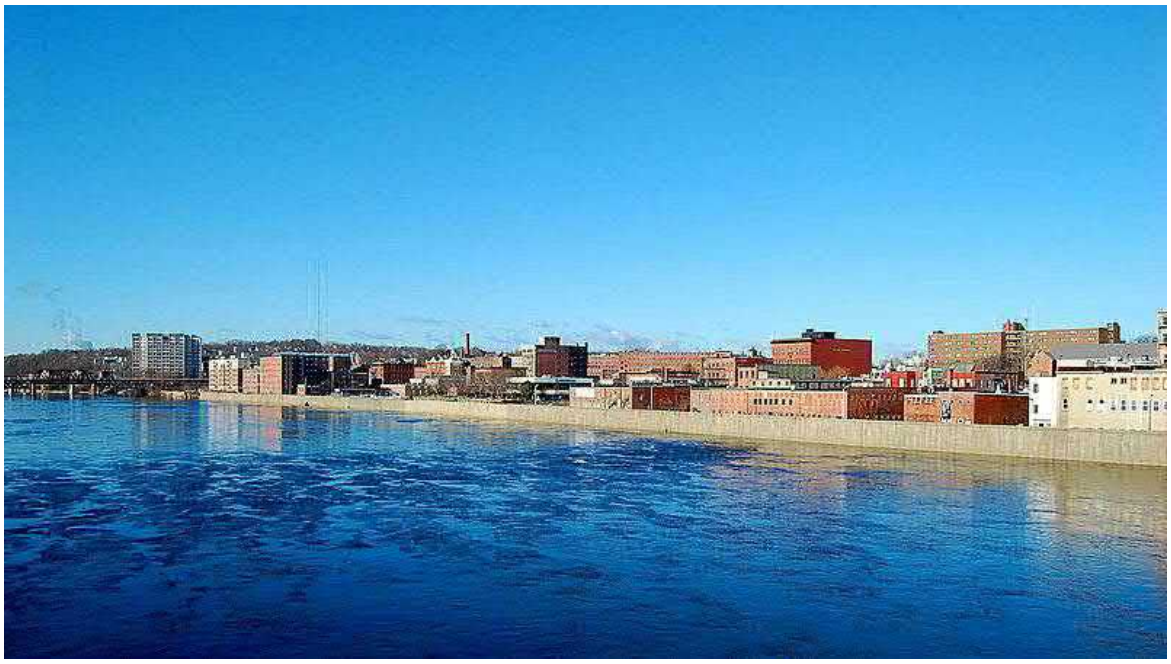
City of Haverhill



Community Resilience Building Workshop

Summary of Findings

June 2020

FUSS & O'NEILL

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City of Haverhill

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Summary of Findings

Overview

Extreme weather and natural and climate-related hazards are an increasing concern for the communities of Massachusetts, and there is a clear need to involve municipalities, corporations, organizations, and the State in increasing resilience at all levels. Recent storm events affecting the region have highlighted many of the vulnerabilities that towns and cities face. Hurricane Irene and Superstorm Sandy brought intense flooding to many municipalities and threatened (or destroyed) infrastructure across the state. Extreme temperatures at both ends of the spectrum have pushed the limits of communities' preparedness to protect both infrastructure and people. In coastal communities, the impacts of sea level rise are felt daily and further exacerbate the impacts of other extreme events. Current climate modeling indicates that all of these hazards are expected to increase in frequency and scale over the coming decades. The Municipal Vulnerability Preparedness (MVP) program provides support and a prescribed process for towns and cities in Massachusetts to plan proactively for resiliency and implement key climate change adaptation actions.

In 2020, the City of Haverhill was awarded a $70,600 MVP grant to fund the planning stage of this process. The City partnered with Fuss & O'Neill, a state certified MVP Provider, to complete a comprehensive, baseline climate change and natural hazard vulnerability assessment and develop a list of priority actions for the City, with an expanded scope to study the impact of contaminated sites on environmental justice (EJ) populations. This process involved the development of an MVP Core Team, which met on February 4, 2020 to determine initial concerns and worked to identify stakeholders within the municipality and set goals for the process. Those stakeholders were then invited to participate in a Community Resilience Building (CRB) workshop on March 4, 2020, engaging in a day-long, tried and tested process developed by The Nature Conservancy. The CRB methodology is an "anywhere at any scale" format that draws on stakeholders' wealth of information and experience to foster dialogue about the strengths and vulnerabilities within the City. Workshop participants interacted at both large and small group levels, using an iterative process to gather input, synthesize ideas across groups, and ultimately develop a set of priority resilience and adaptation actions.

The CRB workshop's central objectives were to:

- Define top local natural and climate-related hazards of concern;
- Identify existing and future strengths and vulnerabilities;
- Develop prioritized actions for Haverhill;
- Identify immediate opportunities to collaboratively advance actions to increase resilience.

Top Hazards and Vulnerable Areas

During the Community Resilience Building workshop, participants were asked to identify the top four natural hazards of concern for the City of Haverhill. Discussion of the top hazards built on earlier conversations that took place at the MVP Core Team Meeting. Flooding was identified as a top hazard, as was extreme precipitation (which could take the form of rain or snow and ice). Extreme temperatures—both very hot days and very cold days—were seen as a third major hazard. Major storm events—including hurricanes, Nor'easters, and tornadoes— were identified as a fourth hazard. These four hazards have already had demonstrated impacts on the City, and as climate change progresses, these hazards are expected to have ever greater consequences for infrastructure and environment, as well as for various societal elements. Specific areas of concern are identified below.

Top Hazards

- Flooding
- Extreme Precipitation
- Extreme Temperatures
- Major Storm Events

Areas of Concern

While many impacts are expected to be felt City-wide, certain elements, locations, or community groups present particular concerns.

Neighborhoods/Communities
Acres neighborhood, Mount Washington neighborhood, environmental justice communities, recently arrived immigrants (including undocumented), homeless population, senior population

Facilities
Haverhill Public Library, Citizen Center, Haverhill Public Schools, Whittier Regional Vocational Technical High School, wastewater treatment plant, Homeless shelters, water treatment plant, Haverhill Fire Department

Dams
Little River Dam, Frye Pond Dam, Millville Dam

Infrastructure
Route 110, Route 97, River Street, Kenoza Avenue, Bradford Bridge and Riverside Bridge, drinking water infrastructure, water pump stations, Army Corps Flood Wall and Marginal Pump Station (downtown flood protection system), electrical substations

Current Concerns and Challenges Presented by Hazards

Major storm events have been a recurring threat to Haverhill throughout its history, from hurricanes bringing wind, intense precipitation, and localized flooding, to winter storms delivering ice and snow. Haverhill experienced extensive flooding during the Flood of 1936, when successive bouts of heavy precipitation caused the Merrimack River to flood to record levels and left the downtown area under feet of water. In response, the Army Corps of Engineers built a 30-foot tall flood wall in the downtown area. Later, in the 1950's, the City lost a significant portion of its street trees to hurricanes during the 1950's—the tree canopy has not recovered.

More recently, the City has been experiencing an increasing regularity of storms, with the so-called 100 year storm occurring every few years. In a City accustomed to hurricanes, there is a sense that Haverhill has been through this before, and knows how to handle storm-proofing, but there is also a sense that modern storms are different in important ways. The Fire Chief referred to these events as "more powerful and quick hitting" than the City has previously been accustomed to. The City's DPW director noted that over the last ten to fifteen years in particular, he has noted an increasing frequency of storms, and there has been a significant uptick in FEMA emergency declarations in the past three to four years. The Mother's Day Flood of 2006 flooded parts of the South side of the City, and the Merrimack River rose to within two feet of the top of the floodwall protecting downtown.

More intense storms delivering higher volumes of precipitation in a single event are expected to continue to put significant pressure on the City's infrastructure, including dams, culverts, and other drainage infrastructure that were designed to handle smaller storms with more consistent distributions of precipitation. This problem already manifests itself at points across the City, such as River Street, Kenoza Avenue, Route 97, and Route 110, which are prone to flooding. Anecdotal evidence suggests that the City's 13 combined sewer overflows (CSOs) have been discharging more frequently because of this increase in heavy precipitation, contributing to water quality problems in the Merrimack River.

The Merrimack River has also been experiencing a rapid increase in erosion along its banks, which City stakeholders attribute to the increased heavy precipitation.

At the opposite extreme, drought has also had recent impacts on the City. In 2016, Haverhill was under voluntary water restrictions, and drought was sufficiently severe that it reinforced Haverhill's need to connect to alternate sources of drinking water supply. The City built on previous efforts of pursuing additional water supply, focusing on a redundant groundwater source to reduce the City's reliance on surface water.

Extreme temperatures are also negatively impacting the City's infrastructure. Haverhill's water infrastructure, much of which is over 100-years old, is prone to bursts and leaks during freezing temperatures and flooding events. Extreme temperatures have also had social impacts in the City, leading to greater use of cooling and warming shelters, which are especially critical for the high percentage of vulnerable populations in the City. The Haverhill Public Library and the Citizen Center have both served as cooling shelters in recent years. In 2019, the Council on Aging opened as a cooling shelter for seven days. The City has had to open neighborhood fire hydrants to create opportunities for kids in densely populated downtown areas to cool down, since the City lacks adequate opportunities for swimming and cooling off.

Specific Categories of Concerns and Challenges

Infrastructural

Bridges and Culverts
Existing culverts and bridges were designed to accommodate historic patterns of precipitation and runoff, but are rapidly becoming inadequate as a result of climate change. While design standards have changed, the City's infrastructure largely predates such changes, and thus has not kept up with new standards. As precipitation events become more intense and less predictable, undersized culverts are expected to pose a greater threat of failure and flooding. Moreover, many of the City's bridges and culverts are known to be in poor structural condition, which could increase their risk of failure. Although culverts and bridges are a concern City-wide, workshop participants focused on several in particular, including the Bradford Bridge and Riverside Bridge. The City has implemented some recommendations from a City-wide bridge assessment conducted approximately 20 years ago, including elevating the Rocks Village Bridge and Basiliere Bridge.

Stormwater Infrastructure
Stormwater infrastructure is recognized as a potential concern City-wide. Similarly to culverts conveying natural streams, there is a general recognition that much of the stormwater drainage system in City was designed to accommodate historic patterns of precipitation and runoff, and may be undersized as climate and weather patterns continue to shift. The City's aging stormwater infrastructure exacerbates flooding potential during heavy rains. According to John Pettis, City Engineer, the City deals with stormwater problems on a weekly basis due to aging and undersized infrastructure, with residents constantly reporting new problems at various locations.

Roads
Roads in Haverhill are subject to flooding during heavy precipitation events. Workshop participants noted several in particular—River Street, Kenoza Avenue, Route 97, and Route 110—as being prone to flooding. Workshop participants discussed how this flooding may impact commutes and how roadway impacts due to hazard events may compromise the City's ability to provide emergency services. A lack of snow storage due to narrow streets was also mentioned as a topic of concern—the City has had to buy larger snow blowers to be able to fully clear roads and sidewalks.

Electrical Infrastructure
Electrical lines can be knocked out by snow, ice, and wind events, causing extensive impacts to the City. Workshop participants recalled the 2008 ice storm, where ice accretion cause downed power lines in portions of the City. Haverhill is currently connected to seven different electrical grids, and the downtown area is fed from two different substations, though both systems have gone down simultaneously at least one time in recent years. The City has some underground electrical in the downtown area, which is aging and subject to flooding during heavy precipitation events. Workshop participants also expressed concern over flooding at substations as well as an interest in storm-hardening and establishing redundancy in the system in the case of power outages—a number of historic substations in the City are located on waterways and may need to be raised or rebuilt to prepare for the potential impacts of climate change. National Grid recently renovated the Water Street substation to make resiliency improvements, though it is still located in a flood-prone area, and some workshop participants questioned why it had not been relocated to higher ground. According to workshop participant Joe Muraco, Community and Customer Management at National Grid, National Grid is addressing climate resiliency in Haverhill in two ways: 1) by assessing the resilience of existing infrastructure and 2) by improving the long-term sustainability of the electrical system. National Grid is working to increase the use of renewable

generation and also considering how best to address challenges posed by expected future shifts in peak energy use, such as a potential spike in nighttime usage due to increasing number of electric vehicles being charged at night, when solar production is at its lowest.

Gas Infrastructure

Many of the aging gas lines in the City are made of cast iron or bare steel, both of which are prone to water leaks during flooding events. When water gets into the system, the lines must be shut down to purge the water, and each individual service address must then be visited in order to restore service. This can result in gas service being unavailable for several days when there is a need to purge water from the lines. National Grid is in the midst of implementing a state-wide gas system enhancement plan (GSEP) to replace leak-prone infrastructure, including cast iron, bar steel, and wrought iron pipes; the plan is expected to be fully implemented within 20 years. A representative from National Grid also noted that a critical gas shutoff valve is located in the floodplain.

Water and Wastewater Infrastructure

Aging water infrastructure, especially in the floodplain, is a concern City-wide. A considerable amount of the water and wastewater infrastructure in Haverhill is over 100 years old, and is therefore undersized for current demand and vulnerable to freezing and flooding hazards that exacerbate stress on already aging structures, such as brick sewer lines. Workshop participants noted an increase in drinking water main breaks during freezing temperatures. Additionally, in early 2020 a 30-inch combined sewer pipe collapsed on Main Street near the bridge. The City's main sewer pump station is also vulnerable to flooding, though the pump stations do have back-up power supplies. The wastewater treatment plant has backup for primary treatment, but not for the secondary treatment systems.

