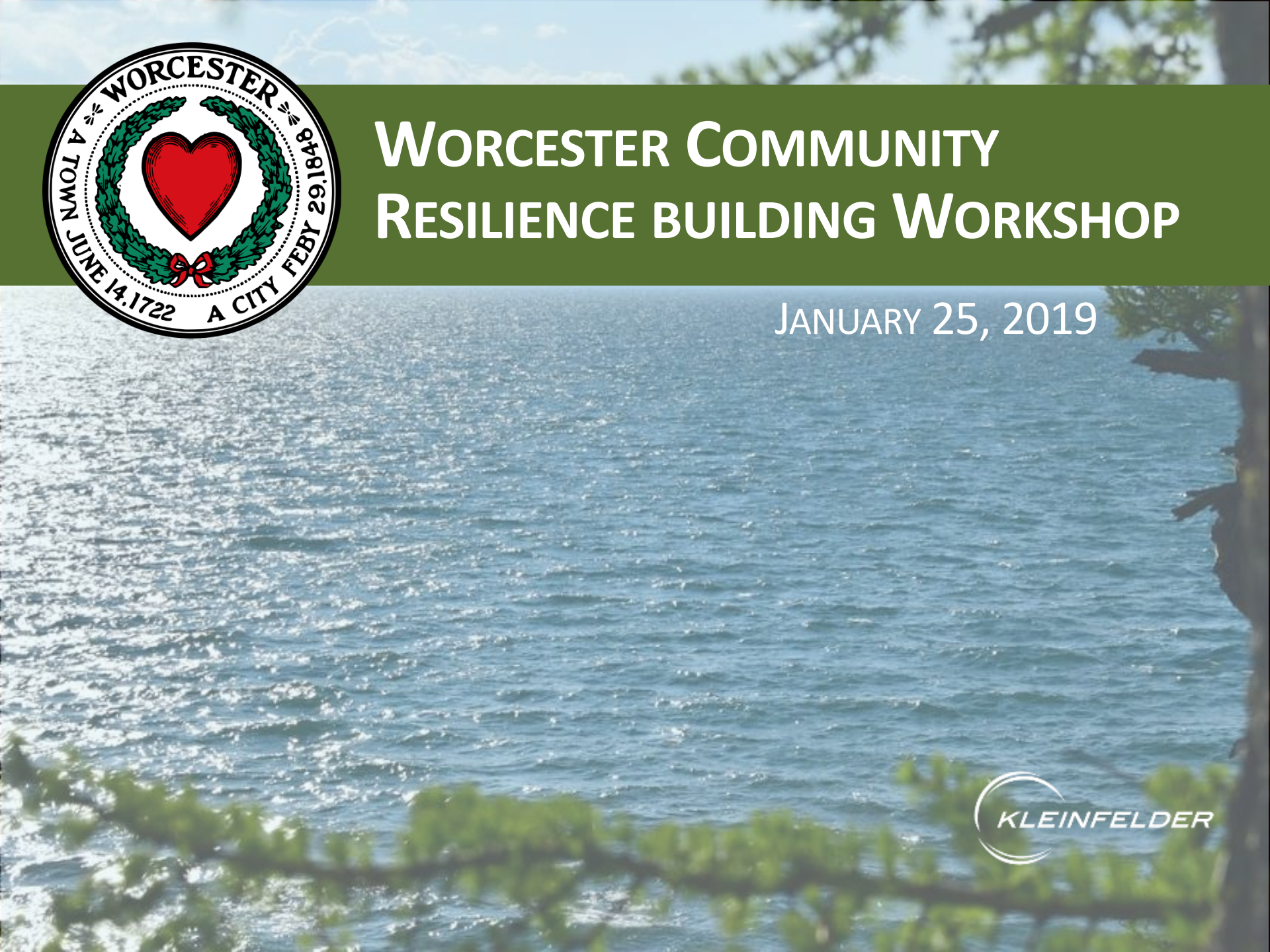
Appendix A

Presentation from the Community Resilience Building Workshop (1/25/2019)

Worcester Community Resilience building Workshop

January 25, 2019

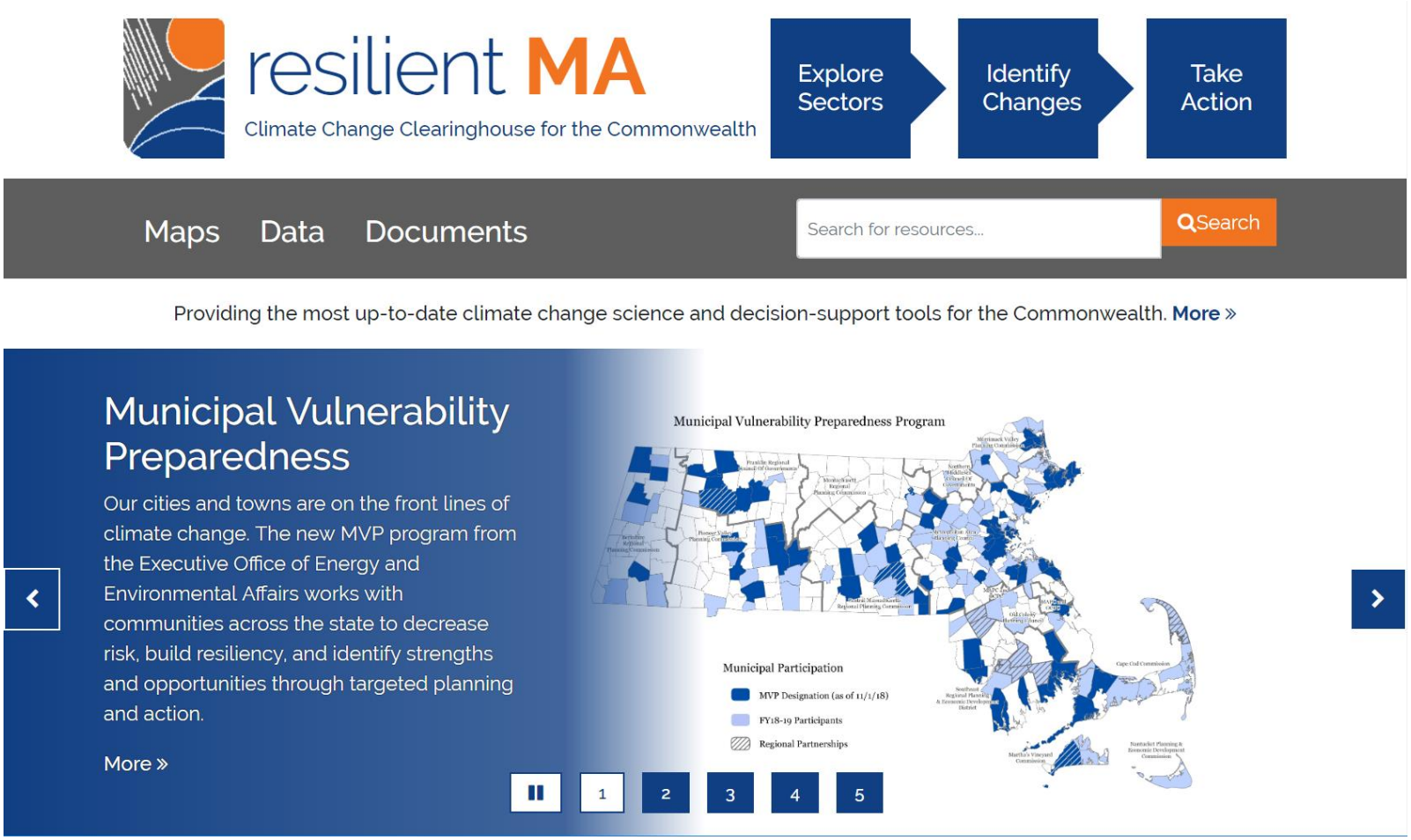


I. Workshop Agenda

I.	**Arrival / Light breakfast**	8:00 am
II.	**Welcome and agenda overview**	8:30 am
	Luba Zhaurova, Sustainability Project Manager, City of Worcester	
III.	**Opening remarks**	8:45 am
	Edward M. Augustus Jr., Worcester City Manager	
IV.	**Kick-off / Participants Introductions**	9:00 am
	Led by the Kleinfelder team	
V.	**Hazards**	9:30 am
	○ Presentation (by Kleinfelder)	
	○ Large group discussion – determine the highest priority hazards	
VI.	*Break*	10:30 am
VII.	**Community Strengths and Vulnerabilities**	10:45 am
	○ Presentation (by Kleinfelder)	
	○ Small groups' exercise (infrastructural, societal, environmental)	
	○ Small groups present findings	
VIII.	*Lunch*	12:00 pm
IX.	**Community Actions**	1:00 pm
	○ Presentation (by Kleinfelder)	
	○ Small groups' exercise	
X.	*Break*	2:00 pm
XI.	**Priority Actions**	
	○ Small groups' exercise (identifying overall priority actions using a risk matrix)	2:15 pm
	○ Small groups present findings	3:00 pm
	○ Large group identifies highest priority actions; defines 6 locations for further risk & vulnerability assessments	3:30 pm
XII.	**Summary and Closing**	3:50 pm-4pm

What is Climate Change?

Visit www.resilientma.org to learn more!



What is Climate Change?

Visit www.resilientma.org to learn more!

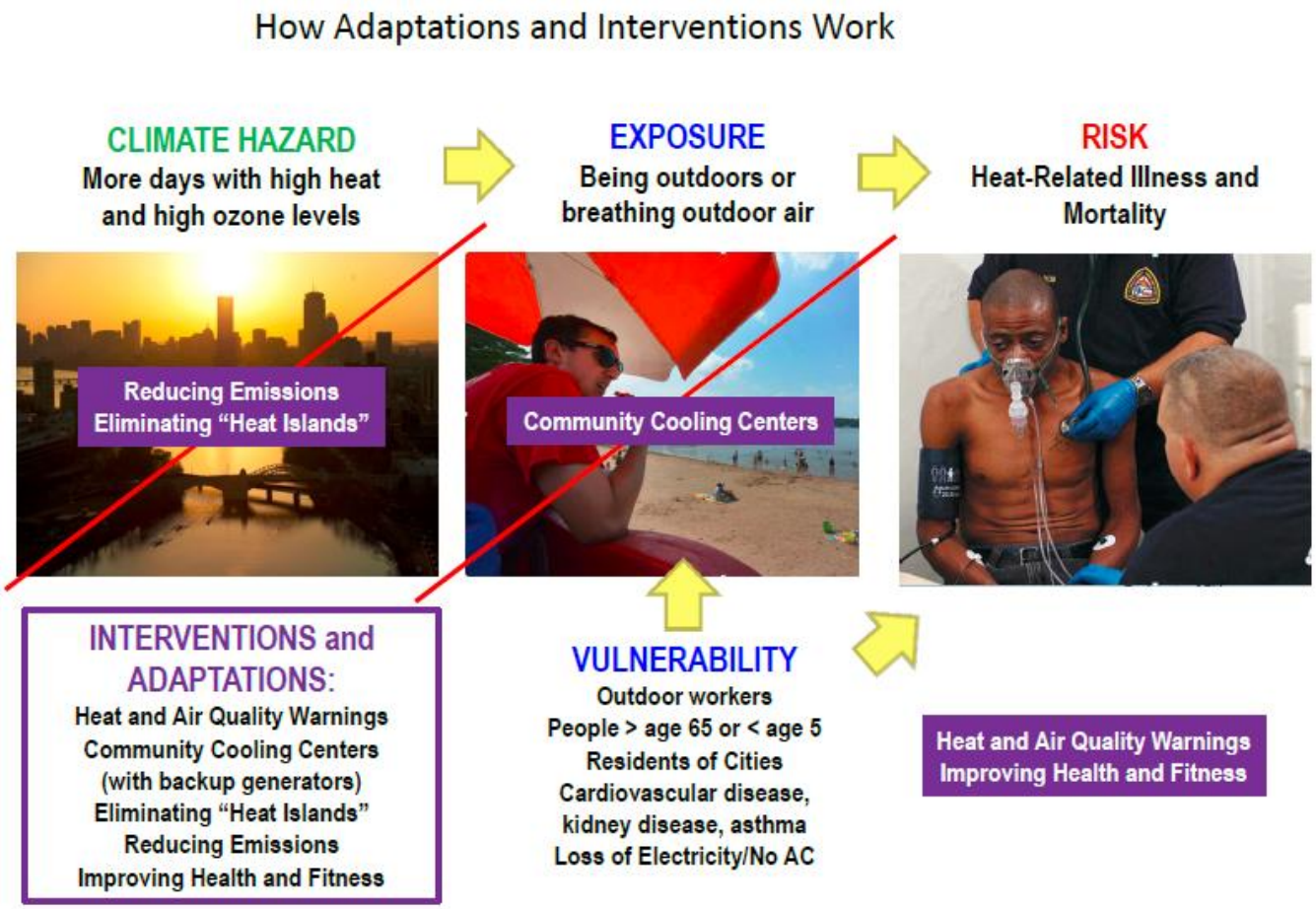
Climate Change Projections for Massachusetts

CLIMATE CHANGES	RELATED NATURAL HAZARDS	PROJECTIONS BY THE END OF THIS CENTURY
Changes in precipitation	– Inland flooding – Drought – Landslide	– Annual precipitation: Increase up to 16% (+7.3 inches) – Days with rainfall accumulation 1+ inch: Increase up to 57% (+4 days) – Consecutive dry days: Increase 18% (+3 days) – Summer precipitation: Decrease
Sea level rise	– Coastal flooding – Coastal erosion – Tsunami	– Sea level: Increase 4.0 to 10.5 feet along the Massachusetts coast
Rising temperatures	– Average/extreme temperatures – Wildfires – Invasive species	– Average annual temperature: Increase up to 23% (+10.8 degrees Fahrenheit) – Days/year with daily minimum temperatures below freezing: Decrease up to 42% (-62 days) – Winter temperatures: Increase at a greater rate than spring, summer, or fall – Long-term average minimum winter temperature: Increase up to 66% (+11.4 degrees Fahrenheit) – Days/year with daily maximum temperatures over 90 degrees Fahrenheit: Increase by up to 1,280% (+64 days) – Growing degree days: Increase by 23% to 52%
Extreme weather	– Hurricanes/tropical storms – Severe winter storms/nor'easters – Tornadoes – Other severe weather	– Frequency and magnitude: Increase

Note: This plan also assesses earthquakes, but there is no established correlation between climate change and earthquakes.
Source of Climate Change Projections: Northeast Climate Adaptation Science Center at the University of Massachusetts, Amherst.

How we are adapting?

Visit www.resilientma.org to learn more!



Introduce Yourselves!

