Horsley Witten Group
Sustainable Environmental Solutions
113 R2 Water Street • Exeter, NH • 03833
603-658-1660 • *www.horsleywitten.com*

Summary of Findings

Newburyport Municipal Vulnerability Preparedness Workshop

Newburyport, Massachusetts

May 31, 2018

Prepared for:
City of Newburyport
Resilience Committee
Attn: Jon-Eric White, City Engineer
Department of Public Services, Engineering Division
16C Perry Way
Newburyport, MA 01950

Prepared by:
Horsley Witten Group, Inc.

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Newburyport Municipal Vulnerability Preparedness Workshop
Summary of Findings

Acknowledgements:

Funding to support the Newburyport Municipal Vulnerability Preparedness (MVP) Workshop was provided by the Massachusetts Executive Office of Energy and Environmental Affairs through an MVP Planning Grant, issued to the City of Newburyport during the fiscal year of July 2017 through June 2018.

The City of Newburyport contracted with the Horsley Witten Group, Inc. to provide MVP certified staff to support the City in planning and facilitating the workshop.

We would like to thank Michael Morris, co-chair of the Newburyport Resilience Committee, for his climate change presentation at the workshop that so aptly set the stage for the day's discussions.

We would also like to thank David Chatfield, co-chair of the Newburyport Resilience Committee, for facilitating the planning meetings of the Newburyport MVP Workshop Core Team.

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Newburyport Municipal Vulnerability Preparedness Workshop
Summary of Findings

Executive Summary

On April 7, 2018, Newburyport held a Municipal Vulnerabilities Preparedness (MVP) workshop. The workshop's goal was to identify hazards Newburyport faces that are being exacerbated by climate change, and to prioritize actions the City can take to prepare for identified hazards. This workshop, planned by a core team of organizers and the Horsley Witten Group, Inc. was a step towards MVP certification, which allows certified communities access to additional state grants for projects related to climate change resiliency. Thirty-eight community members attended the workshop, representing a wide cross section of city officials, response partners, and other interested parties.

During discussion, participants concluded that the most relevant hazards to Newburyport were storms including nor'easters, winter storms, and hurricanes; bipolar weather including extreme cold, extreme heat, and drought; inland flooding; and sea level rise. In four small groups, participants listed features of Newburyport that may be impacted by climate change or may help the community cope with climate related hazards. Small groups then listed actions that could be taken to protect or utilize features to mitigate the impact of prioritized hazards. Following small and large group discussion and voting, participants prioritized the following seven action items:

- Enhance the resilience of the wastewater treatment facility. Specifically, in the short term, protect and flood proof the wastewater treatment facility, and in the long term (estimated 40-50 years, at the close of the useful lifespan of the current facility), relocate the waste water treatment plant.
- Create a short term and long term plan for the City's management of Plum Island, including discussion of access via the Plum Island Turnpike, dune and floodplain management and potential retreat from current residential areas.
- Enhance emergency preparedness and response procedures. Specifically, improve participation in and use of the community's Code Red system, and enact an educational program to help residents improve their family's emergency preparedness.
- Develop a resiliency study of the Lower Artichoke Reservoir Dam to improve protection of the public water supply.
- Improve flood protection of utilities (water, sewer, electric, and gas). Specifically, require an annual accountability report from all utilities in the community.
- Create an inventory of coastal infrastructure (e.g., seawalls, boat ramps, bulkheads, and jetty) and conduct an assessment evaluating the efficacy of each component.

- Evaluate and plan for raising roadways and modifying culverts in areas of the City where it may be needed due to current or potential inundation risks (e.g., Water Street, Business Park, and Malcolm Hoyt Drive).

These action items will be incorporated into ongoing municipal planning efforts and will inform the City's Resilience Committee as it embarks on an effort for city-wide resilience planning. Actions identified in this process are also eligible for future grant funding under the MVP Action Grants program administered by the MA Executive Office of Energy and Environmental Affairs (EEA). By undertaking the MVP workshop and preparing this report, the City is also initiating its certification as an MVP Certified Community, which enables the City to apply for future MVP Program grants and elevates the scoring profile for related project proposals to other state grant programs.

Table of Contents

1. Introduction

The Municipal Vulnerabilities Preparedness (MVP) Program is a Massachusetts state program designed to increase municipality-level resilience to natural hazards being exacerbated by climate change. This program is designed to help municipalities identify their vulnerabilities and strengths along with as opportunities to take action to reduce risk and build resilience. Workshops utilize the Community Resilience Building (CRB) Framework, a system of discussion and note taking developed by the Nature Conservancy and prescribed by the MVP Program. Newburyport received a grant to participate in the MVP program in order to build on its prior resiliency planning efforts and develop a list of priority actions to focus on in the immediate future.

Workshop Planning and Core Team

Following the award of the technical assistance grant, several city employees and members of the Newburyport Resilience Committee began to serve as a core organizing team. Team members included the following individuals, and were assisted by Ellie Baker of the Horsley Witten Group (HW), Newburyport's MVP Provider:

- Julia Godtfredsen, Conservation Administrator
- Jon-Eric White, City Engineer
- Molly Ettenborough, Recycling and Sustainability Coordinator
- David Chatfield, Newburyport Resilience Committee Co-Chair
- Michael Morris, Newburyport Resilience Committee Co-Chair
- Mayor Donna Holaday

Team members met four times between January 18 and March 15, 2018, and communicated via email and telephone as needed. Responsibilities of the core team included planning workshop logistics; reviewing workshop agenda; providing reference material, context and background for the MVP effort; reviewing maps and reference materials for use in workshop discussion groups; identifying a diversity of representative stakeholders to invite to the workshop; reaching out to invitees to encourage attendance; and participating in the workshop as discussion facilitators, note takers and stakeholders.

Workshop Attendees and Materials

Newburyport's MVP workshop was held on April 7, 2018 at the Newburyport Senior Center. A total of 51 stakeholders were invited to the workshop and 34 stakeholders attended. Participants represented a wide cross section of the City's stakeholders and decision-makers, including Mayor Donna Holaday, members of the Storm Surge interest group, an electric utility representative, a facilities manager at the local hospital, students, and a wide variety of municipal department staff and volunteers from local boards and commissions, among others. See Attachment A for a full list of participants, including their organizational affiliation.

On the day of the workshop, participants were provided with a copy of the agenda for the day (see Attachment 2) and a handout summarizing climate change resiliency measures that have been previously identified and recommended in recent city plans, including the Newburyport Natural Hazards

Mitigation Plan, the Great Marsh Coastal Resilience Plan, and the Newburyport Master Plan (see Attachment B). The following additional informational materials were located on each small group's table to be shared in order to encourage communication and collaboration throughout the workshop:

- Summary of climate projections for the Merrimack Basin provided by EEA and prepared by the Northeast Climate Science Center (see Attachment B)
- Example vulnerabilities and strengths excerpted from the CRB guidance document (see Attachment B)
- Summary of Newburyport demographic data (see Attachment B)
- Newburyport base map showing critical infrastructure and FEMA floodplain data (see Attachment C)
- Newburyport base map showing projected floodplains for the year 2070 compiled by the Woods Hole Group (see Attachment C)

The Workshop Process

Following introductions and an overview of the MVP Program and workshop agenda, workshop participants listened to two presentations, one by Newburyport Resilience Co-Chair and Storm Surge member Michael Morris and one by MVP Certified facilitator Ellie Baker, HW, about climate change projections and their current and potential future impacts on Newburyport. The presentations discussed specific infrastructural and environmental challenges facing the City in the light of climate change. Challenges discussed included the impact of sea level rise on Plum Island, flooding after severe rain events, and increasing drought severity. Following this introduction, HW led a large group discussion in which participants honed in on four primary climate change hazards to frame the discussions for the remainder of the workshop.

The remainder of the workshop was conducted in four small discussion groups. Groups were made up of a facilitator (either a HW staff member or member of the core planning team), a note taker, and about 8 workshop participants. Small group discussion began by listing environmental, societal, and infrastructural features that represent either a vulnerability or a strength of the community in the face of anticipated climate change hazards. Features were marked on the base maps and listed on the risk matrix, a framework for note taking developed as a part of the CRB framework. Groups listed between 10 and 16 features for each category, along with information about their location, ownership, and if they are a strength or vulnerability for the City.