Water Supply

A majority of the City, with the exception of approximately 1,000 private drinking water wells, relies on the City's public water supply. The City currently sources all of its drinking water from surface water drawn from Crystal Lake, Kenoza Lake, Millvale Reservoir, and Round Pond. Prior to the 2016 drought, the City began assessing potential additional water sources to increase resilience and reduce the City's reliance on surface water; although the City was not under emergency restrictions from the State during the 2016 drought, the City adopted voluntary water restrictions, and the incident reinforced the City's need for connection to additional water supplies. The City plans to build a new groundwater well that will tap into supplies from sand and gravel deposits beneath the Merrimack River to diversify the City's public water supply. This would provide the City with a redundant water supply of six to seven million gallons a day, although this source is not anticipated to be online for at least 5 years. There are also three surface water supplies that are still registered as emergency water sources for the City, but that have not been actively used since the 1980s—Johnson Pond, Hovey's Pond, and Chadwick Pond. These supplies were pulled offline due to water quality issues with cryptosporidium and giardia that were not cost-effective to treat. The City is currently in the process of upgrading the Drinking Water Treatment Plant (built in 1980, with a current capacity of 12mgd); upgrades are expected to be operational within 1-2 years.

Flood Wall

In response to the Flood of 1936, the Army Corps of Engineers built a 30-foot high, 2,200 foot long floodwall along the Merrimack River where it flows adjacent to the City's downtown area. During the 2006 Mother's Day flood, the level of the Merrimack River was approximately two-feet below the top of the wall; the elevation of the 2006 flood was eight feet below the elevation of the 1936 flood. Recently, the City upgraded the flood protection system to provide additional protection. There are numerous businesses, many of them small businesses, located in the downtown area protected by the floodwall. Because they are protected by a federally-certified floodwall, these businesses are not currently located in a mapped FEMA floodplain; however,

if the flood wall were to fail, they would be at risk of flooding. According to workshop participants, many of the small businesses in the downtown area would not be able to recover from flood-related closures and losses. Furthermore, workshop participants expressed concern over the lack of backup power supply at the original 1930's Army Corps of Engineers pump station, which is still relied on today. In addition to the flood wall built by the Army Corp of Engineers, there are privately-owned retaining walls date back to the 1800s along the river. These are deteriorating and in need of maintenance.

Septic Systems and Private Wells

Septic systems may be subject to failure and leakage, especially during flooding or heavy precipitation events, potentially leading to discharges of sanitary waste to the environment, posing a threat to both human health and the environment. Workshop participants expressed concern over the potential increased risk of failure of the approximately 3,000 septic systems in the City. In addition, there are approximately 1,000 private wells in the City which may be subject to both drought impacts or potential contamination from flooding.

Dams

The Little River Dam is the primary dam of concern in the City. The dam was originally built for mill power, although it has not been used for this purpose for many decades. The Little River runs north to south, and divides the City, with limited crossover points available. Workshop participants noted that as a result of the dam, upstream areas at Apple Street and Little River Street experience an artificially high flood elevation. Workshop participants discussed several potential benefits of removing the dam, including 1) increased flood capacity and reduced flooding risk in an Environmental Justice area 2) the addition of a river access point, and 3) a potential increase in the marketability of the adjacent property, which the City believes has been hindered in part due to the additional liability associated with taking on ownership of the Little River Dam. Frye Pond Dam, which also serves as a bridge across Snows Brook at North Avenue, was also brought up as a dam of concern, in part due to its close proximity to a hospice center. Workshop participants were uncertain of the dam's condition or ownership, but expressed interest in removing the dam and replacing it with a bridge. Millvalle Dam was also discussed by workshop participants as a dam in need of repair. The dam, which was built to create the Millvalle Reservoir, is the only "high" hazard dam in the City.

Buildings and Facilities

The Water Street Fire Station, and wastewater treatment plant are both located within the floodplain, which poses a threat to vehicles and equipment and threatens the ability of the personnel to respond to emergencies during hazard events. As noted above, the City's wastewater treatment plant lacks emergency power for its secondary treatment equipment; the City is in the engineering stages of developing upgrades to the facility. The City's schools are aging. Four elementary schools in the City lack air conditioning, and some face problems related to aging HVAC systems. Whittier Regional Vocational Technical High School, which is approximately 50 years old, is exploring options for rebuild/redesign and considering what HVAC options will provide the best capacity to adapt to changes in extreme temperatures expected as a result of climate change (there is currently no centralized air at the facility). Workshop participants also brought up concerns over privately-owned buildings that play an important role in social support organizations, including Head Start/Early Head Start, which is housed in a building that lacks air conditioning and is in need of a new roof. The organization has applied for a grant for air conditioning. In general, backup power supply for City buildings and facilities is limited. Some of the City's schools as well as the Fire Station have backup generators, although workshop participants identified them as being insufficient for the needs of the facilities.

Merrimack Valley Regional Transit Authority (MVRTA)

Joe Costanzo, Administrator of the Merrimack Valley Regional Transit Authority (MVRTA), voiced concerns over the MVRTA facility, which houses approximately 70 vehicles, being located in the floodplain. There are numerous hazardous substances, including anti-freeze, oil, and diesel, on-site. During the 2006 Mother's Day

Flood, the Merrimack River crested at 38 feet and almost flooded the facility. He expressed the need for contingency planning to prepare for climate hazard events and flooding of the facility.

Environmental

Water Quality

Surface waterbodies are subject to algal blooms, particularly during times of excessive heat and/or drought. Excessive algal growth is exacerbated by climate change impacts, including increasing temperatures, drier summers, and overall lower water levels. This can in turn result in fish kills, recreation impacts, and negative health effects. The problem is exacerbated by increasing nutrient pollution, which is frequently driven in part by land use change around ponds and reservoirs. If residential lawns lead right down to the water, there is no buffer to trap and filter nutrients. Workshop participants in Haverhill expressed concern over the potential impacts of climate change on the City's drinking water source, as the City currently obtains its water supply entirely from surface water. As noted above, the City is currently pursuing a redundant groundwater supply source. Water quality in Haverhill is also impacted by 13 combined sewer overflows (CSOs) that discharge to the Little River and the Merrimack River. The City is under a consent order to reduce CSOs, and is in Phase III of a plan to eliminate CSOs. DPW is working in partnership with the Watershed Council and Conservation Commission to implement these plans. Workshop participants expressed concern over the potential increase in CSO discharges as a result of increased heavy precipitation events.

Local Agriculture

Climate change is expected to result in a longer growing season for New England, which can be beneficial for some crops but may lead to issues with others, for instance, by allowing additional time for blight or other crop diseases to develop. Early melt of snow pack, drought, excessive rain, and changing temperatures may all affect agriculture and livestock at varying scales. Workshop participants expressed concern over how unpredictable climate and weather conditions may impact the long-running Haverhill Farmers Market, as well as specific farms in the City, such as Wally's Farm Stand, a vegetable producer, and Kimball Farm, which produces beef, pork, and eggs. In 2019, the City adopted an Agricultural Commission to help support and protect farms.

Trees and Forests

Forests provide critical ecosystem services that help buffer the effects of climate change, from storing and sequestering carbon, to increasing groundwater recharge, to modulating local temperature. Street trees are likewise critical for infiltration of rainwater and provision of shade and cooling. However, trees and forests are also threatened by climate change. Wind and storms cause blowdowns, drought can contribute to die-off, new invasive pests (e.g., Emerald Ash Borer and Hemlock Wooly Adelgid) are eliminating certain tree species, and others are in decline (especially oaks) due to shifting temperature and precipitation regimes that favor more southerly species. Haverhill lost a significant portion of its street trees during a hurricane event in the 1950's. Tree decline and riverbank erosion are also closely linked in the City, with severe erosion undermining root systems, and loss of trees along the banks further exacerbating erosion. Haverhill is part of the Massachusetts's Department of Conservation and Recreation's "Greening the Gateway Program," and had a goal of planting 3,000 trees through the program. Haverhill's Mayor has a separate goal of planting at least 15,000 trees to restore shade and cooling capacity to the river and urban center as part of an urban forestry program.

Merrimack River

Haverhill is the most upstream tidally-influenced City along the Merrimack River. The river hosts important fish breeding grounds, particularly in the area adjacent to Haverhill's downtown. Andrew Helihy noted during the Core Team meeting that the River is governed by two conflicting laws, one which requires the River depth to be maintained via dredging to ensure transportation access, and another that prevents dredging to maintain sensitive fish habitat. Along the River's banks, erosion is a major concern. According to workshop participants, millions of dollars are already being spent in an effort to combat this erosion. Homeowners along the Merrimack River on the east side of the City have begun implementing various bank stabilization solutions independently, at a cost of approximately $1,000 per linear foot. This piecemeal approach is not necessarily consistent with nature-based solutions or a cohesive bank protection strategy. Workshop participants expressed interest in establishing a vegetation program to restore riparian buffers and reduce erosion along the riverbank. Business owners on River Street are also concerned with the potential economic impacts of riverbank erosion. Businesses are losing significant portions of their land, and some face imminent risk to their buildings if action is not taken to prevent further erosion. The City is simultaneously focused on redeveloping areas along the riverfront for both economic development and public river access. (Historically, exceptionally poor water quality in the Merrimack River deterred high-value development along the River, as this land was largely undesirable.) Workshop participants expressed interest in finding a balance between riverbank stabilization and conservation and economic development of the riverfront area.

Parks and Open Space

Open space provides ecosystem services that help buffer the effects of climate change, from sequestering carbon, to increasing groundwater recharge, to modulating local temperature. Open space is also critical in floodplains for providing a buffer and increased flood storage, near public water supplies to maintain high water quality and promote recharge, and to maintain overall habitat connectivity that will be vital to allowing ecosystems and individual species to adapt to a changing climate. From a social perspective, open space and parks also provide opportunities for recreation, stress-relief, and relief during heatwaves. Workshop

participants expressed concern over the accessibility of these resources to vulnerable populations, especially those living in densely populated areas. The City currently only has one swimming area, and it is not accessible to much of the population from the most densely populated areas of Town. Recreation opportunities for inner city kids and access to areas where people can cool off are a priority for the City.

Environmental Contaminants

Haverhill received additional scope as part of its MVP Planning process to examine the relationship between legacy environmental contamination, climate impacts, and environmental justice communities/climate vulnerable populations. Workshop participants raised questions about the location and extent of environmental contaminants that remain as legacy pollution from the City's industrial past, the potential negative impacts these contaminants have had and may continue to have on the City's water quality, and how human communities, ecosystems, and wildlife could be affected. This is particularly pertinent as climate change threatens to mobilize latent contamination through increased heat or flooding risks.

Societal

Vulnerable Populations

Most of Haverhill is mapped as part of an environmental justice (EJ) community (minority, low-income, and non-English speaking). Workshop participants also identified seniors, recently arrived immigrants (including undocumented residents), the homeless, children, fixed-income individuals, and individuals living in densely populated areas as populations of concern. These populations may lack adequate resources to adapt to the effects of climate change in Haverhill, including changes in extreme temperatures. These populations may lack access to City resources such as cooling stations or river/swimming access during extreme heat events. As a result, in the past, the City has opened hydrants in these neighborhoods as cooling stations. Workshop participant John Cuneo, CEO of Community Action, Inc., also expressed concern over the changing complexity of assistance to these communities as a result of temperature shifts—for example, residents who receive heating assistance now may require cooling assistance in the future. Senior residents who are susceptible to extreme temperatures and emergency events may be resistant to leaving their homes to utilize cooling centers or emergency shelters. Further, workshop participants voiced concern over the potential for high housing density in the City to exacerbate climate impacts for certain portions of the population. A shortage of available and affordable housing has caused residents to crowd extra people into living spaces and occupy areas such as basements and attics in violation of fire and building codes, creating conditions that are unsafe under normal circumstances, but may be particularly dangerous during emergency events or extreme temperatures.

Homeless Shelters

The City of Haverhill has an individual shelter, and two shelters serving homeless families. There has been a steady increase in the homeless population in Haverhill, with shelters across the City experiencing an increase in guests in recent years. There is increasing concern over how shifting weather patterns will impact the homeless, especially with limited sheltering capabilities. As recently as 7 years ago, the shelters typically functioned at 70-80% of capacity, but in the past few years, the individual shelter has consistently operated at over 100% capacity, squeezing in 40 beds instead of their usual 30. In addition to the population housed in shelters, there is also a consistent group of roughly 15 to 18 unhoused and unsheltered individuals in the City. Shelter personnel and emergency services are generally aware of where these individuals can be found and make attempts to ensure that they have access to necessary resources in advance of storms and other hazard events.

Vulnerable Neighborhoods

Workshop participants identified the Acre and Mount Washington as the two primary vulnerable neighborhoods, as they are home to high percentages of environmental justice populations and are densely populated.

Particular neighborhoods in Haverhill are at risk from flooding due to their proximity to waterbodies, such as the Little River. The area surrounding Dale Street, Kelly Street, Bradley Avenue, and Hatch Street was also identified as an area that has flooded in the past and may be prone to future floods.

Schools

Haverhill's schools and student population are affected by a variety of hazard types. Schools are increasingly forced to cancel classes due to snow and ice events or extreme cold that make it impossible to safely get students to school. Stakeholders from the schools noted that student attendance drops on snowy and rainy days because students do not have the appropriate gear to get to school in inclement weather. Cancellations, in turn, have the potential to extend the school year further into the summer, which exacerbates the risks that school will be in session during extreme heat events. As days above 90 degrees increase, heat stroke is a concern for the student population in general, as many schools are not air conditioned. Further, there is often a ripple effect of unintended consequences when schools close, in which parents have to miss work, which results in lost wages. Conversely, in hot weather, students are impacted by the lack of air conditioning in the schools, which can have impacts ranging from lack of concentration to heat stroke. Transportation to and from school is especially complicated for those schools that draw students from other communities. Kara Kosmes, Business Manager at Whittier Regional Vocational Technical High School (Whittier Tech) identified transportation to the regional school as a major concern, especially when school is cancelled due to hazard events, as there are 11 districts that feed into the school, many of which are surrounded by water. During the 2006 Mother's Day flood, school was cancelled for two days and they were unable to transport students during that time. Workshop participants expressed concern over how shifting weather patterns may continue to impact attendance at schools throughout the City.