- Name
- Affiliation
  - *(department, organization, business, resident, etc.)*

Ground Rules

1. Everyone must participate (and listen)
2. Everyone's input is equally valued
3. Disagree without being disagreeable
4. No side conversations
5. Stay on topic

NATURAL HAZARDS

Community Resilience Building Risk Matrix

www.CommunityResilienceBuilding.org

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

1

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	Hazard	Actions	Priority H - M - L	Time S Short L Long O Ongoing
Infrastructural							
Societal							
Environmental							

Keep in mind that the prioritized features will be used in the

Task 2 – Risk and Vulnerability Assessments

COMMUNITY STRENGTHS AND VULNERABILITIES

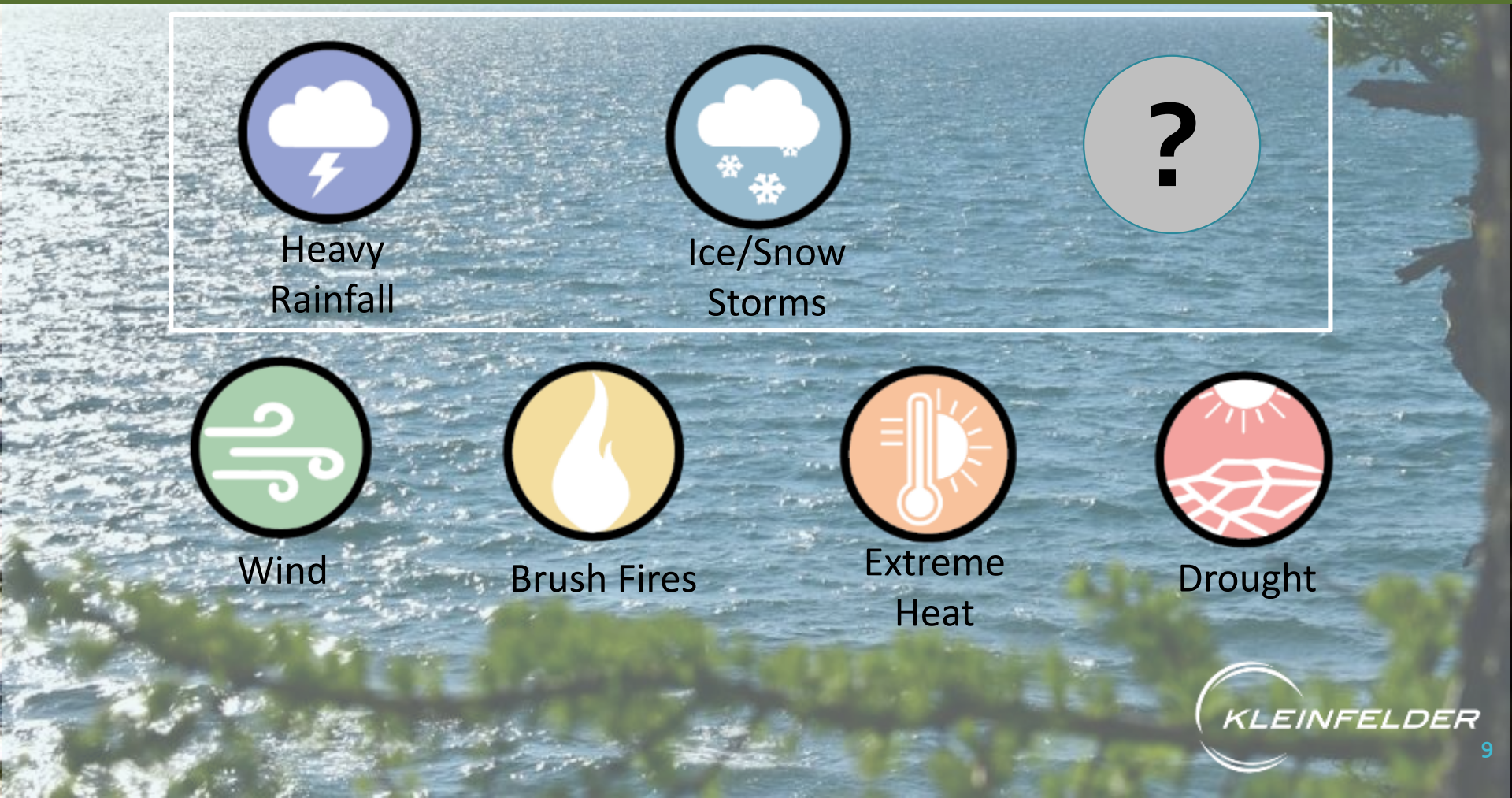
COMMUNITY ACTIONS

PRIORITY ACTIONS

Part 1 **Part 2** **Part 3**

II. Hazards and their impacts

What are Worcester's past, current, and future hazards?

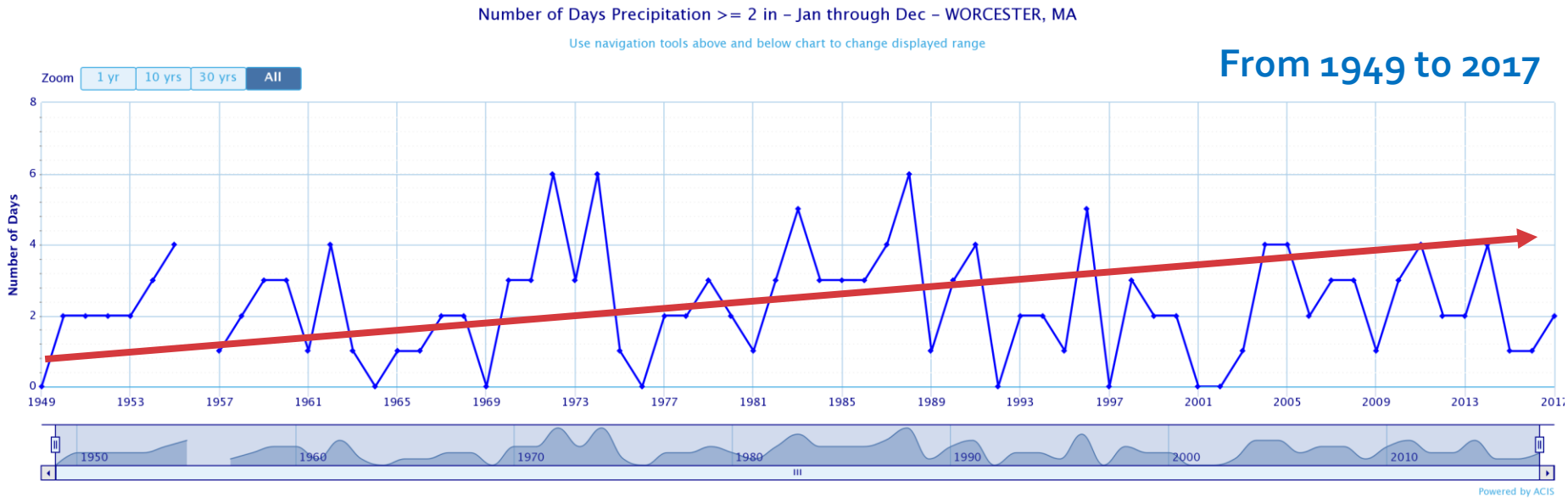


KLEINFELDER

Identified Hazard 1:

Heavy Rainfall

Heavy Rainfall – Historical Data

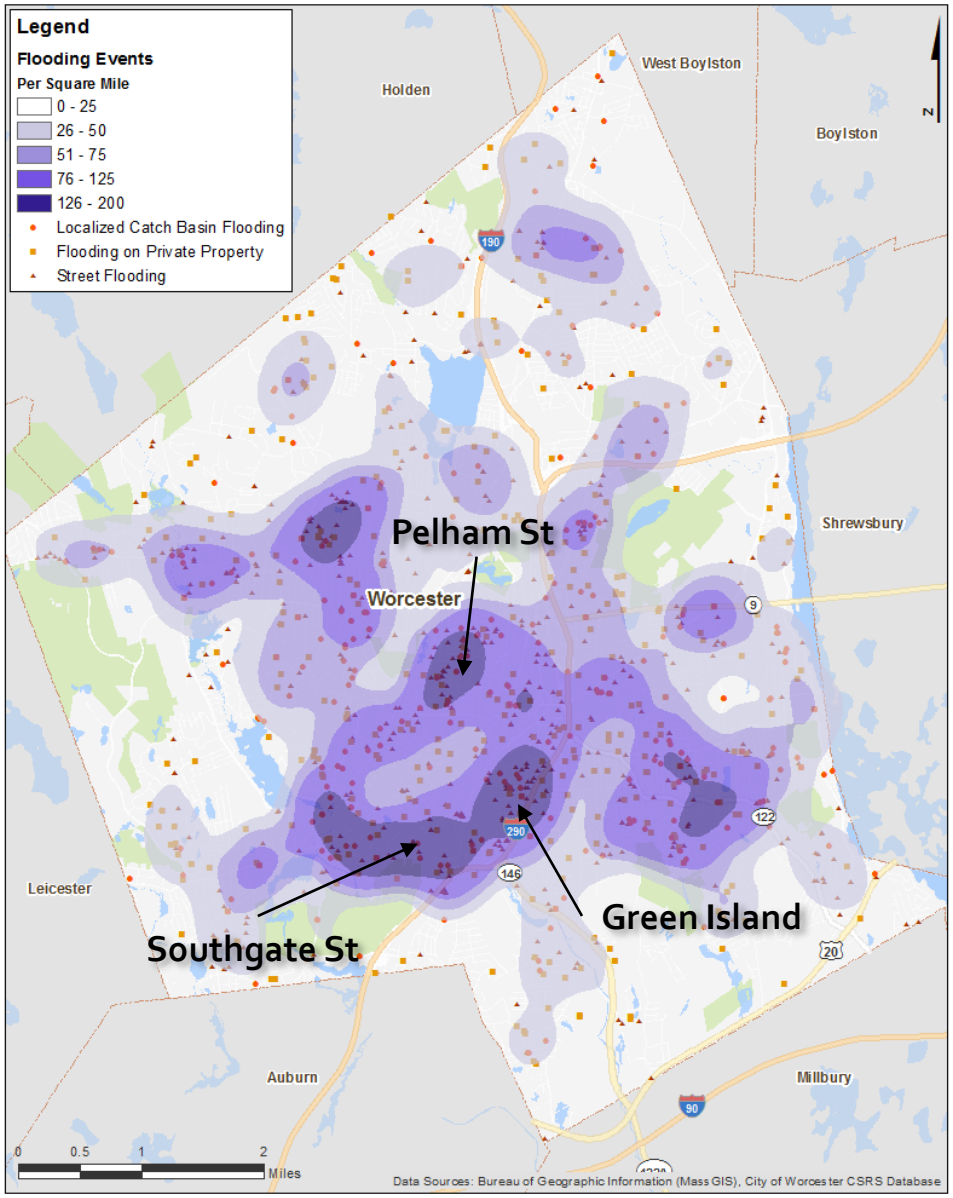


Two types of rainfall flooding:

- Overbank flooding from rainfall / snowmelt
- Piped Infrastructure backup / failure (Culverts, CSO, SSO)

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Heavy Rainfall – Historic Flooding Events



Concentration of Reported Flooding Events

- Heavy rainfall already causes flooding in Worcester.
  - Green Island (Elsworth St, Quinsigamond Ave)
  - Pelham St (small area, localized flooding)
  - Southgate St (near Green Island, failing infrastructure and erosion issues)
- Impacts: infrastructure, property damage, loss of life/injury, natural resources.

Note: Map based on the Worcester's Customer Service Request System (CSRS) data for flooding events 2006-2016.

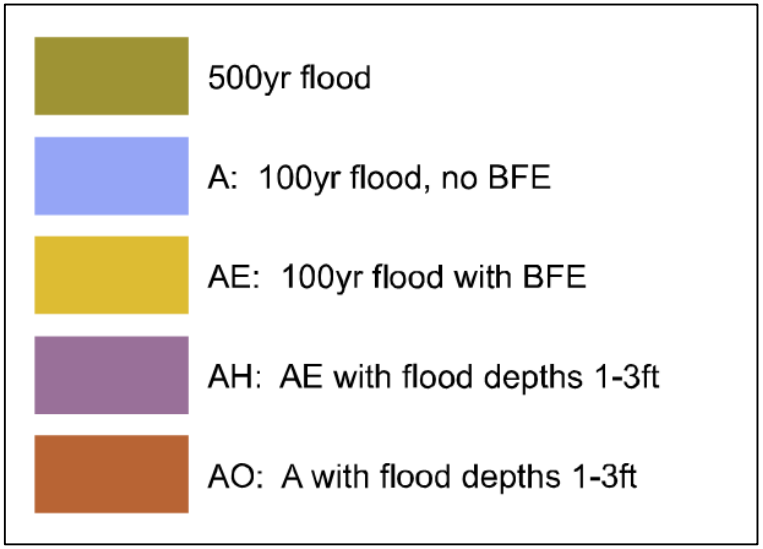
Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

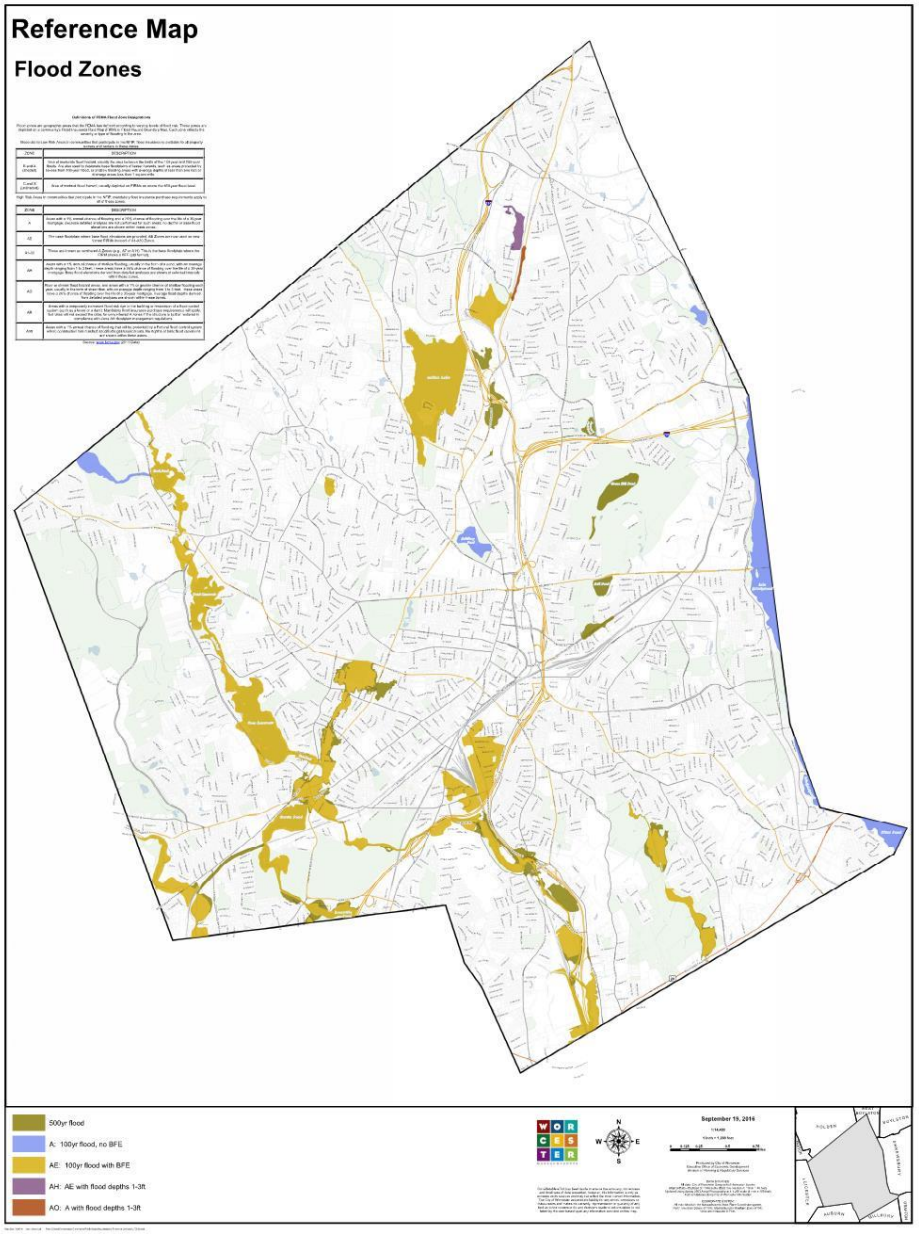
Heavy Rainfall – FEMA Flood Zones

FEMA flood zones are based on probabilities of future flooding events.

- Example: A 100-year flood is a an event that has a 1% probability of occurring in any given year (500-year flood has 0.2% probability).
- These zones are used by communities to set building and flood insurance requirements.