Following a lunch break, groups moved on to discussing action items that address the threats posed by priority hazards, or enhance the strengths identified. Action items could either be a way to protect a vulnerable feature from a negative impact or how to better utilize one of Newburyport's strengths. Common action items listed included raising or increasing flood protection for critical infrastructure, increasing emergency shelter capacity, and enhancing existing environmental protection efforts. Throughout small group discussion, the workshop's lead facilitator circulated between groups to ask questions and provide guidance.

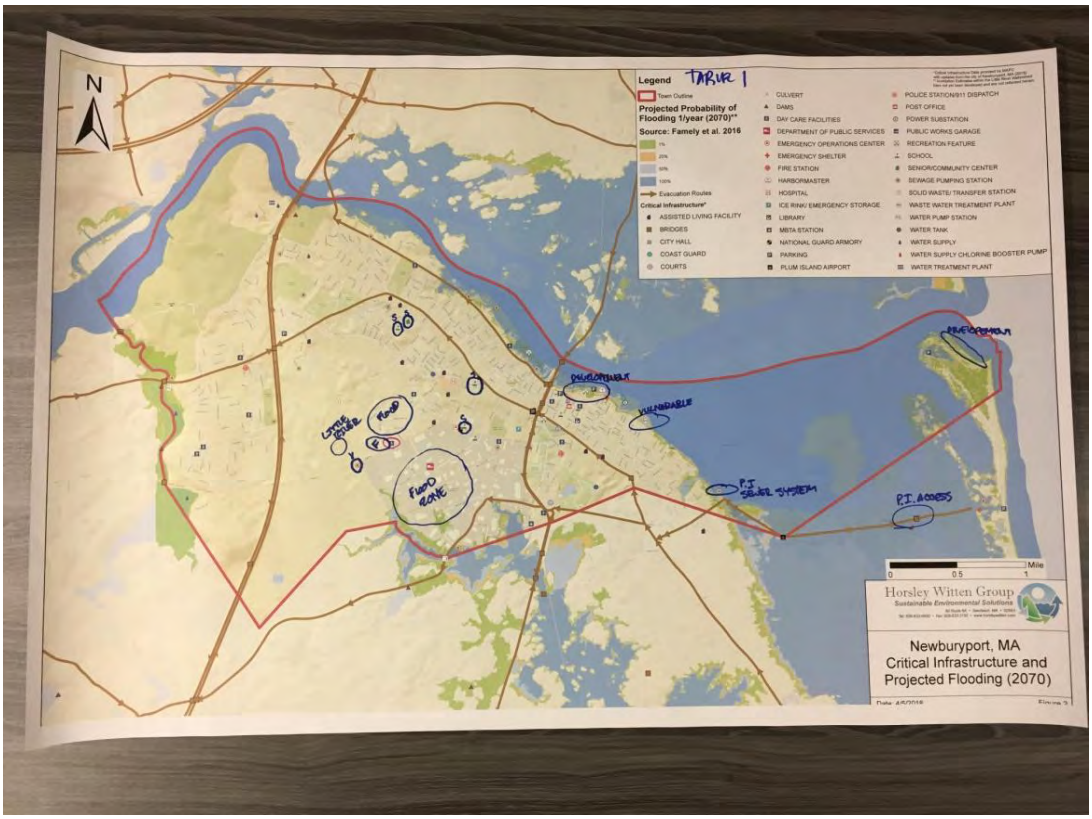

Photo 1 Groups annotated maps to highlight vulnerable infrastructure, flood zones, and community resources**.**

Once complete lists of action items to address infrastructural, environmental, and societal vulnerabilities had been compiled, groups began the process of prioritizing actions. Groups completed this process in different ways, with some identifying the priority level for each suggested action items and others only determining which were of the highest priority. Groups prioritized items by discussion and/or by dot voting, in which each participant was given several dot stickers, which they could place next to ideas they wished to prioritize.

After all groups had prioritized five or six action items, a representative of the group reported out to the full workshop the prioritized items along with a brief summary of their group's discussion. Following the presentation of each group's priorities, workshop participants together along with the workshop facilitator combined duplicative suggestions to create a final list of priority actions that the city of Newburyport should embark upon to increase the resilience of the community in the face of anticipated climate change impacts.

The results of each stage of the workshop discussions are presented in the subsequent sections of this report. Attachment D includes a transcription of the summary matrices produced by each of the four discussion groups. Attachment E includes a matrix presenting a compilation of the recommended high priority actions from the four discussion groups. Action items prioritized during small or large group discussion are indicated with underlined font. Attachment F includes the maps that contain notations from each of the four discussion groups.

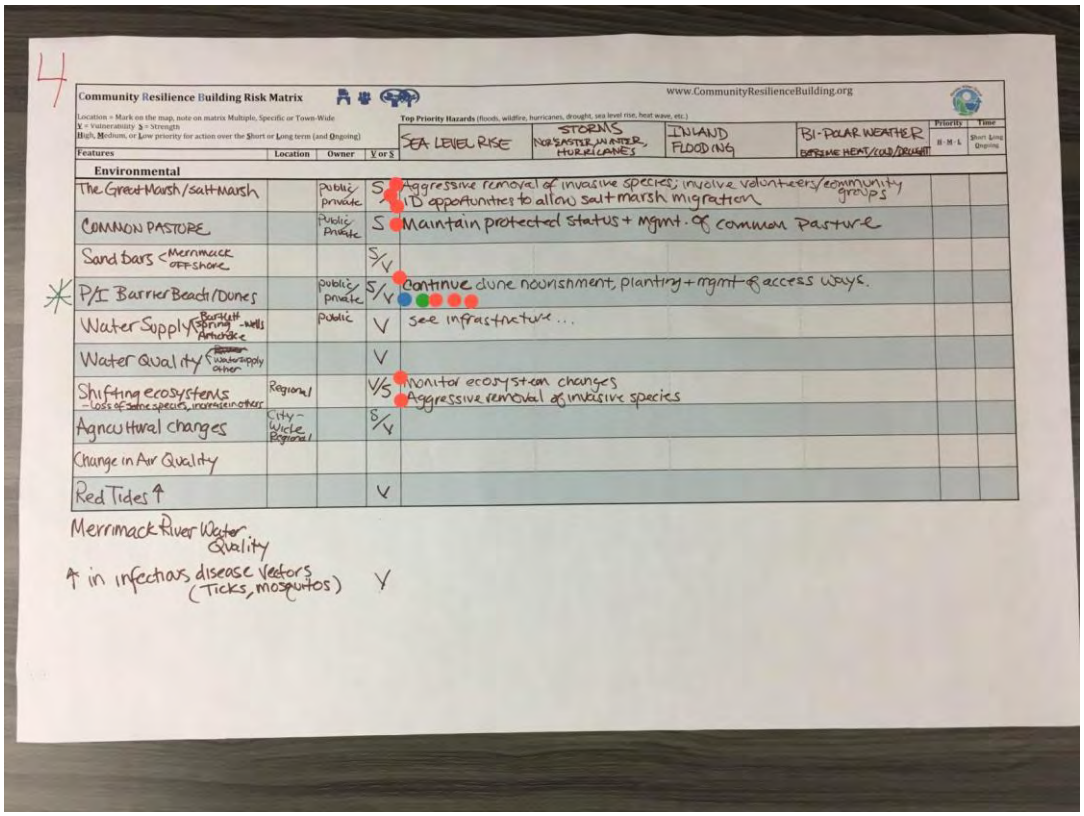

Photo 2 An example completed risk matrix. Colored dots indicate the small group member voting to prioritize each action.