Provisions, Medicine, and Fuel

Maintaining access to essential supplies like groceries, medicines, and fuel (for vehicles, heating, and generators), as well as critical medical care and drug treatment during emergencies, is important during hazard events. Issues of access can be exacerbated for vulnerable populations, and for particular neighborhoods where there is limited access to grocery stores. Haverhill has pharmacies, grocery stores, gas stations, and a hospital within the City, however, despite having these resources in City, workshop participants expressed concern that certain vulnerable populations may not be able to access these resources during hazard events.

Historic Properties and Cemeteries

There are numerous landmarks and historic properties in the City that may be vulnerable to the impacts of climate change, especially flooding. There are also historic cemeteries in the City where graves pre-date modern burial practices of enclosing caskets in concrete vaults, and leaching of embalming chemicals may pose a potential contamination threat during heavy precipitation events.

Heating and Cooling Centers

The Haverhill Public Library, which is controlled by a private trust, serves as an unofficial community center and is where many residents go during power outages and for heating/cooling during extreme temperature events. Workshop participant Sarah Moser, Director of the Haverhill Public Library, voiced concern over how the effects of climate change may place an even greater burden on the library to provide these services and how it may impact the library's budget. The library currently runs on geothermal and is connected to the same grid as the Police Department—as a result, the facility rarely experiences power outages. After the Lawrence gas explosion, the library served as a regional shelter for those affected. The Council on Aging has also opened as a cooling center in the past—it was open for seven days in 2019 as a cooling shelter.

Emergency Shelters

The Citizen Center and four schools in the City serve as shelters. The Senior Shelter and the Northern Essex Community College (NECC) have also served as shelters in the past. Workshop participants identified a

perceived increase in the number of FEMA disaster declarations (3-4 in the past few years), which may place an increased burden on these shelters, including resources and staffing. Workshop participants also discussed a need for planning for pets at emergency shelters, as many residents are unwilling to leave their homes if they cannot bring their pets with them.

Pests and Disease Control

Climate change is affecting pests and disease vectors both through changing precipitation conditions and changing temperature conditions. Warmer, wetter conditions lead to increased mosquito populations, while the absence of sufficient periods of cold means that pest populations that would historically have been killed off or reduced are able to survive the winter and emerge in greater numbers the following season. Further, as the Massachusetts climate begins to look more like the climate of the mid-Atlantic and southern states, we are seeing new types of diseases show up in existing pests (e.g. mosquitoes carrying West Nile Virus, Eastern Equine Encephalitis, or Zika and ticks carrying Rocky Mountain Spotted Fever). These changes present a major public and animal health challenge in terms of education, prevention, and treatment. 2018 marked the Commonwealth's highest ever incidence of West Nile Virus diagnosis, and 2019 marked the highest number of EEE cases in recent history in Massachusetts. The City is currently a member of a Mosquito Control District, and did not experience any human cases of EEE in 2019, although mosquitos in the City tested positive for the virus. There has also been an increase in Lyme disease and tick-borne diseases in the City in recent years. At the same time, the City is facing inadequate public health staff capacity with places an extra burden on the City to address these climate impacts.

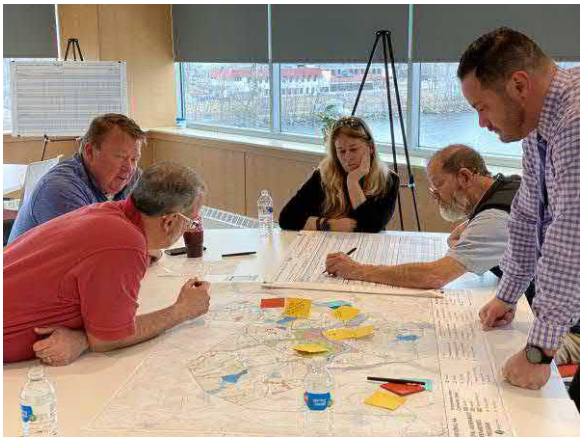
Emergency Planning and Communications

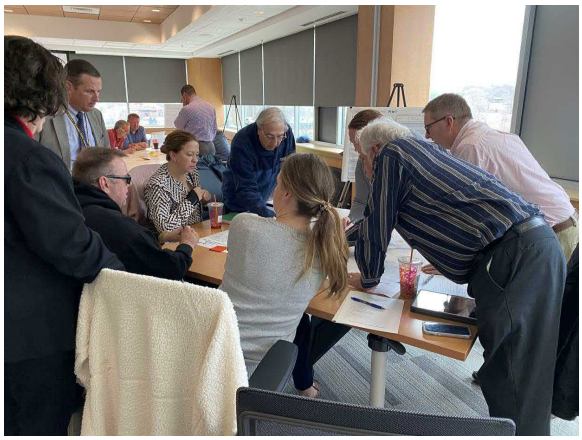
The City deploys an emergency alert system during emergency situations, which sends emergency messages to anyone with a phone number registered with the system. As in many municipalities, this system requires residents to opt-in, and question remains whether critical communications services like this can reach everyone with consistent and reliable information, especially homeless populations, residents without a cell phone or landline, and residents who speak English as a second language. Existing social organizations in the City complement and bolster the formal communications system by coordinating on-the-ground information gathering and sharing strategies to reach more citizens.

There is a need for more coordinated emergency and evacuation planning in the City, especially for vulnerable groups such as environmental justice populations, the homeless, and seniors.

Stress on Emergency Services

Workshop participant Bill Laliberty, Chief of the Haverhill Fire Department, noted that storms are becoming more frequent and intense, which puts extra stress on the City's emergency response department and reduces the preparation time between events. Haverhill's Fire, Police, and Public Works departments bear much of the burden of responding to the increased human threats that result from climate-induced hazards. An ever larger percentage of the departments' time and resources must be devoted to handling things like traffic accidents resulting from ice or other dangerous conditions and activities to maintain traffic flows or protect property during storm events, and Public Works is relied upon to clear roads and maintain access throughout the City. Emergency management personnel also noted the increase in crime that tends to accompany certain climate hazards, particularly heat waves.





Current Strengths and Assets

While the City recognized a number of vulnerabilities, workshop participants identified key strengths as well.

- The City operates an **emergency notification system** that can be used to share information relevant to short-term hazards or expected long-term hazards.
- There are has short-term **heating and cooling centers** available in the City.
- The City is in the process of updating its **Forest Management Plan**.
- Haverhill has a **strong culture of volunteerism** among its residents.
- The City has conducted initial **feasibility studies for dam removal** at two locations.
- The City is building a **new groundwater well near the Merrimack River** for public water supply.
- The City's **emergency shelters** include the Citizen Center and Northern Essex Community College (NECC).
- Haverhill is part of a **mosquito control district**.
- Haverhill is designated as a **Green Community**.
- The City is part of the **Greening the Gateways Cities Program,** which promotes increasing urban tree coverage**.**
- The City recently **upgraded its communication systems**.
- There are **dispersed police and fire facilities** on both sides of the Merrimack River.
- National Grid has a **gas system enhancement plan (GSEP)** to replace leak-prone infrastructure within 20 years.
- The recently **upgraded Water Street substation** offers increased resiliency.
- Haverhill recently updated the City's **Master Plan.**
- The City has conducted **bridge repairs** at Rocks Village Bridge and Basiliere Bridge
- The City is making progress toward an **upgraded wastewater treatment plant**.
- The **Haverhill Agricultural Commission** provides support for local agriculture.

Top Recommendations to Improve Resilience in Haverhill

Participants at the CRB workshop identified a number of recommendations to address vulnerabilities and increase resiliency in three main topic areas: infrastructure, environment, and society. The impacts of extreme precipitation and flooding were a primary concern that emerged in both the small and large group discussions, encompassing a wide variety of infrastructural and societal concerns. Providing sufficient protections and planning for vulnerable populations in City, such as seniors, the homeless, and environmental justice communities, was a second major theme. Developing a green belt through the City to improving the quality of the Merrimack River, increase urban tree cover, and promote river access was a third theme.

Highest Priority

- **Conduct a full feasibility assessment and identify grant opportunities for removal of the Little River Dam** to meet the following goals: 1) investigate opportunities to restore the riparian zone and create river access points along the river corridor, using land exposed by draining the dam impoundments, 2) increase flood capacity and reduce flooding risk in upstream Environmental Justice neighborhoods and 3) increase redevelopment potential of the adjacent property.

- **Conduct a full feasibility assessment for removal of Frye Pond Dam** to protect downstream properties and facilities from flooding and increase habitat connectivity along Snows Brook. Replace the existing structure with a bridge. Identify funding opportunities, including via state grants.

- **Assess options for riverbank stabilization,** such as implementing a vegetation program**.** Coordinate efforts with volunteer organizations and neighboring communities where feasibility studies for stabilization have been conducted.

- **Develop demonstration sites for the public that model nature-based riverbank stabilization and erosion protections.** Use public education campaigns to provide information on effective methods that can be used to limit erosion and protect private property without negative impacts to neighbors or the environment.

- **Conduct a City-wide field inventory of bridges and culverts** that builds upon the City's past assessments. Rank and prioritize projects for increased flooding resiliency and storm-hardening, followed by design and implementation of priority re-sizing or replacement projects. Green infrastructure, Low-Impact Design, and other nature-based solutions should be integrated with hard-infrastructure improvements to establish approaches that will be robust in the face of natural hazards and climate-change scenarios.

- **Implement green infrastructure opportunities across the City.** Build on the work currently underway as part of the City's work to address CSOs to develop a list of specific priorities, assess feasibility and cost, and rank priority projects in terms of climate resilience potential. Focus on areas where green infrastructure can simultaneously address impacts relating to both climate hazards and CSOs. Review the City's bylaws and regulations and update as necessary to support green infrastructure and low-impact development.

- **Establish a green corridor along the Merrimack River** to increase water quality and provide additional opportunities for river access, added shade, and flood resiliency for the City.

- **Develop a comprehensive tree and forests management program** that builds on the Greening the Gateway Program, to identify, remove, and replace problem trees, preserve intact forests and increase street tree cover, and provide guidance and resources for gradually moving toward more climate-resilient trees and forest communities (e.g. species that will tolerate warmer temperatures). Incorporate management of City trails into the overall planning effort. Identify funding opportunities. Petition the state for programming and climate-ready forest management advice.

- **Implement necessary repairs at the Millvale Dam.**

- **Implement plans to develop a backup groundwater supply for the City.** Ensure that climate resiliency considerations are incorporated at all stages of the design and planning process.

- **Perform a risk assessment of the wastewater treatment plant** and establish priority actions for reducing potential flooding impacts, including consideration of nature-based solutions or green infrastructure approaches.

- **Establish a regional hub for climate resiliency and communication** to coordinate efforts among municipalities, identify and share resources, and develop coordinated climate hazard response planning.

- **Evaluate opportunities to provide green emergency backup power** to critical facilities, including feasibility of green power and battery storage. City-wide, there are a number of buildings and facilities in need of adequate backup power and/or battery storage systems, such as the Fire Department and schools, City Hall, nursing homes/facilities for the elderly, homeless shelters, and the Citizen Center.

- **Revisit assessment and planning for solar and battery banking for the High School and Consentino Middle School.** Consider whether green power options could be incorporated at either location, and pursue a solar carport to provide storm protection for vehicles while simultaneously helping to power the schools.

- **Develop an Alternate Emergency Staffing Plan** to ensure that essential roles are covered during an emergency. Provide training so that City employees in non-essential roles could be redirected to essential roles to provide support during emergencies.

- **Develop a comprehensive strategy for sheltering** that evaluates strengths and vulnerabilities of existing shelters and recommends tangible steps for improvements. Include a plan for communication to residents about shelter locations, amenities, and availability, ensuring communication with vulnerable populations.

- **Develop transportation and evacuation plans** for senior residents, children, the homeless, environmental justice populations, and other at-risk populations, including those in need of critical medical equipment or care that may be unavailable during hazard events. Include planning for access to shelters, obtaining food and medications, and receiving emergency services during hazard events.

- **Post emergency evacuation routes,** with particular attention to the needs of homeless, environmental justice, and senior populations and other vulnerable residents.

- **Establish emergency plans for group homes and homeless shelters** and ensure that all group homes are identified as high risk facilities and that emergency plans coordinate with the City's emergency procedures.

- **Develop communications and outreach strategy for vulnerable populations**, particularly seniors, environmental justice populations, and the homeless, that may be more vulnerable to climate-induced risks, such as extreme temperatures, may lack appropriate shelter during increasingly intense storms, or that may be unprepared if stranded or cut off from supplies due to flooding or storm events. Coordinate with community groups on outreach and communication efforts.

- **Coordinate existing neighborhood groups to conduct outreach to vulnerable neighborhoods**, such as Mount Washington and the Acres, to identify vulnerabilities and needs within the communities and develop support programs accordingly. Additionally, identify trusted partners of vulnerable neighborhoods (e.g., religious organizations) to aid in communication of the City's resources.

- **Assess options for increasing affordable housing stock** outside of densely populated areas.

- **Ensure access to clean, high quality water for all residents and businesses**. Make sure that local businesses, particularly in the food industry, who rely on water for their production, have adequate information about water quality and efforts the City is making to reduce CSOs and other threats to water quality and supply.

