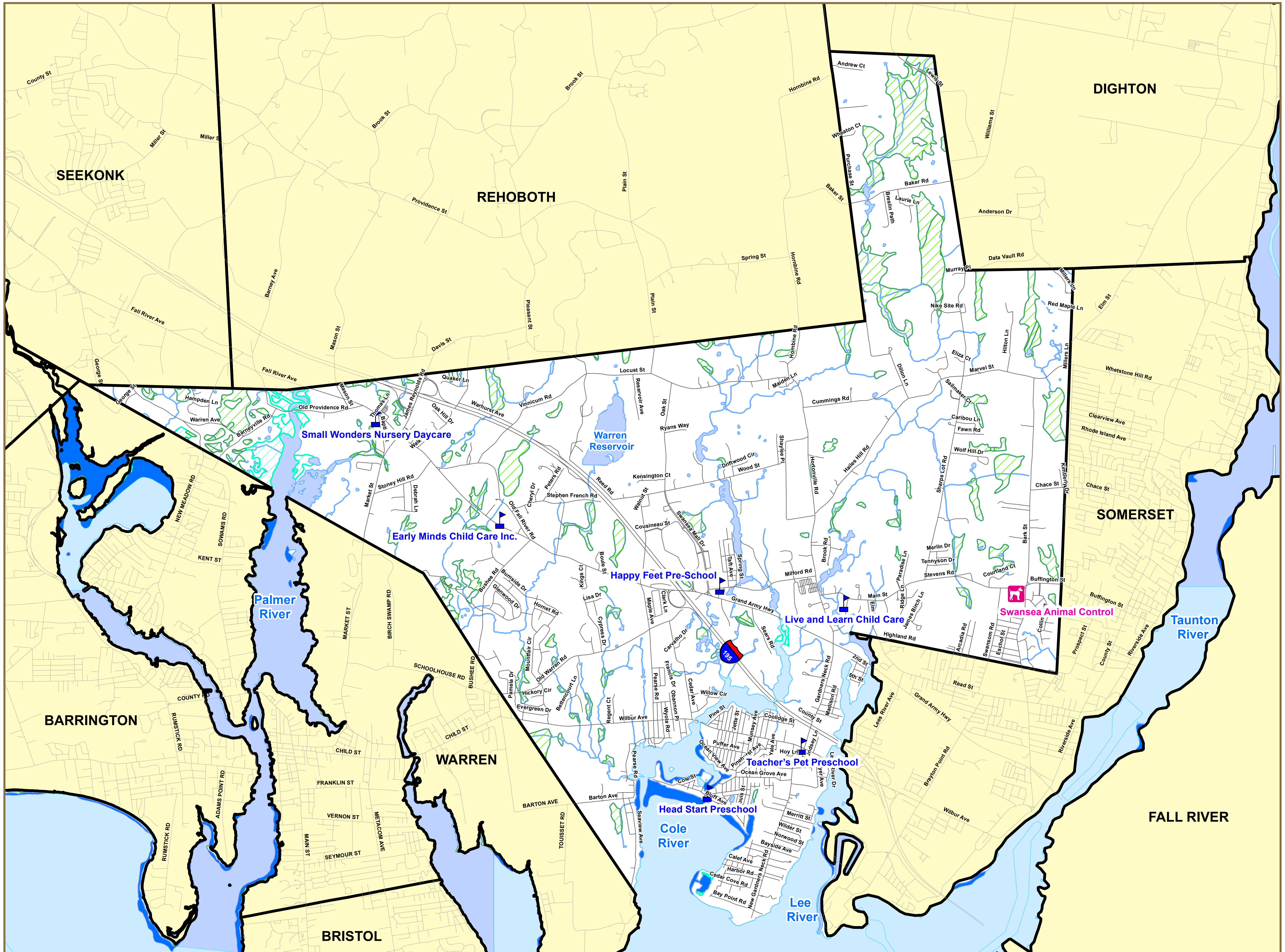

Figure 6

Tier 3 Critical Infrastructure

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Kindergarten, Preschool, and Daycare Facilities
- Animal Facilities
- Town Boundary

Hydrography

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Figure 7

Evacuation Routes

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
December 2015

Legend

- Evacuation Routes
- Surge Inundation Zones
- FEMA National Flood Hazard Layer
- Town Boundary
- Road

Hydrography Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS and
Town of Swansea

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Comprehensive Environmental Incorporated

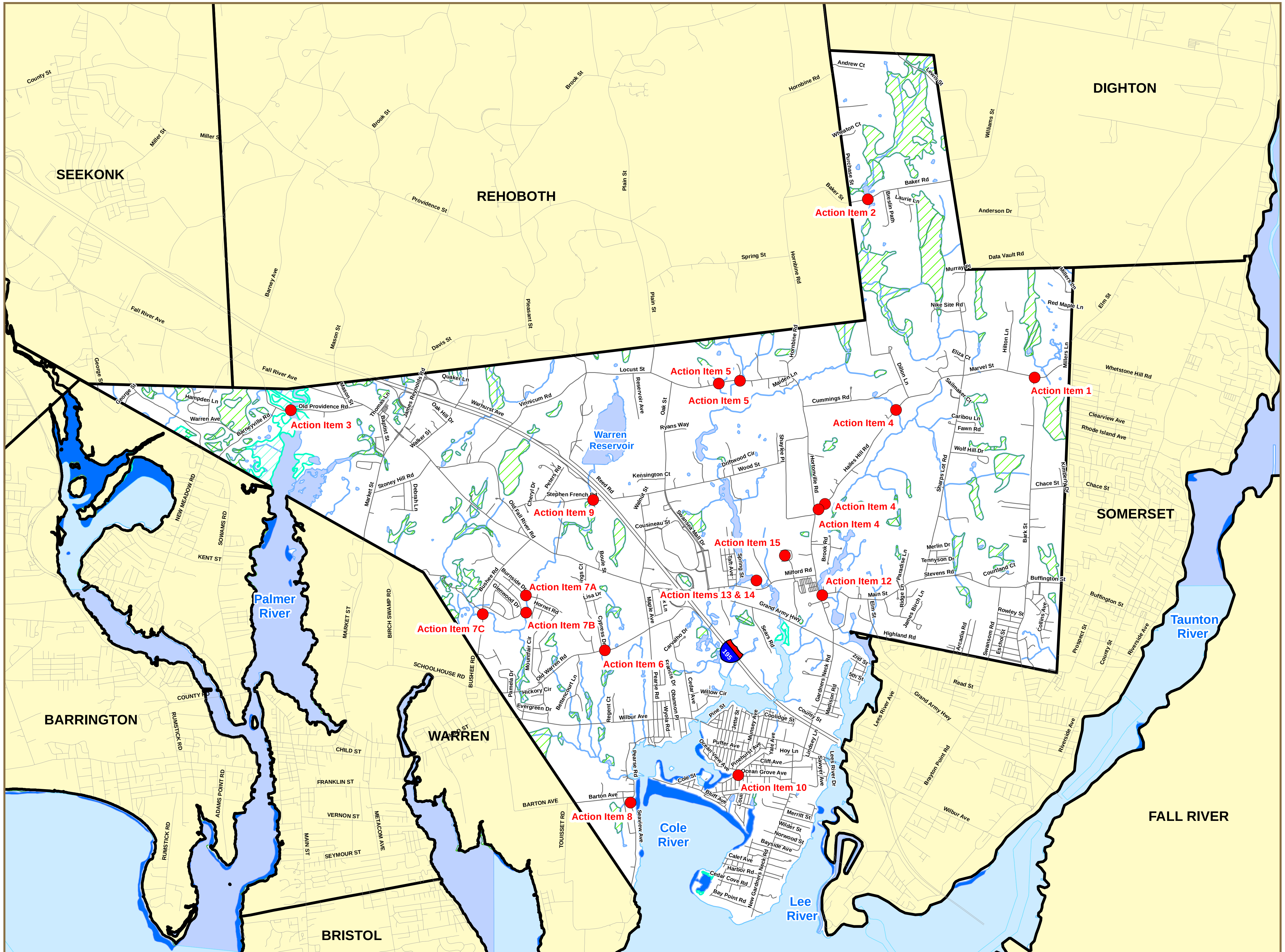

Figure 8

Proposed Structural Projects

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Action Item Locations
- Town Boundary

Hydrography

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS, RIGIS and
Town of Swansea

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APPENDIX A – PLANNING PROCESS MEETING MINUTES

Meeting 1 Minutes

Attendees: see attached attendance sheet

Discussion Items

- Introductions
- MEMA Hazardous Mitigation Plan Development Process Presentation:
    - HMGP has to document at least two times of public engagement such as posting of meeting minutes on website, presentation at public meeting, visualization of risk (i.e. marking on local building with height of potential/historical floods)
    - Document all of the meetings and strategies related to hazardous mitigation and provide all supporting documentation to MEMA
    - During planning process include neighboring communities or any other stakeholder critical to development of the plan
    - Every 5 yrs the plan has to be reviewed and updated
    - Identify community hazards and summarize vulnerability
    - Risk Assessments: 1)identify and profile hazards, 2) inventory community assets, 3) analyze risk – estimate losses and 4) summarize vulnerability
    - When inventorying assets include private areas/buildings in addition to town owned ones to estimate potential losses
    - Use assessors information to estimate value of buildings that could be impacted by hazardous events
    - National Flood Insurance Program: find addresses that have had past flood claims to include within the flood profiles (specific confidential request by Town)
    - Risk assessments focus on potential risk areas
    - Review each high priority Action Item to evaluate vulnerability
    - HMGP projects will only be funded if there is a greater monetary benefit in terms of avoided losses than cost associated with each project, based upon FEMA's Benefit Cost Analysis (BCA) software
    - Under the current program, when a project is approved 75% is funded from the federal gov't and 25% from the town

Follow-Up Items

- Send to Chief Peter Burke: copy of Dartmouth's HMGP, list of typically approved and unapproved HMGP projects, copy of all 3 GIS maps (Locus Map, FEMA Flood Map, and Hurricane Inundation Zones), High Hazards Worksheet, Recent Disasters Worksheet, Information Request Worksheet
- Next meeting scheduled for March 31, 2015 at 10 AM (rescheduled to April 7, 2015)

Meeting 2 Minutes

Attendees: see attached attendance sheet

Discussion Items

General Meeting Info (reviewed overall schedule and normal meeting schedule)

Utilities within Town

- National Grid takes a while during and after a storm to come out and turn off power to downed lines, creating problems for emergency access to areas within Town. Liaison system ineffective. (reoccurring problem)
- Slow response for gas company to respond to spills. (reoccurring problem)
- Previous storms have knocked out the 911 system. In the event of a storm, only have power for telecommunications as long as the backup batteries last (about 5 to 6 hours). Residents with DSL more than 50% likely that they are not hardwired to the central office and in the event the power goes out these individuals will only have telephone lines for as long as the backup battery units last. Historically, Town has lost telecommunications for more than 5 days.
- Communication is a huge issue for emergency response management in the town; noted strong presence of ham radio operators that have been used in the past for emergency communication. May want to consider as part of formal emergency response.
- Propane Tanks: must be above flood elevation; problems with emergency generator installations (Plumbing Inspector).
- All utilities must be underground for any new subdivision (cable, telephone, and electric)

Applicable Bylaws: see attached Worksheet

Dams located (or affecting) Town

- See attached Worksheet for listing of dams
- Critical dam is Upper Milford Pond Dam; problems with control structure
- Question on Warren Reservoir dam (owned/controlled by Bristol County Water)

Boat moorings

- No standard in town of how to deal with boat moorings, to prevent boats from coming loose during the storm and becoming projectiles.
- Potential need for Public Ed: alert public to tie down boats especially before a storm

Evacuation Issues

- In the event of a Mandatory/Suggested Evacuation, historically very few people evacuate. Some don't want to leave their pets and the Swansea shelter doesn't accommodate pets.
- Few people on Ocean Grove leave when emergency personal ask residents to evacuate.
- Evacuation Centers: High school is the only evacuation center in Swansea, centrally located and historically has had sufficient capacity to handle residents in need.

Meeting 2 Minutes

- Neighboring town of Somerset has an evacuation center at high school with trailers and cots that Swansea residents could use if needed.
- Nearest Red Cross Evacuation Center in Fall River but it's too far for residents to travel.
- To encourage residents to evacuate when necessary, need a way to accommodate pets. Currently the animal shelter in town is at capacity. Could reach out to vet clinic and private shelters to help with pets in the case of an evacuation, this point is actively on the agenda in MEMA and accommodating pets is a part of emergency management plans moving forward. Subsequent Hazardous Mitigation Grants might be used to fund a kennel trailer for pets that could be located at the evacuation center.

Developments pending (with issues/concerns noted)

- Chapter 40B project proposed at Coles River Fun Center, located south of Route 6 and just west of Gardners Neck Road (low lying area).
- Chapter 40B project proposed off Colletti Lane, located just beyond the existing LPG facility (concerns with limited access and high hazard area).
- 18 lot subdivision near Bushee Road (low lying area, undersized culvert).

Recent Disasters: See attached worksheet

High Hazard Areas: See attached worksheet

Follow-Up Items

- Meeting minutes to Chief Burke, to approve at next meeting and submit to town clerk
- Coordinate with Colleen for GIS layers
- Coordinate with Chief Burke for AST records
- Set up additional meeting with Highway Dept. to visit existing flood prone areas

Next meeting scheduled for May 12th, 2015 at 10 AM

HMPG Planning Meeting- April 7, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd., Swansea MA 02777

Name	Department	Email	Phone
1. PETER J. BURKE	FIRE DEPT	PBURKE @ TOWN.SWANSEA.MA.US	508 672 4305
2. CARL F. SAWEJKO	EMA	CFSAW@JUNO.COM	774-488-1921
3. Nuno Jorge	Highway Dept.	NUNOJORGE@COMCAST.NET	508-642-1565
4. ROBERT A. MARQUIS	SWANSEA WATER DISTRICT	RMARQUIS@SWANSEAWATERDISTRICT.COM	508-676-9097
5. GEORGE ARRUDA	Swansea Police	george.arruda@swanseapolice.com	508-674-8464
6. JOSEPH CARVALHO	BOH	JOEYC1015@YAHOO.COM JCARVALHO@TOWN.SWANSEA.MA.US	508 324 6704
7 Colleen Brown	Conservation Comm.	Swansea Con Com @ aol.com	508-673-6447
8. STEVE ANTINELLI	SWANSEA PLANNING	SANTINELLI@TOWN.SWANSEA.MA.US	508-324-6730
9. Natalie Koncki	Comprehensive Environmental Inc.	nkoncki@ceiengineers.com	508-281-5202
10. Moe Pukulis	Highway	mpukulis@town.swansea.ma.us	508-679-5615
11.			
12.			
13.			
14.			

INFORMATION REQUESTED FROM SWANSEA
(as obtained at April 7, 2015 LPT Meeting)

Utilities within Town:

- Gas: Liberty Gas
  Gas: Columbia Gas
- Water: Swansea Water District
- Electric: National Grid
- Wastewater: On Site Septic
- Cable: Comcast
- Phone: Comcast and Verizon

Applicable Bylaws:

- General
- Open Space and Recreation Plan
- Zoning: updated 2014
- Wetland protection Bylaw: 1988

Dams Present in Town:

- Swansea Print Works Dam
- Montaup #5 Dam
- Cole River Pond Dam
- Montaup #3 Dam
- Warren Reservoir Dam
-
- Milford Pond Dams
  (Upper and Lower)
-

Town GIS layers: Get Layers from Colleen

AST records (fire department)

Existing FEMA-Approved plan: SRPEDD Plan (limited information specific to Swansea)

RECENT DISASTERS (as obtained from April 7, 2015 LPT Meeting)

Hazards associated with natural disasters typically encountered (e.g. flood events, hurricanes, winter storms) include high winds, heavy rains and localized flooding.

1. Winter Storms (snow storms/blizzards/nor'easters)
   - Ice Storms (periodic)
   - 2013 Blizzard

2. Flood events (hurricanes, stormwater impacts)
   - March 2010, Route 6 was inundated at several locations, people were able to raft across Bushee Rd
   - Hurricanes – Irene, Sandy

3. Other Wind Events

4. Dam Breaches (Dam has never been breached)

5. Forest Fires
   - Fires behind Town Hall around 30-40 acres
   - Fires near Burnside Drive

6. Other
   - Tornado – Ocean Ave 2007, came from Warren
   - Earthquake - 1995

HIGH HAZARD AREAS (as identified at April 7, 2015 LPT Meeting)

High hazard areas are geographic areas identified as having a high risk from natural disasters. They typically include areas prone to river and stream flooding, coastal flooding, stormwater flooding, high winds, etc. High hazard areas may be chosen by the Local Planning Team or developed from FEMA flood reports and maps.

Each section should outline information such as:

- Location (culvert, street address, etc.)
- Size of impacted area (parking lot, 2 residential lots, etc.)
- Frequency (during heavy rains, spring snowmelt events, every 2 years, etc.)
- Impacts (flooded parking lots, basements or yards, impassible streets, etc.)
- Expected causes if known (undersized pipe, culvert or bridge, etc.)
- Potential solutions (enlarged culvert, upgraded drainage system, etc.)