Source: https://www.fema.gov/disaster/updates/fema-flood-maps-and-zones-explained





Source: http://www.worcesterma.gov/planning-regulatory/boards/conservation-commission

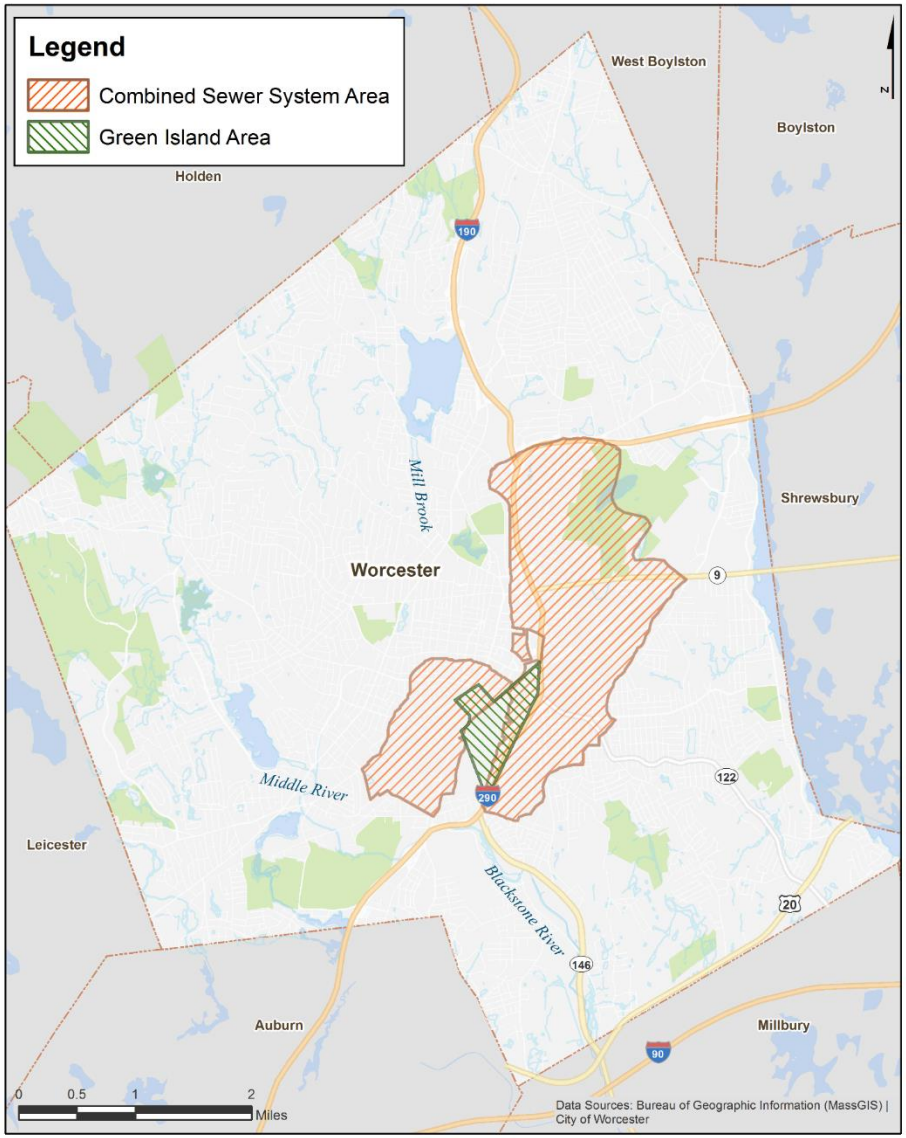
Heavy Rainfall – Piped Infrastructure Flooding

Sewer backups are an issue in Worcester

- ~400 miles of sewer pipeline in the city
- ~60 miles of combined sewer pipes in the city
- Old pipe infrastructure: combined sewer and drain (CSO) makes up about 15 % of wastewater collection system area (about 4 mi sq), but 60% of the total system flow is generated in the combined system.
- CSO piping increases chance of backup during wet weather because of increased stormwater runoff.

Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

Heavy Rainfall – Combined Sewer Infrastructure



Combined sewer infrastructure map

- Combined sewer areas (in brown) are located near populated areas of the city.
- Locations are vulnerable to Combined Sewer Overflows (CSOs).
- Green Island (in green) area is particularly susceptible given its topography.

Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

Heavy Rainfall – Green Island

Projected Locations of Flooding in the Green Island Area

Source: CDM Smith Green Island Area Flooding Study, May 2016

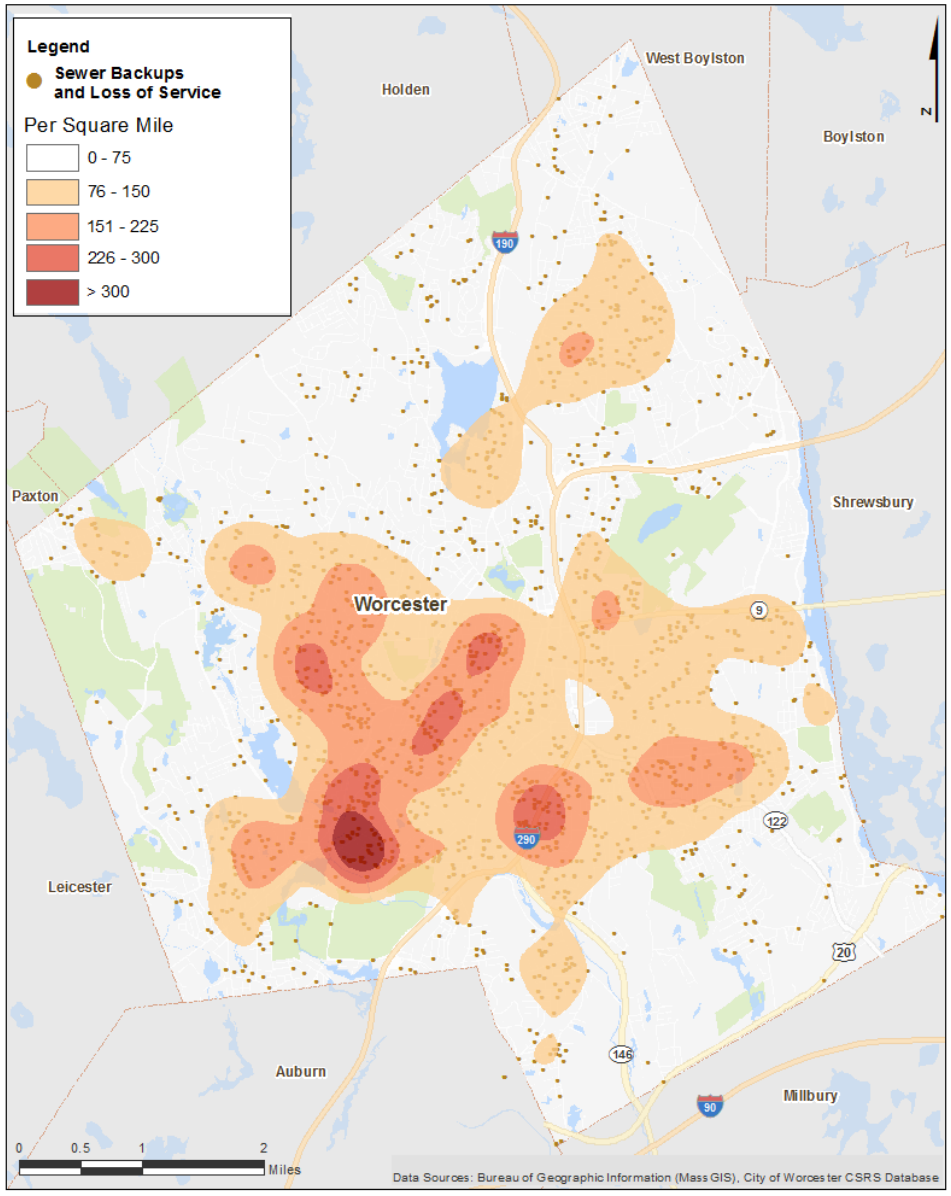
The Green Island area is highly susceptible to flooding events.

- Lowest elevation in the city.
- Situated at the confluence of Mill Brook and Middle River.
- Large portion lies within FEMA flood zone.
- Combined sewer infrastructure.
- Area is densely populated.

Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

Flooding on Southgate Street – June 2010

Heavy Rainfall – Historic Piped Infrastructure Flooding



Density of Reported Sewer Backups and Loss of Service

Data based on reported sewer backups and service losses from Worcester residents between 2006 and 2016.

Note: Map based on Customer Service Request System (CSRS) data for sewer backups and loss of service 2006-2016

Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

Heavy Rainfall – Bank Erosion

Erosion a concern for Worcester:

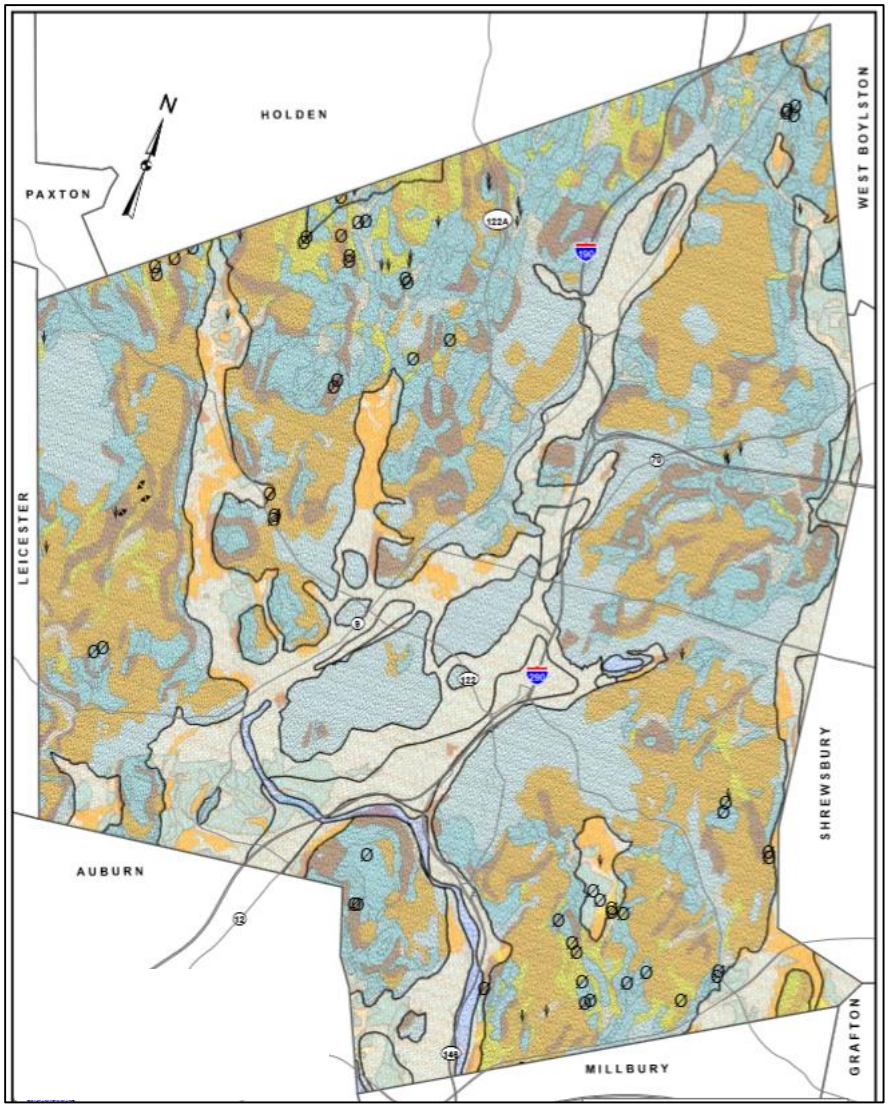
- Caused by a combination of factors (intense rainfall, flooding events, soft sediments, farming activity, land topography, etc).
- A danger for properties, ecosystems and other infrastructure along the river.

Heavy Rainfall – Riverbank Erosion

From the map:

- Soft sediments like sand and gravel are common.
- Topography is hilly - a large portion of the city has sloped land.