- **Conduct a microgrid feasibility study** to identify potential critical locations for implementation, such as operations facilities or elderly living complexes.

Moderate Priority

- **Develop public/private partnerships and an emergency support corps** to provide extra capacity to aid the City during hazard events. For example, enlist boat owners to help provide water-based rescue services during flooding events. Identify assets across the City that can be mobilized in time of need.

- **Conduct robust education and outreach to build awareness of the City's resources** and make Haverhill residents aware of the many planning efforts, agreements, shelters, etc. which are focused on making the City more resilient to climate change impacts. Ensure that all residents know how to access these resources when they are needed. Continue to encourage enrollment in the City's emergency alert system.

- **Develop education and outreach to residents living in in the floodplain and flood-prone areas** to ensure that all individuals and families residing in these areas are aware of the potential risks, as well as mechanisms, such as flood insurance, to reduce their risk exposure. Ensure that outreach targets renters as well as property owners.

- **Explore options for opening additional cooling and heating shelters** to serve vulnerable populations during extreme temperature events.

- **Construct water parks, splash pads, or other cooling facilities** for the City's children to utilize during extreme heat. Emphasize access for environmental justice neighborhoods and densely-populated areas of the City.

- **Assess the potential climate-change impacts to the City's landfills**, particularly whether changes in precipitation may require modifications to the existing cap or other protections to limit contamination or leaching from the landfills.

- **Analyze hazardous materials risk to develop an understanding** of how climate-change induced hazards could potentially increase the risk of contaminants originating from 21E sites or locations with significant chemical storage such as the MVRTA.

- **Assess options to address excessively hot days in schools, such as installing air conditioning**. Evaluate necessary upgrades to the electrical infrastructure to allow for the additional capacity required to run air conditioning systems.

- **Improve roofs and HVAC systems at the City's schools** to increase storm-hardening and protect students and the facilities from the impacts of extreme temperatures.

- **Develop and implement creative strategies to increase transportation options to help students get to school during inclement weather**, including increasing sidewalk clearing and access through a neighbor-to-neighbor program, increasing availability of school bus routes and decreasing the size of walk-zones, and increasing CDL training programs to ensure adequate availability of trained drivers for school vehicles.

- **Enact a climate resilience curriculum at Northern Essex Community College** that empowers students to serve as a hub for community education and awareness around climate preparedness and resiliency. Capitalize on the dispersed nature of the commuter-based population to distribute information through the City and surrounding communities. Offer NECC programming for the larger community in addition to enrolled students.

- **Continue work through the Transportation Alliance** to provide last-mile and first-mile service for residents of environmental justice communities.

- **Raise road levels and rebuild** road bases in critical low-lying areas.

- **Acquire open space** consistent with the City's planning priorities, focusing on areas that will create flood resiliency through increasing storage capacity in floodplains and/or infiltration capacity. Focus on open space acquisition in the Millville watershed and to protect Crystal Lake.

- **Review eligibility for MassDOT Municipal Small Bridge Program** for bridges of concern in the City.

- **Develop plans for pet evacuation and sheltering** to ensure that individuals' pets are safe and secure during a hazard, and that concern about pets does not prevent people from evacuating during an emergency.

- **Increase public awareness programs related to vector-borne diseases,** such as EEE, West Nile, and Lyme disease, to educate residents on the risks and warning signs of these diseases. This

should include programs targeted at residents to increase awareness of new diseases and encourage early testing.

- **Coordinate with surrounding communities to develop watershed-scale flood protection strategies**, focusing in particular on upstream communities whose actions (or lack of action) will directly impact Haverhill.

- **Continue implementing the gas system enhancement plan** to replace outdated infrastructure and increase flood resiliency.

- **Improve electrical infrastructure**, including focus on protecting flood-prone substations and ensuring that electrical lines can handle additional weight from ice.

- **Ensure that emergency personnel have adequate staffing and resources** to respond in timely fashion to climate hazards and proactively quell tensions that may develop during extreme temperature events.

Lower Priority

- **Assess potential climate-related hazards to historic properties and cemeteries**, as well as potential for contamination from these sites. Develop preservation plans and explore funding options.

- **Educate owners of private septic systems** about the importance of having systems pumped out and keeping them in good working condition in order to prevent risks to public health and the environment from systems that become overwhelmed during periods of heavy precipitation.

- **Assess additional mosquito/pest control options,** including nature-based solutions such as establishment of buffers between developed and undeveloped areas, determination of future risks due to increase in type and quantity of pests/disease vectors due to climate change, and development of an education and outreach program.

- **Distribute an emergency kit list** to all citizens to encourage self-preparedness for hazard events.

- **Communicate with state officials regarding permitting processes**, specifically the financial burden of implementing permitting processes and the added cost of implementing regulations when trying to conduct infrastructure projects and resiliency work.

- **Conduct strategic planning to support regional agriculture** in the face of climate change, coordinating efforts with the Haverhill Agricultural Commission. All of the identified hazards (flooding, drought, extreme temperatures, storm events) have the potential to significantly impact agricultural production, with corresponding threats to livelihoods and food availability. Planning should address hazard resiliency and approaches to connect growers with local buyers to shorten supply chains, as well as long-term plans to transition producers to new techniques and/or into new crops to replace crops/industries that may no longer be viable due to climate change.

- **Develop comprehensive invasive species management** from inventory stage through management planning and implementation to address existing invasive populations that threaten features such as open space or forests, both of which contribute to resiliency, as well as anticipate new invasives that are likely to move into the area as climates shift.

CRB Workshop Participants

All workshop invitees are listed below; attendees are indicated with an asterisk.

Allison Heartquist	Chief of Staff, Haverhill Mayor's Office
James Fiorentini	Mayor of the City of Haverhill
Sarah Moser*	Director, Haverhill Public Library
Robert Ward*	Deputy Director, Haverhill Department of Public Works
Richard MacDonald	Director, Haverhill Department of Inspectional Services
Al Hanscom	Director of Individual Services, Emmaus, Inc.
Paul Malone	Deputy Director of Emergency Management, Haverhill Police Department
Pamela Price*	Assistant Economic Development Director, City of Haverhill
Andrew Herlihy*	Division Director, City of Haverhill Community Development
John Pettis*	City Engineer, City of Haverhill
Rob Moore*	Environmental Health Technician, Haverhill Conservation Department
Melinda Barrett	President, City Council
Charlie Ethier	Assistant Civil Engineer, City of Haverhill
William Laliberty	Chief, Haverhill Fire Department
Heather Forgione	Facilities Supervisor, Haverhill Public Schools
Glenn Smith*	Supervisor, Haverhill Water Maintenance Division
Mike Pfifferling*	Assistant Superintendent, Haverhill Public Schools
Joe Costanzo*	Administrator, Merrimack Valley Regional Transit Authority
Amanda Buckley*	Veterans Services Officer, City of Haverhill
Mark Tolman*	Compliance Inspector, City of Haverhill
Tracey Trask*	Department of Public Safety, Northern Essex Community College
Joe Muraco*	Community and Customer Management, National Grid
Jennifer Hughes*	Environmental Program Manager, Merrimack Valley Planning Council
Harmony Wilson*	Chair, Conservation Commission, City of Haverhill
Mary Connolly*	Community Health Nurse, City of Haverhill
Kara Kasmes*	Business Manager, Whittier Technical Regional Vocational High School
Christina Eckert*	Interim Director, Merrimack River Watershed Council
John Cunao*	President/CEO, Community Action, Inc.
John Barbieri*	Lieutenant, Haverhill Police Department
Ralph Besiliere	Conservation Commission, City of Haverhill
Melinda Barrett*	City Council President, City of Haverhill
Deb Crafts*	Director of Public Safety, Northern Essex Community College
Julianne Busa*	Fuss & O'Neill
Timothy Clinton*	Fuss & O'Neill
Arnold Robinson*	Fuss & O'Neill
Matthew Kissane*	Fuss & O'Neill
Sarah Hayden*	Fuss & O'Neill

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CRB Workshop Project Team

Name	Organization	Role
Allison Heartquist	Chief of Staff, Haverhill Mayor's Office	Project Coordinator/ Core Team Member
James Fiorentini	Mayor of the City of Haverhill	Core Team Member
Sarah Moser	Director, Haverhill Public Library	Core Team Member
Robert Ward	Deputy Director, Haverhill Department of Public Works	Core Team Member
Richard MacDonald	Director, Haverhill Department of Inspectional Services	Core Team Member
Al Hanscom	Director of Individual Services, Emmaus, Inc.	Core Team Member
Paul Malone	Deputy Director of Emergency Management, Haverhill Police Department	Core Team Member
Pamela Price	Assistant Economic Development Director, City of Haverhill	Core Team Member
Andrew Herlihy	Division Director, City of Haverhill Community Development	Core Team Member
John Pettis	City Engineer, City of Haverhill	Core Team Member
Rob Moore	Environmental Health Technician, Haverhill Conservation Department	Core Team Member
Melinda Barrett	President, City Council	Core Team Member
Charlie Ethier	Assistant Civil Engineer, City of Haverhill	Core Team Member
William Laliberty	Chief, Haverhill Fire Department	Core Team Member
Heather Forgione	Facilities Supervisor, Haverhill Public Schools	Core Team Member
Glenn Smith	Supervisor, Haverhill Water Maintenance Division	Core Team Member
Mike Pfifferling	Assistant Superintendent, Haverhill Public Schools	Core Team Member
Julianne Busa	Fuss & O'Neill	MVP Lead Facilitator
Timothy Clinton	Fuss & O'Neill	MVP Facilitator/Scribe
Arnold Robinson	Fuss & O'Neill	MVP Facilitator/Scribe
Matthew Kissane	Fuss & O'Neill	MVP Facilitator/Scribe
Sarah Hayden	Fuss & O'Neill	MVP Facilitator/Scribe