1. Bushee Road (March 2010 Flood)

2. Route 6 by Police Station (March 2010 Flood)

3. Milford Road (March 2010 Flood)

4. Burnside Road (undersized Culvert Pipe for Kickemuit River)

5. Pearse Road

6. Wood Street

7. 40B Rental Development Projects at Coles River Fun Center (low lying area)

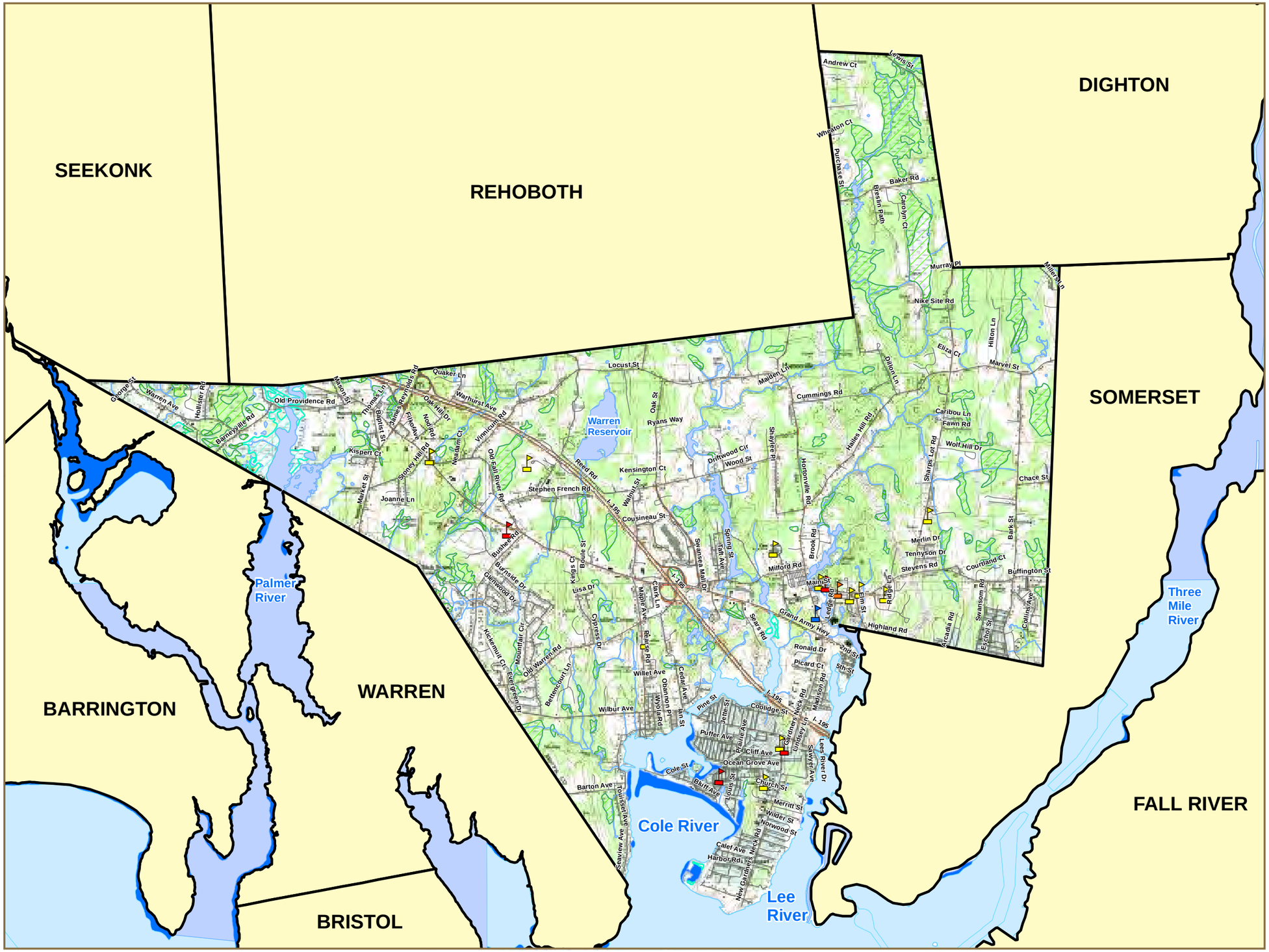
8. 18 Lot subdivision near Bushee Road (culvert is inadequate, low lying area)

Figure 1

Locus Map

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts



Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

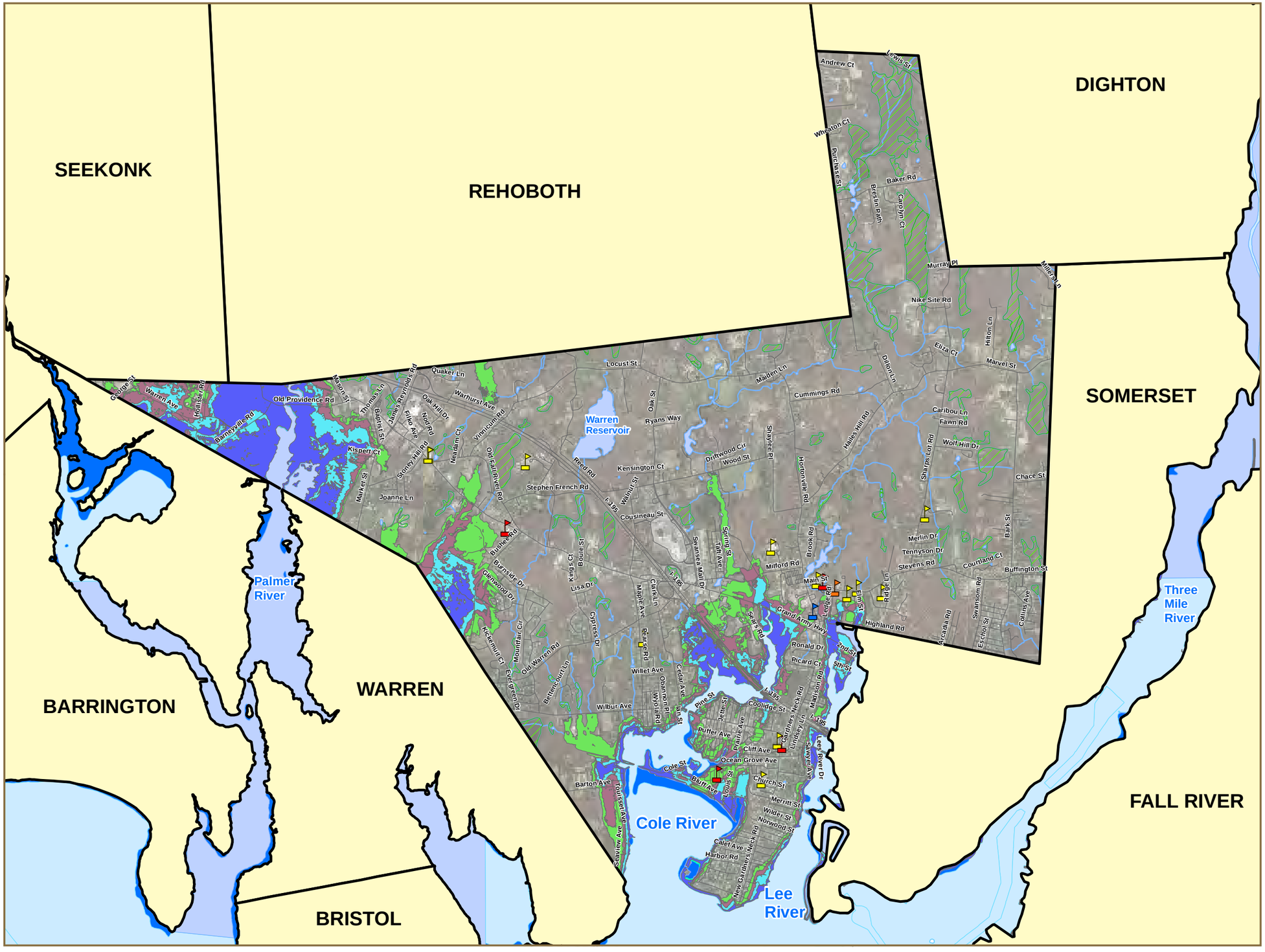

Figure 2

Hurricane Surge Inundation Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Surge Inundation Zones

Hurricane Category

- 1
- 2
- 3
- 4

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

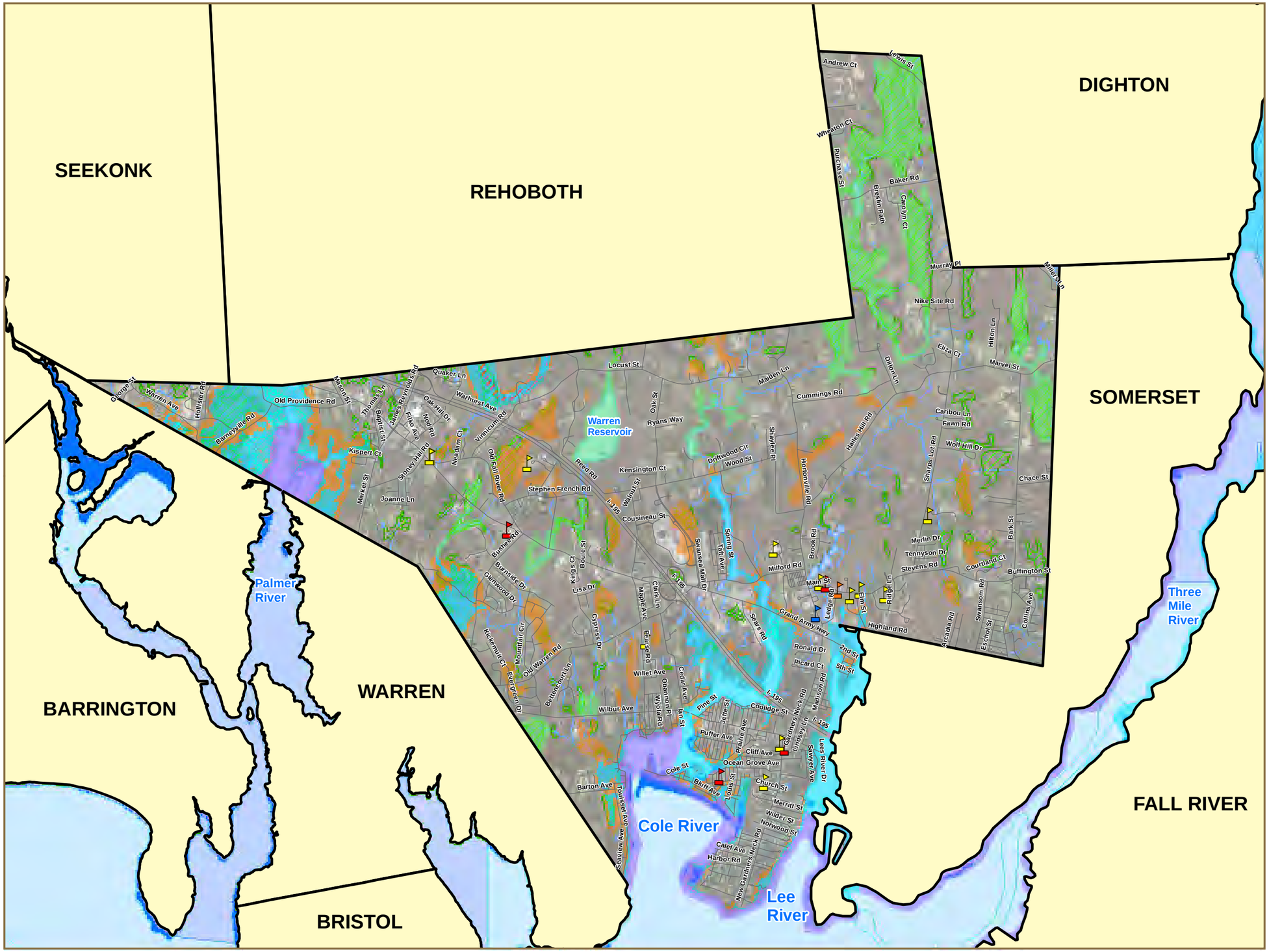

Figure 3

FEMA National Flood Hazard Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Station
- Town Hall
- School
- Police Station

FEMA National Flood Hazard Layer

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- AE: Regulatory Floodway
- AH: 1% Annual Chance of 1-3ft Ponding, with BFE
- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
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- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS and
Town of Swansea

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SCALE 1" = 4500'

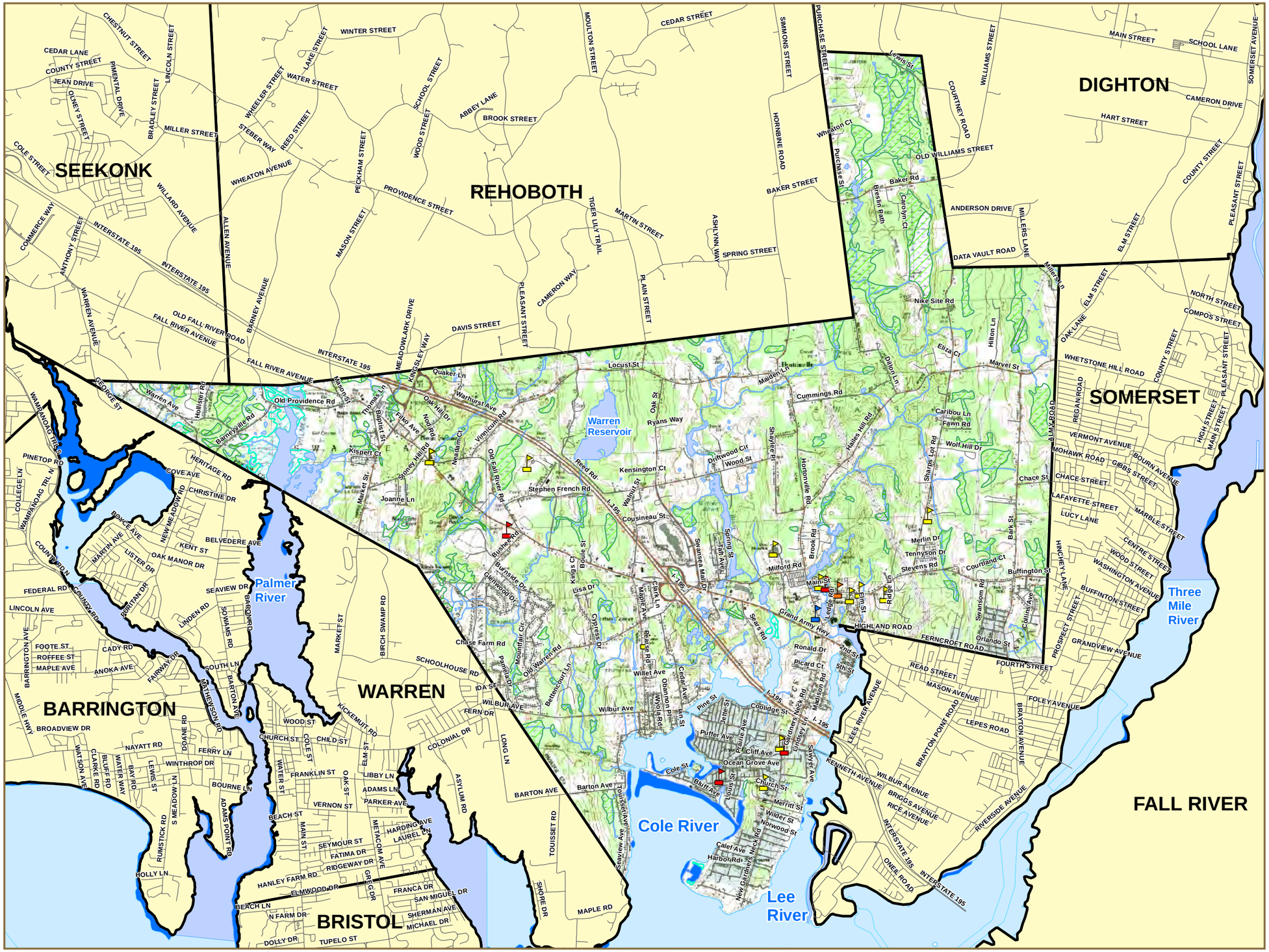
Comprehensive Environmental Incorporated