2. Top Hazards of Concern

The discussion of hazards tended to include both the hazard events as well as the impacts from those events, because the term hazard can be a bit confusing in its use; 'hazard' can refer to the cause and the impact. The following list presents the potential climate change hazards identified by workshop participants in the preliminary discussion:

- Change in water table
- Drought and extreme heat
- Tick and mosquito related illness and infectious disease
- Economic development
- Extreme rain events and inland flooding
- Sea level rise
- Winter storms (ice, snow, winds, erosion, power loss, evacuation)
- Storms (winter, hurricanes, nor'easters)
- Agricultural risks
- Wild fires
- Inland flooding
- Hurricanes and nor'easters, including erosion and coastal flooding

- Saltwater intrusion
- Bipolar weather extremes (drought, extreme heat, and extreme cold)
- Ocean acidification
- Inland flooding

Following initial listing, several hazards were combined together based on the common impacts expected form the hazards, and the list of hazards was narrowed down the list to the four most important hazards for consideration by the City in the MVP process. Workshop participants came to consensus that the following climate-change related hazards were the highest priority for Newburyport:

- Storms including nor'easters, winter storms, and hurricanes (wind, snow, rain, storm surge)
- Bipolar Weather (including extreme cold, extreme heat, drought, and extreme fluctuations)
- Inland Flooding (precipitation)
- Sea Level Rise

3. Current Concerns and Challenges Presented by Hazards

Newburyport has experienced a number of climate- and weather-related challenges in recent years, and can expect to experience more severe events in the years to come due to climate change. Three winter storms in March, 2018 caused severe flooding due to rainfall and storm surge coinciding with seasonal high tides. These storms also brought heavy snow and wind that caused power outages lasting multiple days in many areas of the City and the region as a whole. This was a major disruption to commerce, government, schools, transportation, emergency response and life in general. In 2016 – 2017, Newburyport and the northeast in general experienced a severe drought that challenged the City's water supply and caused the City to place restrictions on public water use. Over the past several years, Plum Island has experienced severe erosion at different rates in different locations on the island's dunes and beaches; as well as significant flooding events, which have threatened private property as well as the water and sewer infrastructure on the island. Houses have been undermined from erosion and the sewer system has suffered shutdowns and experienced backflows into residential homes due to flood and snow impacts. In addition, many roadways in the community have been flooded due to storm surge and surcharged stormwater drainage systems, or in some cases, both.

The biggest challenges, concerns and vulnerabilities that were raised in the breakout discussions at the MVP workshop included:

- *Coastal flooding due to heavy rains and storm surge:* Coastal, tidally influenced flooding occurs on the properties along the Merrimack River, including Cashman Park, the central waterfront, Waterfront West, the Plum Island Turnpike and causeway, the back side of Plum Island and Plum Island center. In addition, during high tides, drainage in Market Square can back up cause flooding in the downtown commercial district. The newly upgraded wastewater treatment facility is located within the Merrimack River coastal floodplain, and key elements of the facility are at risk of failure due to flooding.

- *Beach and dune erosion:* The beaches and dunes along Plum Island have experienced severe erosion and accretion over the past several decades, putting homes and infrastructure at risk. At least one home on Plum Island in Newbury was completely toppled by the erosion of the dune, and there have been numerous efforts by Plum Island residents, the city, and Newbury to the south, to replenish the dunes, protect private property, and consider a range of mechanisms to mitigate the risk to public infrastructure and private property.
- *Power outages:* Winter snow storms and wind events experienced in the early months of 2018 caused widespread power outages across Newburyport and the region, and drew significant attention to the risks to the power grid from future severe weather events. Much of Newburyport's electrical wires are above ground, and many suffered damage from trees and limbs during the storm events.
- *Inland flooding:* Several areas of Newburyport experience inland flooding caused by precipitation events, often combined with localize drainage problems. Roadways and some businesses within the business park as well as nearby residential neighborhoods experience flooding during heavy rain events, which is also exacerbated by high tides and undersized culverts in the Little River that hinder drainage. Flooding in the Merrimack River is a concern for the public drinking water supply at the Artichoke Reservoir, because the dam has almost overtopped during recent storm events, which would cause contamination form river water.
- *Emergency preparedness, response and recovery after a storm event:* The flooding and power outages described above further raised concern about preparations and impacts to emergency response personnel and access to vulnerable populations. The City provides full-time emergency response services (fire, police, and ambulance), has a Code Red communications system, and staffs an emergency management operations center during emergency events. However, strengthening these systems and the city's ability to provide these services was a common concern.
- *Drought:* The City experienced a severe drought in 2016-2017 that challenged the public water supply and required the city to institute a water restriction on lawn watering. The city's water is supplied by the Artichoke Reservoir and two groundwater wells, and efforts to identify an additional source of water supply have not yet been successful.
- *Water quality impacts from flood events:* The Merrimack River is a lifeline of the city, and during heavy rainfall events, it is increasingly contaminated by stormwater runoff as well as discharges of untreated sewage from overflows at upstream wastewater treatment facilities. The contaminated water can impact the city's drinking water supply if the river overtops the Artichoke Reservoir Dam. The contaminated river water can also hinder the economic wellbeing of the City, which depends in part on a tourism industry based on fishing, boating, swimming and recreating near the shore.

4. Current Strengths and Assets

Among the discussion groups at the workshop, a number of strengths were also identified among the infrastructural, societal and environmental assets of the city. These include:

Infrastructural:

- The Solarize Newburyport program to bring solar energy options to Newburyport residents, creating less dependence on fossil fuels and remote energy sources.
- The strength of the existing asset management program within the Department of Public Services.
- The recent school construction and renovation projects, which enhances the ability to use those buildings as shelters.
- The strength of the emergency services (fire, police and ambulance) and the ability of the city to provide these services via paid staff rather than volunteers.
- The existence of the water storage infrastructure for public water supply.
- The location of main roads along higher elevations for use as evacuation routes to connect to Interstate 95.

Societal:

- The location of the local hospital outside of flood risk and the strength of the medical community in Newburyport.
- The existence of local agriculture for local food supply.
- An engaged citizenry, a strong community and a large network of regional and local non-profit entities.
- Strong local leadership.
- A wealthy community that can provide resources.
- The ability to provide emergency services.

Environmental:

- A strong street tree program.
- A host of environmental groups.
- The Great Marsh system buffers the impacts of storms and flooding.
- The existence of Plum Island as a natural protective barrier island.
- The significant network of protected open spaces.

5. Top Recommendations to Improve Resilience

Following the presentation of each group's priorities, workshop participants, along with the workshop facilitator, combined duplicative suggestions to create a final list of suggestions. These suggestions were then further prioritized using dot voting. Seven action items were chosen as highest priority and are listed below.

- Enhance the resilience of the wastewater treatment facility. Specifically, in the short term, protect and flood proof the wastewater treatment facility, and in the long term (estimated 40-50 years, at the close of the useful lifespan of the current facility), relocate the waste water treatment plant.
- Create a short term and long term plan for the city's management of Plum Island, including discussion of access via the Plum Island Turnpike, dune and floodplain management and potential retreat from current residential areas.
- Enhance emergency preparedness and response procedures. Specifically, improve participation in and use of the community's Code Red system, and enact an educational program to help residents improve their family's emergency preparedness.
- Develop a resiliency study of the Lower Artichoke Reservoir Dam to improve protection of the public water supply.
- Improve flood protection of utilities (water, sewer, electric, and gas). Specifically, require an annual accountability report from all utilities in the community.
- Create an inventory of coastal infrastructure (e.g., seawalls, boat ramps, bulkheads, and jetty) and conduct an assessment evaluating the efficacy of each component.
- Evaluate and plan for raising roadways and modifying culverts in areas of the City where it may be needed due to current or potential inundation risks (e.g., Water Street, Business Park, and Malcolm Hoyt Drive).

Photo 3 A workshop participant presents Group 3's prioritized action items.

6. Conclusion and Next Steps

Newburyport will continue the MVP certification process by presenting and distributing this report to the public at a formal public information and listening session, scheduled for 6:30 PM on June 29, 2018 at City Hall Auditorium. This session will provide an opportunity for any member of the interested public to learn, ask questions, and provide feedback about the April 7, 2018 MVP Workshop and the recommended highest priority actions that emerged from that workshop.