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Appendix A

Final Risk Matrix

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

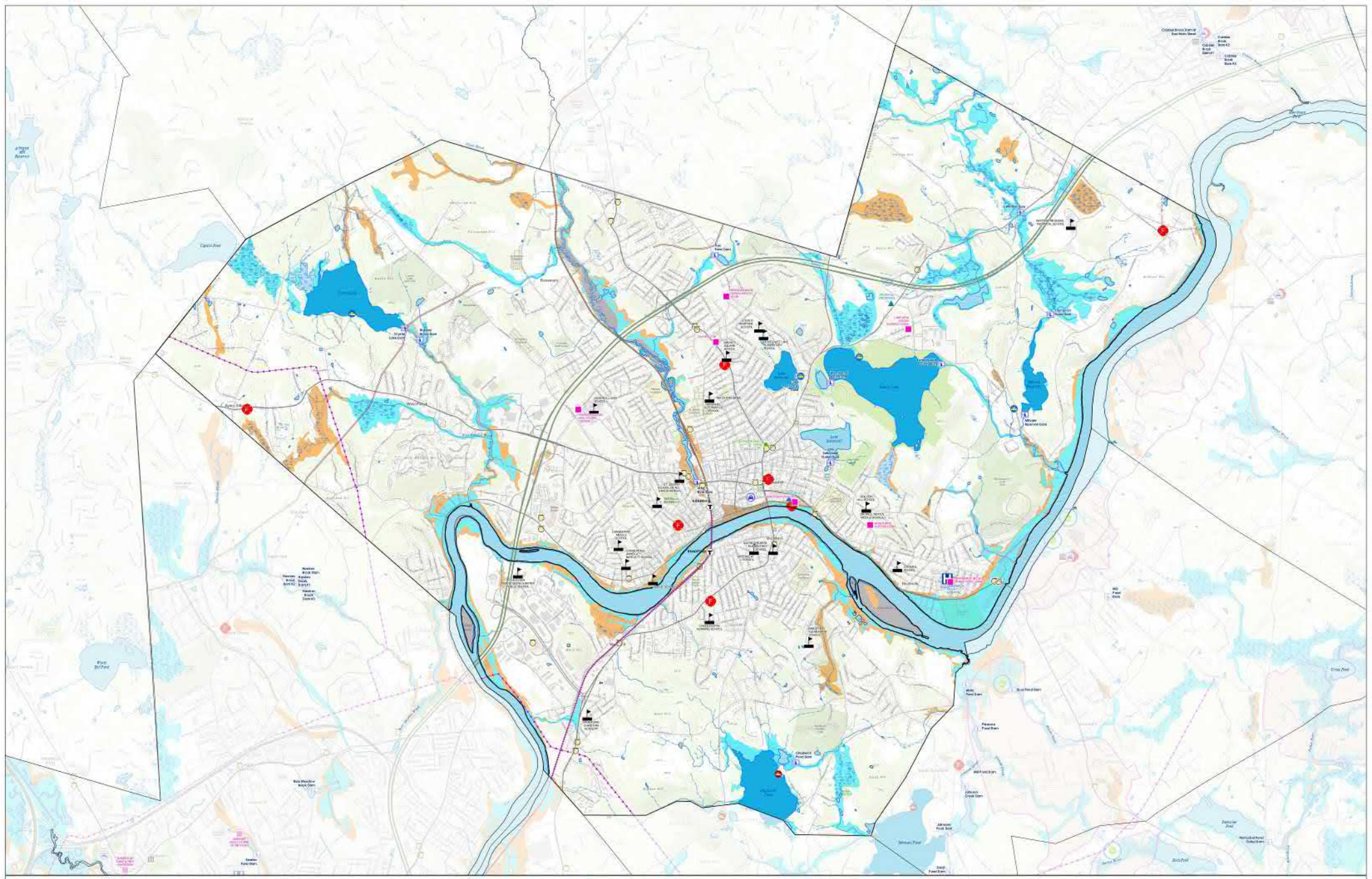
H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Features	Location	Ownership	V or S	Flooding	Extreme Precipitation	Extreme Temperatures	Major Storm Events	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Bridges and Culverts	City-wide	City, State, Private	S	The City has conducted bridge repairs at Rocks Village Bridge and Basiliere Bridge				N/A	O
			V	Review eligibility for MassDOT Municipal Small Bridge Program for bridges of concern in the City.				M	S
Stormwater Infrastructure	City-wide	City	V	Implement green infrastructure opportunities across the City. Build on the work currently underway as part of the City's work to address CSOs to develop a list of specific priorities, assess feasibility and cost, and rank priority projects in terms of climate resilience potential. Focus on areas where green infrastructure can simultaneously address impacts relating to both climate hazards and CSOs. Review the City's bylaws and regulations and update as necessary to support green infrastructure and low-impact development.				H	S
			V	Coordinate with surrounding communities to develop watershed-scale flood protection strategies, focusing on upstream communities whose actions (or lack of action) will directly impact Haverhill.				M	L
Roads	City-wide	City	V	Raise road levels and rebuild road bases in critical low-lying areas.				M	L
Electrical Infrastructure	City-wide	City	S	The recently upgraded Water Street substation offers increased resiliency.				N/A	O
			V	Improve electrical infrastructure, including focus on protecting flood-prone substations and ensuring that electrical lines can handle additional weight from ice.				M	L
Gas Infrastructure	City-wide	City	S	National Grid has a gas system enhancement plan (GSEP) to replace leak-prone infrastructure within 20 years.				N/A	O
			V	Continue implementing the gas system enhancement plan to replace outdated infrastructure and increase flood resiliency.				M	O
Water Wastewater Infrastructure	City-wide	City	S	The City is making progress toward an upgraded wastewater treatment plant.				N/A	O
			V	Perform a risk assessment of the wastewater treatment plant and establish priority actions for reducing potential flooding impacts, including consideration of nature-based solutions or green infrastructure approaches.				H	S
Water Supply	City-wide	City, Private	S	The City is building a new groundwater well near the Merrimack River for public water supply.				N/A	O
			V	Implement plans to develop a backup groundwater supply for the City. Ensure that climate resiliency considerations are incorporated at all stages of the design and planning process.				H	O
			V	Ensure access to clean, high quality water for all residents and businesses. Make sure that local businesses, particularly in the food industry, who rely on water for their production, have adequate information about water quality and efforts the City is making to reduce CSOs and other threats to water quality and supply.				H	L
Flood Wall	Merrimack River	Army Corps of Engineers	S/V	No priority actions were discussed for this topic.				N/A	O
Septic Systems and Private Wells	City-wide	Private	V	Educate owners of private septic systems about the importance of having systems pumped out and keeping them in good working condition in order to prevent risks to public health and the environment from systems that become overwhelmed during periods of heavy precipitation.				L	L
Dams	Millvalle Dam, Frye Pond Dam, Little River Dam	City, Private	S	The City has conducted two initial reconnaisance studies for dam removal at two locations.				N/A	O
			V	Conduct a full feasibility assessment and identify grant opportunities for removal of the Little River Dam to meet the following goals: 1) investigate opportunities to restore the riparian zone and create river access points along the river corridor, using land exposed by draining the dam impoundments, 2) increase flood capacity and reduce flooding risk in upstream Environmental Justice neighborhoods and 3) increase redevelopment potential of the adjacent property.				H	S
			V	Conduct a full feasibility assessment for removal of Frye Pond Dam to protect downstream properties and facilities from flooding and increase habitat connectivity along Snows Brook. Replace the existing structure with a bridge. Identify funding opportunities, including via state grants.				H	S
			V	Implement necessary repairs at the Millvale Dam.				H	S
Buildings and Facilities	City-wide	City, Private	V	Evaluate opportunities to provide green emergency backup power to critical facilities, such as the Fire Department and schools, City Hall, nursing homes/ facilities for the elderly, homeless shelters, and the Citizen Center. Include options for green power and battery storage.				H	S
			V	Revisit assessment and planning for solar and battery banking for the High School and Consentino Middle School. Consider whether green power options could be incorporated at either location, and pursue a solar carport to provide storm protection for vehicles while simultaneously helping to power the schools.				H	L
			V	Conduct a microgrid feasibility study to identify potential critical locations for implementation, such as operations facilities or elderly living complexes.				H	S
			V	Communicate with state officials regarding permitting processes, specifically the financial burden of implementing permitting processes and the added cost of implementing regulations when trying to conduct infrastructure projects and resiliency work.				L	L
			V			Improve roofs and HVAC systems at the City's schools to increase storm-hardening and protect students and the facilities from the impacts of extreme temperatures.		M	L
Merrimack Valley Regional Transit Authority (MVRTA)	MVRTA	MVRTA	V	Analyze hazardous materials risk to develop an understanding of how climate-change induced hazards could potentially increase the risk of contaminants originating from the facility.				M	S
Societal									
Vulnerable Populations	City-wide	N/A	V	Develop transportation and evacuation plans for senior residents, children, the homeless, environmental justice populations, and other at-risk populations, including those in need of critical medical equipment or care that may be unavailable during hazard events. Include planning for access to shelters, obtaining food and medications, and receiving emergency services during hazard events.				H	S
			V	Develop communications and outreach strategy for vulnerable populations, particularly seniors, environmental justice populations, and the homeless, that may be more vulnerable to climate-induced risks, such as extreme temperatures, may lack appropriate shelter during increasingly intense storms, or that may be unprepared if stranded or cut off from supplies due to flooding or storm events. Coordinate with community groups on outreach and communication efforts.				H	S
			V	Continue work through the Transportation Alliance to provide last-mile and first-mile service for residents of environmental justice communities.				M	O
Homeless Shelters	City-wide	Private	V	Establish emergency plans for group homes and homeless shelters and ensure that all group homes are identified as high risk facilities and that emergency plans coordinate with City emergency procedures.				H	S
Vulnerable Neighborhoods	The Acres, Mount Washington	N/A	V	Coordinate existing neighborhood groups to conduct outreach to vulnerable neighborhoods, such as Mount Washington and the Acres, to identify vulnerabilities and needs within the communities and develop support programs accordingly. Additionally, identify trusted partners of vulnerable neighborhoods (e.g., religious organizations) to aid in communication of the City's resources.				H	S
			V	Assess options for increasing affordable housing stock outside of densely populated areas.				H	L
			V	Develop education and outreach to residents living in the floodplain and flood-prone areas to ensure that all individuals and families residing in these areas are aware of the potential risks, as well as mechanisms, such as flood insurance, to reduce their risk exposure. Ensure that outreach targets renters as well as property owners.				M	S
			V	Construct water parks, splash pads, or other cooling facilities for the City's children to utilize during extreme heat. Emphasize access for environmental justice neighborhoods and densely-populated areas.				M	S

Schools	City-wide	City, State	V			Assess options to address excessively hot days in schools, such as installing air conditioning. Evaluate necessary upgrades to the electrical infrastructure to allow for the additional capacity required to run air conditioning systems.	M	L
			V	Develop and implement creative strategies to increase transportation options to help students get to school during inclement weather, including increasing sidewalk clearing and access through a neighbor-to-neighbor program, increasing availability of school bus routes and decreasing the size of walk-zones, and increasing CDL training programs to ensure adequate availability of trained drivers for school vehicles.			M	S
			V	Enact a climate resilience curriculum at Northern Essex Community College that empowers students to serve as a hub for community education and awareness around climate preparedness and resiliency. Capitalize on the dispersed nature of the commuter-based population to distribute information through the City and surrounding communities. Offer NECC programming for the larger community in addition to enrolled students.			M	L
Provisions, Medicine, and Fuel	City-wide	Private	V/S	No priority actions were discussed for this topic.			N/A	N/A
Historic Properties and Cemeteries	City-wide	City	V	Assess potential climate-related hazards to historic properties and cemeteries, as well as potential for contamination from these sites. Develop preservation plans and explore funding options.			L	L
Heating and Cooling Centers	City-wide	City	S			There are short-term heating and cooling centers available in the City.	N/A	O
			V			Explore options for opening additional cooling and heating shelters to serve vulnerable populations during extreme temperature events.	M	S
Emergency Shelters	City-wide	City, State	S	There are numerous emergency shelters in the City, including the Citizen Center and Northern Essex Community College (NECC).			N/A	O
			V	Develop a comprehensive strategy for sheltering that evaluates strengths and vulnerabilities of existing shelters and recommends tangible steps for improvements. Include a plan for communication to residents about shelter locations, amenities, and availability, ensuring communication with vulnerable populations.			H	S
			V	Develop plans for pet evacuation and sheltering to ensure that individuals' pets are safe and secure during a hazard, and that concern about pets does not prevent people from evacuating during an emergency.			M	S
Pests and Disease Control	City-wide	City, Private	S	Haverhill is part of a mosquito control district.			N/A	O
			V	Increase public awareness programs related to vector-borne diseases, such as EEE, West Nile, and Lyme disease, to educate residents on the risks and warning signs of these diseases. This should include programs targeted at residents to increase awareness of new diseases and encourage early testing.			M	S
			V	Assess additional mosquito/pest control options, including nature-based solutions such as establishment of buffers between developed and undeveloped areas, determination of future risks due to increase in type and quantity of pests/disease vectors due to climate change, and development of an education and outreach program.			L	L
Emergency Planning and Communications	City-wide	City	S	The City operates an emergency notification system that can be used to share information relevant to short-term hazards or expected long-term hazards.			N/A	O
			S	Haverhill has a strong culture of volunteerism among its residents.			N/A	O
			V	Post emergency evacuation routes, with particular attention to the needs of homeless, environmental justice, and senior populations and other vulnerable residents.			H	S
			V	Conduct robust education and outreach to build awareness of the City's resources and make Haverhill residents aware of the many planning efforts, agreements, shelters, etc. which are focused on making the City more resilient to climate change impacts. Ensure that all residents know how to access these resources when they are needed. Continue to encourage enrollment in the City's emergency alert system.			M	S
			V	Distribute an emergency kit list to all citizens to encourage self-preparedness for hazard events.			L	S
Stress on Emergency Services	City-wide	City	S	There are dispersed police and fire facilities on both sides of the Merrimack River.			N/A	O
			V	Establish a regional hub for climate resiliency and communication to coordinate efforts among municipalities, identify and share resources, and develop coordinated climate hazard response planning.			H	L
			V	Develop an Alternate Emergency Staffing Plan to ensure that essential roles are covered during an emergency. Provide training so that City employees in non-essential roles could be redirected to essential roles to provide support during emergencies.			H	S
			V	Develop public/private partnerships and an emergency support corps to provide extra capacity to aid the City during hazard events. For example, enlist boat owners to help provide water-based rescue services during flooding events. Identify assets across the City that can be mobilized in time of need.			M	L
			V	Ensure that emergency personnel have adequate staffing and resources to respond in timely fashion to climate hazards and proactively quell tensions that may develop during extreme temperature events.			M	L
Environmental								
Water Quality	City-wide	Public, private	V	Implement green infrastructure opportunities across the City. Build on the work currently underway as part of the City's work to address CSOs to develop a list of specific priorities, assess feasibility and cost, and rank priority projects in terms of climate resilience potential. Focus on areas where green infrastructure can simultaneously address impacts relating to both climate hazards and CSOs. Review the City's bylaws and regulations and update as necessary to support green infrastructure and low-impact development.			H	S
Local Agriculture	City-wide	Private	S	The Haverhill Agricultural Commission provides support for local agriculture.			N/A	O
			V	Conduct strategic planning to support regional agriculture in the face of climate change, coordinating efforts with the Haverhill Agricultural Commission. Planning should address hazard resiliency and approaches to connect growers with local buyers to shorten supply chains, as well as long-term plans to transition producers to new techniques and/or into new crops to replace crops/industries that may no longer be viable due to climate change.			L	L
Trees and Forests	City-wide	Public, private	S	The City is in the process of updating its Forest Management Plan. The City is also part of the Greening the Gateway Cities Program, which promotes increasing urban tree coverage.			N/A	O
			V	Develop a comprehensive tree and forests management program that builds on the Greening the Gateway Cities Program, to identify, remove, and replace problem trees, preserve intact forests and increase street tree cover, and provide guidance and resources for gradually moving toward more climate-resilient trees and forest communities (e.g. species that will tolerate warmer temperatures). Incorporate management of City trails into the overall planning effort. Identify funding opportunities. Petition the state for programming and climate-ready forest management advice.			H	L
			V	Develop comprehensive invasive species management from inventory stage through management planning and implementation to address existing invasive populations that threaten features such as open space or forests, both of which contribute to resiliency, as well as anticipate new invasives that are likely to move into the area as climates shift.			L	L
Merrimack River	City-wide	Public, private	V	Assess options for riverbank stabilization, such as implementing a vegetation program. Coordinate efforts with volunteer organizations and neighboring communities where feasibility studies for stabilization have been conducted.			H	S
			V	Develop demonstration sites for the public that model nature-based riverbank stabilization and erosion protections. Use public education campaigns to provide information on effective methods that can be used to limit erosion and protect private property without negative impacts to neighbors or the environment.			H	L
			V	Establish a green corridor along the Merrimack River to increase water quality and provide additional opportunities for river access, added shade, and flood resiliency for the City.			H	L
Parks and Open Space	City-wide	Public, private	V	Acquire open space consistent with the City's planning priorities, focusing on areas that will create flood resiliency through increasing storage capacity in floodplains and/or infiltration capacity. Focus on open space acquisition in the Millville watershed and to protect Crystal Lake.			M	L
Environmental Contaminants	City-wide	N/A	V	Assess the potential climate-change impacts to the City's landfills, particularly whether changes in precipitation may require modifications to the existing cap or other protections to limit contamination or leaching from the landfills.			M	S
			V	Analyze hazardous materials risk to develop an understanding of how climate-change induced hazards could potentially increase the risk of contaminants originating from 21E sites or locations with significant chemical storage such as the MVRTA.			M	S