Figure 1

Locus Map

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts



Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

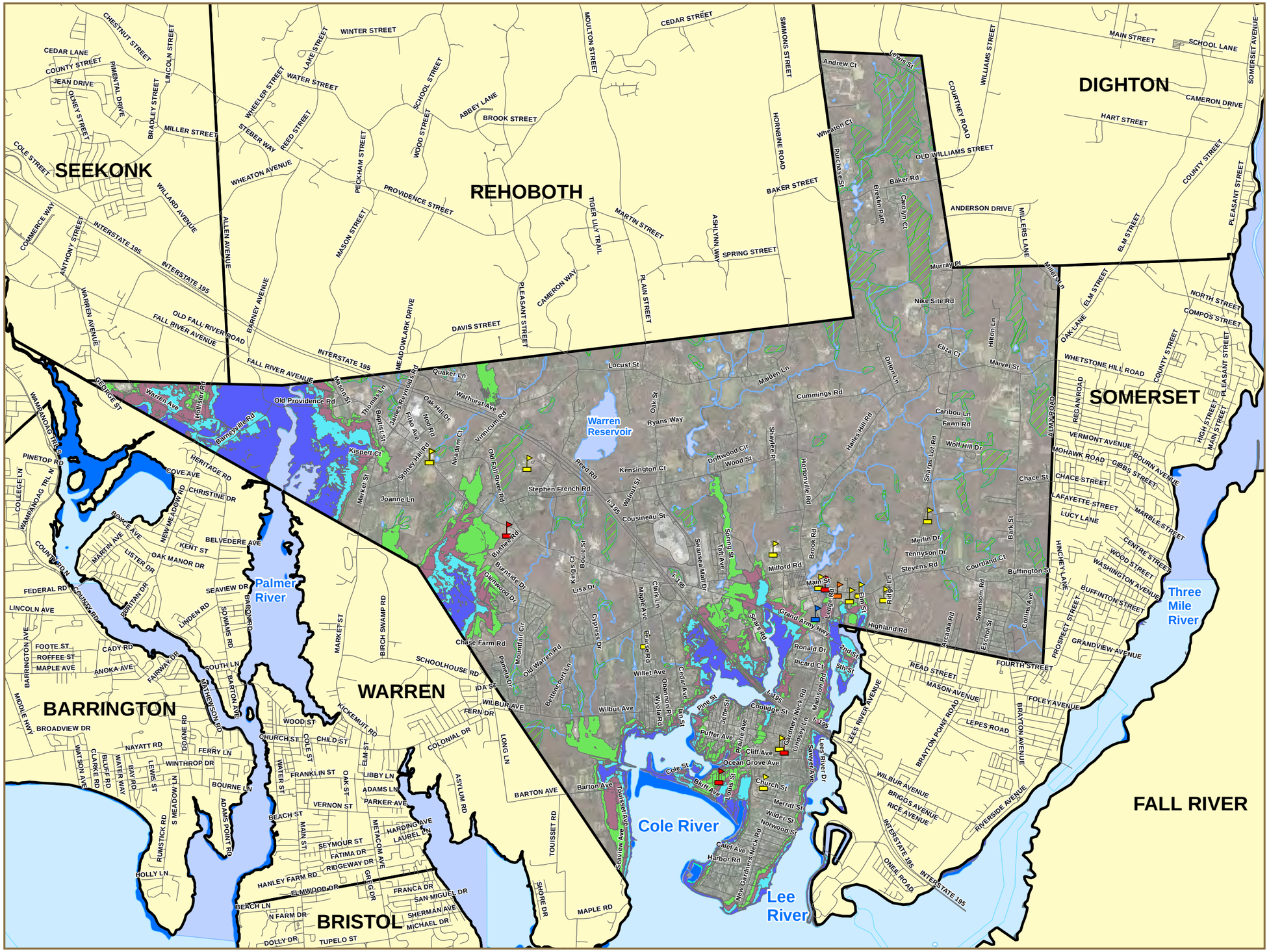

Figure 2

Hurricane Surge Inundation Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

Legend

- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Surge Inundation Zones

Hurricane Category

- 1
- 2
- 3
- 4

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

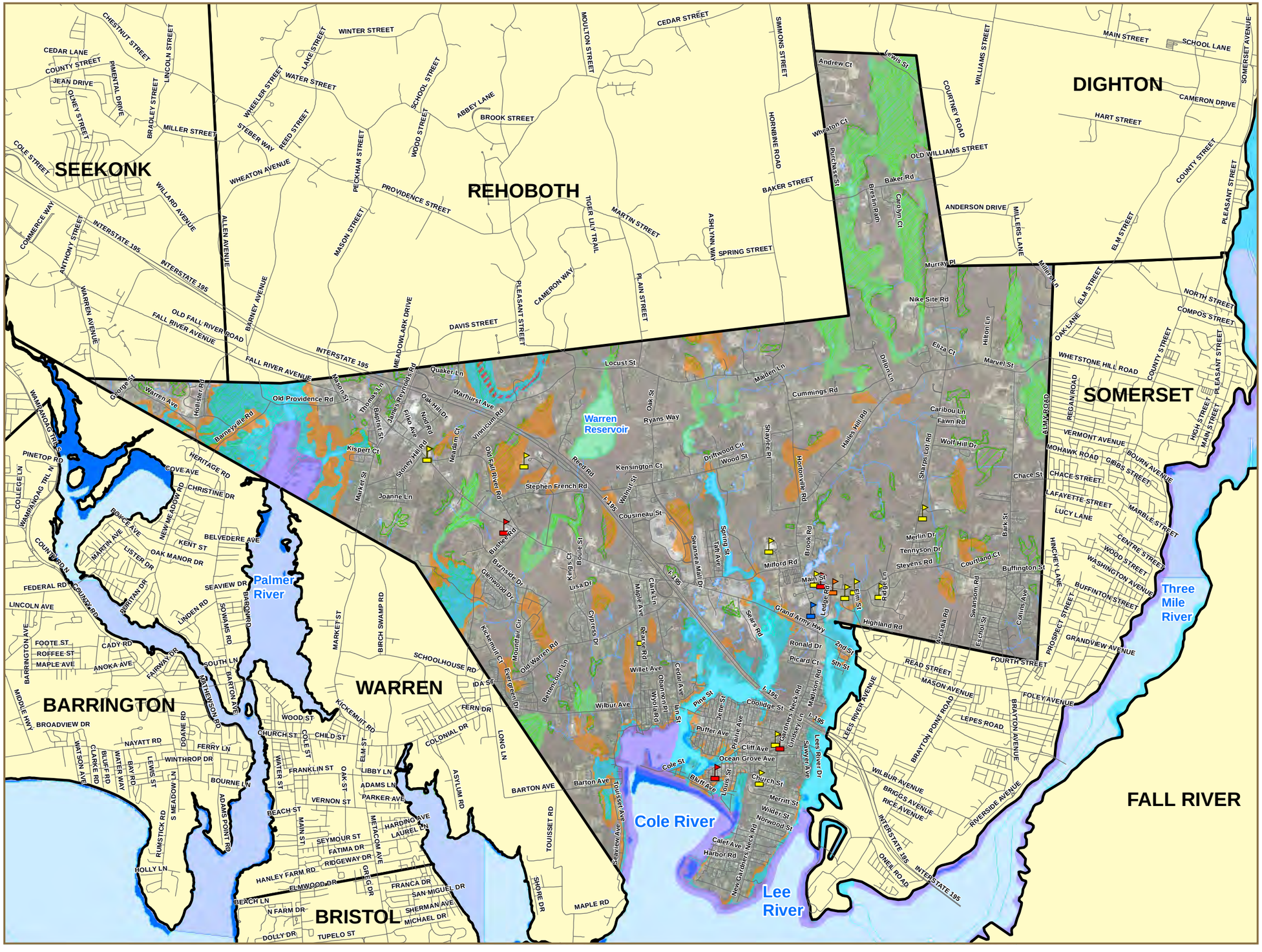
Comprehensive Environmental Incorporated

Figure 3

FEMA National Flood Hazard Zones

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts



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Hydrography

Type

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- Salt Wetlands
- Lake, Pond
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FEMA National Flood Hazard Layer

Flood Zone Designations

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- AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding, with Depth
- VE: High Risk Coastal Area
- D: Possible But Undetermined Hazard
- X: 0.2% Annual Chance of Flooding
- X: Reduced Flood Risk due to Levee
- Area Not Included
- Area with no DFIRM - Paper FIRMs in Effect

Data Source: MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 3 Minutes

Attendees: see attached attendance sheet

Discussion Items

Flooding/Problem Locations:

- Milford Pond dam - high risk because of flood control structure.
- Route 6 downstream of Stephen French Road (floods then Route 6 becomes inundated).
- Hailes Hill Road and Hortonville Road, houses have flooded in the past, built on a swamp. Hortonville Road flooding was addressed with upgraded culverts but Hailes Hill Rd still has not been addressed.
- Seaview Ave – existing 8 inch culvert undersized (inland flooding/backup).
- Pearse Road scheduled to replace culvert in Summer of 2016, have to raise it higher to account for sea level rise, Pearse Road flooding only a problem right along the water.
- Cyprus Drive at Old Warren Road
- Bushee Road at South Entrance of Burnside Road, undersized culvert causes road closure on Bushee Road, east of Burning Tree, culvert is a CMP with deteriorated invert.
- Hollister Road and Warren Ave area historically floods but has been better since detention pond was installed.
- Bridge on Old Providence Road, flows have overtopped base of the bridge, road has been closed down.
- Locust Street, replaced culvert pipe recently.

Evacuation Problems

- No one leaves Seaview Ave area when there is a suggested storm evacuation; Fire Department and Police Department previously have gone through Warren, RI to access Seaview Ave to rescue residents in emergency. Homes on Seaview Ave required to have a generator because of frequent flooding problems.
- Residents of Ocean Grove Ave do not typically evacuate during suggested evacuation.
- Bushee Road often used as evacuation route for Warren, RI but often this is inundated during evacuation; issue with Warren, RI which is directing its residents along this route even though it may be impassable.
- Bristol, RI evacuates through Route 136; typically can't evacuate through Pearse Road and have to go down Long Lane instead.
- North/South evacuation routes (priority routes to keep open)
    - Gardners Neck Road for Ocean Grove area
    - Pearse Road historically has flooded at lower end, OK north of Wilbur Ave; problem is specifically at culvert and bridge
    - Bushee Road historically floods from culvert along Burnside Road
    - Market Street (Route 136) for Warren, RI

Isolated Problem Areas during a Storm Event

- Ocean Grove
- Old Providence Road, northwest corner becomes completely isolated
- Little Neck

Critical Infrastructure

- Swansea Water District's Intake critical, Old Providence Road (facility above flood elev)
- Swansea Water District sources: Rocky Run bedrock well, subject to flooding; auxiliary generators exist at all sources except Bushee Road
- Swansea Water District has critical pipeline near Treatment Facility – issue with pipe joints at bridge crossing
- Raw Water System on Old Providence Road
- Highway Department and associated Fuel Depot (back-up generator)
- Council on Aging Center
- Swansea Ambulance Company
- Evacuation Center will have generator (repaired or replaced) in the near future
- Police Station has back-up generator, 92 hrs of propane, uses natural gas most of the time
- All Fire Stations have diesel generators for emergency power

Follow-Up Items

- Set up additional meeting with Moe Pukulis/Nuno Jorge from the Highway Dept. to visit existing flood prone areas
- Contact MassGIS to revise/correct Police Station location

Next meeting scheduled for June 2, 2015 at 10 AM

HMPG Planning Meeting- May 12, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

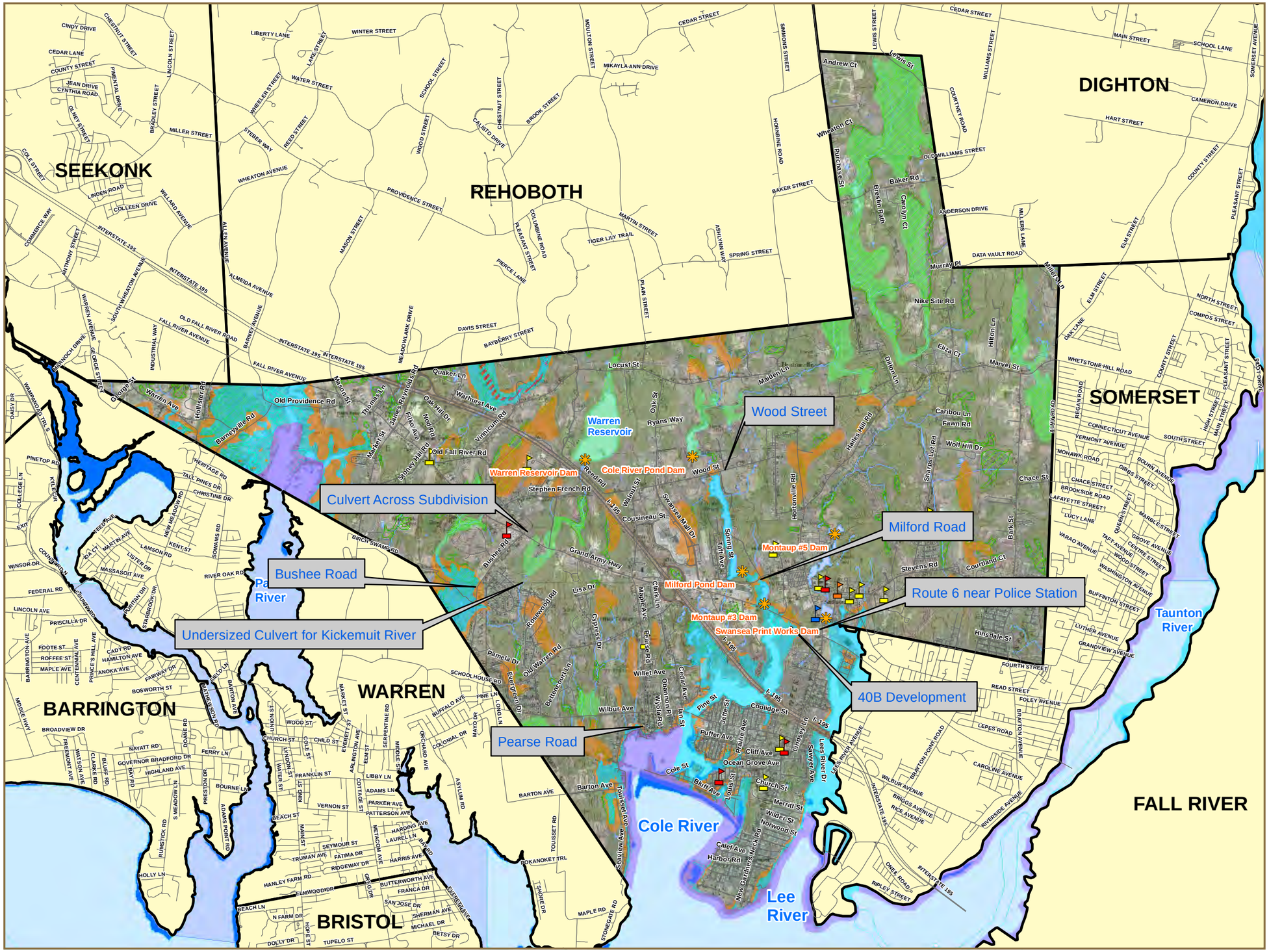
Name	Department	Email	Phone
Colleen Braun	Swan Cor Com	swanseacomcor@aol.com	508-673-6767
ROBERT MARQUIS	SWANSEA H2O	RMARQUIS@SWANSEAWATERDISTRICT.COM	508-676-9097
Steve Antinelli	Swansea Planning	SANTINELLI@TOWN.SWANSEA.MA.US	508-324-6730
George ARRUDA	Swansea Police	george.arruda@swanseapolice.com	508-674-8464
Nuno Jorge	Swansea Highway	NUNOJORGE@COMCAST.NET	508 678-5615
William McGRADY	Building Dept.	WMCGRADY@TOWN.SWANSEA.MA.US.	508.272.9527
Peter J Burke	SWANSEA FIRE DEPT	P.Burke@Town.Swansea.ma.us	508 672 4305
CARL F. SAWEJKO	SWANSEA EMA	CFSAW@JUNO.COM	508-676-2981
Natalie Koncki	CEI	nkoncki@ceiengineers.com	508-281-5202
Michael Ohl	CEI	mohl@ceiengineers.com	508-281-5177

Figure 4

Flood Prone Areas

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts



Legend

- Dam
- Fire Station
- Town Hall
- School
- Police Station
- Town Boundary
- Road

Hydrography

Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

FEMA National Flood Hazard Layer

Flood Zone Designations

- A: 1% Annual Chance of Flooding, no BFE
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- Area Not Included
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Data Source:
MassGIS and
Town of Swansea

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SCALE 1" = 4500'