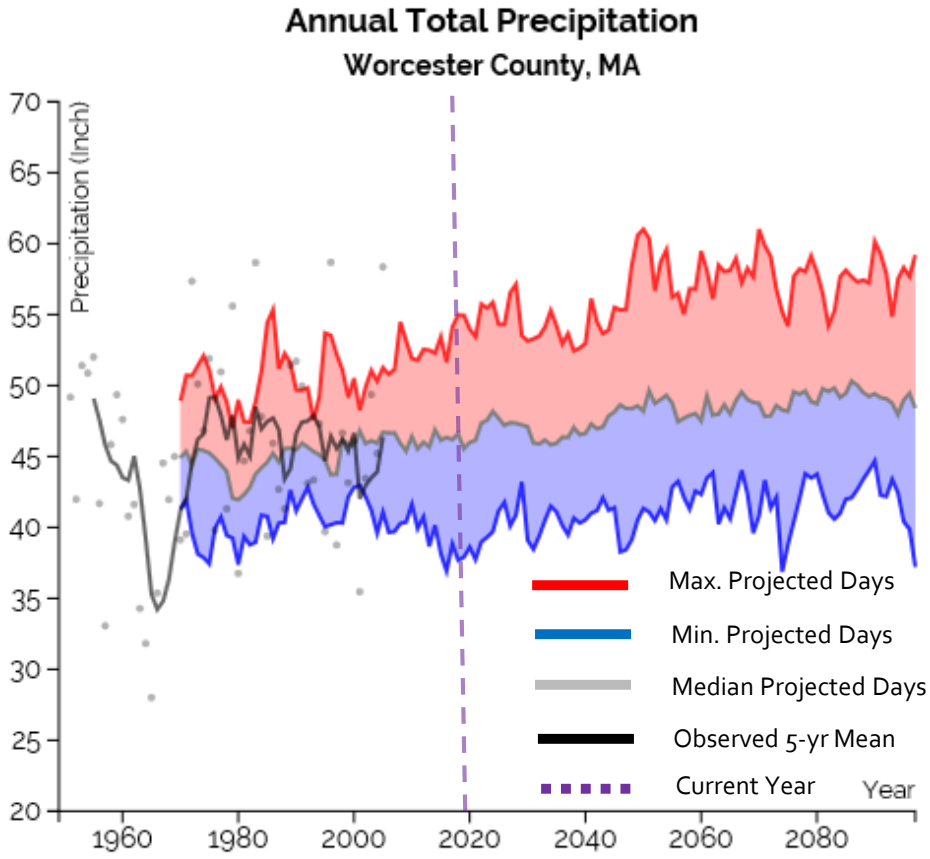
Soils and Geologic Features Map

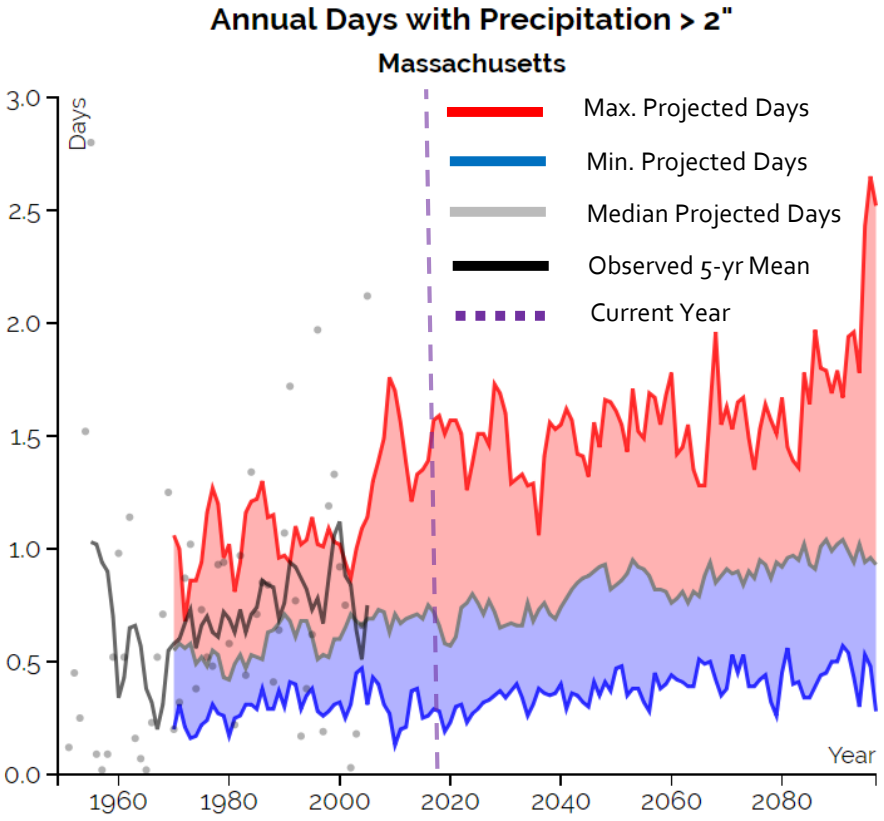


Source: Weston & Sampson OSRP Report, 2013

Heavy Rainfall – Future Projections

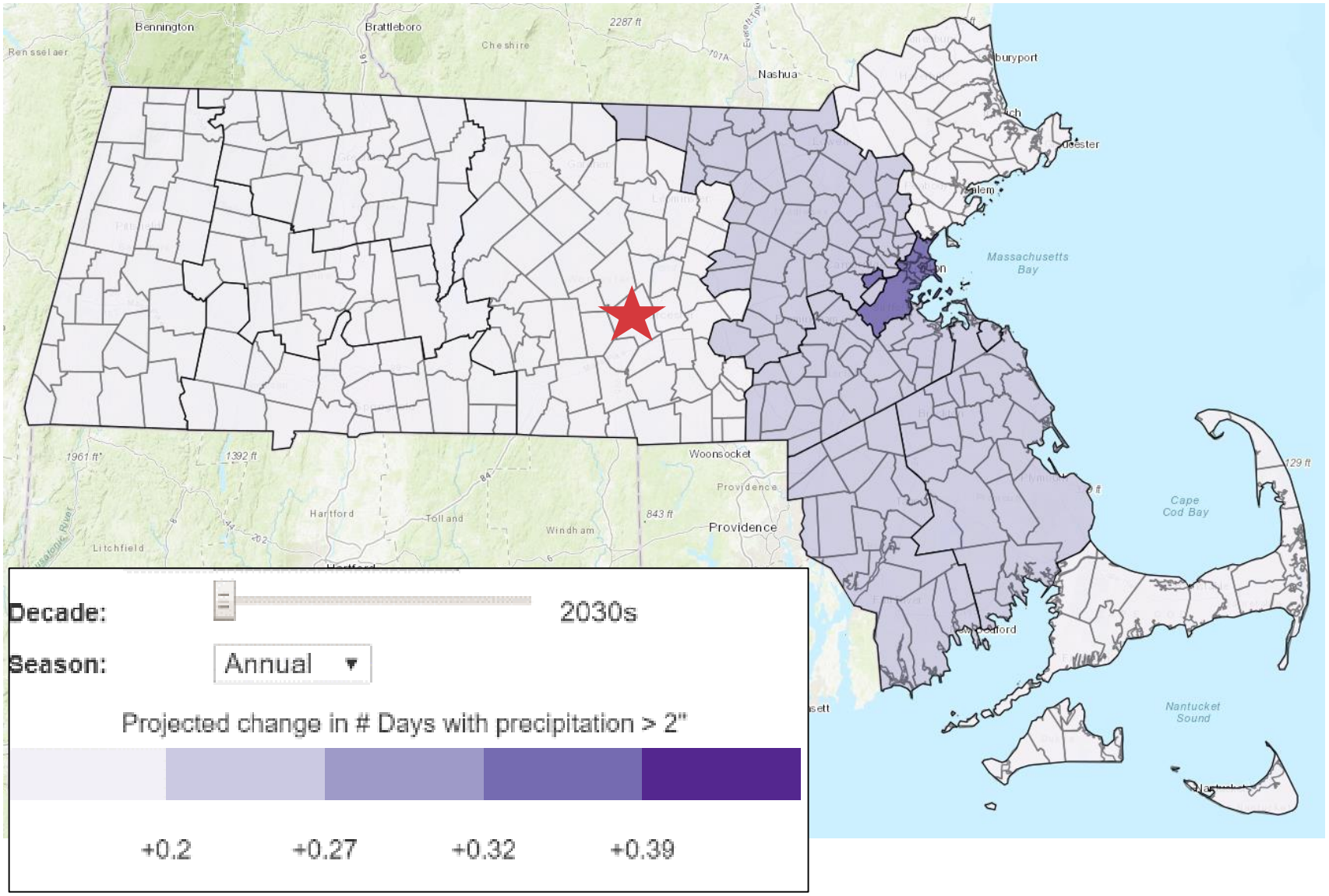
- Total annual rainfall will increase
- Heavy rainfall events will become more frequent





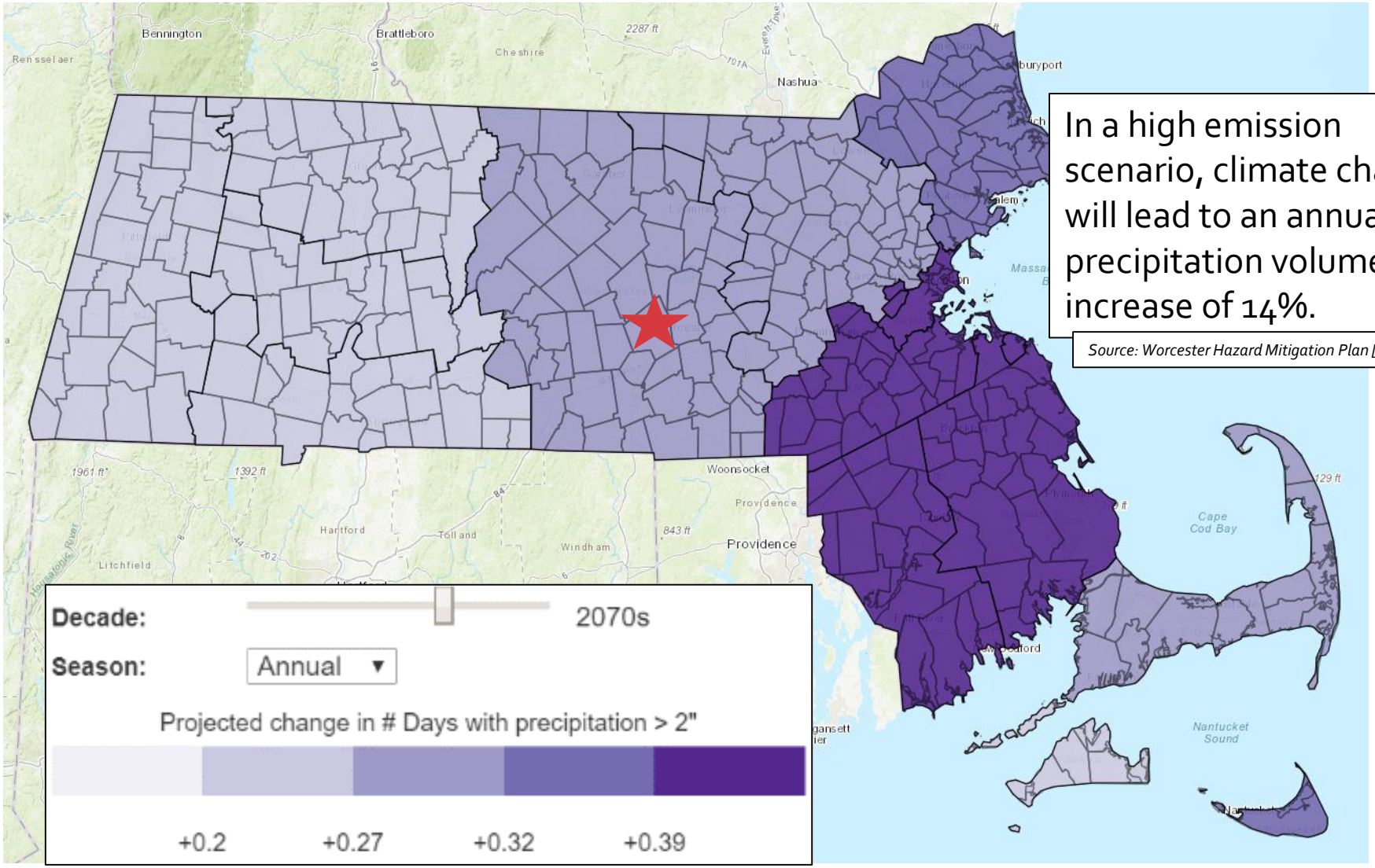
Source: resilientma.org, 2018

HEAVY RAINFALL – 2030



Source: resilientma.org, 2018

Heavy Rainfall – 2070

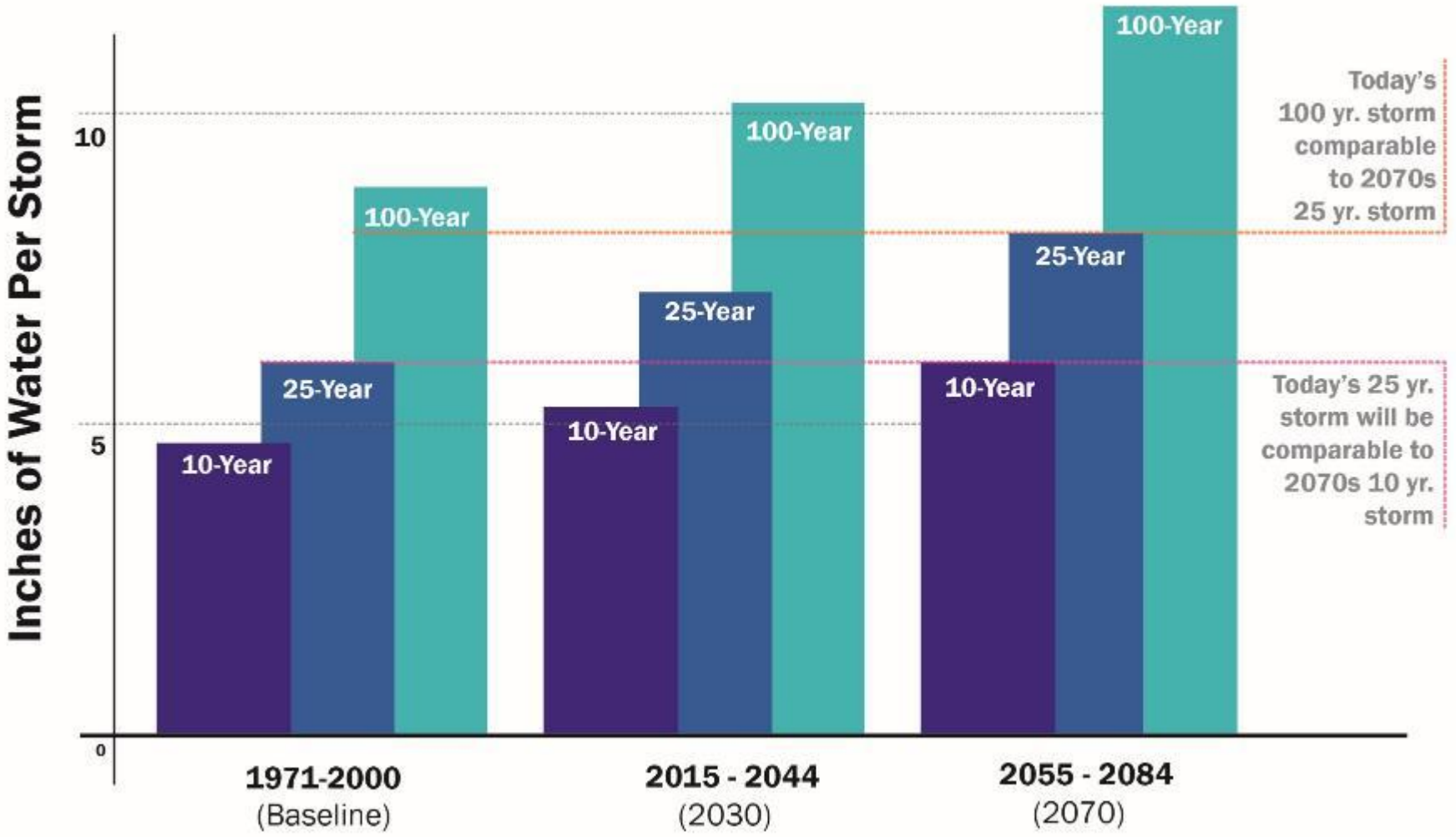


In a high emission scenario, climate change will lead to an annual precipitation volume increase of 14%.

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Source: resilientma.org, 2018

Heavy Rainfall



Source: Design storm projections for the Boston metro area based on Kleinfelder/ATMOS projections, Nov. 2015, Kleinfelder for City of Cambridge.

Identified Hazard 2:
Snow/Ice Storms

Snow/Ice Storms

Worcester is susceptible to large snow and ice storm events:

- The local geography plus the way eastern MA protrudes towards the Atlantic Ocean makes Worcester particularly susceptible to nor'easters and other severe winter storms.
- 62 high impact storms since 1968 (> 10 in).
- **Named snowiest city (of population 100,000 or more) in U.S. in 2015 with 90.1 inches (by GoldenSnowGlobe.com).**

Potential Impacts:

- Power outages, school closings, internet and phone outages, utility damage, tree damage, roadway blockage, property damage, unsafe roads.

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018
Source: https://www.masslive.com/news/worcester/index.ssf/2015/02/worcester_named_snowiest_city.html

Snow/Ice Storms

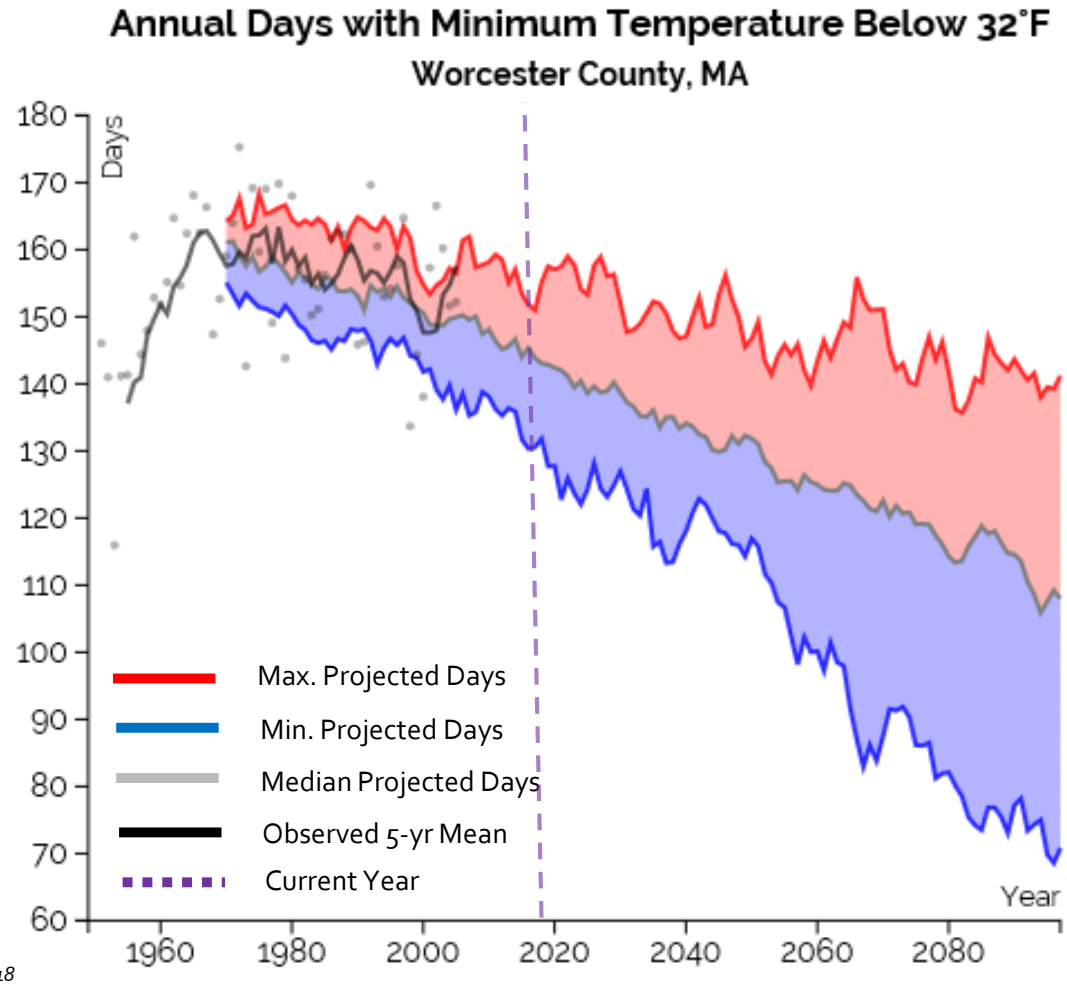
Ice storm (December 11-12, 2008):

- ½ inch of ice blanketed the region.
- Millions of dollars worth of damage.
- Extended power outages and school closings.
- Vivid reminder of how damaging ice storms can be.