Appendix B

CRB Workshop Base Map



HAVERHILL, MA

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM

FUSS & O'NEILL

- Police Station
- Fire Station
- Hospital
- School
- Town Hall
- Town Boundary
- Assisted Living Facility
- Nursing Home
- Rest Home
- Dam
- Wellhead Protection Zone I
- Wellhead Protection Zone II
- Community Groundwater Source
- Surface Water Intake
- Non-Community Groundwater Source
- Emergency Surface Water
- Underground Storage Tanks
- Pipeline
- Powerline
- Powerline Arbitrary Extension
- Landing Strip/Airport
- Railroads - Active Service
- Regular Service
- Regular Service
- Interstate
- State Route
- Non-numbered Road

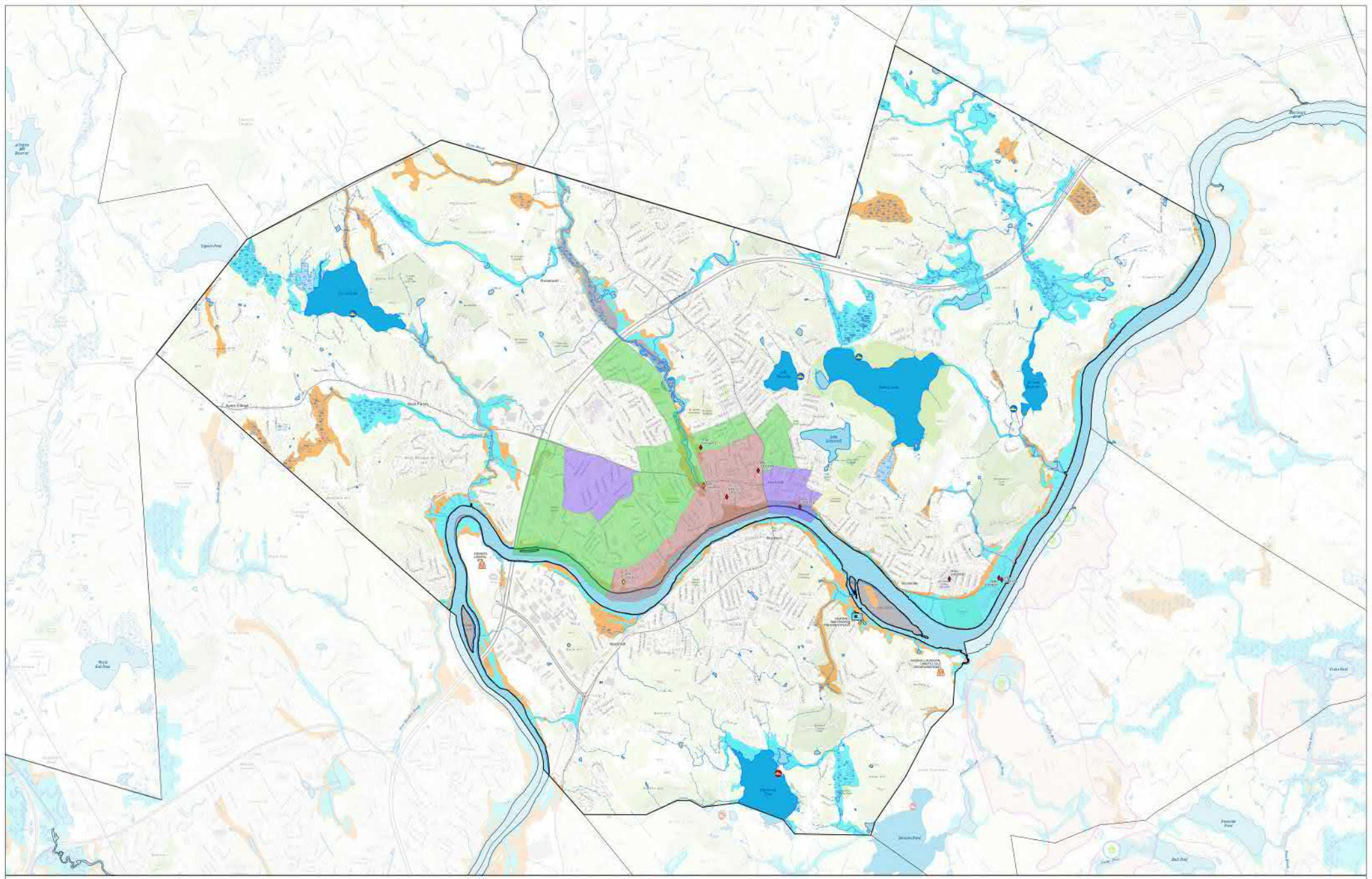
Flood Zone Designations

- 1% Annual Chance of Flooding
- Regulatory Floodway
- 0.2% Annual Chance of Flooding
- Reduced Flood Risk due to Levee

N

Data sources:
MassGIS - Infrastructure, Hydrology, and Administrative Data
ESRI - Base Map

0 0.38 0.75 1.5 Miles


HAVERHILL, MA
EXPANDED SCOPE
MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM
FUSS & O'NEILL
Landfill
Wastewater Treatment Facility
Chapter 21E Site
Tier 1D
Tier I
Tier II
Environmental Justice Community Criteria
Income
Minority
Minority and Income
Town Boundary
Wellhead Protection Zone I
Wellhead Protection Zone II
Community Groundwater Source
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0.38
0.75
1.5
Miles

Appendix C

CRB Workshop Outputs:
Participatory Mapping Exercise & Risk Matrices

B

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Features	Location	Ownership	V or S	FLOODING	EXTREME PRECIPITATION	EXTREME TEMPERATURES	MAJOR STORM EVENTS	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
~~Early Childhood~~ Public Schools - Roofs, HVAC	Multiple	Public	√	Roof + HVAC	Add back-up power where needed; Revisit planning for solar + battery backing for; ↳ pursue solar carport		H.S. + Consentino reno/rebuild		
Dams	Little River; North Ave	Private; Public	√	Remove Dam - Frye + Lake	Repairs for Millvale Dam - looking @ engineering now			H	↑?
Small bridges + culverts Piped	City-wide	Public	√				City-wide assessment	H	S - Planning to Completion
Water Supply			S/V	Good capacity, New well being looked at - ground water from under River. Make sure flood impacts are well considered in siting		acquire open space to protect Millvale watershed + Crystal Lake			
WWTP	Floodplain	Public	S/V	Protect - Assess how to do this	Upgrades being planned to reduce CSOs			H	S: Assessment to Protect; Ongoing
Utility Infrastructure	City-wide	N. Grid	V/S	protect gas pipes through enacting GSEP Plan (gas system enhancement plan)	City connected to 7 different grids	Water St. planning	substation upgraded for weight of ice on lines	M	Ongoing
Societal City Hall + Police - have solar already - need for battery storage to maintain supply during outage?				Haverhill sig. amt of leak-prone pipe					
Elderly Facilities	Multiple	Private + Public	√	Replace roofs/HVAC, Add back-up power					
Homeless Shelters Emmaus Citizens Etr.	Winter + Harw Sts. Adjacent to GAR Park	Private + Public	√	Add b-up power		Shelter from high heat + extreme cold		H	
Vulnerable Neighborhoods	Acre, Mt. Washington	Private	√		Coordinate neighborhood groups to identify vulnerabilities + develop programs, eg. sidewalk snow shoveling campaign			H	
Emergency Shelter	NECC on Kenoza	State	S					H	
Early Childhood Ctrs + Social Service centers	75 Elm St., 23a Hilldale Ave	Private	√	Roofs + HVAC ← Grant pending for 75 Elm; back-up power supply - solar would be a plan for					
Students	City-wide		√	NECC - student educ./awareness around evac. routes/ preparedness - @ homes → disperse info through City	↑ sidewalk access + clearing through ↑ City efforts + neighbor-to-neighbor; ↑ busses + ↓ walk-zones; ↑ CDL training programs to staff busses/school vehicles				
TRANSPORTATION - public access	City-wide			NECC program for community on Climate Resilience		continue work on Transportation Alliance for last mile/first mile service for EJ comm's			
Environmental									
BANK EROSION			√						
Tree Inventory			√						
Farmland		Private + Public subsidy	√						
Merrimack River			V/S	Ground water					
OPEN SPACE						Protect Millvale/Crystal Lake watersheds			

c

Community Resilience Building Risk Matrix

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H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	FLOODING	EXTREME PRECIPITATON	EXTREME TEMPERATURES	MAJOR STORM EVENTS	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
water supply - food business; adequacy of downtown flood protection - Downtown ↳ down-gradient impacts / lack of regional coordination ↳ promoting green infrastructure as part of development		public and private	V	How can green/nature-based solutions work for flood protection if upstream communities aren't implementing similar solutions?					
water main breaks - extreme cold - legionel disease ↳ happening underground; don't know at first ↳ frost heave	city-wide; City-wide	private; public	V; V	Food businesses rely on large volumes of clean water. CSOs / WWTP releases / during extreme events can threaten availability of clean water / power outages / infrastructure failures; extreme cold penetrating deeper resulting in breaks = requires rapid emergency response / repairs					
- live wires down / Police Dept limited coverage / taxed staff	city-wide	public	V / S	leverage strong volunteerism to supplement emergency responders?					
CSO overflows - extreme rainfall; but can happen w/ relatively small events — phased approach to upgrade due to funding limitations (separation preferred for Lock St problem area)	city-wide	public	V	phased approach to understand unintended consequences of upgrades before addressing next area of system / limited funding					
erosion exposing / threatening buried utilities	river front	public; private	V	how to improve soil stability beyond installing flood walls					
landfill capping / landfill forms bank; pumpstations (not all have generators)	Groveland Road; city wide	public	V	landfill stabilization / adequate capping protective of projected flood frequency changes					
Societal — Old infrastructure / indoor climate problems	city-wide / NECC / schools	public / private	V	upgrade climate controls, incorporate renewables					
crime uptick in heat / emergencies; changes in manning / PD staff shortage	city wide	public	V	faster resolution to emergencies / restoration of services to quell tensions that can result					
development pressure on river	river front	public; private	V	incorporate green infrastructure into existing / proposed developments + public space by way of zoning / ordinances / municipal RFP process					
availability of emergency resources (NECC) citizens shelter ↳ lacks generator	NECC campus - citizens shelter	public	S	NECC is a resource for emergency sheltering					
Master Plan outreach = Public Safety + Infrastructure are priorities ↳ police ↳ water = critical items	city-wide	public	S	recent MP process providing feedback regarding community / resident priorities					
containing diseases			V						
- minimize duration of emergency events - take burden off emergency services (limited staff) - volunteerism in City			V / S	see above					
Environmental									
Water quality - food business / drinking water ↳ Haverhill has competitive water / sewer rates									
stormwater pollutants impacting river									
endangered species restrictions / permitting burden limiting construction projects	river corridor		V	does state realize unintended consequences of these restrictions on ability to implement / cost of infrastructure					

D
Notes

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Extreme Precipitation	Extreme Temperatures	Major Storm Events	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Substations → Power	citywide	PRIVATE/NG	Both	Add redundancies	storm hardening site	Strengthening infrastructure to handle larger demand →	→	H	O
Schools/other City buildings as Shelters	citywide	Public/some private	V/S	generators, cots, mobile showers, transportation	→	→	→	H	S→O
Water System	Citywide	Public	V/S	OK	OK	Alternative source	OK	M	S
Sewer System	citywide	Public	V/S	Sep. storm water/sewer flood protection around plant →	→	→	→	M/L	O
Flood Protection System	citywide	Public	S	Remove ~~some~~ Little River dams	→	→	→	H	O
Transportation/Road Access/Public	citywide	Public/Private	V/S	more evac/emer. planning	private/public partnership	watercraft, etc.	identify assets →	H	S→O
Societal	* communication systems, marketing, notifying public								
Large Elderly Population	citywide	Public	V	emergency communication plans - how to reach, where to	evacuate to, public education programs	more cooling centers, grants for AC etc. →	→	H	S→O
Homeless (unsheltered)	citywide w/ concentrations	Public/Private	V	locating, identifying, communicating resources	transportation coordination	more cooling/heating centers →	→	H	S→O
Recent Arrivals (esp. undocumented)	citywide	Public	V	identifying partners they trust, community action, churches, Y, Emmaus → build plan	↑ to communicate resources multi lingual, volunteers	→	→	H	S→O
High Density Areas	concentrated neighborhoods DOWNTOWN	Public	V	increase inspectional services, affordable housing outside of current areas, increase	police monitoring/fire dept patrols	→	→	H	S→O
Pets/Animals	city wide	Public/Private	V	public health monitoring mirack shelters, shelters allowing pets	→	→	→	H	S→O
Large Child/Youth Population	citywide	Public	V	emergency planning for families, where to go	increase transport backup care	"Water parks" AC in schools	snow removal, identify vulnerable families	H	S→O
Environmental									
Historical Properties/Districts	citywide	Public/Private	V	graveyards - plan hazards, chemicals etc. →	→	→	→	L	O
Large Geographical Area	citywide	Public/Priv.	V/S	regional plan/communications, public/private partnerships	volunteer corps, backup staff, secondary positions →	→	→	H	S→O
Flood Zones - Specific Neighborhoods	localized to waterways	Public/Priv	V	evacuation plans, public education, partnerships, define roles	→	→	→	M	O
Forests/Trails	citywide	Pub/Priv	V/S	management plan always fluid, seek outside funding, public education →	→	→	→	L	L→O
Farms	citywide	Priv	V/S	know what is what, resources, specific needs →	→	→	→	L	L→O
Regional Hub	citywide	Pub/Priv	V/S	regional communication plan, identify resources, who has what →	→	→	→	H	O