Priorities identified during the April 7, 2018 MVP Workshop will be integrated into existing municipal planning efforts, including in particular the resilience planning effort being initiated by the Newburyport Resilience Committee appointed by the Mayor in late 2015. The City will also consider pursuing grant funding to implement the priority actions identified through the MVP Workshop process to continue to improve the City's resilience to climate change.

Attachment A: List of Participants

Newburyport MVP Workshop, April 7, 2018
Participants

FIRST	LAST	ROLE
Ted	Angelakis	Water Treatment Plant Operator
Steve	Bergholm	Director of Facilities/Maintenance, Newburyport Public Schools
Peter	Binette	Building Commissioner
James	Brugger	Planning Board
Olivia	Capp	Graduate Student at Duke Univ. (Env and Bioethics), Resident
Art	Chaisson	Harbormaster's Office
David	Chatfield	Resident, Resilience Committee
Jeff	Clark	Newburyport First Religious Society Environmental Group, Storm Surge
Barry	Connell	City Councilor
Joseph	Costanzo	Merrimack Valley Regional Transit Authority
Vernon	Ellis	Resident of Plum Island
Molly	Ettenborough	Recycling and Energy Coordinator
Bailey	Fogel	Student, Newburyport Public Schools
David	Fowler	Facilities Manager, Anna Jaques Hospital
Mike	Frey	Resident of Quail Run neighborhood, NBPT Open Space Comm
Julia	Godtfredsen	Conservation Administrator
Donna	Holaday	Mayor
Tony	Komornick	Transportation Mgr, Merrimack Valley Planning Commission
Christine	Masiello	Greater Newburyport Association of Realtors
Mike	Morris	Storm Surge Interest Group, Resilience Committee
Doug	Muir	Custom House Museum
Bill	Mullen	Resident
Jerry	Mullins	Citizen, Parker River Clean Water Association
Joe	Muraco	National Grid Municipal Liason
Paul	O'Brien	Chief of Staff, Mayor Holaday
John	O'Connell	Town of Newbury Resilience Committee member

FIRST	LAST	ROLE
Pamela	Palombo	Public Nurse
Bill	Peterson	Director of Parker River National Wildlife Refuge
Matthew	Pieniazek	Chair, Board of Trustees, Newburyport Waterfront Trust
Chris	Richards	Fire Chief and Emergency Management Director
Mike	Strauss	Chair, Energy Advisory Committee
Joe	Teixeira	Conservation Commission Chair
Jon-Eric	White	City Engineer
Robert	Wolcik	Regional Emergency Planning Committee, EMS Manager, Strem Chemical

Attachment B: Workshop Handouts

Agenda

Prior Recommendations

Climate Change Projections

Example Vulnerabilities and Strengths

Demographics

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Newburyport Municipal Vulnerability Preparedness (MVP) Workshop

Saturday, April 7, 2018, 8:00 am - 4:00 pm

Newburyport Senior Center

AGENDA

TIME	ACTIVITIES	SPEAKER
8:00 AM	Registration and Refreshments	
8:30 AM	Welcome	Mayor Holaday
8:40 AM	Introductions and Overview of the Workshop	Ellie Baker *Horsley Witten Group*
9:00 AM	**Overview Presentation**: Science, Past Planning Efforts, and Data Resources, including: Great Marsh Coastal Adaptation Plan (2017) Newburyport Master Plan (2017) Merrimack Valley Multi-Hazard Mitigation Plan (2016) EPA Resilience Workshop (2015-2016)	Ellie Baker, *Horsley Witten Group* Mike Morris, *Newburyport Resilience Committee*
9:50 PM	**DISCUSSION #1: Large Group** Identify top 4 Climate Change Hazards facing Newburyport	
10:30 AM	*15 MINUTE BREAK*	
10:45 AM	**DISCUSSION #2: Small Group** Identify Features that are Vulnerabilities and Strengths	
12:20 PM	*40 MINUTE LUNCH*	
1:00 PM	**DISCUSSION #3: Small Group** Identify municipal actions to address Vulnerabilities or protect Strengths. Discuss timeframe, responsibility, funding, as time allows. Prioritize top 5 Actions (last 20 minutes).	
2:25 PM	*15 MINUTE BREAK*	
2:40 PM	**DISCUSSION #4: Small Groups Report Out** Each group reports out top 5 Priority Actions	
3:10 PM	**FINAL DISCUSSION: Large Group** Select top 3-5 priority Actions to improve Newburyport's Climate Resilience. Discuss timeframe, responsibility, funding.	Ellie Baker *Horsley Witten Group*
3:50 PM	**Wrap Up and Closing Remarks**	Mayor Holaday
4:00 PM	Adjourn	

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Newburyport Municipal Vulnerability Preparedness (MVP) Grant Project:

RECOMMENDATIONS FROM EXISTING PLANS

RECOMMENDATION	HAZARD	Existing Plans			
		GMCAP	HMP	MP	EPA
Waste Water Treatment Facility • Short-term: Elevate critical utilities, floodproofing, evaluate shoreline protection structures/living shoreline options, use inflatable berm during storms • Long-term: Plan for relocation	Flooding	✓	✓	✓	✓
Sewage Pump Stations • Long-term: Floodproof 9 sewage pump stations that are vulnerable to SLR	Flooding		✓		
Lower Artichoke Reservoir • Short-term: Raise elevation of dam, assess possible breach points, increase flood-storage options, install overflow pumping, control new development to decrease water demand, set up response plan to deal with breach from Merrimack River • Long-term: Pursue new/additional drinking water sources (e.g., wells)	Flooding, causing salt water inundation	✓		✓	✓
Bartlett Spring Pond • Short-term: Set up response plan to deal with breach from Merrimack River, raise road currently on berm, retrofit existing berm to raise and include drainage outlet • Long-term: Pursue new/additional drinking water sources (e.g., wells)	Flooding, causing salt water inundation	✓		✓	✓
Redundant Water and Sewer • Long-term: Provide redundant water and sewer systems, focus on Plum Island	All hazards		✓		
Central Waterfront (between Green St and Harbor Master Building) • Short-term: Engage stake holders so redevelopment incorporates climate change predictions, raise elevation of park and parking lots, create flood-storage opportunities/dual purpose parking lots, floodproofing retrofits for buildings, incentivize development away from flood prone areas • Long-term: Consider raising seawall with new flood walls at open ends of streets and include natural components, consider planned retreat	Flooding	✓			✓
Market Square • Short-term: Evaluate and correct drainage capacity structure problem	Flooding		✓	✓	
North End of Plum Island • Short-term: Continue dune reconstruction, grass planting, and fencing; reduce foot traffic on dunes; enforce existing regulations; explore regulatory options such as freeboard incentives, voluntary buyback programs, zoning changes; continue monitoring programs to gather data that will support planning efforts; develop emergency response plan for possible inundation of Reservation Terrace • Long-term: Consider planned retreat, incorporate climate projections in long-term planning, coordinate with U.S. Army Corps of Engineers on jetties	Flooding, inundation, erosion	✓		✓	

RECOMMENDATION	HAZARD	Existing Plans			
		GMCAP	HMP	MP	EPA
Plum Island Turnpike (Joppa Flats Audubon Center to Sunset Drive) • Short-term: Safety improvements (e.g., warning system for residents, reflectors on road), increased data recording during flooding events • Long-term: Raise road elevation	Flooding	✓	✓	✓	
Cashman Park • Short-term: Consider living shoreline to replace riprap, increase drainage with storage/culvert improvements • Long-term: Incorporate climate projections in long-term planning, raise fields	Flooding	✓	✓	✓	
Business Park (including Hale St, Parker St/Scotland Rd, Henry Graf Rd, Fox Run neighborhood) • Short-term: Upgrade culverts, swale restoration, floodproofing retrofits for buildings, implement green infrastructure stormwater BMPs, create a City stormwater utility to provide funding and incentivize BMPs, update emergency response plans to manage chemicals during flooding events, create an overlay district for the business park • Long-term: Incorporate climate projections in long-term planning	Flooding	✓	✓	✓	✓
Water Street (Joppa Seawall to Ocean Ave) • Short-term: Repair Joppa seawall and include drain openings, investigate using a living shoreline or offshore reef, including a hybrid living shoreline/hard armoring structure to reduce flooding and erosion • Long-term: Incorporate climate projections in long-term planning, raise buildings and road, raise seawall coupled with new seawalls at open end	Flooding	✓		✓	✓
Merrimac Street (near Mersen and pump station) • Long-term: Roadway improvements, including drainage capacity upgrade	Flooding		✓	✓	
Forestry Management • Long-term: Thin crowded trees, particularly at March's Hill and Maudslay	Brushfires		✓		
Additional Non-Structural Recommendations • Extend T1 hardware between municipal systems and DPS facility/PITA Hall Update zoning and building codes; consider enacting stricter standards for new development in terms of stormwater, wind bracing and flooding; communicate risks to property owners prior to project start • Investigate participating in FEMA's Community Rating System (CRS) • Create a "flood smart" community and educate the public about natural hazards through outreach programs • Prepare Municipal Resiliency Plan for SLR/storm surge/climate change, planning for 2 to 5 feet of SLR by 2100 • Encourage regional planning with other towns to address hazards • Increase enforcement of existing regulations	All hazards	✓	✓		✓