Source: Worcester Telegram, 2018

Snow/Ice Storms

- Annual precipitation volume in winter is projected to ***increase*** 30% due to climate change.
- Annual days below freezing is projected to ***decrease*** over the next 80 years due to climate change.
- Projected rising temperatures will cause more winter precipitation to fall as rain or freezing rain instead of snow.
- Higher chance of ice and freezing rain storms

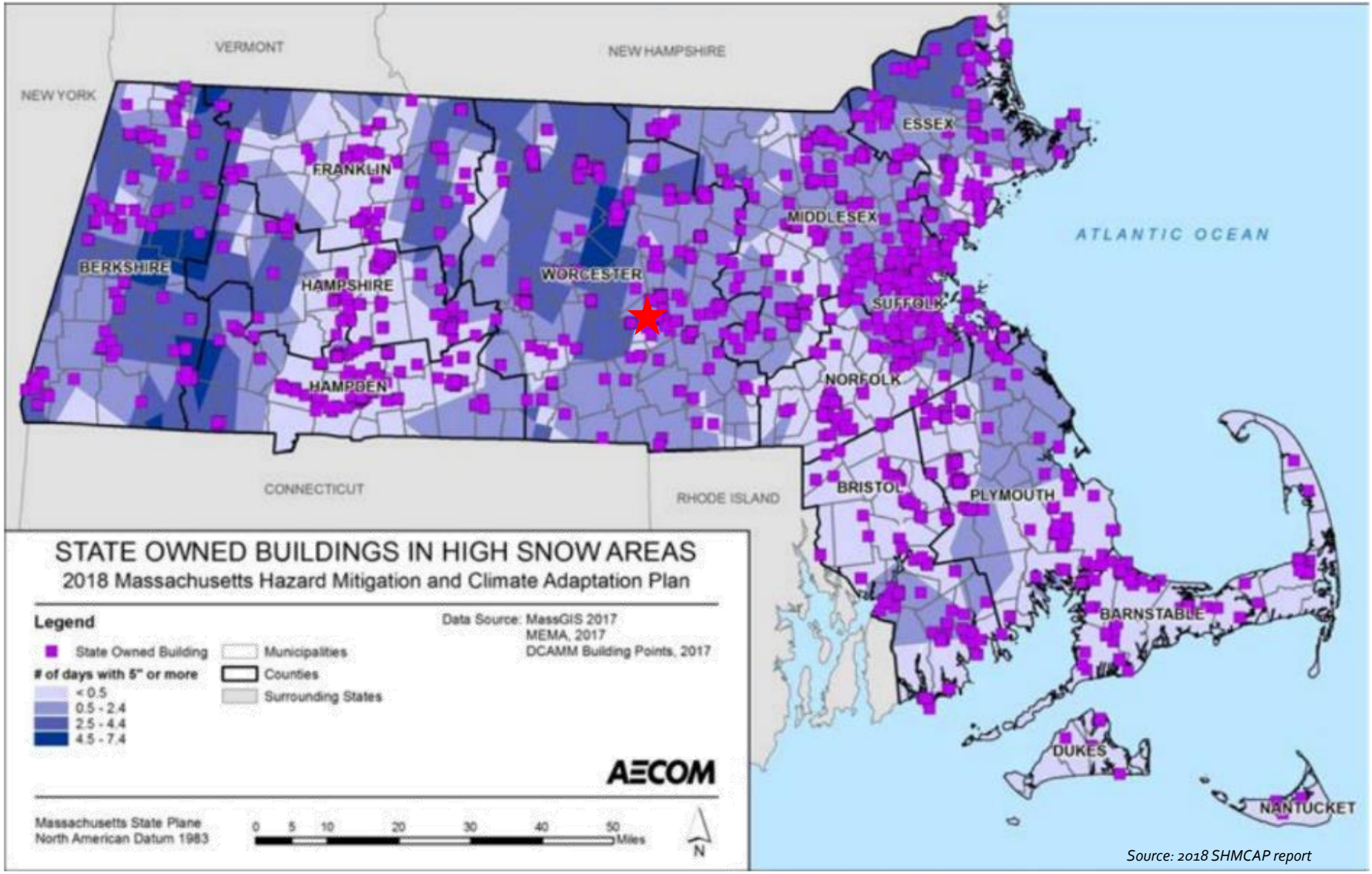


Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Source: resilientma.org 2018

Snow/Ice Storms – Historic Data

Figure 4-64: Number of Days with 5 Inches of Snow or More



Source: 2018 SHMCAP report

Identify a Third Hazard:

Extreme Heat

Drought

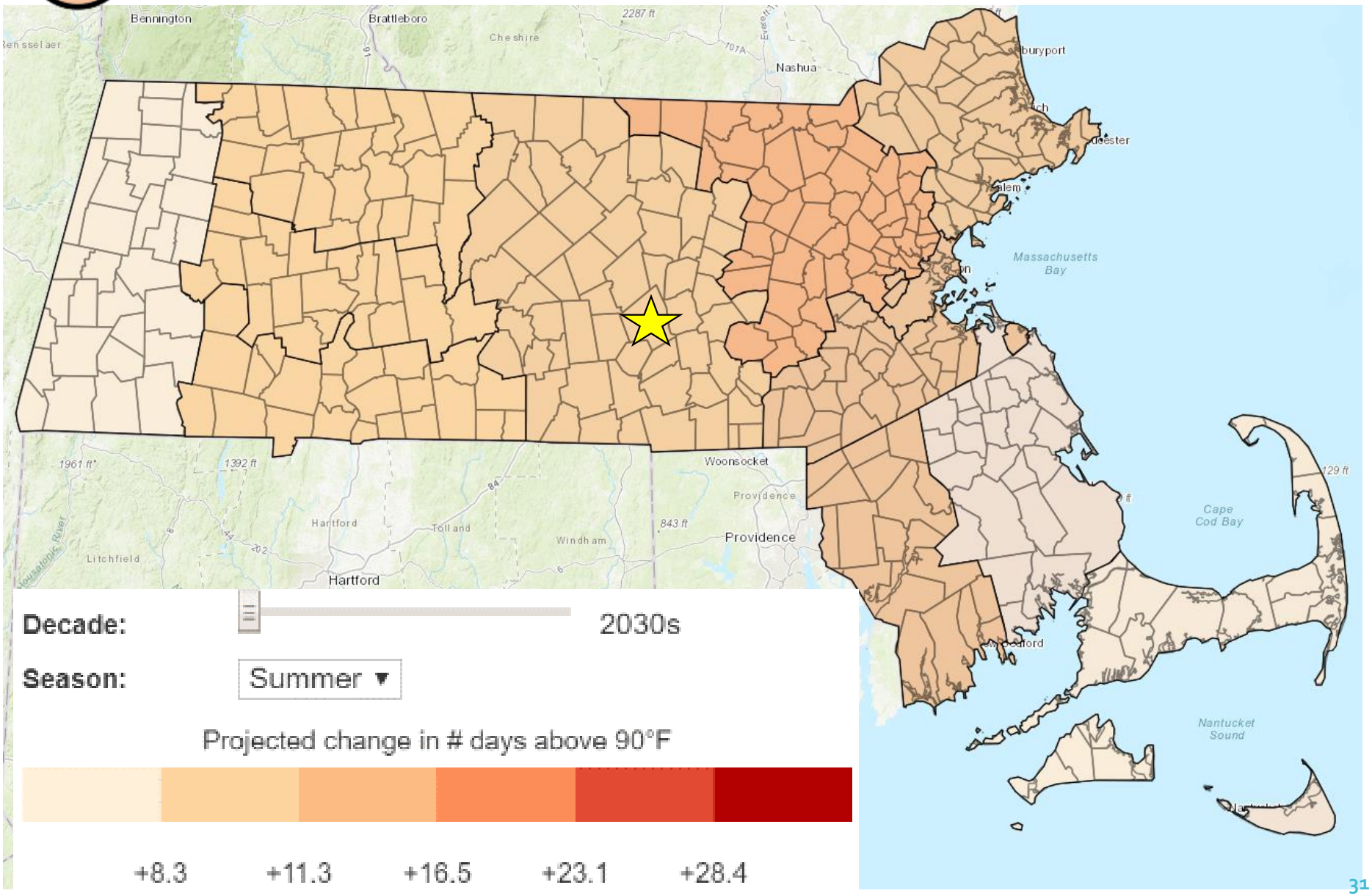
Wind

Brush Fires

Extreme Heat – Present Hot Spots

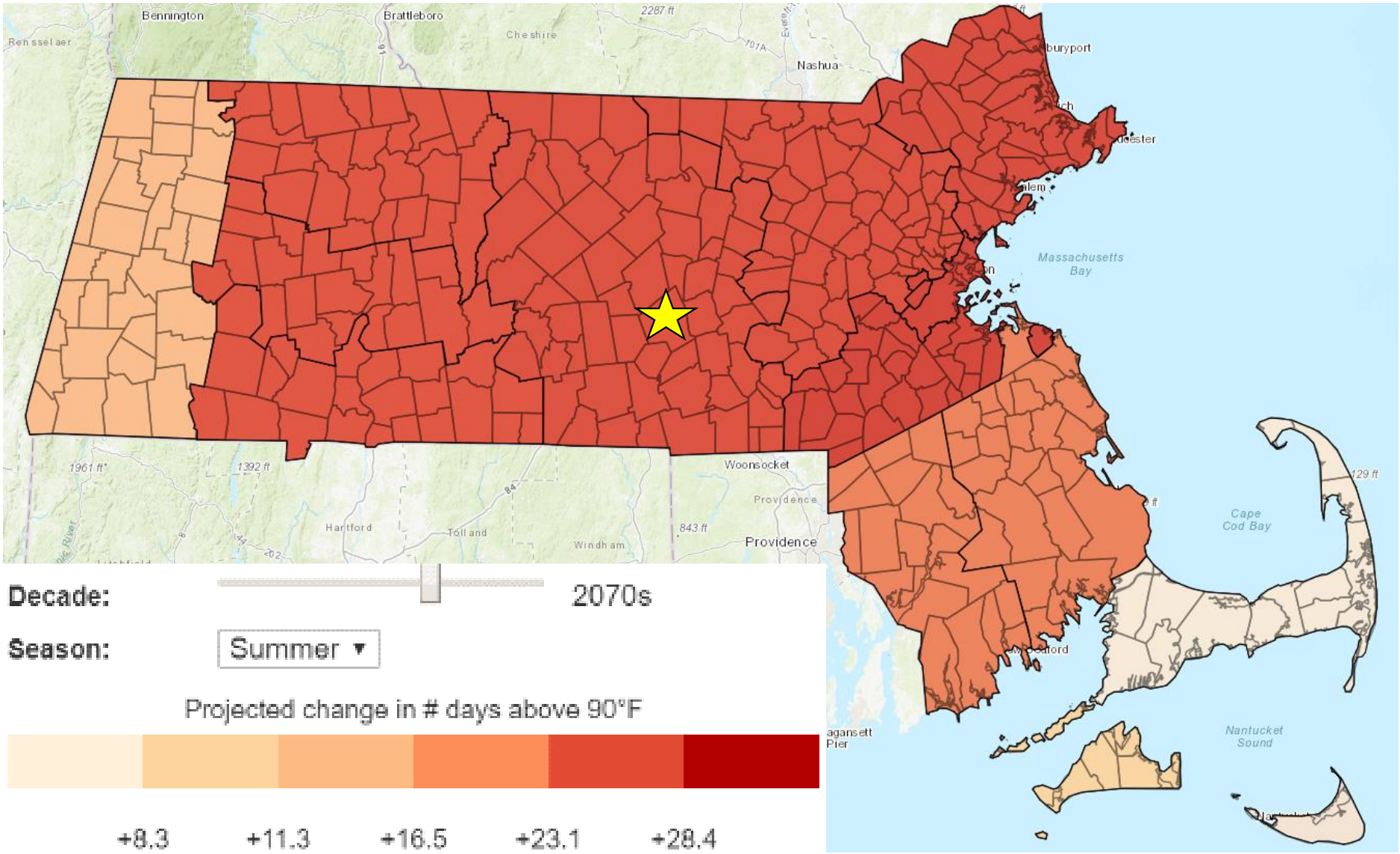
- Heat effect exacerbated in impervious surface areas in the city known as "heat islands".
- Often located in business districts or downtown areas.

Extreme Heat - 2030



Source: resilientma.org, 2018

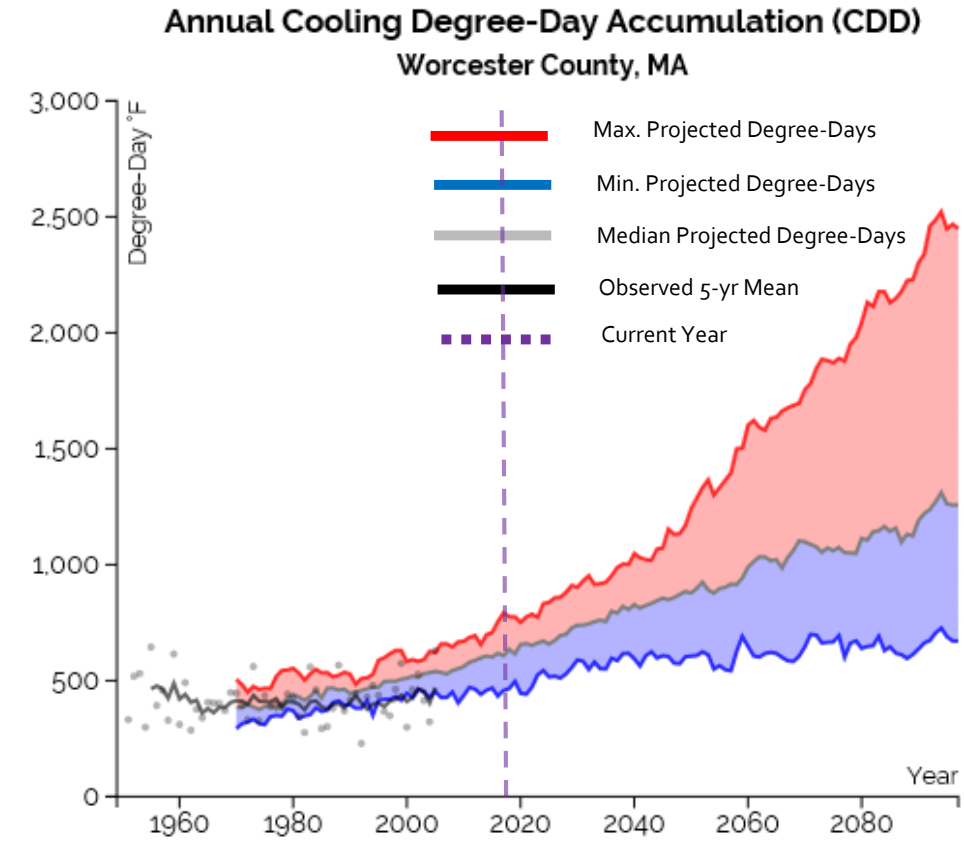
Extreme Heat - 2070

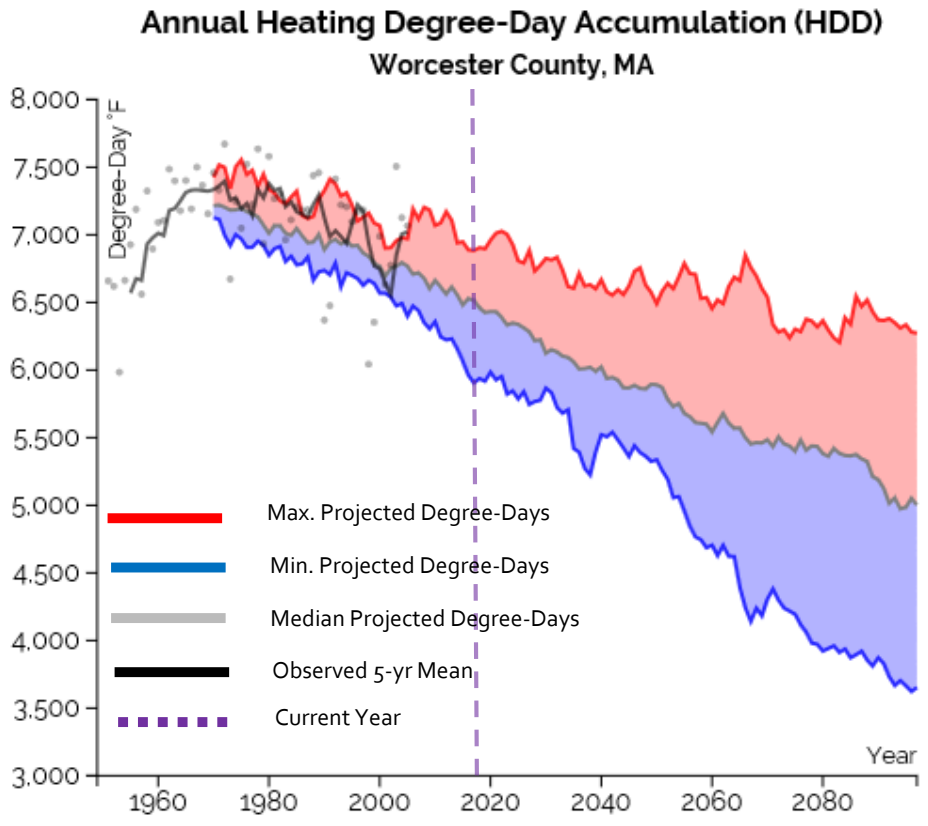


Source: resilientma.org, 2018

Extreme Heat – Energy Demand

- There will be more cooling degree-days than heating degree-days by 2070!
- Degree-days are a sum of the year's high or low temperatures relative to the mean. HDD apply to temps lower than the mean, CDD apply to temps higher than the mean.