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	Flooding	Extreme Precip.	Extreme Temp	Major storm events	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Flood wall									
Societal									
Vulnerable Neighborhoods	flooding ← Riverdale Ave; cutoff ← Neck; Areas w/ limited crossings; limited crossings over river	N/A	✓	Transportation plan/increased crossings? Dam removal to relieve flooding			→		
Environmental									

A

Community Resilience Building Risk Matrix

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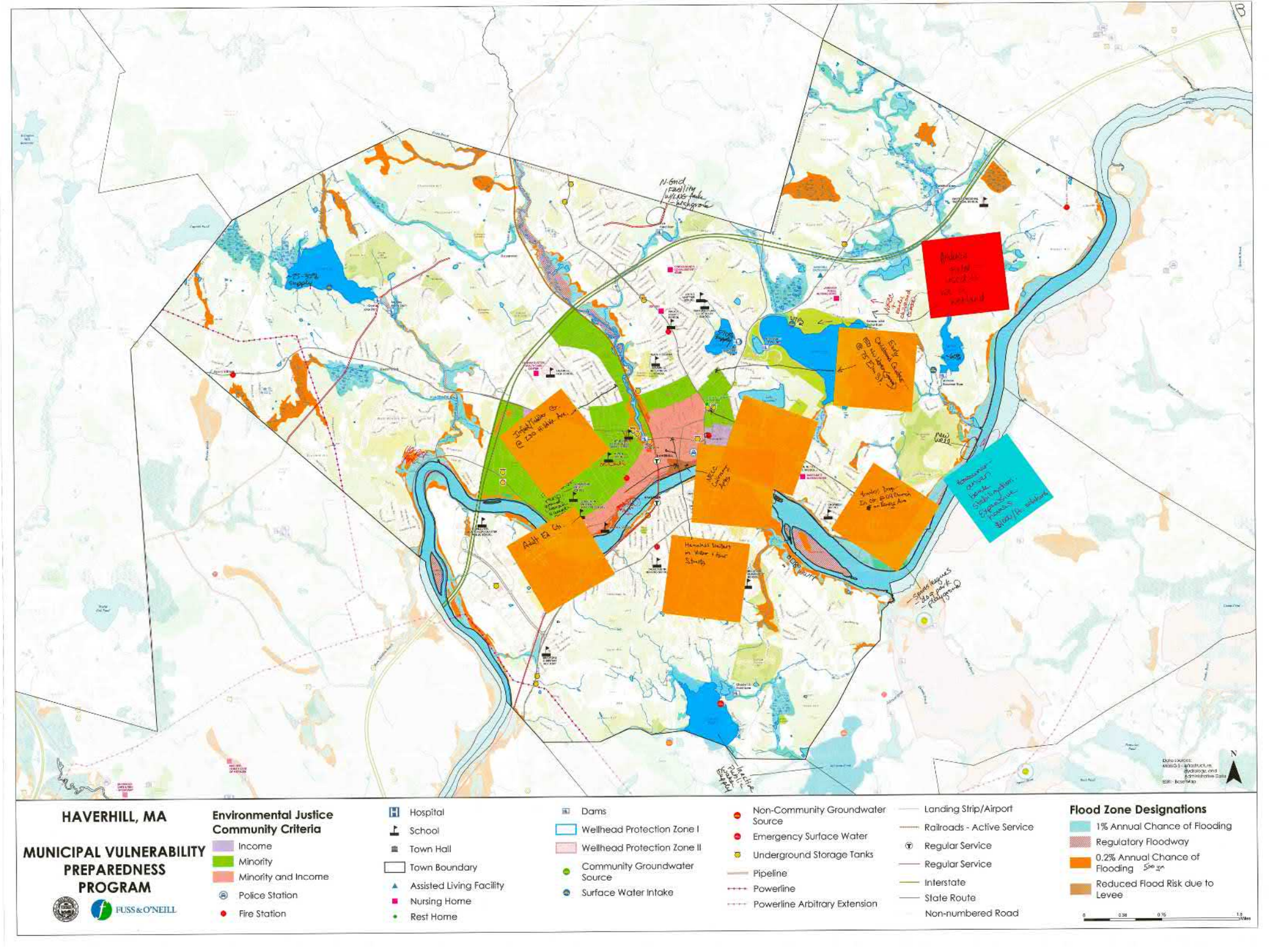
H-M-L priority for action over the **S**hort or **L**ong term (and **O**ngoing)
V = Vulnerability **S** = Strength

city may assume ownership of dam w/ business dead

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S	FLOODING	EXTREME PRECIPITATION	EXTREME TEMPERATURES	MAJOR STORM EVENTS	Priority H-M-L	Time Short Long Ongoing
Infrastructural									
LITTLE RIVER DAM / Fine Pond Dam	LAFAYETTE SQUARE	PRIVATE	V	MODEL IMPACT OF DAM REMOVAL ON FLOOD WATERS →	IDENTIFYING GRANT OPPS.		→	M/H	O
ROADS / culverts	CITY WIDE (110), (97) + Newton rd	MUNICIPAL	V / S	feasibility assessment raise roads prone to flooding	culvert assessments; Little River culvert replaced/repaired			M	O
BRIDGES	CITY-WIDE	MUNICIPAL	S+V					H	O
WASTEWATER	CITY-WIDE	MUNICIPAL	V	CSO's	CSO's	~~CSO~~ POWER BACKUP		H	O
BACKUP POWER SUPPLY	CITY-WIDE (WW treatment, EMER SER)	MUNICIPAL/ PRIVATE	V	Explore		GREEN COMM. ACCESS TO ASSOCIATED GRANTS			
Stormwater / Infrastructure + management	city-wide	Municipal	V	Assessment City-wide of SW structures, Explore GI options	Zoning bylaw review LID/GI - wetlands ordinance - SW bylaw review				
Societal									
EMERGENCY SHELTERS/PREPAREDNESS	CITY-WIDE	MUNICIPAL/ PRIVATE	S + V - LACK OF HEALTH DEPT. - HOSPITAL	Assess sheltering capacity, Increase awareness of resources, transportation plan; Coded / self-preparedness					
ACCESS TO MED. SERVICES, GAS, + FOOD	CITY-WIDE	MUNICIPAL/ PRIVATE	S						
SCHOOLS + ~~NURSING HOMES~~ / vuln pop	city-wide	"	V / S	transportation plan (cancellation awareness, coordination) - safety					
Vulnerable pop (low income, seniors, homeless) EJ	city-wide	N/A	V / S	Transportation to shelter, communication plan/awareness of resources (what works in other cities/towns) - canceled extreme cold/heat; renovation planned - what will need in 50 yrs - adapting/resilient					
Evac Routes	city	municipal/state		Explore options for signage / tie-into transportation plan	→		→		
Disease (Lyme Disease) Encephalitis (EEE?)	city-wide	municipal / private	V / S	(inc. problem in Town, increased awareness) - Mosquito Control District - BT Tablets in CB					
Environmental									
Drinking Water Supply / water quality (well on Merrimack) rainy well -	Town-wide	municipal	V	STUDY + IMPLEMENTATION OF RAINEY WELL SYSTEM FOR BACKUP WATER SUPPLY					
Invasives	Town-wide	municipal/ private	S/V	Forest Mgmt. Plan - woolly adelgid, ash borer, took out oaks, have been affected - temp					
Forests / Trees	Town-wide	municipal, private	S	Forest Mgmt Program - State run program in city					
River Bank Erosion	Town-wide	Various	V	Balance b/w devel. + bank restoration/stabilization ~~increase~~					
Agricultural ~~Board~~ Commission	Town-wide	municipal	S	still in infancy, local food supply, handful of major farms scattered - work w/ neighbors - that won't development - FOOD		- Chases, Kimball, Wally's, Syronyish, etc. ...		conserve vs. develop	
Open Space Conservation	"	public/ private	S	Greenbelt lens on Merrimack to ID parcels for conservation - have facilitate acquisitions + preservation; (EJ - communities - opportunities for open space/heat wave) → Splash pads / River access					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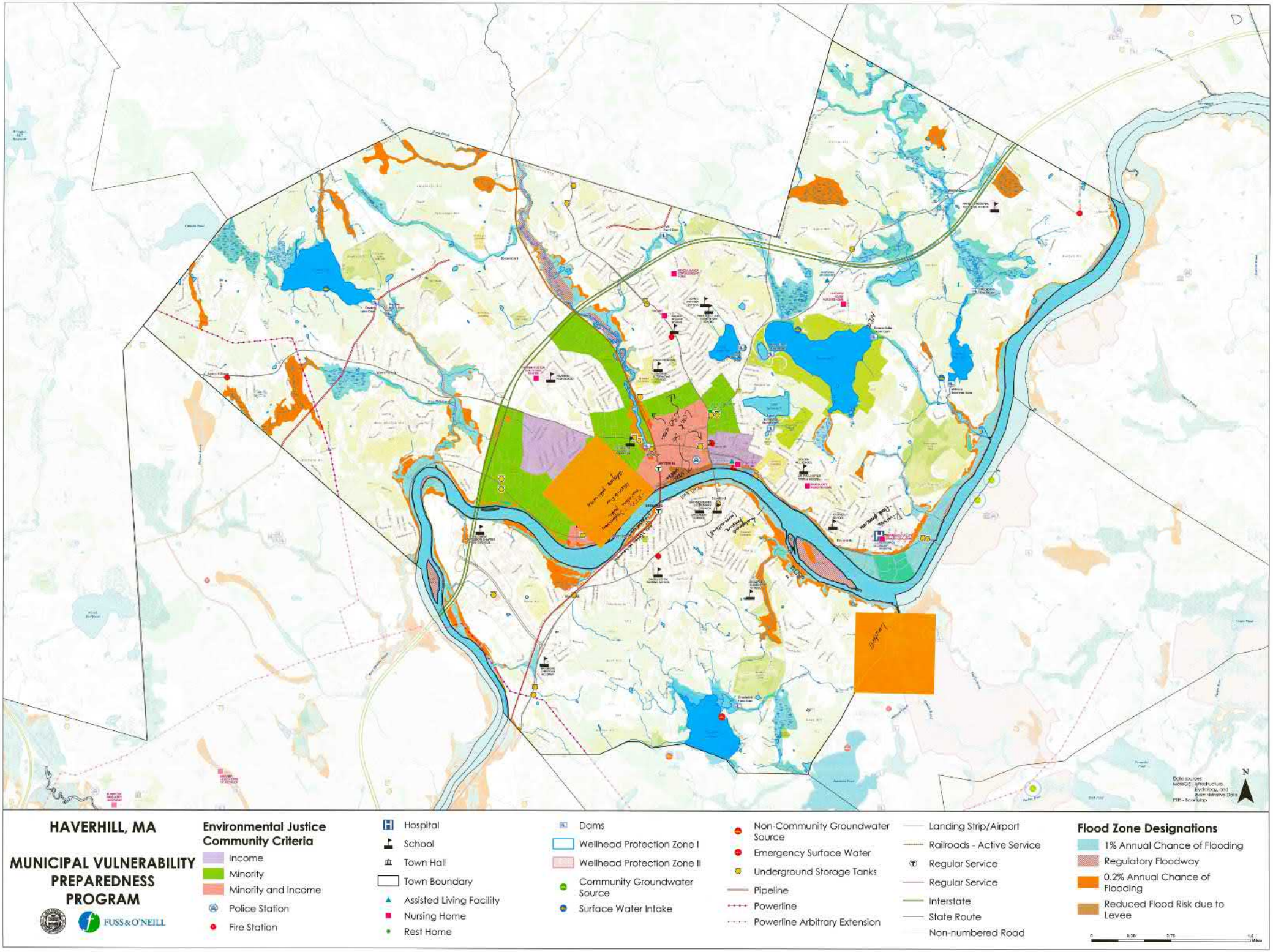
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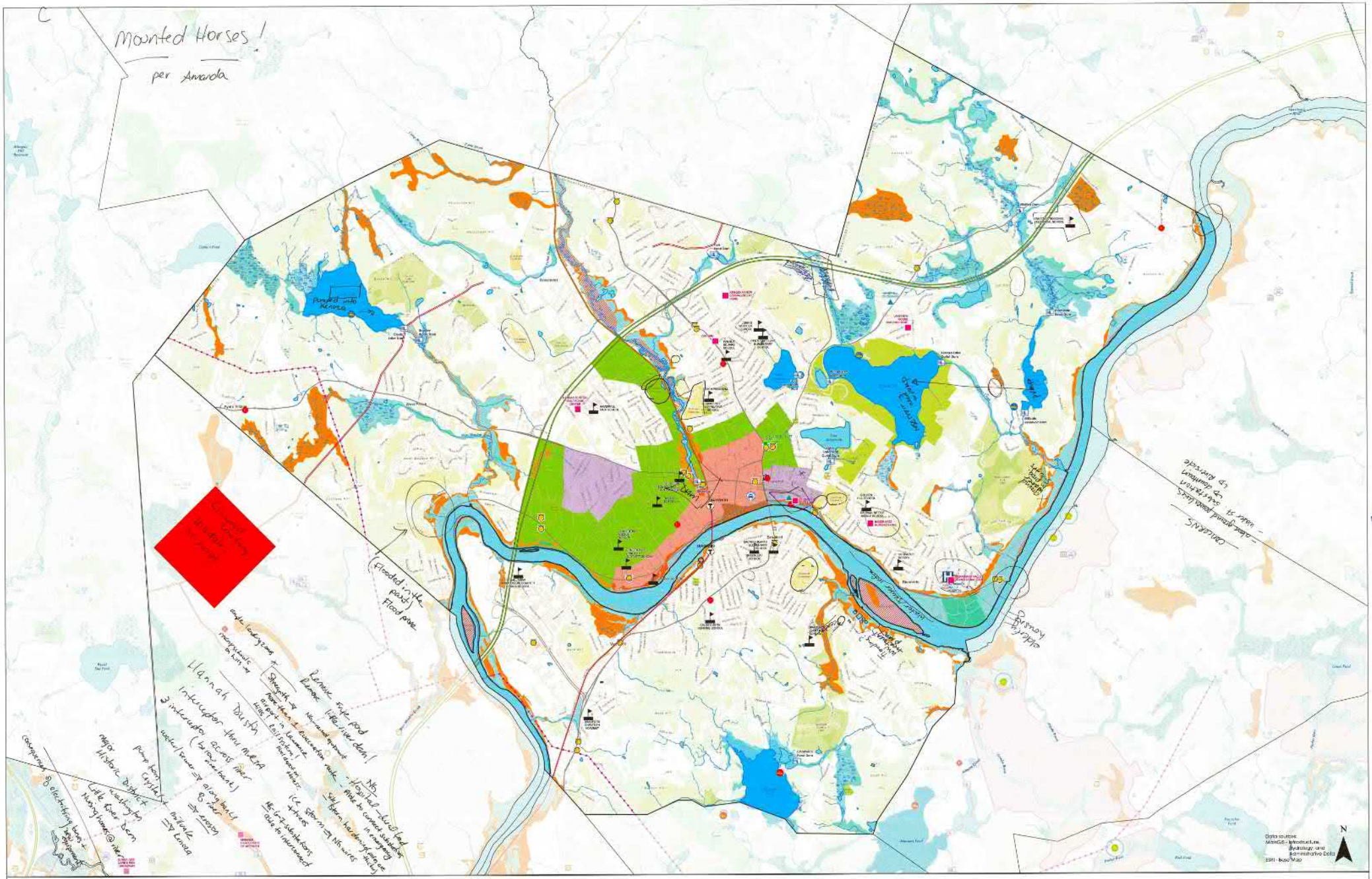