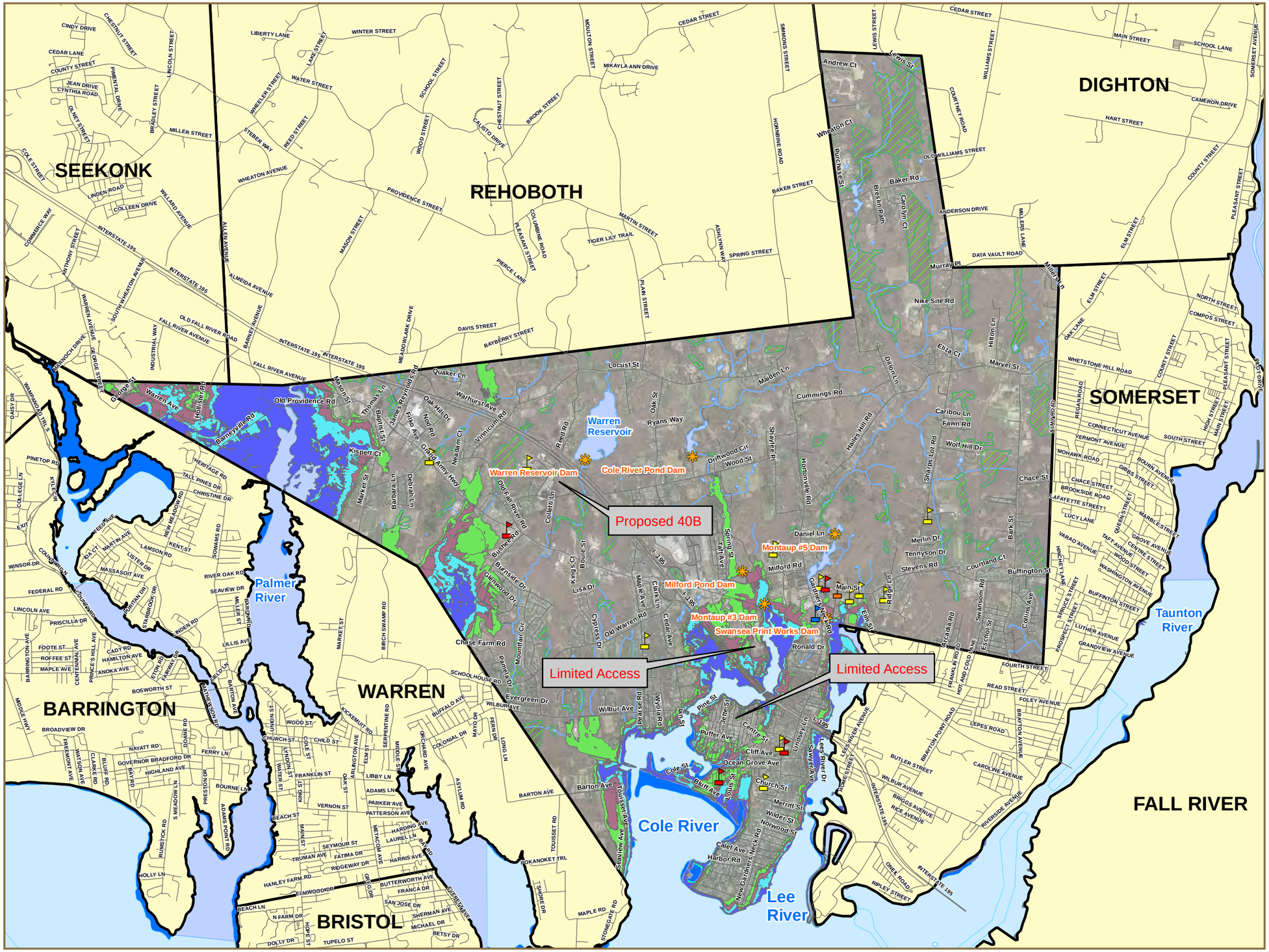
Comprehensive Environmental Incorporated

Figure 5

Limited Access Areas

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts



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Surge Inundation Zones

Hurricane Category

- 1
- 2
- 3
- 4

- Town Boundary
- Road

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Critical Infrastructure Maps

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts

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Critical Infrastructure Maps

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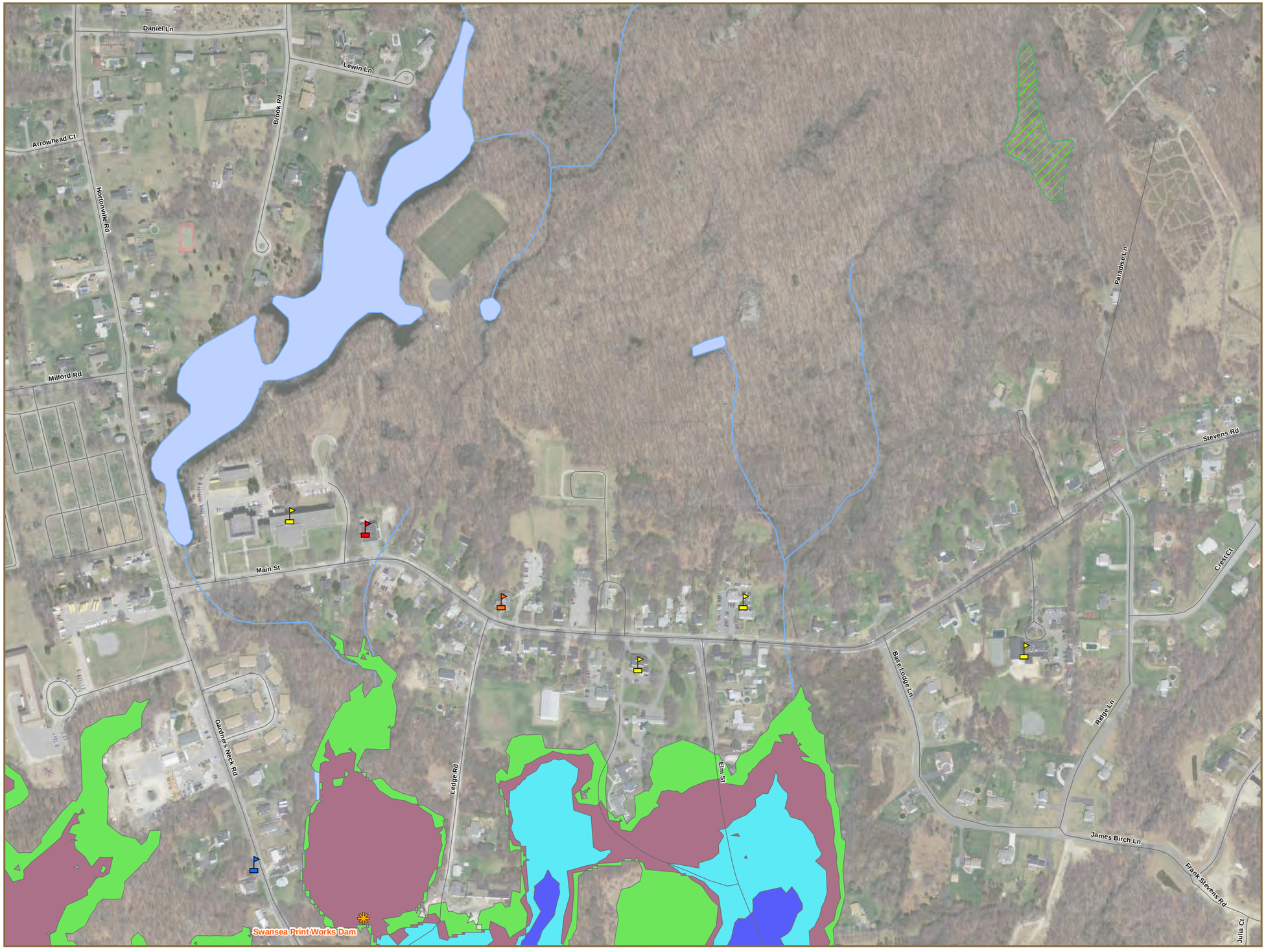
Swansea, Massachusetts



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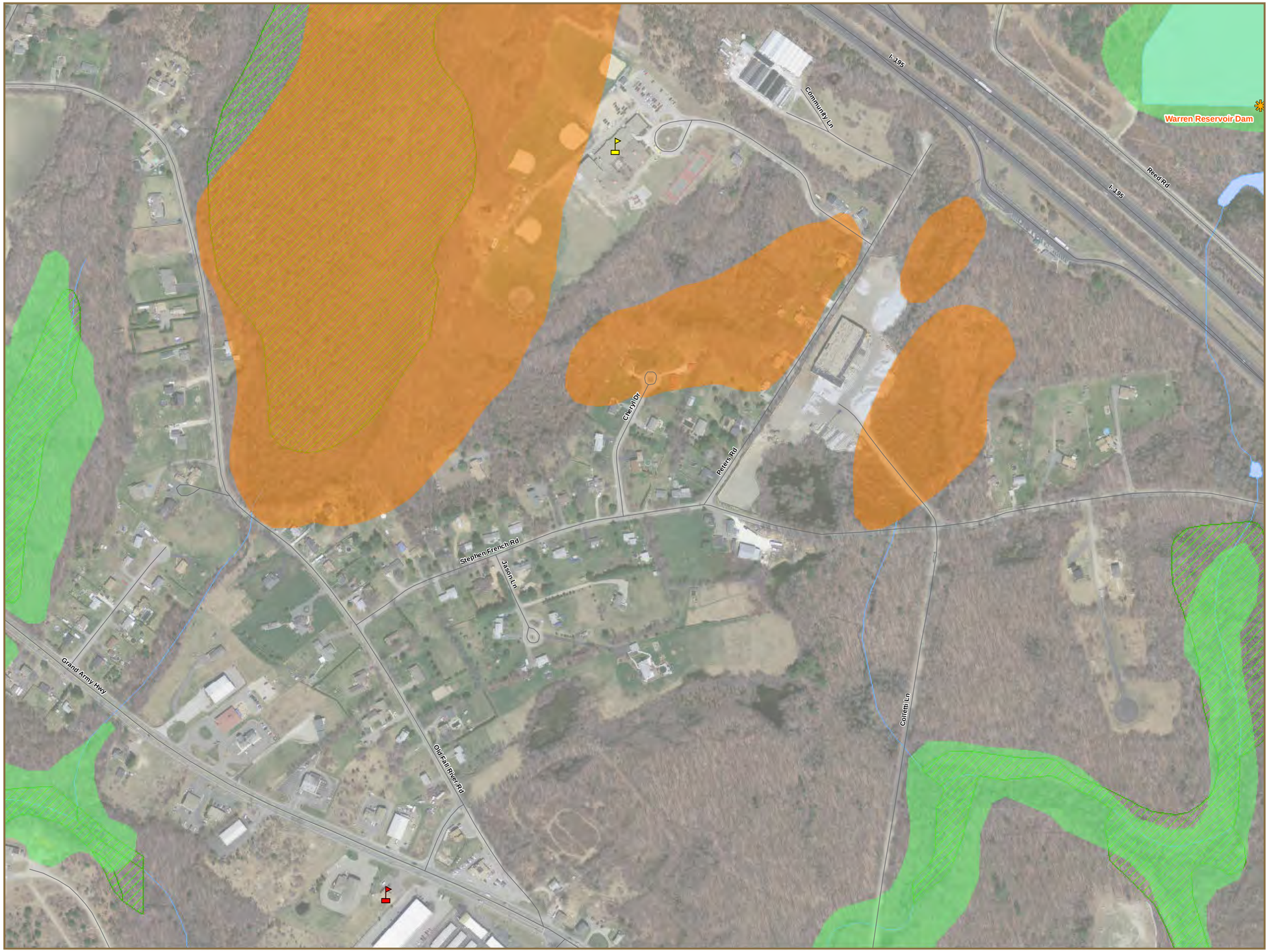

Critical Infrastructure Maps

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Miles

SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 4 Minutes

Attendees: see attached attendance sheet

Discussion Items

Follow-up from previous Meeting

- Swansea Police Department location changed to correct location on MassGIS website

Communication Issues

- Town has a good relationship with the local radio station (WSAR-AM), keeps transmitter operating during times of emergency.
- Communications are OK as long as cell towers are operating and people have power and access to their cell phones. However, 24 hrs into a storm emergency, communication situations are typically exacerbated due to loss of backup power (battery units) at cell towers. Possible solution is use of portable generators at cell tower sites as needed.
- Historically, ham radio operators have provided critical communications link during extended power outages.
- Communications exercise planned for June, including ham radio operators.
- Verizon copper wire system is susceptible to outages when manholes get flooded.
- Route 6 at Somerset creamery is a distribution point for Verizon throughout the town, historical problems of flooding and freezing water in the distribution manhole
- Internal communication network during an emergency is typically strong.
- New communication system being implemented in Town (microwave) that will be independent of Verizon copper wire system and mobile phone service; this will help during a storm with internal emergency response communications. Swansea Water District to be considered in communication system upgrade.
- Public communication is lacking (or can be compromised) during emergencies
    - Need a mobile phone database to get message out. Communities do not have the ability to do a reverse 911 mobile call, they don't have cell phone numbers for residents or businesses.
    - Could perform a sign-up on a voluntary basis to get mobile phone numbers or could hire a vendor that will send emergency text messages for a fee
    - Public Education Component- best to reach people ahead of hazardous event

Venus de Milo (Large Scale Inoculation Center for Swansea Health Department)

- Staging area for contagious disease outbreak
- Buses can maneuver in and out easily
- Somerset might be using the same infectious disease location with the Board of Health
- Potential problem if concurrent flooding with disease outbreak (limits facility access); however, the High School evacuation center is not a viable alternative.

Water Supply Info

- Most residents in town are on public water

- Historically no one on the public water system has been without water during a storm
- Most stream crossings have isolation valves on either side

Evacuation Logistics and Problems

- Route 6 is the primary East/West route out of town during an emergency.
- Best way to get around Route 6 flooding is Interstate 195 or to go through Rehoboth
- In case of Providence Road flooding, alternate route is to follow Hollister Road to Warren Ave to Barneyville Road
- Primary North/South evacuation routes
    - Gardners Neck Road
    - Barton/Seaview/Pearse/Maple Roads
    - Bushee Road
- Problem with Old Warren Road (culvert near Cypress Drive)

Potential local Evacuation Centers for Ocean Grove area: (Gardner School or Council on Aging), if determined to be beneficial in addition to the High School:

- Good location on Gardner's Neck Road for a potential evacuation center, assuming residents are unable to leave the area and get to the High School
- Council on Aging facility does not have a generator; would need to be purchased, installed and hardwired in with automatic transfer switch.
- Need to resolve how to handle pets because people historically won't evacuate without their pets. Council on Aging facility would be hard to accommodate pets; might not be an ideal location but could still be a temporary emergency evacuation spot.
- Could have people stay at Gardner School in case Gardners Neck Road is impassable.
- Purchasing a generator at Council on Aging or Gardner's School is a potential project that could be funded through the hazardous mitigation grant program.

New Development Problems

- Steven French Road, access route becomes impassible due to flooding (dead end)
- Culvert at Hailes Hill Road (flooding issues)
- Culvert at Nike Site Road being replaced (new YMCA location)
- 40B site next to Propane facility on Colletti Road (flooding issues, access issues)

Dams

- Recent development with Milford Pond dam – sluice gate operating mechanism is missing and debris is blocking outlet (apparent vandalism). Consider long-term solution to current operating mechanism – permanent/lockable lifting mechanism instead of portable hand operated winch.
- MassGIS incorrectly labeled dam risk; Milford Pond dam should be moderate risk per the specific dam inspection reports; if stream floods a lot of people are stranded, historically water in Target store parking lot.
- Colleen has copies of the individual dam assessment reports.

Emergency Generators

- High school back-up generator needs new head gasket, test run needed to see what is powered (or not) off the generator. Need to do a live load test. Alternative is complete replacement of the emergency generator.
- Fire Department typically goes to the schools in July/August and pulls the breaker to make sure the generators work.
- Before a storm, Swansea Water District preemptively switches to auxiliary power in case the power goes out in the middle of the storm (eliminates problems during storm events).
- Need to develop comprehensive list of emergency generators in Town that are related to critical infrastructure, along with routine testing and operating protocols.

Repetitive Loss Properties (general areas, since specific property locations are confidential)

- Cole River
- Ocean Grove

Additional Items

- Church on Sharps Lot Road, now being transformed into a YMCA daycare, has only one entrance road over a stream; a lot of people from outside Swansea (i.e. Fall River) will use this facility; if river floods there is only one way to get everyone out.
- Bethany Gospel church is located in place of the former rest home on Lindsey Lane, so no longer a critical facility.
- Town Hall Annex could be a possible staging area in time of emergency, animal shelter on the same property, communications from this location, medical helicopters have previously landed here.
- Concerns noted about hazards other than natural disasters, specifically associated with chlorine gas from Fall River facility and other hazards from Brayton Point power facility. Current study is focused on natural hazards; will see how these other man-made hazards can be addressed as part of the overall emergency response efforts and evacuation routes.