EXISTING HAZARD PLANS:

GMCAP: Schottland, T., M. Merriam, C. Hilke, K. Grubbs, and W. Castonguay, 2017. *Great Marsh Coastal Adaptation Plan*. National Wildlife Federation Northeast Regional Office, Montpelier, VT. 237 p.

HMP: Merrimack Valley Planning Commission, 2016. *Merrimack Valley Region Multi-Hazard Mitigation Plan Update*. April. 420 p.

MP: City of Newburyport, 2017. *City of Newburyport, Massachusetts Master Plan*. 188 p.

EPA: EPA, 2016. *Flood Resilience for Riverine and Coastal Communities, Building Blocks for Sustainable Communities.* Newburyport, Massachusetts. Next Steps Memorandum. January 29. 23 p.

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Newburyport Municipal Vulnerability Preparedness (MVP) Grant Project:

CLIMATE CHANGE PROJECTIONS[1]

TEMPERATURE

HIGHLIGHTS:

- ✓ Temperature increases could make Newburyport feel like present-day New Jersey by 2050 and present-day Tennessee by 2100.[2]
- ✓ By 2050, we could have more than 5 times as many very hot days (over 90°F) than we do today. By 2100, we could have more than 11 times as many.
- ✓ We will have far fewer days with temperatures below freezing.
- ✓ We will have to expend less energy on heating in the winter, and far more on air conditioning in the summer.
- ✓ The growing season will increase by up to 50% by 2050 and could almost double by the end of the century.

Table 1: TEMPERATURE PROJECTIONS

Merrimack Basin Climate Parameter	Baseline (1971-2000)	Mid-Century (2050s)	End of Century (2090s)
Average Annual Temperature (°F)	48.1	51.1 – 54.5	52.0 – 59.0
Maximum Annual Temperature (°F)	59.1	61.8 – 65.4	62.7 – 70.0
Minimum Annual Temperature (°F)	37.0	40.2 – 43.5	41.2 – 48.0
Annual Days with Max Temp over 90°F	7	18 – 40	22 – 81
Annual Days with Min Temp below 32°F	148	106 – 129	82 – 123
Annual Heating Degree-Days (Base 65°F)	6,693	5,072 – 5,924	4,190 – 5,661
Annual Cooling Degree-Days (Base 65°F)	526	809 – 1,263	925 – 2,044
Annual Growing Degree-Days (Base 50°F)	2,466	3,015 – 3,692	3,196 – 4,879

[1] Source: Northeast Climate Science Center, 2018. *Massachusetts Climate Change Projections*. University of MA Amherst. Published by MA Executive Office of Energy and Environmental Affairs. January. 213 p. Available at: http://www.massclimatechange.org/resources/resource::2152/massachusetts-climate-change-projections-statewide-and-for-major-river-basins. Data is for the Merrimack Basin, which includes the majority of the land area of Newburyport.

[2] NOAA National Centers for Environmental Information, Climate at a Glance: Statewide Mapping, Average Temperature, published March 2018, retrieved on March 22, 2018 from http://www.ncdc.noaa.gov/cag/.

PRECIPITATION

HIGHLIGHTS:

- ✓ Average annual precipitation in Newburyport will increase up to 13% by 2050 and up to 17% by 2100.
- ✓ The largest increases in precipitation will occur in winter.

Table 2: PRECIPITATION PROJECTIONS

Merrimack Basin Climate Parameter	Baseline (1971-2000)	Mid-Century (2050s)	End of Century (2090s)
Total Precipitation (inches):			
Annual	44.2	44.2 – 50.0	45.1 – 51.8
Winter	10.8	10.8 – 13.2	11.2 – 14.6
Spring	11.3	11.2 – 13.4	11.5 – 13.8
Summer	10.3	9.7 – 12.3	9.2 – 12.1
Fall	11.9	10.8 – 13.4	10.5 – 13.2
Annual Days with Precipitation over 1 inch	7	7 – 10	8 – 11
Annual Days with Precipitation over 2 inches	1	1 – 2	1 – 2
Annual Days with Precipitation over 4 inches	0	0 – 0	0 – 0
Annual Consecutive Dry Days	17	17 – 19	17 – 20

SEA LEVEL RISE

HIGHLIGHTS:

- ✓ Sea levels could rise as much as 2.6 feet by 2050 and 9.8 feet by 2100.
- ✓ The projections below present the 'most likely range' of sea level rise.

Table 3: SEA LEVEL RISE PROJECTIONS

Year	Emissions Scenario	Boston Likely Range (feet relative to mean sea level in 2000)	Seavey Island, Kittery, ME Likely Range (feet relative to mean sea level in 2000)
2050	Medium	0.8 to 1.4	0.6 to 1.2
	High	0.8 to 1.5	0.7 to 1.4
2100	Medium	1.5 to 3.1	1.2 to 2.8
	High	2.0 to 4.0	1.7 to 3.7

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Newburyport Municipal Vulnerability Preparedness (MVP) Grant Project:

EXAMPLES of VULNERABILITIES and STRENGTHS[1]

INFRASTRUCTURE

Examples of Vulnerabilities:

- Main road floods during storms, blocking emergency response.
- Power outages during heat waves lead to health concerns.
- Wildfire and high winds resulting in supply chain interruptions.
- Sewer pump stations become submerged and inoperable.
- Compromised rail system due to heat-related warping of tracks.

Examples of Strengths:

- Critical road elevated and passable by emergency management
- Hurricane roof installed at school with improved sheltering capacity.
- Hardened utility lines reduce outages due to ice storms.
- Undersized culvert replaced to reduce flooding in key intersection.
- Improvement to communication systems during extreme weather.

SOCIETAL

Examples of Vulnerabilities:

- Senior housing without backup generators during heat waves.
- Residents without access to transportation during hurricane evacuation.
- Household contamination and sewage mobilization during flooding.
- Limited areas of refuge in elementary schools during tornados.

Examples of Strengths:

- Reliable communications protocols across departments for all employees.
- "Neighbor-helping-neighbor" program aligned with emergency operations.
- Well-supported volunteer organizations (fire, ambulance, CERTs).
- Faith-based and civic groups with hazard preparedness plans.

ENVIRONMENTAL

Examples of Vulnerabilities:

- Beachfront development reducing protection provided by dunes.
- Proliferation of subdivisions in wildfire and flood prone areas.
- Lack of urban tree canopy increasing heat island effect.

Examples of Strengths:

- Oyster reefs and tidal wetlands help reduce wave damage to property.
- Forested watersheds maintain drinking water supply during droughts.
- Native, vegetated slopes remain stable after intense 24hr rain events.
- Floodplains provide stormwater storage and downstream flood reduction.