Source: resilientma.org, 2018

Extreme Heat – Public Health

Human health issues:

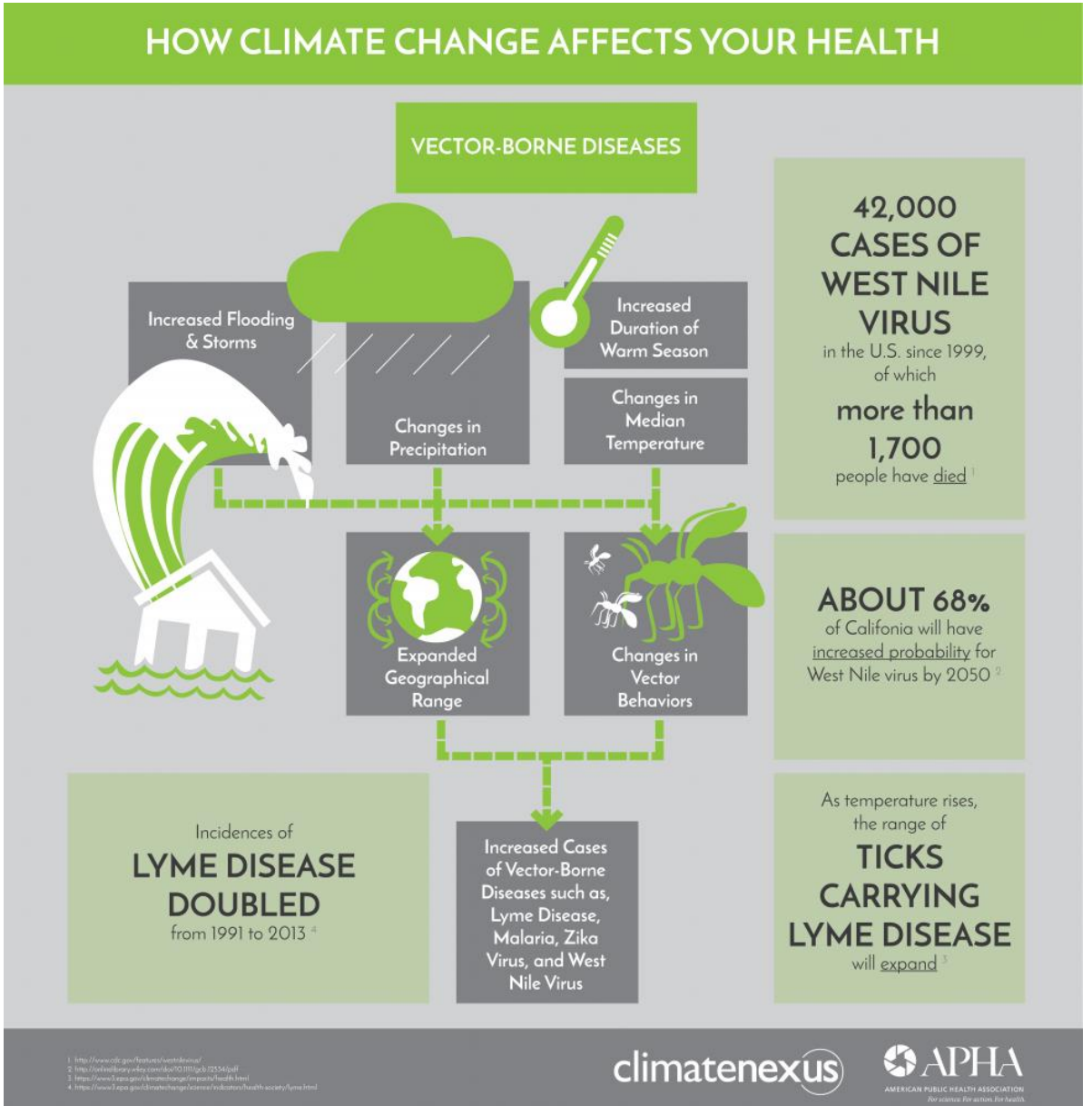
- Heat-related illness and mortality
  - Study shows deaths during heat waves in NYC are more common in neighborhoods with higher relative daytime surface temperature

Source: Madrigano, Jaime & Ito, Kazuhiko & Johnson, Sarah & Kinney, Patrick & Matte, Thomas. (2015). A Case-Only Study of Vulnerability to Heat Wave–Related Mortality in New York City (2000–2011). Environmental health perspectives. 123. 10.1289/ehp.1408178.

- Air quality, asthma
  - Emissions of pollutants like ozone and PM2.5 increase at high temperatures. Especially an issue in the north-eastern US, leading to concerns about related illness and mortality.

Source: Kinney, Patrick. (2018). Interactions of Climate Change, Air Pollution, and Human Health. Current Environmental Health Reports. 5. 10.1007/s40572-018-0188-x.

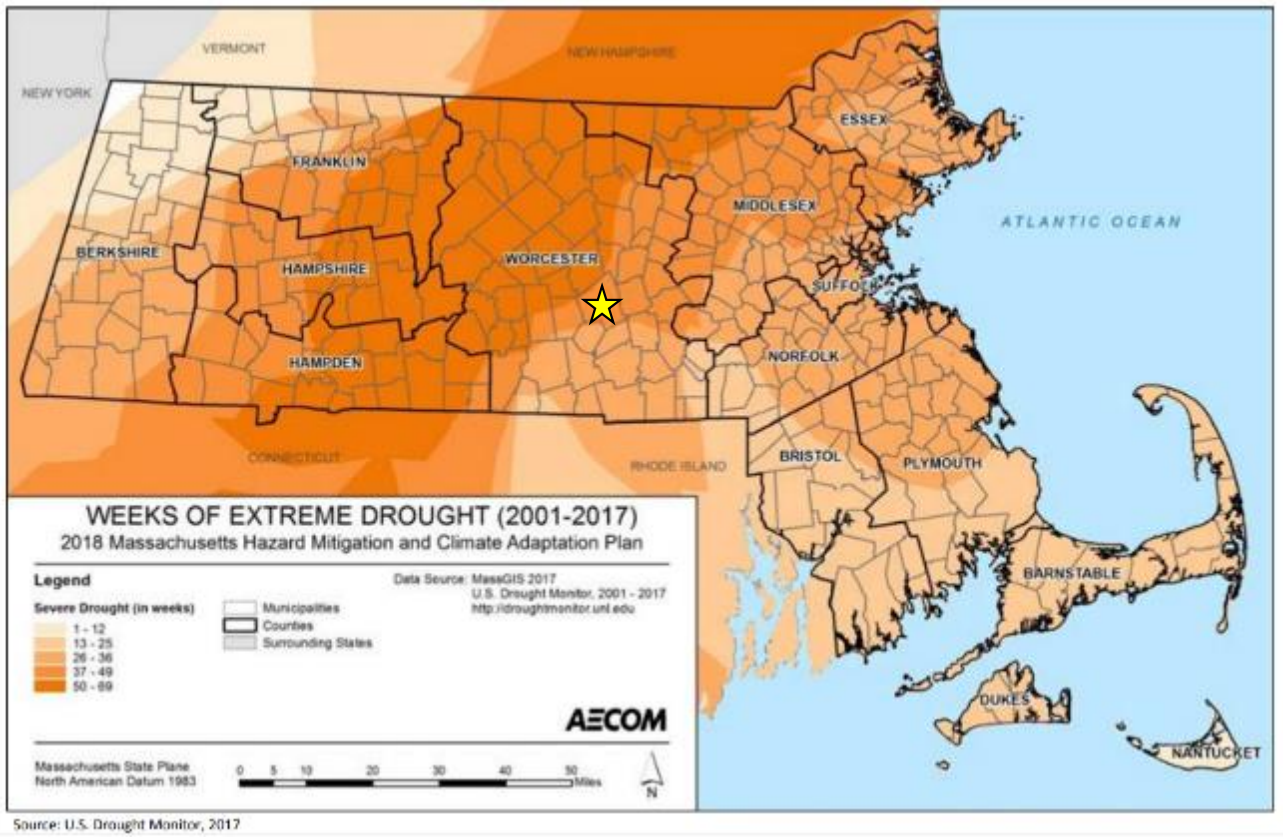
- Vector-borne diseases



Drought – Historic Data

- More rainfall in large events could mean longer gaps with no rainfall locally.
- Could impact natural resources:
  - Trees
  - Water quality
  - Aquatic organisms
  - Aquifers / Reservoirs

Figure 4-8: Weeks of Severe Drought (2001-2017)

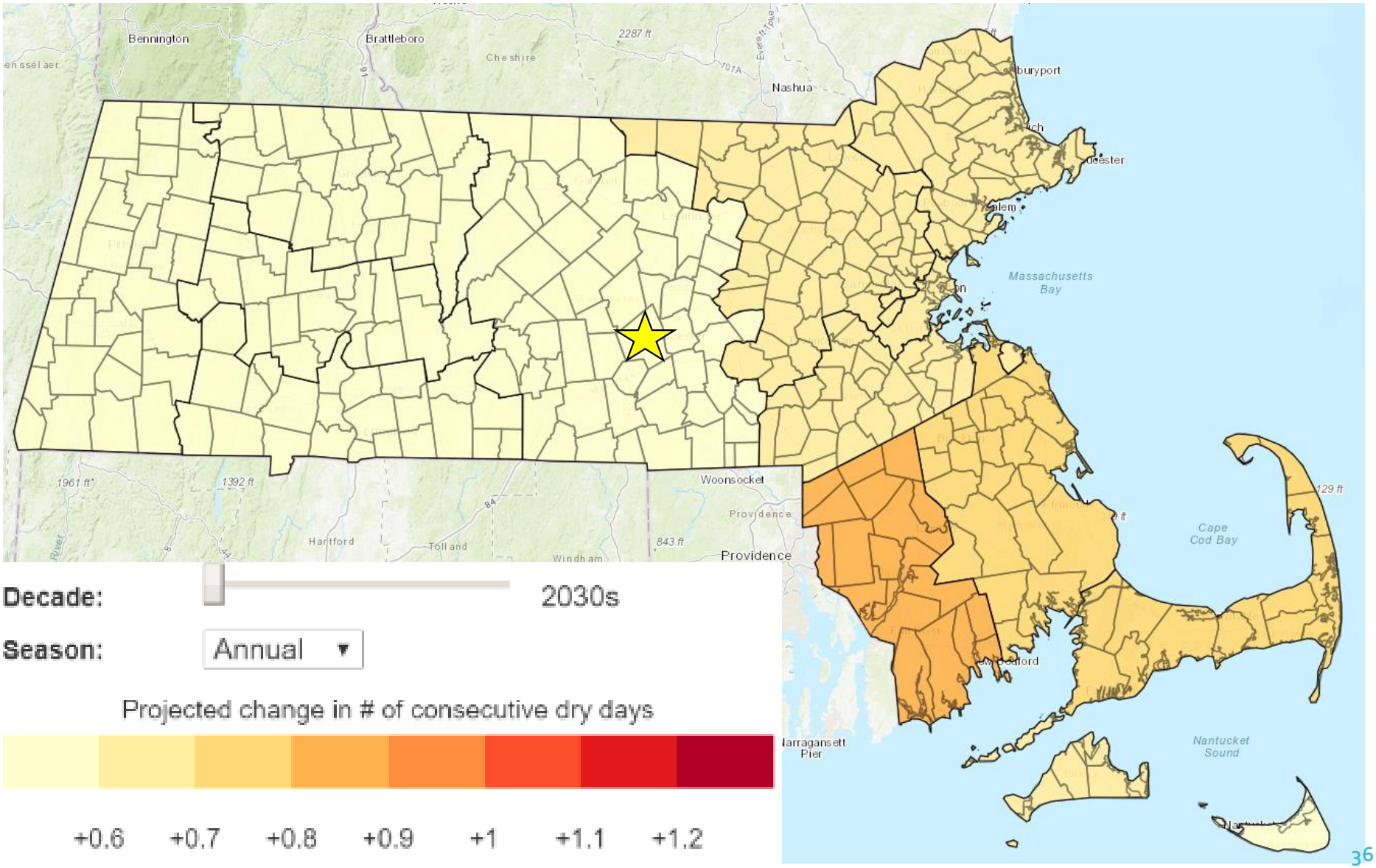


Source: U.S. Drought Monitor, 2017

- In Worcester, there have been 7 major droughts since 1930 (3-8 years each)