Follow-Up Items

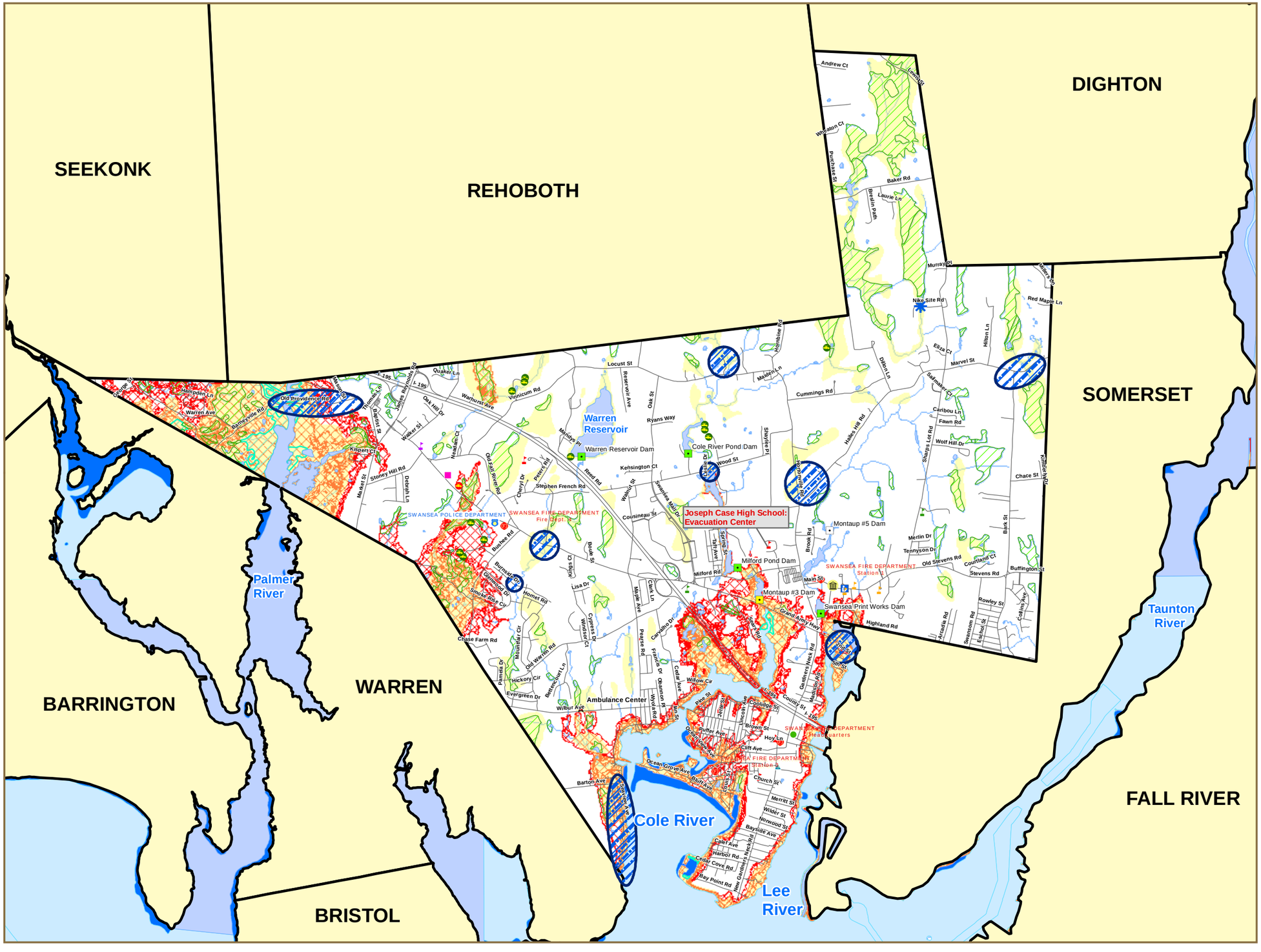
- Follow up with Colleen for copies of dam inspection reports and GIS layers
- Show Ambulance Corps location on Wilbur Avenue (previously Yale Avenue)
- Add senior apartments to critical infrastructure layer
- Add Town Hall Annex, Animal Shelter, Council on Aging and Veterinary Center on Critical Infrastructure Map
- Add 2009 tornado to historical disaster list
- Create evacuation route map

Next meeting scheduled for June 30th, 2015 at 10 AM

HMPG Planning Meeting- June 2, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

Name	Department	Email	Phone
Peter Burke	Fire	PBurke@TownSwansea.MA.us	508 6724305
Carl F. Sawejko	EMA	CFSAW@JUNO.COM	774-488-1921
Nuno Jorge	Highway	njorge@Town.Swansea.MA.us	508 6785615
George Arruda	Swansea Police	george.arruda@swanseapolice.com	674-8464
John McAuliffe	Town Administrator	JMcAuliffe@TownSwansea.MA.us	Town Hall
Robert A. Marques	Swansea H2O District	RAMarques@swansearwaterdistrict.com	508-676-9097
Natalie Koncki	Comprehensive Environmental Inc.	NKoncki@ceiengineers.com	508-281-5202
Colleen Brown	Swansea Con Com	cbrown@town.Swansea,MA.us	508-623-6467
Michael Ohl	CEI	mohl@ceiengineers.com	508-281-5177
Steve Antinelli	Planning	SAntinelli@Town.Swansea.MA.us	508-324-6730

June 30 10:00



Critical Infrastructure and Flood Prone Locations

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
June 2015

Legend

- Flood Prone Area
- Flood Prone Areas
- **Dams**
  - High Hazard
  - Significant Hazard
  - Low Hazard
  - N/A
- Road
- Town Boundary
- FEMA National Flood Hazard Layer
- Surge Inundation Zones
- **Hydrography**
  - **Type**
    - Bay, Ocean
    - Tidal Flats, Shoals
    - Salt Wetlands
    - Lake, Pond
    - Wetland
    - Stream, Brook
- **Critical Infrastructure**
  - Ambulance Center
- **Schools (PK - High School)**
  - Public
  - Private
  - Charter
  - Collaborative
  - Special Education
- **Libraries**
  - **Type**
    - Public
- **Police Stations**
  - Local Police
- **Fire Stations**
  - Fire Stations
- **Town Hall**
  - Town Hall
- **Long Term Care Residences**
  - **Facility Type**
    - Assisted Living Facility
    - Nursing Home
    - Rest Home
- **PWSDEP_PT**
  - Community Groundwater Source
  - Non-Community Groundwater Source

Data Source:
MassGIS and Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 5 Minutes (LPT and Site Visit)

Attendees: see attached attendance sheet

Discussion Items

Follow-up from previous Meeting

- Corrected May 12, 2015 meeting minutes, redistribute at next LPT meeting

General Meeting Minutes

- Went over evacuation map and highlighted addition routes that are historically used during emergency (I-195, Route 118, Hales Hill Road, Sharps Lot Road)

Site Visit to Problem Areas after LPT Meeting with Nuno Jorge

1) **Bark Street at Marvel Street** (just east of Bark Street)
   - three 24" diameter concrete pipes, all in good condition, no obstructions
   - historically, flooding has overtopped road and backed up to Marvel/Bark intersection
   - sidewalk on downstream side is undermined
   - one 12" diameter DI pipe from nearby CB/MH
   - partially developed site around corner on Marvel, with incomplete stormwater controls

2) **Baker Road**
   - estimate 5' diameter CMP
   - no apparent flooding problems
   - poor condition (visible corrosion)
   - minimal cover (2' +/-)

3) **Hales Hill Road** (just SW of Dillon Lane)
   - 18" CMP (estimated)
   - eroded headwall (collapsed in front of pipe)
   - flooding linked to blocked pipe

4) **Halles Hill Road** (near house #57)
   - 18" CMP/12"CMP (parallel pipes)
   - condition ok
   - headwall needs rework

4A) **Hales Hill Road** (just east of Hortonville Road)
   - 30" CMP (possibly 36" diameter)
   - condition ok
   - possible capacity issue with flow from the north from Hortonville Road area
   - corrective measures being designed

5) **Locust Street** (near power line crossing)
   - no access (fenced/overgrown)
   - reportedly floods, but significant detention areas (low lying) upstream, so possible blockage (requires further investigation, need area cleared for visual inspection)

6) **Old Warren Road near Cypress Drive**
   - two 30" diameter concrete pipes (possibly 36") visible from upstream side
   - no obstructions, all in good condition
   - two 30" diameter concrete pipes plus one 36" HDPE visible from downstream side (appears that 36" may connect to MH, from west)

7) **Bushee Road area**
   - flooding near power lines, where Burnside Drive backs up
   - Bushee Road culverts are substantial: dual box culverts (4x 10 each)
   - lots of overgrowth/sediment upstream (one culvert partially blocked)
   - Nuno working with Mosquito Control to get area cleared (Power line property)

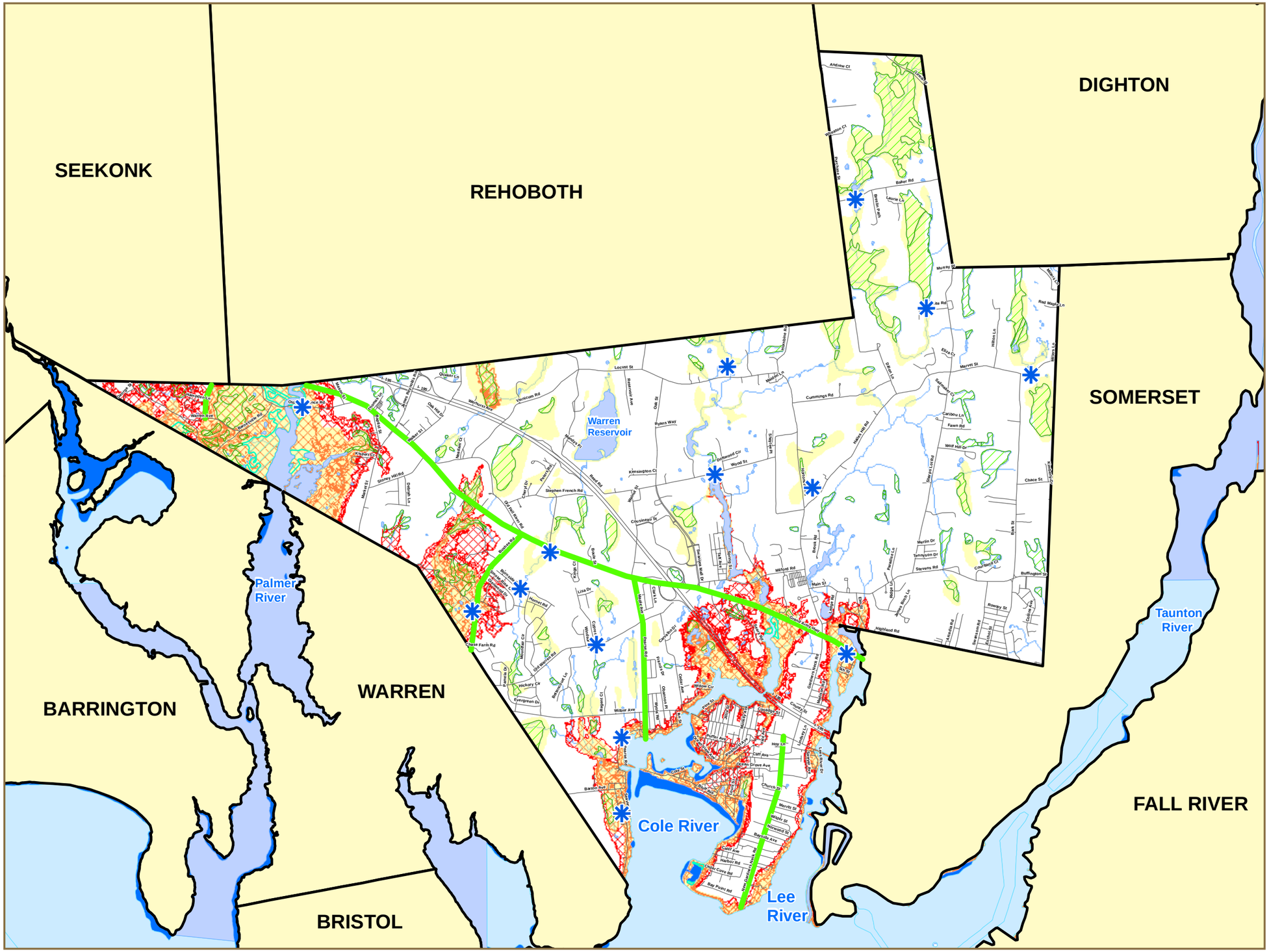
   Lynwood Rd (upstream of Bushee Road crossing)
   - two 60" diameter CMP
   - bottom 1/3 filled/blocked with sediment
   - possible invert corrosion (visible settlement in road)
   - problems with debris/blockage

   Burnside Drive (upstream of Lynnwood Road crossing)
   - two 42" diameter CMP
   - overtops, but flows west/south on road surface (estimated 6" deep, high velocity) down Ash Rd, then Smoke Rise Circle, then out to Bushee Road
   - problems with debris clogging existing structure?
   - downstream headwall has settled

Follow-Up Items

- Update evacuation map

Next meeting scheduled for September 1st, 2015 at 10 AM



Evacuation Routes

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
June 2015

Legend

- Flood Prone Points
- Evacuation Routes
- FEMA National Flood Hazard Layer
- Surge Inundation Zones
- Road
- Town Boundary

Hydrography
Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS and
Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 6 Minutes (LPT)

Attendees: see attached attendance sheet

Discussion Items

Reviewed updated Evacuation Route map.

Reviewed action item list and developed initial prioritization (high/medium/low).

- Reviewed Flood Prone Locations (map and information gathered in June).
- Back-up generator at High School is presently inoperable – needs new head gasket or complete replacement.

High priority items include sites along the evacuation routes and critical infrastructure.

Follow-Up Items

- Steve Antinelli following up with Scott Adams (Advanced Engineering Group LLC), regarding the status of the Hortonville Road culvert improvements and if any upcoming projects are targeted to address the Hailes Hill Road flooding. Site could be a potential location to receive hazardous mitigation grant funding.
- Colleen Brown is following up with Bristol County Water Authority (BCWA) to inquire about Warren Reservoir Dam management. Open up dialogue to see if they would be willing to lower the dam before a large rain storm event, since BCWA is not presently withdrawing water which may increase reservoir water levels and spillway flows, compared to historical storm events.
- Nuno Jorge is following up to see who owns the property at the stream crossing at Bushee Road, to facilitate clearing of vegetation.

Next meeting scheduled for October 13, 2015 at 10 AM

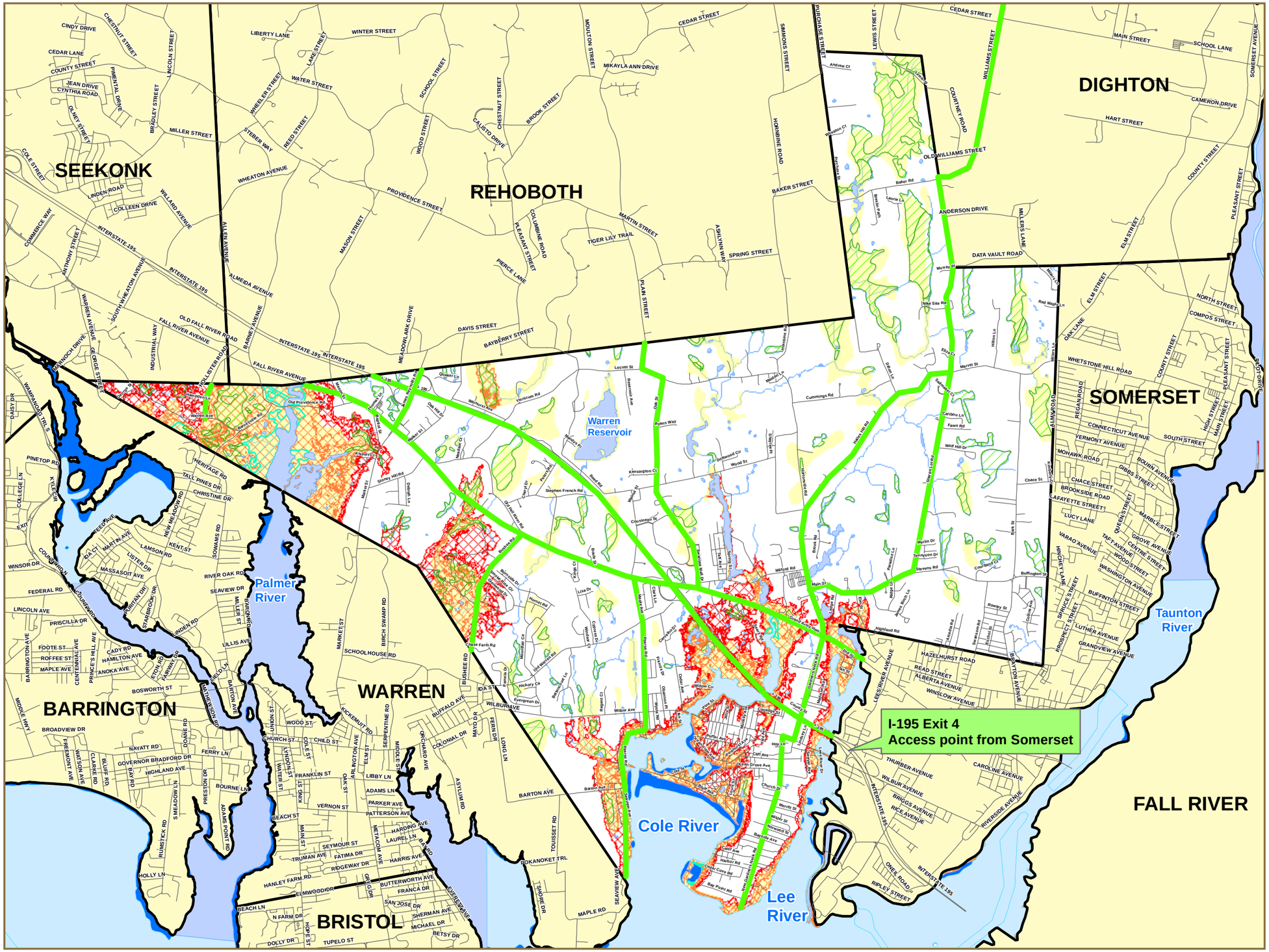
HMPG Planning Meeting- September 1, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, Ma 02777