[1] Source: Community Resilience Building Workshop Guide, communityresiliencebuilding.com

Horsley Witten Group
Sustainable Environmental Solutions

Newburyport Municipal Vulnerability Preparedness (MVP) Grant Project:

SELECTED DEMOGRAPHIC DATA[1]

Population	17,416 people
Age	0-19 = 21% 20-34 = 12% 35-64 = 48% 65+ = 19%
Household Income	<$40K = 22% $40-60K = 14% $60K+ = 64%
% Below Poverty Line	7%
Race	White = 96% Black = 1% Asian = 1% Other = 2%
Ethnicity	Hispanic = 2% Not Hispanic = 98%
% Population in an Environmental Justice Neighborhood	0.0%
% Population Over 65 Living Alone	5.8%
Heart Attack Hospitalizations (over age 35)	25.2 (age-adjusted rate per 10,000 people)
Asthma Emergency Department Visits	41.7 (per 10,000 people)
Pediatric Asthma Prevalence	6.2% of all children enrolled in grades K-8
Heat Stress Emergency Department Visits	0.0 (age-adjusted rate per 10,000 people)

[1] Source: MA Dept of Public Health, 2018. MA Environmental Public Health Tracking Community Profile for Newburyport. Report Created on March 14, 2018. 10 p.

Attachment C: Base Maps

N

Legend

*Critical Infrastructure Data provided by MAPC with updates from the city of Newburyport, MA (2018)

- Town Outline
- Evacuation Routes
- Open Space

FEMA Flood Zones

eff. 07/16/2014

- A (100yr Flood Zone)
- V (Velocity Zone)

Critical Infrastructure*

- ASSISTED LIVING FACILITY
- BRIDGES
- CITY HALL
- COAST GUARD
- COURTS
- CULVERT
- DAMS
- DAY CARE FACILITIES
- DEPARTMENT OF PUBLIC SERVICES
- EMERGENCY OPERATIONS CENTER
- EMERGENCY SHELTER
- FIRE STATION
- HARBORMASTER
- HOSPITAL
- ICE RINK/ EMERGENCY STORAGE
- LIBRARY
- MBTA STATION
- NATIONAL GUARD ARMORY
- PARKING
- PLUM ISLAND AIRPORT
- POLICE STATION/911 DISPATCH
- POST OFFICE
- POWER SUBSTATION
- PUBLIC WORKS GARAGE
- RECREATION FEATURE
- SCHOOL
- SENIOR/COMMUNITY CENTER
- SEWAGE PUMPING STATION
- SOLID WASTE/ TRANSFER STATION
- WASTE WATER TREATMENT PLANT
- WATER PUMP STATION
- WATER TANK
- WATER SUPPLY
- WATER SUPPLY CHLORINE BOOSTER PUMP
- WATER TREATMENT PLANT

Mile
0 0.5 1

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

Newburyport, MA
Critical Infrastructure and FEMA Flood Zones

Date: 4/5/2018 Figure 1

Path: H:\Projects\2018\18005 Newburyport MVP\GIS\Maps\CriticalFacilitiesInfrastructure_v3.mxd

N

Legend

Town Outline

Projected Probability of Flooding 1/year (2070)**

Source: Famely et al. 2016

- 1%
- 25%
- 50%
- 100%

Evacuation Routes

Critical Infrastructure*

- ASSISTED LIVING FACILITY
- BRIDGES
- CITY HALL
- COAST GUARD
- COURTS
- CULVERT
- DAMS
- DAY CARE FACILITIES
- DEPARTMENT OF PUBLIC SERVICES
- EMERGENCY OPERATIONS CENTER
- EMERGENCY SHELTER
- FIRE STATION
- HARBORMASTER
- HOSPITAL
- ICE RINK/ EMERGENCY STORAGE
- LIBRARY
- MBTA STATION
- NATIONAL GUARD ARMORY
- PARKING
- PLUM ISLAND AIRPORT
- POLICE STATION/911 DISPATCH
- POST OFFICE
- POWER SUBSTATION
- PUBLIC WORKS GARAGE
- RECREATION FEATURE
- SCHOOL
- SENIOR/COMMUNITY CENTER
- SEWAGE PUMPING STATION
- SOLID WASTE/ TRANSFER STATION
- WASTE WATER TREATMENT PLANT
- WATER PUMP STATION
- WATER TANK
- WATER SUPPLY
- WATER SUPPLY CHLORINE BOOSTER PUMP
- WATER TREATMENT PLANT

*Critical Infrastructure Data provided by MAPC with updates from the city of Newburyport, MA (2018)
** Inundation Estimates within the Little River Watershed have not yet been developed and are not reflected herein.

Mile
0 0.5 1

Horsley Witten Group
Sustainable Environmental Solutions
90 Route 6A • Sandwich, MA • 02563
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com

Newburyport, MA
Critical Infrastructure and Projected Flooding (2070)

Date: 4/5/2018 Figure 2

Path: H:\Projects\2018\18005 Newburyport MVP\GIS\Maps\CriticalFacilitiesInfrastructure_v3.mxd

Attachment D: Discussion Matrices from the Four Discussion Groups

Community Resilience Building Risk Matrix

Group 1

www.CommunityResilienceBuilding.org

Location = Mark on the map, note on matrix Multiple, Specific or Town-Wide
V = Vulnerability **S** = Strength
Type of Feature = **I**nfrastructural, **S**ocietal, or **E**nvironmental
High, **M**edium, or **L**ow priority for action over the **S**hort or **L**ong term (and **O**ngoing)

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

Features	Location	Owner	V or S	Sea Level Rise	Storms (Nor' Easter, Hurricane, Winter)	Inland Flooding	Bi-Polar Weather (Extreme Heat, Extreme Cold, and Drought)	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Sewer System on Plum Island	Plum Island	public	V	Maintain and upgrade system				H	O
Rain barrel Program	city-wide	public/private	V/S						
Lifeline Systems (power, gas, water, sewer)	city-wide	public/private	V/S	Flood protection assessment with utilities Annual accountability report from utilities				H L	S/O O
DPS Proactive Asset Management	city-wide	public	S						
Plum Island Access During Storms, Emergency Response	Plum Island	public/private	V	Elevate roadway with columns (cooperate with Newbury)				H	L
Transportation Systems (road and rail)	city-wide	public	V	Alternatives analysis (raise roads and railways)				H	L
Alternative parking for emergency access	city-wide	public	V	Conduct a feasibility study and audit existing parking ban protocol				M	S
Interruption of Trash Pickup	Downtown	public	V	Monitor SOPs				L	O
Lack of State and Federal Funding	city-wide	public	V	Increase grants and lobbying				H	O
Barrier Island Buffer	Plum Island	public/private	S	Limit development				L	O
School Construction Upgrades and Shelters	city-wide	public	S	Expand to include other vulnerable populations				H	L
Emergency Operations Center	city-wide	public	S						
Solarize Newburyport	city-wide	public/private	S						
Societal									
Impacts to Drinking Water	city-wide	public	V						
Vulnerable Populations	city-wide	public/private	V	Implement next door neighbor plan				M	O
Power Grid	city-wide	public/private	V	Continue comm. improvement across municipal partners				M	O
Local Hospital	city-wide	private	V/S						
Code Red System	city-wide	public	S	Evaluate systems to be point or neighborhood specific				H	O
Wastewater Treatment Down	city-wide	public	V						
Agriculture, Food Security	city-wide	private	V/S						
Tree Management	city-wide	public	S	Outreach/ Information				M	O
Public Awareness	city-wide	public	V/V	Clarify public notification systems available Reactivate certifications, expand to include SBA				H	O
Emergency Response	city-wide	public	S						

Transportation Systems	city-wide	public	V/S			
Regional Collaboration	regional	public	S			
Local Non-Profits Collaborating For Vulnerable Populations	city-wide	public/private	S		H	O
Federal, State, and City Collaboration	regional	public	V	Grants and lobbying		
Economic Impacts to Society	city-wide	public/private	V	Business continuity plan, flood plan manager, develop BMPs for education	M/L	O
Environmental						
Beachfront and Waterfront Development	Multiple	public/private	V	Continue to evaluate and strengthen zoning	H	O
Regulatory Reform (Zoning)	Multiple	public/private	S			
Salt Marshes and Wetlands	City-wide	public/private	V/S	Invasive management	H	O
Hazardous Materials in Business Park	Business Park	private	V	Improve communication with building owners to keep information updated	H	O
Agricultural Impact	Multiple	private	V			
Environmental Advocacy (Tree Trimming)	City-wide	public/private	V/S			
Infections Diseases	City-wide	public/private	V	Public education campaign, Mass Mosquito	H	O
Wastewater Plants	Regional	public	V			
Loss of Flood Storage (Development Pressures)	City-wide	public/private	V	Implement 2017 great marsh resiliency plan, purchase more open space, plant more trees in business park	H	L
Municipality Forward Training	City-wide	public	S			
Loss of Native Species Due to Invasives	Multiple	public/private	V			
Loss of Dunes Due to Lack of Planning	Coastal	public/private	V			
Loss of Wildlife Habitat	Regional	public/private	V			
Working Waterfront	Waterfront	public/private	V/S	Waterfront management plan	L	L
Litter and Debris in Wetlands	City-wide	public/private	V	Expand stewardship of waterways, ban Styrofoam	L	O