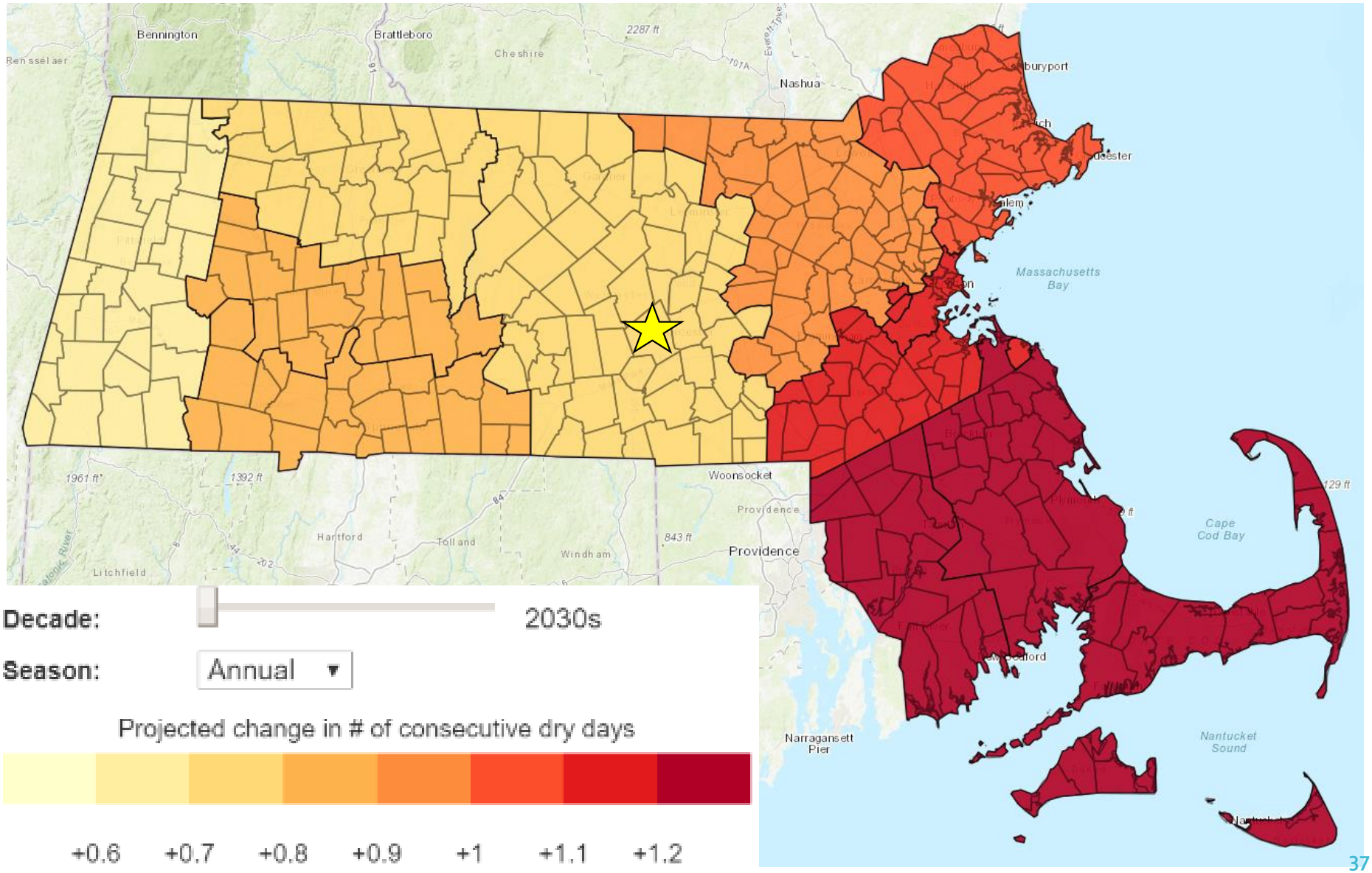
Source: 2018 SHMCAP report
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Drought – Consecutive Dry Days 2030



Source: 2018 SHMCAP report

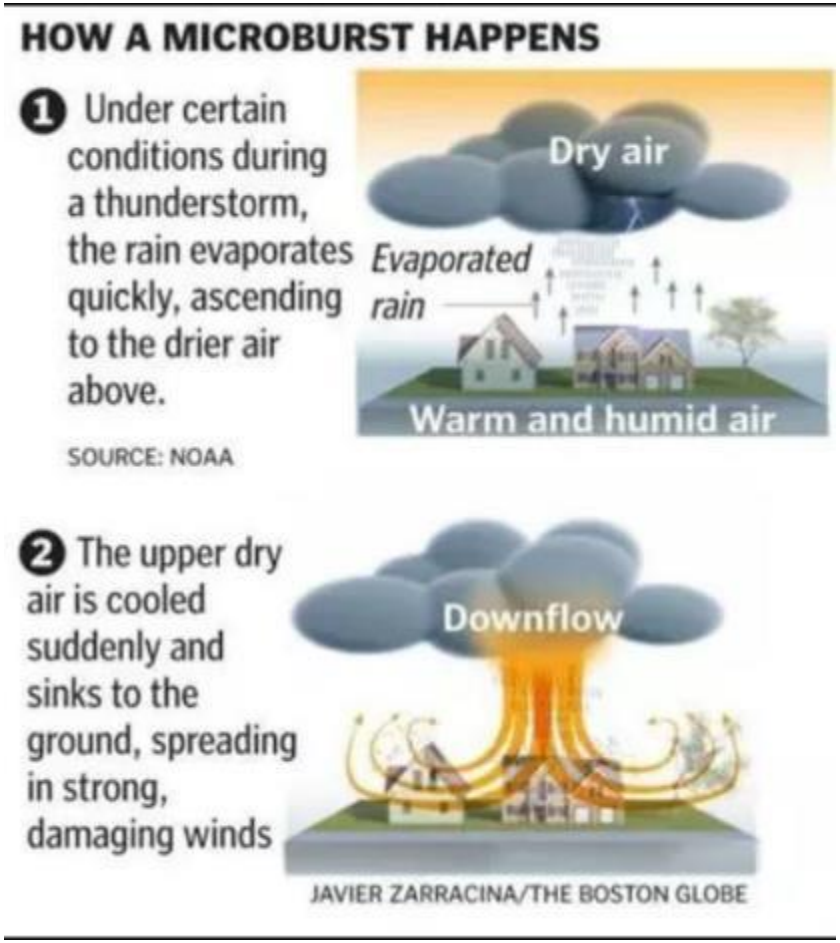
Drought – Consecutive Dry Days 2070



Source: 2018 SHMCAP report

Wind

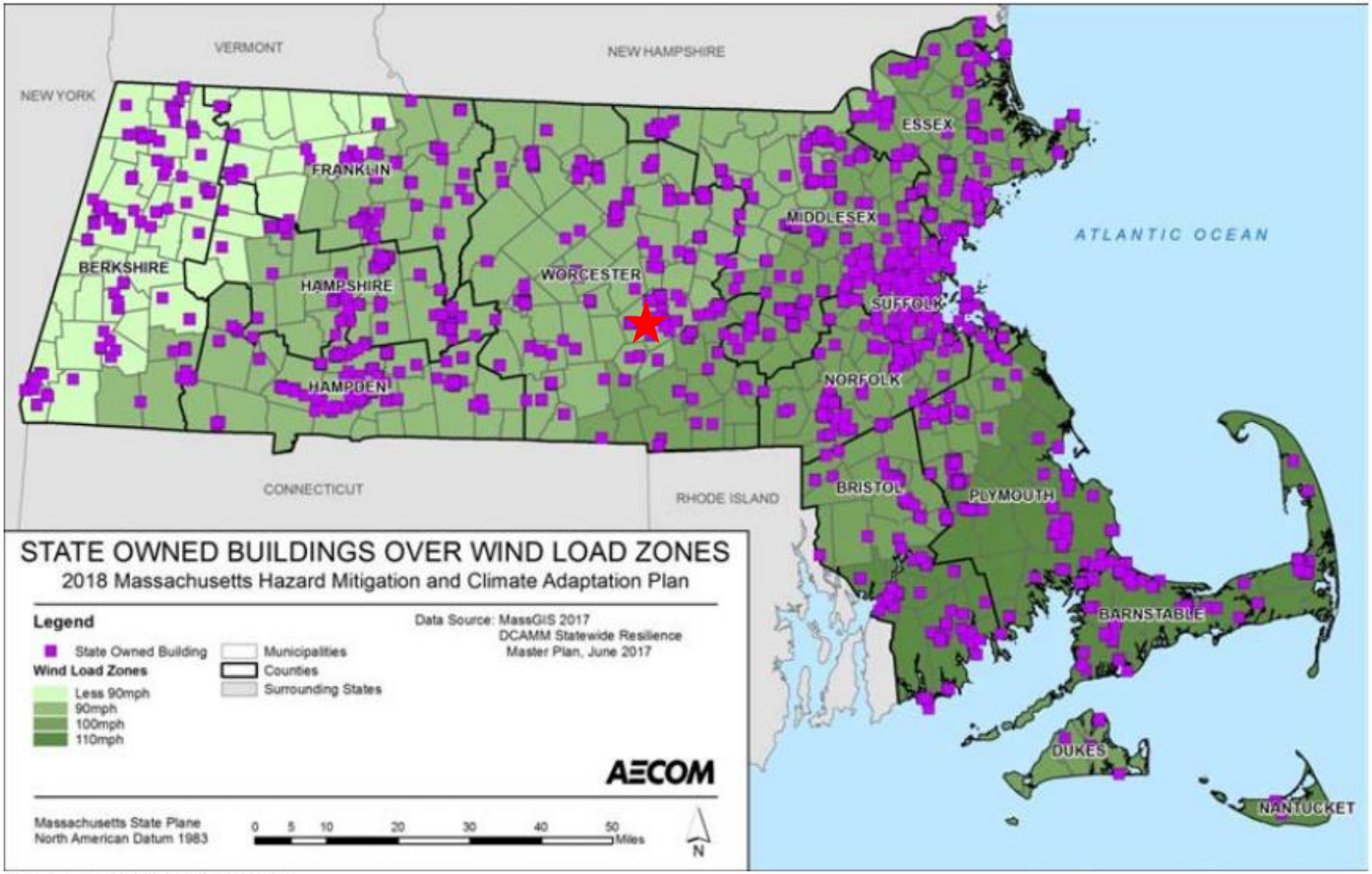
- Typically, damaging winds are classified as those exceeding 50-60 mph.
- Damaging winds can result from microbursts, thunderstorms, blizzards, tropical storms, tornados, etc.
- Impacts: town resources, infrastructure, private and public property.



Source: Joanne Rathe/Globe Staff

WIND – HISTORIC DATA

Figure 4-76: Wind Load Zones in the Commonwealth of Massachusetts



Source: DCAMM, 2017 (facility inventory)

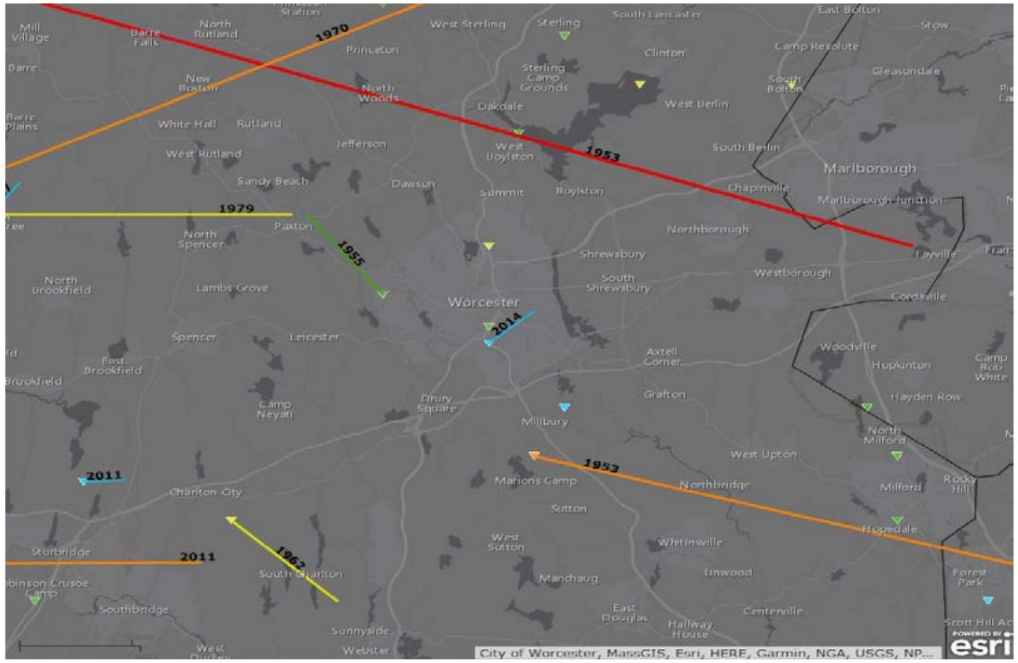
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

TORNADOES

- Destructive swirling columns of air, often formed during severe thunderstorm events.
- Rotational wind speeds can reach 250 mph.
- Path can be difficult to predict because they often stall or change direction abruptly.
- In MA, tornado events have occurred most frequently in the Connecticut River Valley and in western Worcester County.

Impacts from tornadoes can be devastating: Loss of life, tree and power line damage, personal property loss.

Tornado tracks in Worcester area 1950 - 2016



Tornado Magnitude Scale

F/EF 0	Lowest Magnitude
F/EF 1	
F/EF 2	
F/EF 3	
F/EF 4	
F/EF 5	Highest Magnitude

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Brush Fires

- Like wind, brush fires are typically a result of dry ground conditions and drought.
- Approximately 90% of wildfires in Massachusetts are caused by humans, the other 10% by lightning.
- Impacts: natural resources, infrastructure, private and public property.

Source: CBS Boston c/o Dustin Fitch)

Brush Fires – Historical Data

Worcester Susceptibility:

- 21% of the city is forested.
- 1442 incidents, 499 acres burned between 2006-2015, but no major events.
- Risk is exacerbated in times of drought.
- Specific at risk areas are Worcester Airport, Crow Hill Conservation Area, Newton Hill and Elm Park, Bovenzi Conservation Park and God's Acre

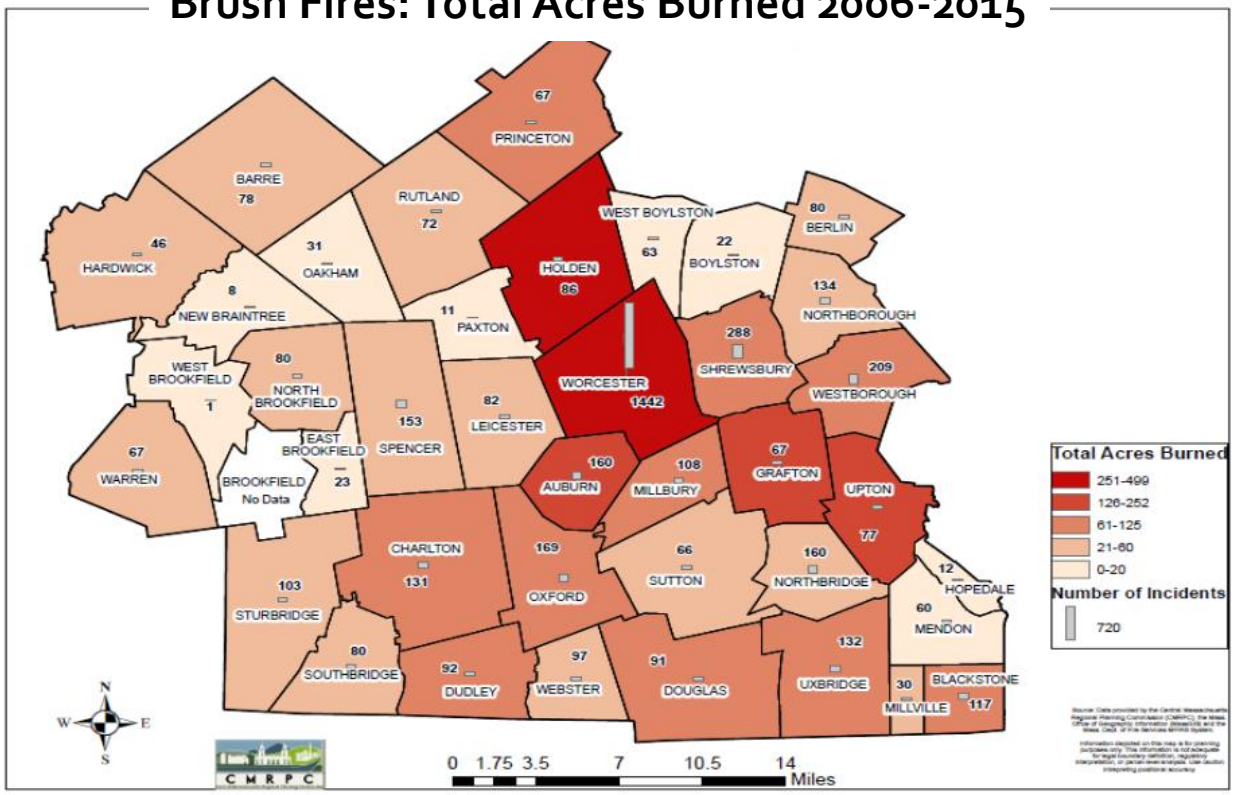


Figure 9 - Forest, Grass and Brush Fires, 2006-2015

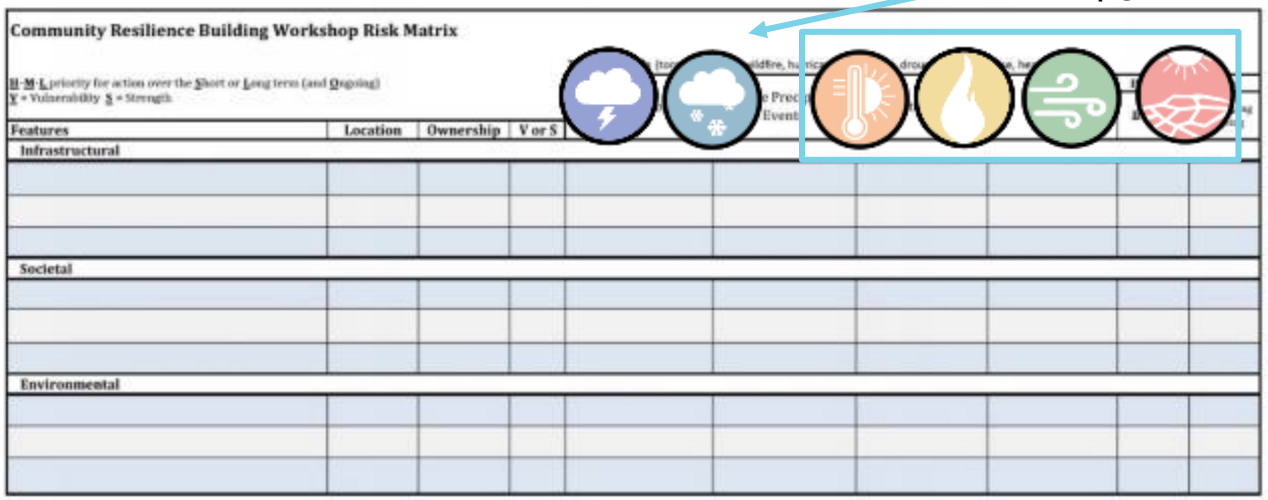
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

II. VOTE FOR YOUR 3RD HAZARD

AND PROVIDE A REASON

- What hazards have impacted your community in the past/present?
  - Where, how often, and in what ways?
- What is exposed to climate threats now and in the future?
- What have been the impacts to operations and budgets, planning and mitigation efforts?