Name	Department	Email	Phone
Peter Burke	FIRE	PBurke@TOWN.SWANSEA.MA.US	508 6724305
Natalie Koncki	CEI	nKoncki@ceiengineers.com	508-281-5202
Michael Ohl	CEI	mohl@ceiengineers.com	5177
ROBERT A. MARQUIS	SWANSEA H2O DIST.	RMARQUIS@SWANSEAWATERDISTRICT.COM	508-676-9097
Colleen M. Brown	Conservation Comm.	cbrown@TOWN.SWANSEA.MA.US	508 673-6767
JOHN McAULIFFE	Town ADMIN	JMCAULIFFE@TOWN.SWANSEA.MA.US	508-678-2981
GEORGE ARRUDA	Police CHIEF	george.arruda@swansеepolice.com	508-674-8464
STEVE ANTINELLI	PLANNING	SANTINELL@TOWN.SWANSEA.MA.US	508-324-6730
CARL SAWEJKO	EMA	CFSAW@JUNO.COM	508-676-2981
Nuno Jorge	Swansea Highway Dept.	NJORGE@town.swansea.ma.us	508 6785615

Evacuation Routes

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
June 2015



Legend

- Evacuation Routes
- FEMA National Flood Hazard Layer
- Surge Inundation Zones
- Road
- Town Boundary

Hydrography Type

- Bay, Ocean
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- Lake, Pond
- Wetland
- Stream, Brook

Data Source:
MassGIS and
Town of Swansea

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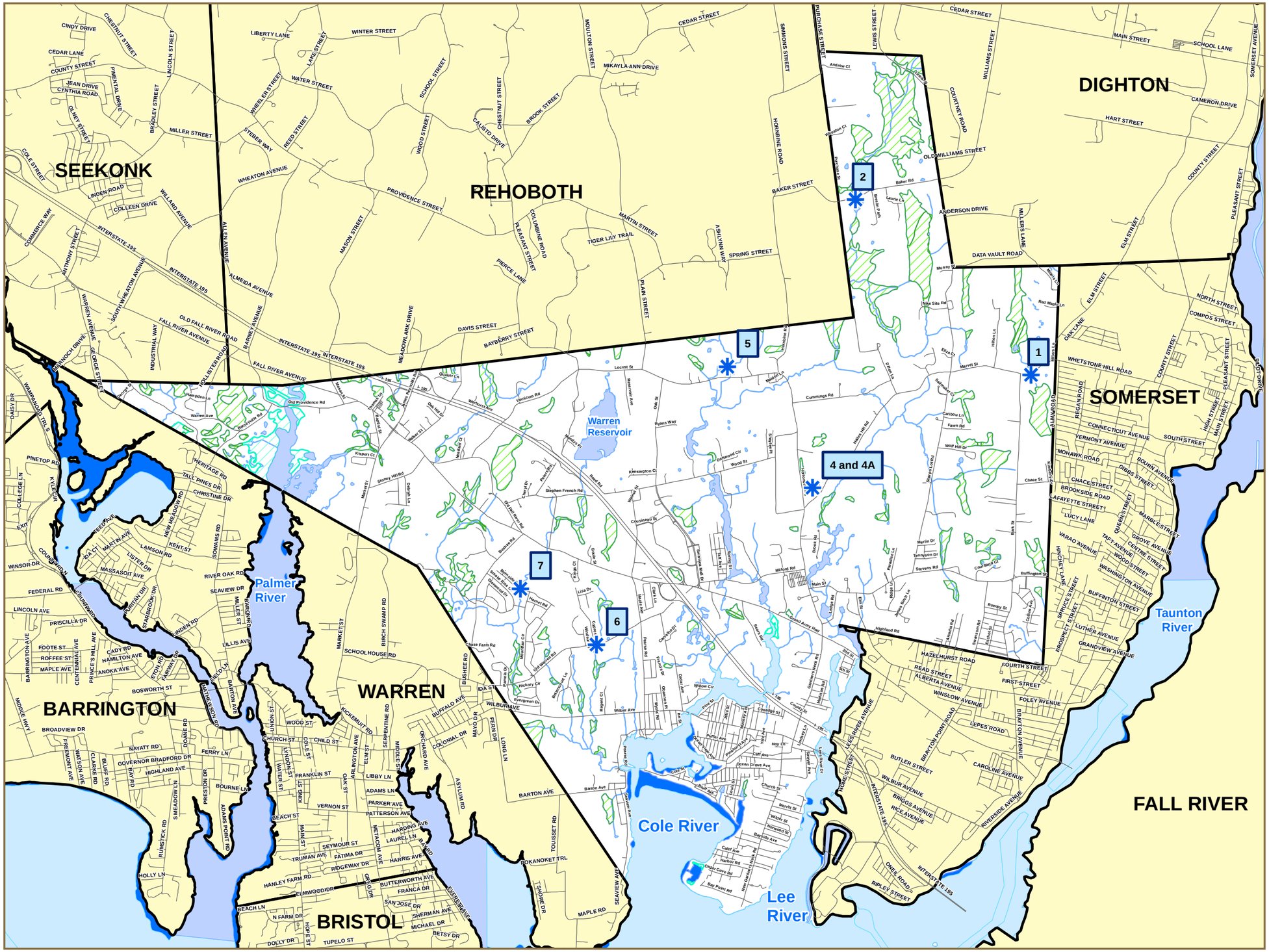
SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Flood Prone Locations Investigated

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
June 2015



Legend

- Flood Prone Points
- Road
- Town Boundary

Hydrography Type

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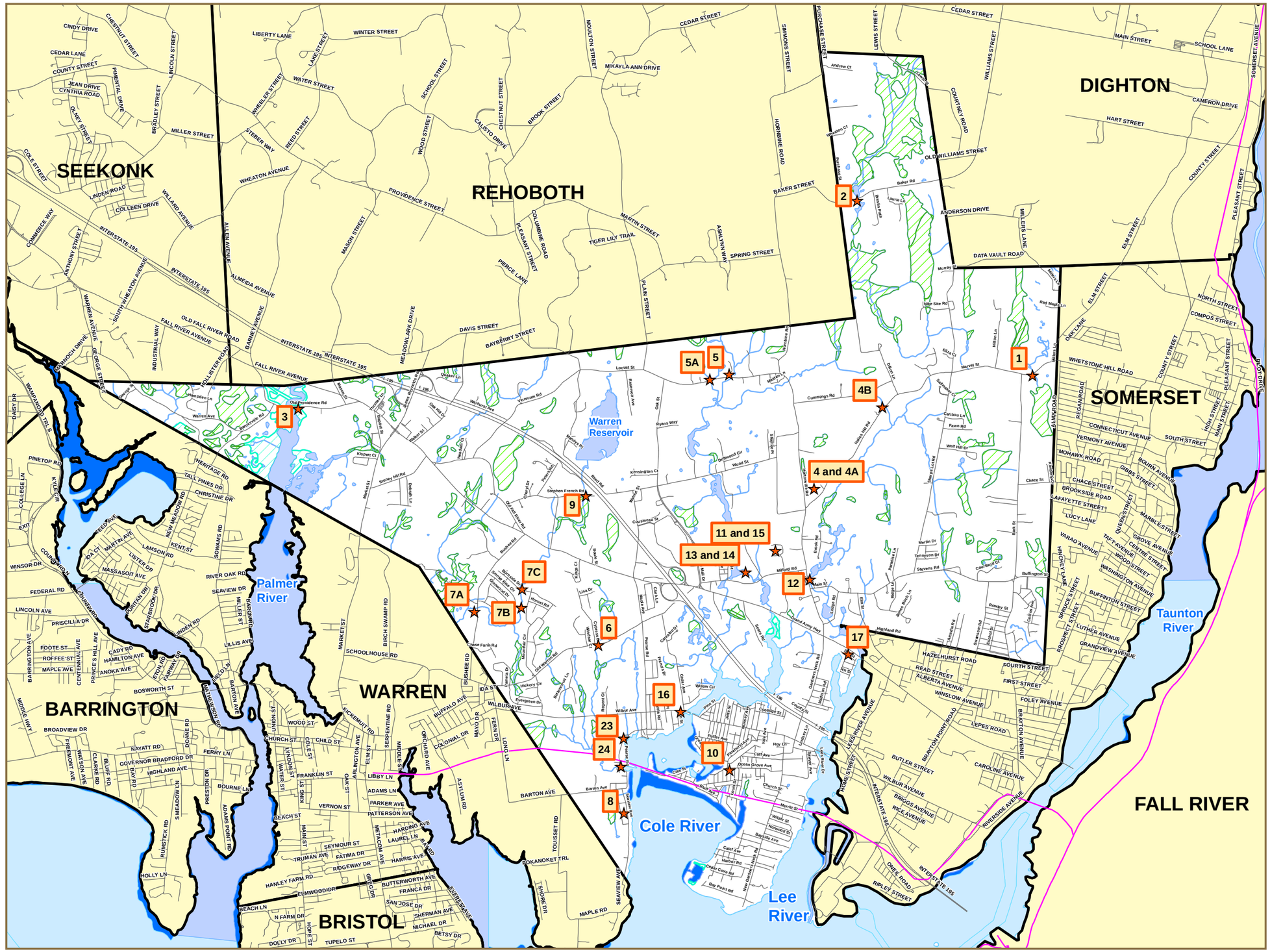
SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Prioritization Map

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
September 2015



Legend

- Prioritization Area
- Railroad
- Road
- Town Boundary

Hydrography Type

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Data Source:
MassGIS and
Town of Swansea

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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 7 Minutes (LPT)

Attendees: see attached attendance sheet

Discussion Items

General Meeting Minutes

- Approved Meeting 6 Minutes.
- Reviewed action item list and refined the high priority areas to differentiate and prioritize into further (high/higher/highest) categories

Updated Action Items (refer to attached spreadsheet and map)

Additional Notes for specific Action Items:

Action Item 4 & 4A:
- Scott Adams will be doing further work on Hailes Hill Road at both locations
- Steve will follow-up with Scott to get cost estimates for each project to include in the plan

Action Item 7B & 7C:
- Lynwood Road still need permission from property owner

Action Item 8:
- Flooding isolates community in that area

Action Item 9:
- Flooding isolates 19 houses

Action Item 11:
- Need to address accommodation for pets and pet food in an emergency

Action Item 12:
- In October 2015, Town was awarded $450,000 in grant money from the state for Swansea Dam

Action Item 14:
- Temporary repair has been completed relative to the sluice gate operation

Action Item 15:
- Head gasket was replaced but failed again

Follow-Up Items

Provide draft report at next meeting.

Next meeting scheduled for December 1, 2015 at 10 AM

HMPG Planning Meeting- October 13, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

Name	Department	Email	Phone
CARL F. SAWEJKO	SWANSEA EMA	CFSAW@JUNO.COM	508-676-2981
STEVE ANTINELLI	PLANNING	SANTINELLI@TOWN.SWANSEA.MA.US	508-324-6730
ALAN M. CORVI	SWANSEA HIGHWAY	acorvi@town.Swansea.ma.us	508-678-5615
Nuno Jorge	Swansea Highway	NJORGE@town.swansea.ma.us	508-678-5615
Mike Ohl	Comprehensive Environmental	mohl@ceiengineers.com	
Natalie Koncki	Comprehensive Environmental Inc.	nkoncki@ceiengineers.com	508-2815202
JOHN MCAULIFFE	TOWN ADMINISTRATOR	JMCAULIFFE@TOWN.SWANSEA.MA.US	508-678-2981 x1
GEORGE PRELOP	Swansea Police	george.arruda@swansea police.com	674-8461
Peter Burke	SWANSEA FIRE	PBURKE@TOWN.SWANSEA.MA.US	672 4305

Swansea HMGP : Prioritization and Implementation of Mitigation Actions

Revised October 13, 2015

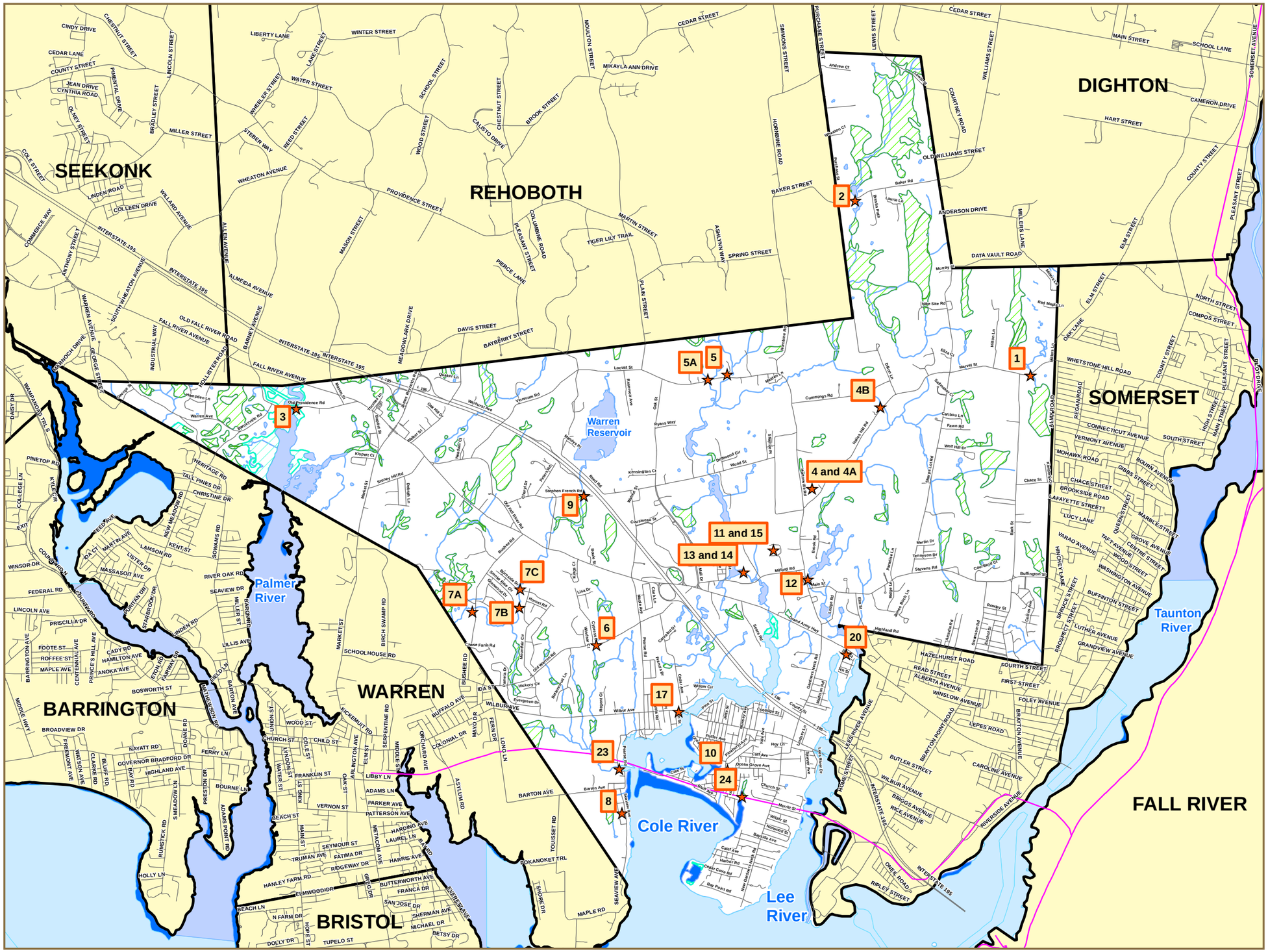
Action Item #	Map ID Number	Description	Location	Existing Conditions and Problem	Estimated Capital Cost for Proposed Mitigation Action	Solution / Mitigation Action	Mitigation Action Time Frame	Priority
1	1	Alleviate Flooding at Bark St @ Marvel St	Bark St at Marvel St	Existing conditions - three 24" culverts (good condition). Adjacent development site has incomplete stormwater controls and thereby floods during a storm.	NA	Perform routine maintenance on culverts.		On-going Maintenance
2	2	Alleviate Flooding on Baker Road	Baker Rd	Corrugated metal culvert (estimated 5 ft diameter) in poor condition and needs to be replaced.	$300K to $500K	Replace with concrete box culvert.		Low Priority
3	3	Alleviate Flooding on Old Providence Rd	Old Providence Rd	Area floods isolating nearby residents. Low lying area. Swansea Water District intake facility is protected, but may have limited access during flooding conditions.	NA	No action required, but continuous evaluation of access to Water Treatment Facility Intake station.		No Action
4	4	Alleviate Flooding on Hailes Hill Road	Hailes Hill Road	Existing conditions - estimated 30" corrugated metal culvert. Site floods during storm, possibly undersized culvert, from runoff from north along Hortonville Rd.	$300K to $500K	Replace with concrete box culvert. Preliminary/conceptual engineering work done by Advanced Engineering Group (Scott Adams).		Highest Priority
4A	4A	Alleviate Flooding on Hailes Hill Road	Hailes Hill Road near House #57 (east of Item 4)	Existing conditions - estimated 18" and 12" corrugated metal culverts. Deteriorated headwall needs repair. Site floods during storm, possibly undersized culverts.	$300K to $500K	Replace with concrete box culvert. Preliminary/conceptual engineering work done by Advanced Engineering Group (Scott Adams).		Highest Priority
4B	4B	Alleviate Flooding on Hailes Hill Road	Hailes Hill Road southwest of Dillon Lane	Existing conditions - estimated 18" corrugated metal culvert. Collapsed headwall needs replacement. Site floods during storm, possibly due to blockage.	$100K	Replace concrete headwall. Perform routine maintenance on culvert.		Low Priority
5	5	Alleviate Flooding on Locust Street	Locust Street near House #235	Existing concrete box culvert (4 ft by 6 ft) in good condition, possible blockage of adjacent catchbasins, existing private dams upstream and downstream. Overtopping of road during past flood conditions.		Confirm size/capacity of existing box culvert to determine if adequate or undersized. Perform routine maintenance on catchbasins. Investigate private dams.		Medium Priority
5A	5A	Alleviate Flooding on Locust Street	Locust Street (near power line crossing)	Reportedly floods, but significant detention area upstream, could just be a blockage (culvert was replaced recently might not be a problem).		Clear overgrown area to investigate condition/capacity of culvert further.		Further Investigation Required
6	6	Alleviate Flooding on Old Warren Road	Old Warren Rd near Cypress Dr	Existing conditions - two 30"concrete culverts upstream, two 30" concrete culverts and one 36" HDPE culvert downstream. Site floods during a storm.		Flooding most likely due to blockages of culverts with debris. Perform routine maintenance on culverts.		Low Priority
7A	7A	Alleviate Flooding on Bushee Road	Stream Crossing at Bushee Rd	Existing conditions - two concrete box culverts (estimated 4 ft by 10 ft each). Road overtops during flood events. Southernmost culvert blocked with sediment and should be cleaned out. Extensive vegetation upstream (beyond Town ROW).		Coordination with others to clear vegetation and remove excess sediment (Mosquito Control /National Grid Utility). Streamflows impacted by operation of Warren Reservoir (Bristol County Water Authority); coordination needed with flood control focus.		Low Priority
7B	7B	Alleviate Flooding on Lynwood Road	Stream Crossing at Lynwood Rd	Site floods during a storm. Two corrugated metal culverts (estimated 60" diameter) with bottom third filled with sediment. Pipe inverts possibly corroded.	$10 K sediment $300K-$500K culvert	Remove sediment and inspect condition of culverts. Replace with concrete box culvert if necessary.		Higher Priority
7C	7C	Alleviate Flooding on Burnside Drive	Stream Crossing at Burnside Dr	Site floods during a storm. Two corrugated metal culverts (estimated 42" diameter). Downstream headwall has settled. Possibly blocked with debris.	$10 K sediment $300K-$500K culvert	Remove debris and sediment to inspect condition of culverts. Replace with concrete box culvert if necessary.		Higher Priority
8	8	Alleviate Flooding on Seaview Ave	Seaview Ave	Undersized 8 inch culvert.	$300K to $500K	Replace with concrete box culvert. Difficult construction due to coastal impacts.		High Priority
9	9	Alleviate Flooding at Steven French Road	Steven French Rd	Site floods during a storm, creating a dead end with no access to residential area (Buckingham Estates). Existing corrugated metal culvert needs replacement.	$300K to $500K	Culvert needs to be replaced. Culvert size/cost dependent upon anticipated flows from Warren Reservoir, as controled by Bristol County Water Authority.		High Priority
10	10	Purchase back up generator to be used at a second evacuation facility in town	Council on Aging	Lack of back-up generator available for second evacuation center (i.e. Council on Aging).	$50K to $100K	Purchase portable generator.		Low Priority
11	11	Purchase a kennel trailer to accommodate pets in an emergency at the evacuation center	Next to High School	Current Swansea evacuation center (High School) does not accommodate pets.		Set-up agreement with pet clinics and animal hospitals. FEMA/MEMA potential funding for pet accommodations, as part of regional emergency response?		High Priority