Community Resilience Building Risk Matrix

Group 2

www.CommunityResilienceBuilding.org

Location = Mark on the map, note on matrix Multiple, Specific or Town-Wide
V = Vulnerability S = Strength
Type of Feature = Infrastructural, Societal, or Environmental
High, Medium, or Low priority for action over the Short or Long term (and Ongoing)

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

Features	Location	Owner	V or S	Sea Level Rise	Storms (Nor' Easter, Hurricane, Winter)	Inland Flooding	Bi-Polar Weather (Extreme Heat, Extreme Cold, and Drought)	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Transportation Shutdown	City wide	public/private	V/S	Raise rail systems and roads, improve culverts, install barriers				M	S/L
Electric Power Grid	City wide	public/private	V	Bury power utilities, invest in micro grids and new technology				H	S
WTP/ WWTP	City wide	public	V	Build a barrier or move	Build a barrier	Zoning requirements, pesticide laws, treatment	Increase storage and water conservation/restrictions	H	S
Communications	City wide	public/private	V						
Public Utilities (W,S,G)	City wide	public/private	V/S						
Aftermath (Damage Assessment)	City wide	public/private	V						
Roadways	City wide	public	V						
Water Supply and Tanks	City wide	public/private	V/S	Raise 113 Dam					
Stormwater Management	City wide	public/private	V/S						
Shelter Capacity and Resiliency	City wide	public/private	V/S	Micro grid					
Medical Facilities and Physical Infrastructure	City wide	public/private	V/S						
Coast Guard	Specific	public	S						
EMS, Etc.	City wide	public	S						
Business Park	Specific	public/private	V						
Societal									
Risk to Life	city-wide	public/private	V						
Extended Disruption to Service (schools close, business shutdown)	city-wide	public/private	V						
At risk Populations- transportation and evacuatio	city-wide	public/private	V						
Food Supply	city-wide	private	V/S						
Water Supply	city-wide	public/private	V/S						
Evacuation Sites, Planning Methods, etc.	city-wide	public/private	V/S						
Communication	city-wide	public/private	V/S	Reverse 911 signup process					
Sewer Backup Issues	city-wide	public	V						
Public utilities failure (W, S, G)	city-wide	public/private	V						
Aftermath (Recovery, Mental Health, Economics)	city-wide	public/private	V/S						
Record Data in Basement	city-wide	public/private	V	Move and scan documents, improve flood preparedness for important key public resources					

Environmental						
Salt Water Intrusion	WTP and Well	public	V/S	Raise dams, inspect and study wells	H	S
Salt March Degradation	city-wide	public	V/S	Acquire lands, relocate salt marshes, stop building through zoning	M	S/L
Beach Erosion	plum island	public/private	V	Master plan	H	L
Fire	city-wide	public/private	V			
Fish Migration	city-wide	public/private	V			
Tree Species Eradication, Tree Canopy	city-wide	public/private	V/S		L	L
Disease (Plant, Human, Animal)	city-wide	public/private	V	Regional study	L	L
Open Space	city-wide	public/private	V/S			
Rivers and Waterways	city-wide	public/private	V/S	Shoreline protection Develop regional plan with upstream watersheds	H	S/L
Environmental Groups	city-wide	private	S			
Oyster and Clam Beds	coastal	public	S			

Community Resilience Building Risk Matrix

Group 3

www.CommunityResilienceBuilding.org

Location = Mark on the map, note on matrix Multiple, Specific or Town-Wide
V = Vulnerability **S** = Strength
Type of Feature = **I**nfrastructural, **S**ocietal, or **E**nvironmental
High, **M**edium, or **L**ow priority for action over the **S**hort or **L**ong term (and **O**ngoing)

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

Features	Location	Owner	V or S	Sea Level Rise	Storms (Nor' Easter, Hurricane, Winter)	Inland Flooding	Bi-Polar Weather (Extreme Heat, Extreme Cold, and Drought)	Priority H - M - L	Time Short Long Ongoing
Infrastructural									
Low Roads	See map	public	V	Raise with fill or redirect Raise seawall					O S
Inadequate Culverts	See map	public	V	Expand culverts and raise bridges					O
Low Elevation of WWTP	See map	public	V	Build wall, increase emergency preparedness Move higher					S L
National Grid Location	See map	private	V	Increase emergency preparedness Move higher					S L
Low Dam on Artichoke	See map	public	V	Continue to conduct a resiliency study			Raise dam to increase storage		
Raw Water Pump Station	See map	public	V/s	See above					
Main Roads at High Elevation	See map	public	S						
Landing Areas, Including the Plum Island Airport	See map	public/private	S						
Sewer Collection and Pump Stations	See map	public	V	ID vulnerabilities and emergency preparedness measures					S
Plum Island Infrastructure Connections	See map	public (shared)	V				Address freezing and other issues		O
Shared Resources and Infrastructure with Newbury and Others	City-wide	public (shared)	V	Increase coordination between neighboring towns					O
Jetty System at River Mouth	See map	federal	V/S	Coordinate with Army Core					S/L
Elevated Electric Grid System	City-wide	public/private	V	Bury electrical lines Create micro grids					O
Trees in City	City-wide	public/private	V/S		Stop planting trees under lines, and maintain existing trees				S/O
Water Storage	See map	public	V/S				Consider expanding storage		O
Societal									
Plum Island Residents and Community			V	Establish Shelter Raise access road Retreat and/or limit new development					S M L
Growing Elderly Population	city-wide		V	Evacuation planning, taking medical needs in to account Larger scale shelter and support (with generator)					
Wealthier Community	city wide		S						
Engaged Local Leadership	city-wide		S	Create plans for evacuation and sheltering					S
Educated Citizenship	city wide		S	See above					
Emergency Management Network	city-wide		S	See above					
Community Hospital	See map	not for profit	S						

Y

Individual Preparedness	city-wide		V	Educational plan, potentially sent with water or sewer bills		S/O
Emergency Shelter Availability		public	V	Plan, identify, and implement new emergency shelters		M
Vulnerable Economic Bases	downtown and business		V	Improve infrastructure (see infrastructure section)		O
Diversified Tax Base (by location)			S	Zone to protect vulnerable areas		S
Strong Community Spirit			S			
Concentrated Development			S	Zone to encourage urban infill Keep open space open		S
Coast Guard		federal	S			
Inconsistent Regulatory Environment			V	Vote		S
Environmental						
Wetlands		public/private	S	Keep intact with zoning and invasive management		O
Protected Areas		public/private	S	Keep open		O
Erosion Vulnerable Areas		public/private	V	Coordinate with Army Corps, conduct erosion control measures (e.g., dunes and plantings), start a buyout program		
Barrier Island		state/national	S	EZ pass to raise funds		
Merrimack		state	V			
Ocean		global	V			
Located at Weather Cross Roads			V			
Water Quality and Upstream Storage		shared	V	Increase communication of sewer overflows to public		
Fisheries		shared	V			
GW Levels	city-wide	shared	V			

Y

Community Resilience Building Risk Matrix

Group 4

www.CommunityResilienceBuilding.org

Location = Mark on the map, note on matrix Multiple, Specific or Town-Wide
V = Vulnerability **S** = Strength
Type of Feature = **I**nfrastructural, **S**ocietal, or **E**nvironmental
High, **M**edium, or **L**ow priority for action over the **S**hort or **L**ong term (and **O**ngoing)