HAVERHILL, MA

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM

FUSS&O'NEILL

Environmental Justice Community Criteria

- Income
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- Minority and Income
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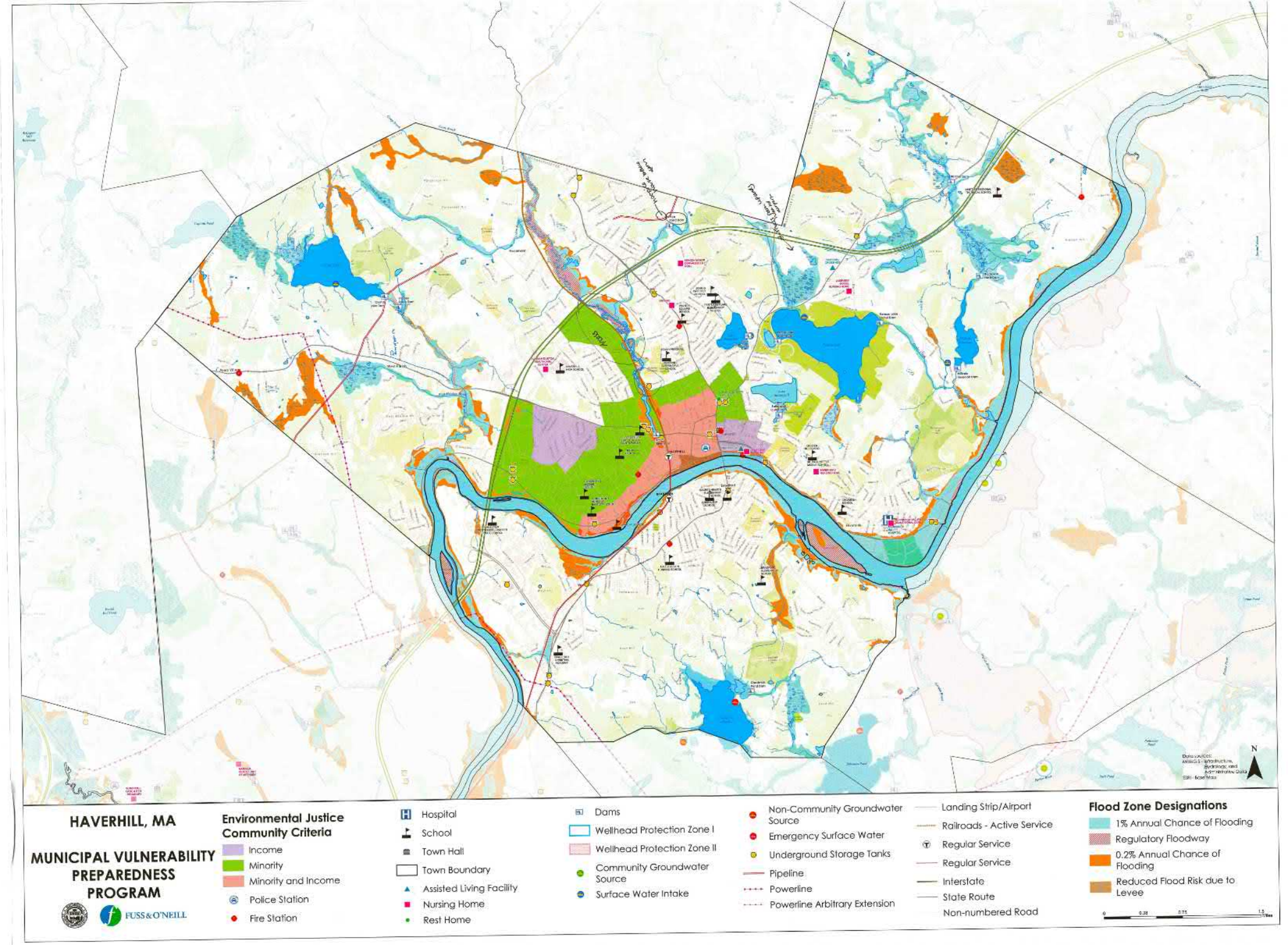
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Appendix D

CRB Workshop Presentation Materials

FUSS & O'NEILL

Boston Firefighters, January 4, 2018 (Reuters)

View of Haverhill, MA from the Merrimack River

Municipal Vulnerability Preparedness Program
Community Resilience Building Workshop
City of Haverhill

March 4, 2020

Community Resilience Building Workshop

Agenda

- CRB Team and participant introductions
- Introduction to Massachusetts Municipal Vulnerability Preparedness Program (MVP)
- Introduction to Climate Change and the City of Haverhill
- Discussion by Haverhill participants on status of current planning and risks
- Introduction to CRB Workshop process

- Large group
  - Determine top four hazards

- Small work groups (Using Risk Matrix)
  - Identify Haverhill's vulnerabilities and strengths
  - Prioritize response actions

- Lunch

- Large group
  - Report out from small groups
  - Determine overall priority actions for the City

- Discussion on next steps
- Conclusion

FUSS & O'NEILL

Fuss & O'Neill Overview

Fuss & O'Neill is a leading MVP consultant in assisting Massachusetts communities secure grant assistance, achieve designation as a Massachusetts Municipal Vulnerability Preparedness (MVP) community, and execute their MVP priority projects.

The MVP team is experienced in local government, environmental services, civil site engineering, stormwater management, and emergency management.

Fuss & O'Neill assisted new MVP communities secure more than $3.6 million in MVP Action Grants in the program's first three funding rounds.

Haverhill's MVP Program–$70,600

- Grant Supports Climate Change Vulnerability Assessments and Resiliency Planning
- MVP Comprehensive Approach
  - Infrastructure
  - Society
  - Environment
- Expanded Scope
  - Environmentally Impacted Sites and Climate Vulnerabilities Study with a focus on Environmental Justice Communities

MVP designation leads to enhanced standing in future funding opportunities

MVP Project Team

Julie Busa, PhD

Julie is a senior environmental scientist in the Water Environment and Natural Resources group of Fuss & O'Neill. She is a Certified Senior Ecologist with over 10 years of experience in the areas of global biodiversity and forest conservation, sustainability, and ecological modelling. Julie works extensively with municipalities on MS4 compliance and the MVP program.

Tim Clinton

Tim is a Project Manager working in Fuss & O'Neill's RI and MA Brownfields and Environmental Assessment and Remediation group. He has extensive experience in the design, planning, implementation, and documentation of numerous environmental assessment and remediation projects. Tim is a Certified Professional Geologist and Licensed Site Professional.

Matt Kissane

Matt is a geologist in the Environmental group of Fuss & O'Neill. He supports the planning, implementation, and documentation of numerous environmental assessment and remediation projects. He has experience in Massachusetts, Connecticut, and Rhode Island environmental regulations, regulatory permitting, and reporting.

MVP Project Team

Arnold Robinson

Arnold, AICP is F&O's Regional Director of Planning and has been practicing in the fields of community planning, historic preservation and urban design for more than 30 years. His practice focuses on effectively engaging residents, public officials and diverse stakeholders in the planning and review process in order to maximize consensus and create achievable projects that improve communities.

Sarah Hayden

Sarah is an environmental scientist in the Water Environment and Natural Resources group of Fuss & O'Neill. She has a background in environmental science as well as a strong foundation in business administration and environmental economics. Sarah works with municipalities on MS4 compliance and the MVP program.

MVP Action Grant

- Grant supports priority actions identified at Community Resilience Building Workshop
- $25,000 - $2,000,000 available (up to $5,000,000 for regional projects)
- Local match of 25% - can be in-kind
- Next funding round anticipated April 2020

Only those communities which have completed the CRB workshop are eligible to apply

Terminology

Climate Change

The Change in Usual Climate Conditions

Conditions

- Rising Temperature
- Changing Precipitation/ Rainfall Amount and Intensity
- Sea Level Rise

City of Haverhill–Merrimack Basin

Rising Temperature

Merrimack Basin	Observed Baseline 1971-2000	Projected Change in 2030s	Projected Change in 2050s	Projected Change in 2070s	Projected Change in 2090s
Average Annual Temperature (°F)	48.09	2.24 to 4.44	2.96 to 6.39	3.56 to 9.13	3.90 to 10.94
Annual Days with Maximum Temperature over 90°F (Days)	7.43	7.35 to 20.01	10.5 to 33.34	12.50 to 54.70	14.93 to 73.79
Annual Days with Minimum Temperature below 32°F (Days)	148.02	-11.77 to -29.91	-19.48 to -42.17	-23.32 to -56.29	-25.48 to -66.09

City of Haverhill–Merrimack Basin

Changing Precipitation

Merrimack Basin	Observed Baseline 1971-2000	Projected Change in 2030s	Projected Change in 2050s	Projected Change in 2070s	Projected Change in 2090s
Total Annual Precipitation (Inches)	44.21	0.12 to 4.54	-0.02 to 5.82	0.89 to 6.93	0.91 to 7.57
Annual Consecutive Dry Days (Days)	17.41	-0.66 to 1.21	-0.42 to 2.01	-0.88 to 2.42	-0.44 to 2.66

Stakeholder Updates

Climate Change Impacts – Temperature

- Economic
  - Winter Recreation
  - Snow and Ice
- Agricultural
  - Longer Growing Season
- Health
  - Increased Pests
  - Heat Stroke
- Infrastructure
  - Road Buckling
  - More Potholes
  - Power Outages
- Environment
  - Change in Habitat

Climate Change Impacts – Precipitation

- Economic
  - Dangerous Floods
  - Lost Work Time
- Agricultural
  - Excessively Wet Spring
  - Drought
- Health
  - Flood/High Water-related Deaths
  - Emergency Response Delays
- Infrastructure
  - Road Washout
  - Environment
  - Sewer System Overflows
  - Compromised Bridges
- Environment
  - Changes in Habitat

MVP Program

- Identify Top Four Hazards
- Review MVP Sectors
- Maps as tool
- List infrastructure, societal, environmental feature
- Determine whether a vulnerability or strength
- Identify actions to reduce vulnerability or reinforce strength
- Prioritize actions
- Report Out
- Finalize Prioritization Plan

Climate Change Hazards

- Flooding
- Extreme Precipitation Events
- Heat Waves
- Drought
- Snow/Ice
- Wildfire
- Tornadoes
- Hurricanes
- Nor'easters
- Other

Risk Matrix

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.com

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

Top Priority Hazards (tornado, floods, wildfire, hurricanes, earthquake, drought, sea level rise, heat wave, etc.)

Features	Location	Ownership	V or S					Priority H-M-L	Time Short Long Ongoing
Infrastructural									
Societal									
Environmental									

MVP Sectors

- Infrastructure
  - Evacuation routes
  - Schools
  - Roads, bridges, dams
  - Water and wastewater
  - Septic systems
  - Hospitals
  - Commercial Buildings, churches
  - Utilities: electric, gas
  - Factories
  - Emergency management facilities

MVP Sectors

- Societal
  - Emergency shelters
  - Senior housing
  - Schools and campuses
  - Economically challenged populations
  - Evacuation plans
  - Animal shelters
  - Hospitals, pharmacies
  - Grocery stores
  - Utilities: electric, gas
  - Homeless
  - Other

MVP Sectors

- Environmental
  - Drinking water supply
  - Rivers and streams
  - Parklands
  - Agriculture
  - Title V systems
  - Stormwater management
  - Open spaces
  - Flood plains
  - Forest
  - Other

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Next Steps:

Public Review of Priorities
Monitor and Update
Annual Review

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Questions?