Action Item #	Map ID Number	Description	Location	Existing Conditions and Problem	Estimated Capital Cost for Proposed Mitigation Action	Solution / Mitigation Action	Mitigation Action Time Frame	Priority
12	12	Dam Repair @ Swansea Lower Dam	Swansea Main Street Upper Lewin Swansea Dam	● Displaced scour apron riprap at the base of the spillway ● Leakage through the dam left of the spillway ● Irregularities along the spillway crest ● Cracked concrete approach slab ● Seepage through the spillway and dam walls ● Masonry joints requiring pointing ● An inoperable low level outlet	$210K-$450K (Dam Assessment)	Funding of required repairs and improvements being sought through State grant program.		Highest Priority
13	13	Dam Repair @ Milford Pond Dam	Milford Pond Dam	● Thick brush and tree growth and an uprooted tree cluster on the top of the upstream slope ● Seepage and leakage through the primary stone spillway ● A sinkhole and shifting crest stone on the primary spillway ● A timber spillway gate not properly seated on spillway invert ● Rotting stringers on the spillway control structure ● Poor conditions downstream of auxiliary spillway	$430K-$1,235K (Dam Assessment)	Funding of required repairs and improvements being sought through State grant program.		High Priority
14	14	Replace hand operated winch and upgrade flood control structure @ Milford Pond Dam	Milford Pond Dam	Portable hand operated winch has been subjected to vandalism andtheft in the past, limiting the Town's ability to operate this flood control structure.		Replace with permanent/lockable lifting mechanism (being done now by Town).		High Priority
15	15	Replace head gasket on generator	High School	Emergency generator at High School Evacuation center) is currently inoperable. Possible new head gasket replacement or completely new unit.	$250K (new unit)	Service or replace generator.		High Priority
16		Comprehensive Plan addressing existing emergency generators in town along with routine testing and operating protocols	Entire Town	Lack of documentation exists listing emergency generators available and routine testing and operating protocols (for all municipal installations in Town).		Establish uniform emergency generator testing protocols for all municipal installations.		Low Priority
17	17	Repair water main pipe joints at bridge crossing near Swansea Water District Office.	700 Wilbur Avenue	Separated joints exist at water main pipe at bridge crossing near main office, with possible risk of pipe failure during storm events.		Swansea Water District presently eliminates risk of service interruption by closing valves at each end of bridge, prior to severe storm events.		Low priority
18		Create storm preparedness plan for boat mooring	Coastal Areas	The town lacks a standard to address boat moorings that come loose during a storm.		Establish minimum requirements for boat moorings; draft policy is presently under consdieration by the Town (BOS).		Low Priority
19		Purchase portable generators to be used at cell towers	Cell Towers	Back-up power is lacking at cell towers; generally only 24 hrs of coverage exists. Impact communication only for general population; internal communications for Town emergency personnel are independent from the cell towers and reliable during power outages.		Cell phone providers do not guarantee infrastructure during storms. Regional issue relative to lack of infrastructure maintenance/investment by the various communication providers.		
20	20	Route 6 Verizon Distribution point	Manhole near Route 6 at White Church, Corner of Maple Ave	Manhole floods and freezes knocking out communications (including 911 service) to a large majority of the town.		Utility company's responsibility.		
21		Reverse 911 to residents	Entire Town	The town lacks a town wide communication system to reach out to residents in times of emergency.		Statewide issue that needs to be addressed, given the complexities of the issue and rapidly changing technology.		
22		Alleviate Flooding on Cole River Area	Cole River/Ocean Grove Area	Area has had repeated property damage.		Coastal flooding, low lying area.		No Action
23	23	Alleviate Flooding on Pearse Rd	Pearse Road at Stream Crossing	Existing culvert undersized and low elevation.		Replace/raise stream crossing culvert (project being done now by Town).		Highest Priority
24	24	Flooding from Railroad culvert	Near Railroad Ave and railroad	Old culvert in need of replacement		Replace culvert.		Higher Priority

Prioritization Map

Local Multi-Hazard Mitigation Plan

Swansea, Massachusetts
October 2015



Legend

- Prioritization Area
- Railroad
- Road
- Town Boundary

Hydrography Type

- Bay, Ocean
- Tidal Flats, Shoals
- Salt Wetlands
- Lake, Pond
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Data Source:
MassGIS and
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SCALE 1" = 4500'

Comprehensive Environmental Incorporated

Meeting 8 Minutes (LPT)

Attendees: see attached attendance sheet

Discussion Items

General - Approved Meeting Minutes (October 13, 2015).

Distributed and reviewed draft report (dated November 2015)

- Will provide electronic copy to Chief Burke and Steve Antinelli for review
- Missing information on local dams (Table 4.12). Will send plan of dam locations, for ease of referencing and checking. Believe there are only 5 dams in Town.
- Reviewed "Natural Hazard Index" scale (Table 4.15). Adjusted rating per discussion.
- Section 5 (Vulnerability Assessment) in progress – need to establish "value" of the various events per FEMA/MEMA methodology.
- LPT noted that the following areas should be highlighted as "critical":
    - Little Neck Road
    - Lee's River Avenue
    - Ocean Grove
- Discussed repetitive loss properties
- Reviewed "High Hazard" areas (Section 6.4).
- Reviewed "Existing Disaster Mitigation Measures Matrix" (Table 7.2). Modified responsibilities per discussion.
- Reviewed proposed mitigation measures, to reflect status of past recommendations (2004 SRPEDD Plan) and discussions. Add stormwater bylaw as proposed mitigation measure.
- Discussed emergency generator situation for critical facilities.
    - Current practice is "exercise" weekly, but not typically under load, as there have been past problems with loss of communication during actual transfer.
    - High School (Evacuation Center) generator needs repair/replacement. Under consideration by Town for funding.
    - Swansea Water District pre-emptively switches its facilities to generator power ahead of major storm events, so there is no interruption in water service.
    - LPT identified need for a complete list of Town-owned generators (Appendix D).
    - Responsibility for Town-owned generators is split among Police Department, Fire Department, School Department, Swansea Water District, etc.
- Discussed general implementation timetable for the proposed mitigation measures.
- Reviewed Public Outreach (Table 7.3). Noted that School Department has an electronic notification system that could be used in an emergency.
- Need listing of Bulk Flammable Storage locations (Appendix C)
- Discussed ongoing issue with pets and evacuation center.

Next meeting scheduled for January 5, 2016. Town representatives will meet internally in late December to collate all comments on the draft report, so they can discussed in January.

HMPG Planning Meeting- Dec. 1, 2015 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

Name	Department	Email	Phone
ROBERT A. MARQUIS	SWANSEA H2O DISTRICT	RMARQUIS@SWANSEAWATERDISTRICT.COM	508-676-0097
CARL F. SAWETKO	EMA	CFSAW@JUNO.COM	508-676-2981
Peter Burke	Fire	PBurke@Town.Swansea	508 672 4305
Mike Ohl	CEI	mohl@ceieng.com	508-231-5177
Joseph Carvalho	BOH	JCARVALHO@Town.Swansea	508-324-6404
Colleen Brown	Conservation	cbrown@Town.Swansea.MA.US	508-673-6467
William McGrady	Building	WMcGRADY@Town.Swansea.MA.US	508.272.9527
Steve Antinelli	Planning	SANTINELLI@TOWN.SWANSEA.MA.US	508-324-6730
George Arruda	Swansea Police	george.arruda@swanseapolice.com	508.674-8464
John McAuliffe	Town Admin	JMCAULIFFE@Town.Swansea.MA.US	508-678-2981
Nuno Jorge	Swansea Highway	NJORGE@Town.Swansea.MA.US	508-6785615
Alan Corvi	Swansea Highway	acorvi@town.swansea.ma.us	508-678-5615

Meeting 9 Minutes (LPT)

Attendees: see attached attendance sheet

Discussion Items

Town representatives met last week to compile internal comments on the draft report. Provided markup of draft report – will update to reflect comments/corrections. Provided updated list of dams located within Town (see attached).

Town has standard building numbering system; will include within report (see attached).

Distributed/presented draft Vulnerability Assessment (Section 5.0). Developed using HAZUS as required by FEMA, but property assessment values seem high. Data based upon historical information within the HAZUS software. CEI will check assessor's database for comparison.

Discussed public presentation (in the future). Key topics to include flood susceptible areas, evacuation routes, power loss issues, pet issues relative to evacuation, etc. Need to determine if the public presentation will be at a regular Board of Selectmen meeting or at a separate meeting. Will post the draft plan (pdf version) on the Town website for public viewing.

Discussed issue of pets and evacuation center.

- Will contact Liz Botelho (Animal Control Officer)
- Discussed potential use of "shop area" in High School (Evacuation Center) for pets. Would need to provide plastic sheeting and kennels/cages, with food to be provided by each pet's owner.
- Special considerations would need to be made relative to "service animals". Would need to establish policy on how to document "service animal" classification.

Discussed evacuation routes. Not specifically identified with any special signs, but experience has shown that people tend to follow their GPS instructions.

LPT identified blizzard/winter storm as greatest risk, due to potential power loss.

Discussed emergency power issues.

- Fire Department has some portable generators that it typically deploys to those with medical equipment, ahead of a major storm event.
- Town is currently considering a new requirement for gas stations to have emergency generators, so that fueling is possible during or after major storm events when the utility power is a greatest risk of failing.

Natural gas service may be vulnerable, especially Taunton River crossing and Palmer River crossing. Chief Burke to contact Liberty Utilities; possibly attend next meeting.

Town investigating new system for emergency alerts. Could ultimately connect to any phones (land lines or cellular) that are within a specific geographic area at any given time.

Follow-Up Items

Will provide updated "draft" report with edits from LPT, comments/discussion from meetings, and addition of the vulnerability analysis.

Next meeting scheduled for February 2016.

HMPG Planning Meeting- Jan. 5, 2016 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

Name	Department	Email	Phone
Peter Burke	Fire	PBurke@Town.Swansea.	508 672 4305
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Nuno Jorge	Highway	Njorge@Town.Swansea.MA.US	508-678-5615
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John McAuliffe	Town Admin	JMcAuliffe@Town.Swansea.MA.US	508-678-2981
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Colleen Brown	Swansea Con Com	cbrown@Town.Swansea.MA.US	508-673-6767
Mike Ohl	CEI	mohl@ceiengineers.com	508-281-5160

Table 4.12

Swansea Dams

Dam Name	Location	River	Owner	Ownership Type	Hazard Code
Swansea Print Works Dam	Ledge Rd	Lewin Brook into Lees River	Brightledge LLC	private	
Cole River Pond Dam	Wood St	Cole River	Wightman	private	
Warren Reservoir	Reed RD	Kickamuit River	Bristol CountyWater Authority	quasi-public	
Milford Pond Dam	Milford Rd	Cole River	Town of Swansea	public	
Swansea Dam (Montaup #5 Dan)	Main St	Lewin Brook	Town of Swansea	public	
Coles River Dam Rte 6 (Montaup #3 Dam)	GAR Hwy	Cole River	Town of Swansea	public	
Upper Lewin Pond Dam	Lewin Lane	Lewin Pond	Town of Swansea	public	

SWANSEA WATER DISTRICT

700 WILBUR AVENUE, SWANSEA, MA 02777
TEL. 508-672-9746 / 508-676-9097
FAX. 508-676-7452

TOWN OF SWANSEA
BUILDING NUMBERING SYSTEM

- EACH DIGIT REPRESENTS TEN FEET OF LINEAR DISTANCE (I.E. HOUSE NUMBER 50 IS 500 FEET FROM POINT OF BEGINNING)

- NUMBERING INCREASES EAST TO WEST

- NUMBERING OF LOCATIONS NORTH OF ROUTE SIX INCREASE FROM SOUTH TO NORTH, WITH THE EXCEPTION OF GARDNERS NECK ROAD WHERE NUMBERING BEGINS AT MAIN STREET AND INCREASES GOING SOUTH.

- NUMBERING OF LOCATIONS SOUTH OF ROUTE SIX INCREASE FROM NORTH TO SOUTH, WITH THE EXCEPTION OF MAPLE AVENUE WHERE NUMBERING BEGINS AT OLD WARREN ROAD AND INCREASES GOING NORTH.

Meeting 10 Minutes (LPT)

Attendees: see attached attendance sheet

Discussion Items

Reviewed updated "draft" report (dated February 2016).

- Pg 45 - Dam failure estimates – review/verify.
- Pg 48 – Add Chapter 40b development off Colletti Lane (Stephen French Road and Buckingham Drive) - potential flooding from Kickemuit River and site access limitations.
- Pg 49 – Revise Bushee Road description
- Pg 69 – Action Item 16. Problem with Verizon infrastructure is not limited to just one manhole structure. Problem areas/locations throughout Town (along Route 6, behind Fire Station, etc.). New Police Station has microwave communication system that eliminates reliance on Verizon system. Will modify action item to transition all emergency communication systems from Verizon to alternative technology.
- Pg 69 – Action Item 17. Consensus that existing regulation of boat moorings is already adequate. Minimal boat moorings and most are located within the marina, which already has specific requirements for replacement/upgrade of moorings.
- Pg 69 – Action Item 18. Consensus that current FEMA maps accurately reflect the areas prone to historical flooding. Will eliminate this action item.
- Pg 69 – Action Item 19. Will recommend that new gas stations (or reconstructions) include emergency generators with automatic transfer switches, as part of the Planning Board review process (currently being implement by Town).
- Certification Statement – signature by Board of Selectmen.