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

Features	Location	Owner	V or S	Sea Level Rise	Storms (Nor' Easter, Hurricane, Winter)	Inland Flooding	Bi-Polar Weather (Extreme Heat, Extreme Cold, and Drought)	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural									
Waste Water Treatment Facility	Water St.	public	V	Protect and/or elevate vulnerable equipment Consider re-location of treatment plant					S L
National Grid Substation	Water St.	Mass. Electric	V	Renew and support National Grid plans for protection of substation					O
Power Lines	Multiple Citywide	private	V/s	Help National Grid identify opportunities to place lines underground; ID high vulnerability areas Maintain street trees to prevent damage to lines					S S
Underground Utilities	Citywide		S/V						
Coastal Infrastructure (i.e., sea walls and jetty)		public	S/V	Inventory and assessment of coastal infrastructure and efficacy					
Coastal Roads		public	V	Evaluate Causes of road flooding and design solutions (e.g., raise roads, construct better drainage, walls, etc.)					
Business Park Roads		public	V						
Water Treatment Plant	Spring Lane		S/V						
Artichoke Dam			V	Raise and protect dam					
Electrical Supply (redundancy of system)			S/V						
Residential Structures in Floodplain		private	V	Consider zoning/planning changes to include adaptation to SLR measures (e.g., freeboard ↑)					
High Street, Access to I95		public	S						
Lift Stations	City wide	public	V						
Impervious Surfaces			V	Identify opportunities to reduce impervious surfaces					
Stormwater Infrastructure			S						
Nuclear Power Plant	Seabrook, NH	private	V						
Societal									
Displacement of Population	Coastal and Business Park	private	V	Educate vulnerable populations, ID facilities Renew emergency management plan to ensure it adequately covers displaced populations					S S
Plum Island Access Lost	Plum Island	private/public	V	Develop plan for longer-term loss of access to Plum Island, work collaboratively with Newbury					
Water St. and Other Access Lost	City-wide	public	V	Develop emergency communications plan					
Loss of Real Estate	Plum Island/ Water Street	private	V	Develop communications plan-education materials for realtors and homeowners					S/O
Water Supply Limitation	City-wide	public	V	Identify possible new water sources, wells, etc; encourage or require water conservations Identify opportunities to increase back-up/emergency storage					
Loss of Cultural Assets	Downtown	public/ private	V	Develop plans to protect ventral waterfront from sea level rise Encourage/require new development to design for sea level rise projections					

Loss of Recreation Areas (tourism)	City-wide	public	V	Evaluate alternative boat ramp designs to reduce flood impacts Conduct feasibility study to protect Cashman Park		
Emergency Services to Aging and/or Disabled and/or Special Needs Populations	City-wide	public/ private	V	Ensure extra staffing "storm coverage" during weather events Install back-up generators at all emergency/public facilities		
Increased Incidence of Tick and Mosquito Born Illne	City-wide	N/A	V	Encourage public policy change to include ticks in state Mosquito control efforts and programs		
Economic Loss- Business and Personal	City-wide		V			
Hospital	AJ	AJ	S			
Emergency Services		public/ private	S			
Waste Removal	City-wide	public	V			
Strong Community			S			
Environmental						
The Great Marsh/ Salt Marsh		public/private	S/v	Aggressive removal of invasive species; involve volunteers/ community groups Identify opportunities to allow salt mash migration		
Common Pasture		public/private	S/v	Maintain protected status and management of common pasture		
Sand Bars (Merrimack and Offshore)			S/V			
Plum Island Barrier Beach and Dunes		public/private	S/V	Continue dune nourishment, planting and management of access ways		
Water Supply		public	V	See infrastructure section		
Water Quality			V			
Shifting Ecosystems (loss of some species, increase in others)	Regional		V/S	Monitor ecosystem changes Aggressive removal of invasive species		
Agricultural Changes	City wide and regional		S/V			
Change in Air Quality						
Increase in Red Tide			V			
Merrimack River Water Quality						
Increase in Infections Disease Vectors (ticks and mosquitoes)			V			

Attachment E: Master Matrix of High Priority Actions Reported out by Each Discussion Group

Community Resilience Building Risk Matrix

Recommended

www.CommunityResilienceBuilding.org

Location = Mark on the map, note on matrix Multiple, Specific or Town-Wide
V = Vulnerability **S** = Strength
Type of Feature = **I**nfrastructural, **S**ocietal, or **E**nvironmental
High, **M**edium, or **L**ow priority for action over the **S**hort or **L**ong term (and **O**ngoing)

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

Features	Location	Owner	V or S	Sea Level Rise	Storms (Nor' Easter, Hurricane, Winter)	Inland Flooding	Bi-Polar Weather (Extreme Heat, Extreme Cold, and Drought)	Group 1-4	Priority H - M - L	Time S Long O ngoing
Infrastructural										
Lifeline Systems (power, gas, water, sewer)	city-wide	public/private	V/S	Flood protection assessment with utilities Annual accountability report from utilities				1	H L	S/O O
Plum Island Access During Storms, Emergency Response	Plum Island	public/private	V	Elevate roadway with columns (cooperate with Newbury)				1	H	L
Lack of State and Federal Funding	city-wide	public	V	Increase grants and lobbying				1	H	O
Transportation Shutdown	City wide	public/private	V/S	Raise rail systems and roads, improve culverts, install barriers				2	M	S/L
WTP/ WWTP	City wide	public	V	Build a barrier or move	Build a barrier	Zoning requirements, pesticide laws,	Increase storage and water conservation/restrictions	2	H	S
Water Supply and Tanks	City wide	public/private	V/S	Raise 113 Dam				2		
Shelter Capacity and Resiliency	City wide	public/private	V/S	Micro grid				2		
Inadequate Culverts	See map	public	V	Expand culverts and raise bridges				3		O
Low Elevation of WWTP	See map	public	V	Build wall, increase emergency prep Move higher				3		S L
Low Dam on Artichoke	See map	public	V	Continue to conduct a resiliency study			Raise dam to increase storage	3		
Elevated Electric Grid System	City-wide	public/private	V	Bury electrical lines Create micro grids				3		O
Waste Water Treatment Facility	Water St.	public	V	Protect and/or elevate vulnerable equipment Consider re-location of treatment plant				4		S L
Coastal Infrastructure (i.e., sea walls and jetty)	Coastal	public	S/V	Inventory and assessment of coastal infrastructure and efficacy				4		
Societal										
Power Grid	city-wide	public/private	V	Continue comm. improvement across municipal partners				1	M	O
Communication	city-wide	public/private	V/S	Reverse 911 signup process				2		
Plum Island Residents and Community	Plum Island	public/private	V	Retreat and/or limit new development				3		L
Individual Preparedness	city-wide	private	V	Educational plan, potentially sent with water or sewer bills				3		S/O
Displacement of Population	Coastal and Business	private	V	Educate vulnerable populations, ID facilities Renew emergency management plan to ensure it adequately covers displaced populations				4		S S
Plum Island Access Lost	Plum Island	private/public	V	Develop plan for longer-term loss of access to Plum Island, work collaboratively with Newbury				4		
Loss of Cultural Assets	Downtown	public/ private	V	Develop plans to protect ventral waterfront from SLR Encourage/require new development to design for SLR projections				4		
Environmental										
Beachfront and Waterfront Development	Multiple	public/private	V	Continue to evaluate and strengthen zoning				1	H	O
Loss of Flood Storage (Development Pressures)	City-wide	public/private	V	Implement 2017 great marsh resiliency plan, purchase more open space, plant more trees in business park				1	H	L

Attachment F. Annotated Maps from Discussion Groups

Photo 1 Map annotated by small Group 1 highlighting vulnerable infrastructure, flood zones, and other community resources**.**

Photo 2 Map annotated by small Group 2 showing open space resources, geographic features, and other community elements.

Photo 3 **Map annotated by Group 3 showing societal and infrastructure features in black and environmental features in teal.**

Photo 4 Map annotated by small Group 4 highlighting critical infrastructure and environmental features of Newburyport.