Follow-Up Items

Will provide updated report for posting on website and for public presentation.

HMPG Planning Meeting- Feb. 16, 2016 Swansea Fire Dept., 50 New Gardners Neck Rd, Swansea, MA 02777

Name	Department	Email	Phone
Peter Burke	Fire Department	PBurke@Town.Swansea.ma.us	508 672 4305
Carl Sawejko	EMA	CFSAW@JUNO.COM	508-676-2981
Alan Corvi	Highway	acorvi@town.swansea.ma.us	508-678-5615
Nuno Jorge	Highway	NJorge@town.Swansea.MA.us	508-678-5615
George Miranda	Swansea Police	george.miranda@swansea police.com	674-8461
Steve Antinelli	Planning	SAntinelli@Town.Swansea.MA.US	508-324-6730
Colleen M. Brown	Conservation Commission	Cbrown@Town.Swansea.ma.us	508-673-6467
Robert A. Marquis	Swansea H2O District	RMarquis@comcast.net	508-676-9097
Michael Ohl	Comprehensive Environmental	mohl@ceiengineers.com	508-281-5160

APPENDIX B – CRITICAL INFRASTRUCTURE

TIER 1 – EMERGENCY RESPONSE AND UTILITIES	
Emergency Response and Infrastructure	
Fire Station 1	137 Main Street
Fire Department, Station 2	50 New Gardner Neck Road
Fire Station 3	29 Riverside Avenue
Fire Station 4	1680 Grand Army Highway
Police Station	1700 G.A.R. Highway
Swansea Water District	700 Wilbur Avenue
Town Offices	
Town Hall	81 Main Street
Highway Department	101 Gardners Neck Road
Medical Services	
Women & Infants Medical Office Thirza C. Lareau Pediatrics	2200 G.A.R. Highway
St. Anne's Hospital	440 Swansea Mall Drive

TIER 2 – MUNICIPAL AND COMMUNITY CENTERS	
Education	
Joseph Case Junior High School	195 Main Street
Elisabeth S. Brown Elementary	29 Gardners Neck Road
Mark G. Hoyle Elementary School	70 Community Lane
Gardner Elementary School	10 Church Street
Joseph Case High School	70 School Street
Joseph G. Luther Elementary	100 Pearse Road
Swansea Special Education	1 Gardners Neck Road
Elderly Care Facilities	
Swan Brook Assisted Living	924 Gardners Neck Road

TIER 3 – OTHER	
Kindergarten, Preschool, and Daycare Facilities	
Happy Feet Pre-School	457 Milford Road
Early Minds Child Care Inc.	1727 Grand Army Highway
Small Wonders Nursery Daycare Inc.	21 Baptist Street
Head Start Preschool	439 Ocean Grove Avenue
Live and Learn Child Care	98 Ledge Road
Teacher's Pet Preschool	141 Wilbur Avenue
Animal Shelters	
Swansea Animal Control	68 Stevens Road

TIER 3 – OTHER (continued)	
Cultural and Historic Sites	
Luther Store	160 Old Warren Road
David M. Anthony House	98 Bay Point Avenue
Harold H. Anthony House	132 Bay Point Avenue
Bark Street School	Stevens Road at Bark Street
Barneyville Historic District	Old Providence and Barneyville Roads
Bend of the Lane	181 Cedar Avenue
Deacon John Buffington House	262 Cedar Avenue
Church of Christ	G.A.R. Highway at Maple Avenue
First Baptist Church and Society	Baptist Street
Francis L. Gardner House	1129 Gardners Neck Road
Joseph Gardner House	1205 Gardners Neck Road
Preserved Gardner House	90 Milford Road
Samuel Gardner House	1035 Gardners Neck Road
Hortonville Historic District	Locust Street from Oak Street to Hortonville Road
Luther's Corner	Old Warren and Pierce Roads
William Luther House	79 Old Warren Road
Short's Tavern	282 Market Street
Smuggler's House	361 Pearse Road
South Swansea Union Church	Gardners Neck Road
Swansea Village Historic District	Main Street from Gardners Neck Road to Stephens Road; Ledge Road
Walkden Farm	495 Marvel Street
Simcock House	1074 Sharps Lot Road
Colony Historic District	Gardners Neck and Mattapoisett Roads at Mt. Hope Bay
Luther House	177 Market Street
Hooper House	306 Hortonville Road
J. V. Johnson House	36 Riverview Avenue
William P. Mason House	5 Mason Street
John Brown IV House	703 Pearse Road
Norton House	61 Old Providence Road
Benjamin Cole House	412 Old Warren Road
Swansea Library	69 Main Street
Parks and Recreational Sites	
Swansea Town Beach	474 Ocean Grove Avenue

APPENDIX C – BULK FLAMMABLE STORAGE

The following provides an inventory of registered facilities storing flammable liquids in excess of 100 gallons, as registered with the Swansea Fire Department.

Registered Flammable Liquid Storage Over 100 Gallons

Facility Name	Address	Qty.	Capacity	Contents
Almeida's Vegetable Equipment Barn	245 Gardners Neck Road	1	500	Diesel
B. Conway Construction	2780 GAR Highway	1	500	LP
Baker Group, LLC	235 Locust Street	1	1000	Diesel
Baker Repeater Station	Rear of 2283 GAR Highway	3	100	LP
Bristol Toyota	2283 GAR Highway	1	2000	Waste Oil
Bristol Toyota Detailing	40 Walker Street	1	500	Class IIIB
Bristol Toyota Detailing	40 Walker Street	1	1000	Class I
Can Dig It Excavating	117B Boule Street	1	1000	Diesel
Can Dig It Excavating	117B Boule Street	1	500	Diesel
Can Dig It Excavating	117B Boule Street	1	600	Virgin Oil
Can Dig It Excavating	117B Boule Street	1	275	Waste Oil
Columbus Energies	1492 GAR Highway	1	8000	Diesel
Columbus Energies	1492 GAR Highway	1	5000	Gasoline
Columbus Energies	1492 GAR Highway	1	8000	Gasoline
Columbus Energies	1492 GAR Highway	1	3000	VP Racing Fuel
Cumberland Farms North	1115 GAR Highway	6	8000	Gasoline
Cumberland Farms South	520 Wilbur Avenue	3	10000	Gasoline
E & V Oil Co.	2500 GAR Highway	4	2000	Heating Oil
Gas On The Run	2264 GAR Highway	3	6000	Gasoline
Gas On The Run	2264 GAR Highway	1	5000	Gasoline
Gas On The Run	2264 GAR Highway	1	300	Waste Oil
The Ice Cream Barn	289 Locust Street	1	500	LP
Kwik Lube & Tune	537 GAR Highway	1	1500	Class IIIB
Kwik Lube & Tune	537 GAR Highway	1	600	Waste Oil
Levesque's Tree Service	531 Hailes Hill Road	1	1500	Diesel

Registered Flammable Liquid Storage Over 100 Gallons (Continued)

Facility Name	Address	Qty.	Capacity	Contents
MC Souza Sand & Gravel	239 Hortonville Road	1	500	Waste Oil
MC Souza Sand & Gravel	239 Hortonville Road	1	350	Virgin Oil
MC Souza Sand & Gravel	239 Hortonville Road	1	1000	Diesel
Mac's Auto Service & Sales	1025 GAR Highway	1	550	Waste Oil
McLeod's Swansea Citgo	737 GAR Highway	1	8000	Gasoline
McLeod's Swansea Citgo	737 GAR Highway	1	10000	Gasoline
McLeod's Swansea Citgo	737 GAR Highway	1	6000	Diesel
Mobil Gas	52 James Reynolds Road	1	10000	Diesel
Mobil Gas	52 James Reynolds	3	10000	Gasoline
Monro Muffler	742 GAR Highway	1	600	Class IIIB
Monro Muffler	742 GAR Highway	1	240	Waste Oil
North Swansea Shell	2345 GAR Highway	3	10000	Gasoline
Ocean Grove Tire & Auto	127 Macomber Avenue	1	1000	LP
Ocean Grove Tire & Auto	127 Macomber Avenue	1	700	Virgin Oil
Ron Nahas & Sons Auto Repair	575 GAR Highway	1	1000	LP
Ron Nahas & Sons Auto Repair	575 GAR Highway	1	600	Waste Oil
Route 6 Auto Mall	1049 GAR Highway	1	350	Virgin Oil
Route 6 Auto Mall	1049 GAR Highway	1	300	Waste Oil
Schmidt Equipment	2397 GAR Highway	1	1500	Virgin Oil
Schmidt Equipment	2397 GAR Highway	1	500	Waste Oil
Sears & Roebuck	262 Swansea Mall Drive	1	2020	Class IIIB
Sears & Roebuck	262 Swansea Mall Drive	1	433	Class III
Sharps Lot Rd Repeater Station	206 Sharps Lot Road	1	500	LP
Shawmut Metal Products	1914 GAR Highway	1	1000	LP
Sherry Construction Corp	215 Sears Road	1	500	Diesel
Sherry Construction Corp	215 Sears Road	1	275	Waste Oil
Speedway East	35 GAR Highway	3	10000	Gasoline
Speedway West	800 GAR Highway	4	10000	Gasoline
Suburban Propane	1499 GAR Highway	1	30000	LP
Swansea Country Club	299 GAR Highway	1	500	Gasoline

Registered Flammable Liquid Storage Over 100 Gallons (Continued)

Facility Name	Address	Qty.	Capacity	Contents
Swansea Country Club	299 GAR Highway	1	500	Diesel
Swansea Country Club	299 GAR Highway	1	300	Waste Oil
Swansea Highway Department	101 Gardners Neck Road	1	1000	LP
Swansea Highway Department	101 Gardners Neck Road	1	7000	Gasoline
Swansea Highway Department	101 Gardners Neck Road	1	5000	Diesel
Swansea Marina	161 Calef Avenue	1	4000	Gasoline
Swansea Oil Co.	2115 GAR Highway	2	2000	Heating Oil
Swansea Police Department	1700 GAR Highway	2	1000	LP
Swansea Water Desalinization Plant	240 Vinnicum Road	1	1525	Diesel
Swansea Water District	700 Wilbur Avenue	1	2000	Gasoline
Swansea Water Vinnicum Rd Well Field	700 Wilbur Avenue	1	500	Diesel
Walmart	54 Cousineau Drive	1	2120	Class III
Walmart	54 Cousineau Drive	1	370	Class I & II
Arthur Orzechowski	365 Hailes Hill Road	1	1500	Diesel
David Fernandes	304 Oak Street	1	1000	Diesel

APPENDIX D – BACKUP POWER SUPPLIES

The following provides an inventory of backup power sources capable of supplying emergency power to infrastructure.

Backup Power Supply Sources

Facility	Address	Power Source	Fuel Type	Quantity	Expected Duration
Baker Repeater Station	Rear of 2283 GAR Hwy	60 KW	LP	3 x 100 lb	N/A
Baystate Veterinary	76 Baptist St	30 KW	Natural Gas	N/A	N/A
Brown Elementary School	29 Gardners Neck Rd	28 KW	Natural Gas	N/A	N/A
Case High School	70 School St	170 KW	Natural Gas	N/A	N/A
Case Junior High School	195 Main St	45 KW	Natural Gas	N/A	N/A
Country Gardens Skilled Nursing	2045 GAR Hwy	185 KW	Diesel	350 g	N/A
East Bay Surgery Center	440 Swansea Mall Drive	150 KW	Diesel	250 g	24 hrs @ 100%
Hoyle Elementary School	1 Community Way	100 KW	Diesel	224 g	N/A
MA/RI Veterinary ER	477 Milford Rd	20/100 KW	Natural Gas	N/A	N/A
Meadowridge Academy	664 Stevens Rd	48 KW	Natural Gas	N/A	N/A
Sharps Lot Repeater Station	206 Sharps Lot Rd	20 KW	LP	500 g	N/A
Swan Brook Assisted Living	924 Gardners Neck Rd	30 KW	Natural Gas	N/A	N/A
Swansea Ambulance Corps	285 Wilbur Ave	20 KW	Natural Gas	N/A	N/A
Swansea Fire Department, Station 1	137 Main St	30 KW	Diesel	135 g	N/A
Swansea Fire Department, Station 2	50 New Gardners Neck Rd	60 KW	Diesel	300 g	N/A
Swansea Fire Department, Station 4	1680 GAR Hwy	50 KW	Diesel	308 g	N/A
Swansea Highway Department	101 Gardners Neck Rd	50 KW	LP	1000 g	6.5 days @ 75%
Swansea Police Department	1700 GAR Hwy	150 KW	Natural Gas Primary w/LP back up	2 x 1000g LP	92 hrs on LP back up

Backup Power Supply Sources (Continued)

Facility	Address	Power Source	Fuel Type	Quantity	Expected Duration
Swansea Police Department	1700 GAR Hwy	58 KW (trailer)	Diesel	90 g	21 hrs
Swansea Water Desalinization Plant	240 Vinnicum Rd	750 KW	Diesel	1525 g	4-5 days
Swansea Water Hornbine Rd Treatment	150 Hornbine Rd	150 KW	Natural Gas	N/A	N/A
Swansea Water Vinnicum Rd Well Field	700 Wilbur Ave	96 KW	Diesel	500 g	4-5 days
Swansea Wood School	789 Stevens Rd	48 KW	Natural Gas	N/A	N/A
Baker Repeater Station	Rear of 2283 GAR Hwy	60 KW	LP	3 x 100 lb	N/A
Baystate Veterinary	76 Baptist St	30 KW	Natural Gas	N/A	N/A

APPENDIX E – STAPLEE PLANNING CRITERIA

The STAPLEE method was developed by the Federal Emergency Management Association as a technique for identifying, evaluating and prioritizing mitigation actions based on existing local conditions. Using the following criteria as provided in FEMA's 2008 Local Multi-Hazard Mitigation Planning Guidance document, local communities can weigh the pros and cons of implementing particular mitigation measures:

- **S**ocial — The public must support the overall implementation strategy and specific mitigation actions. Therefore, the projects will have to be evaluated in terms of community acceptance.

- **T**echnical — It is important to determine of the proposed action is technically feasible, will help reduce losses in the long term, and has minimal secondary impacts. Determine whether the alternative action is a whole or partial solution, or not a solution at all.

- **A**dministrative — Examine the anticipated staffing, funding, and maintenance requirements for the mitigation action to determine if the jurisdiction has the personnel and administrative capabilities necessary to implement the action or whether outside help will be needed.

- **P**olitical — Understand how your community and State political leadership feels about issues related to the environment, economic development, safety, and emergency management. Proposed mitigation objectives sometimes fail because of a lack of political acceptability.

- **L**egal — Determine whether your jurisdiction has the legal authority to implement the action, or whether the jurisdiction must pass new laws or regulations. Legal authority is likely to have a significant role later in the process when your community will have to determine how mitigation activities can best be carried out, and to what extent mitigation policies and programs can be enforced.

- **E**conomic — Cost-effective mitigation actions that can be funded in current or upcoming budget cycles are more likely to be implemented than mitigation actions that would incur long-term debt. Communities with tight budgets or budget shortfalls may be more willing to undertake a mitigation initiative if it can be funded, at least in part, by outside sources.

- **E**nvironmental — Evaluate whether, when implementing mitigation actions, there would be negative consequences to environmental asses such as threatened and endangered species, wetlands, and other protected natural resources.

APPENDIX F – DOCUMENTATION OF PLAN ADOPTION

Final certification to be completed and attached upon plan finalization.

TOWN OF SWANSEA, MASSACHUSETTS

CERTIFICATE OF ADOPTION

SWANSEA, MASSACHUSETTS

BOARD OF SELECTMEN

A RESOLUTION ADOPTING THE

SWANSEA, MA LOCAL MULTI-HAZARD MITIGATION PLAN

WHEREAS, the Town of Swansea established a Committee to prepare the Hazard Mitigation plan; and

WHEREAS, the Town of Swansea, participated in the development of the

LOCAL MULTI-HAZARD MITIGATION PLAN FOR THE TOWN OF SWANSEA*;*

and WHEREAS, the **LOCAL MULTI-HAZARD MITIGATION PLAN FOR THE TOWN OF SWANSEA** contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Swansea, and

WHEREAS, a duly-noticed public meeting was held by the BOARD OF SELECTMEN on _____, 20_____ for the public and municipality to review prior to consideration of this resolution; and

WHEREAS, the Town of Swansea authorizes responsible departments and/or agencies to executes their responsibilities demonstrated in the plan, and

NOW, THEREFORE BE IT RESOLVED that the Town of Swansea Board of Selectmen, formally approves and adopts the **LOCAL MULTI-HAZARD MITIGATION PLAN FOR THE TOWN OF SWANSEA**, in accordance with M.G.L. c. 40.

ADOPTED AND SIGNED this _____, 20_____

ATTEST