Fill in Top 3 or 4 Hazards on Risk Matrix



Community Resilience Building Workshop Risk Matrix

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

Features	Location	Ownership	V or S						
Infrastructural									
Societal									
Environmental									

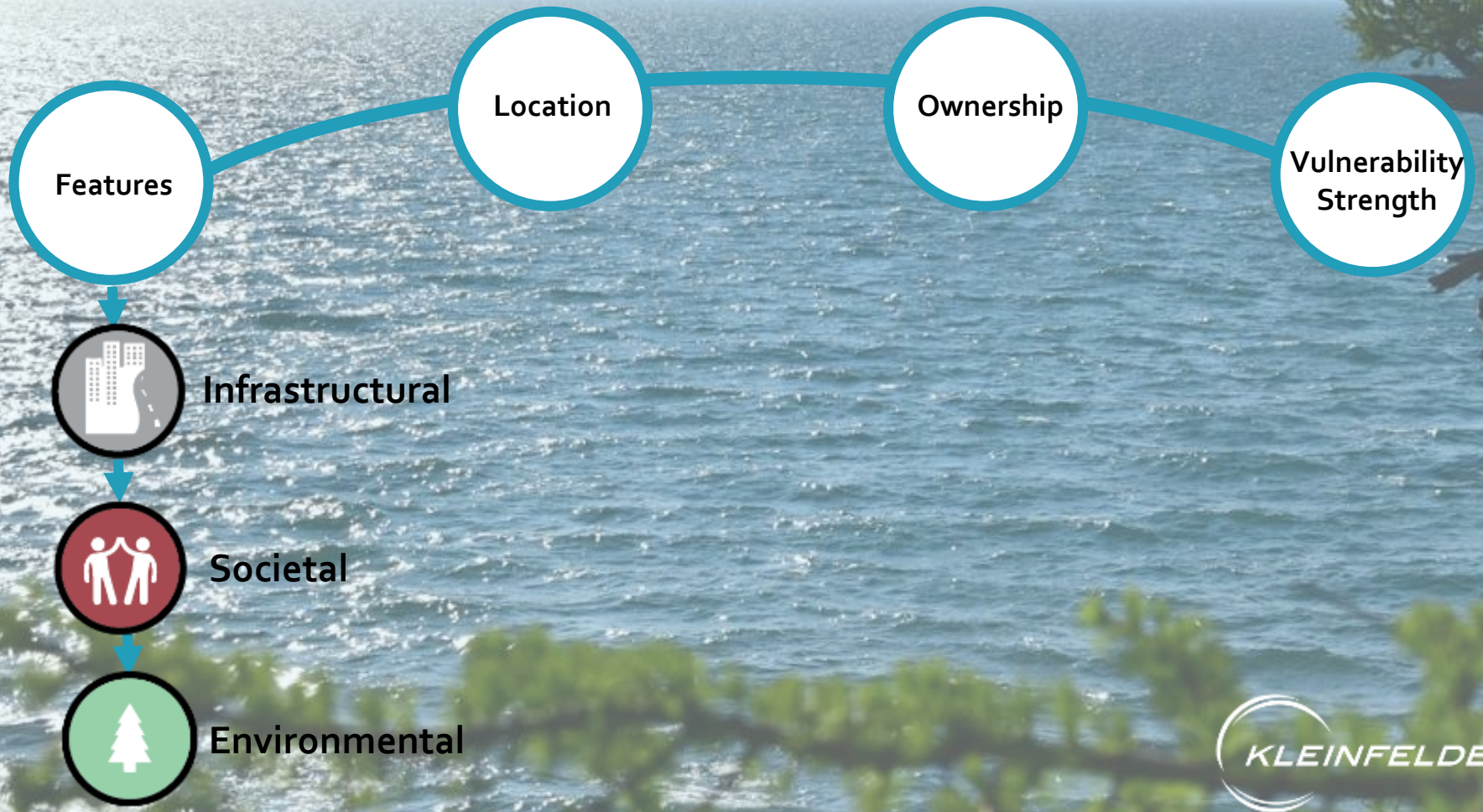
III. Break – 15 mins

Worcester Community Resilience Building Workshop

KLEINFELDER

IV. Strengths & Vulnerabilities

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?



KLEINFELDER

INFRASTRUCTURE

Critical Infrastructure – provides essential services and serves as the backbone of the city's security and health.

- Vital to the hazard response effort.
- Maintains existing level of protection from hazards for the community.
- Would create a secondary disaster if a hazard were to impact it.
- Facilities and populations to especially protect from a hazard.

Examples Include:

- Bridges, Roads
- Dams, Reservoirs
- Emergency Operations
- Municipal Buildings, Schools, Hospitals
- Utilities, Water and Sewer System
- Commercial Buildings and Businesses
- Historic Sites

Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

INFRASTRUCTURE

Nelson Elementary School

Water Filtration Plant

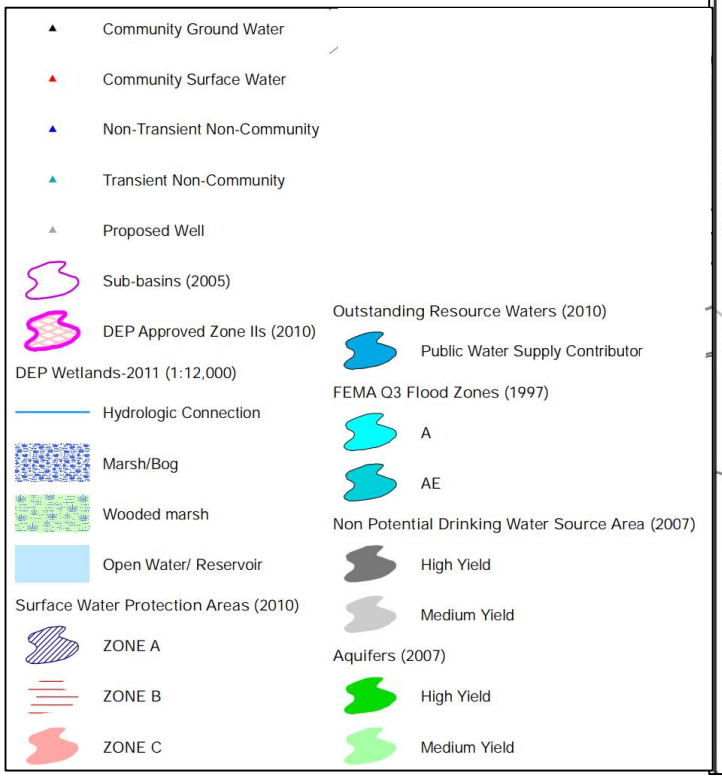
INFRASTRUCTURE

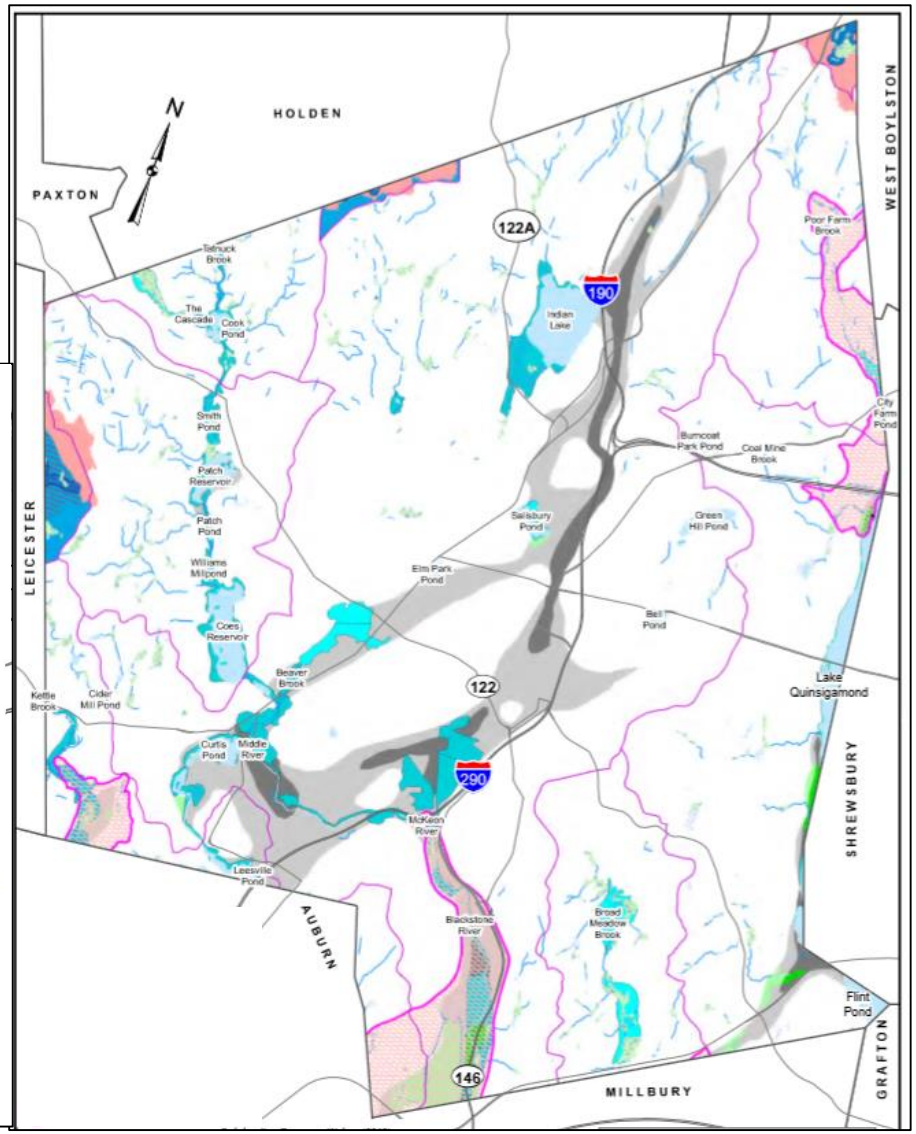
INFRASTRUCTURE

Public Water Infrastructure:

- Essential for city function and survival.

Water Resources Map





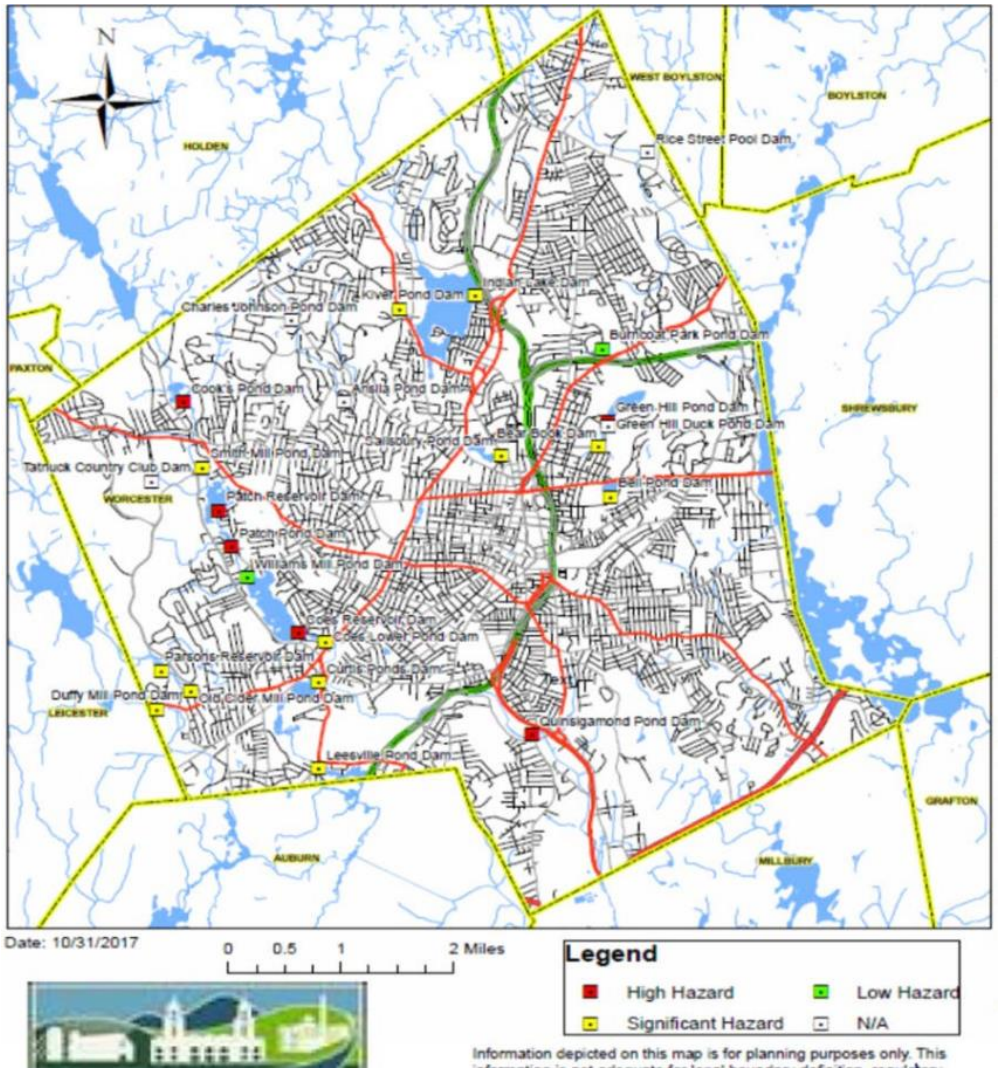
Source: Weston & Sampson OSRP Report, 2013

INFRASTRUCTURE

25 dams in Worcester
- 6 High Hazard
- 12 Significant Hazard

Dam failure is not common but many present a disastrous hazard to lives and property. The hazard level classification reflects the potential impact of a specific dam failure. Extensive flooding would occur in downstream areas.

Dam Locations and Hazards Map



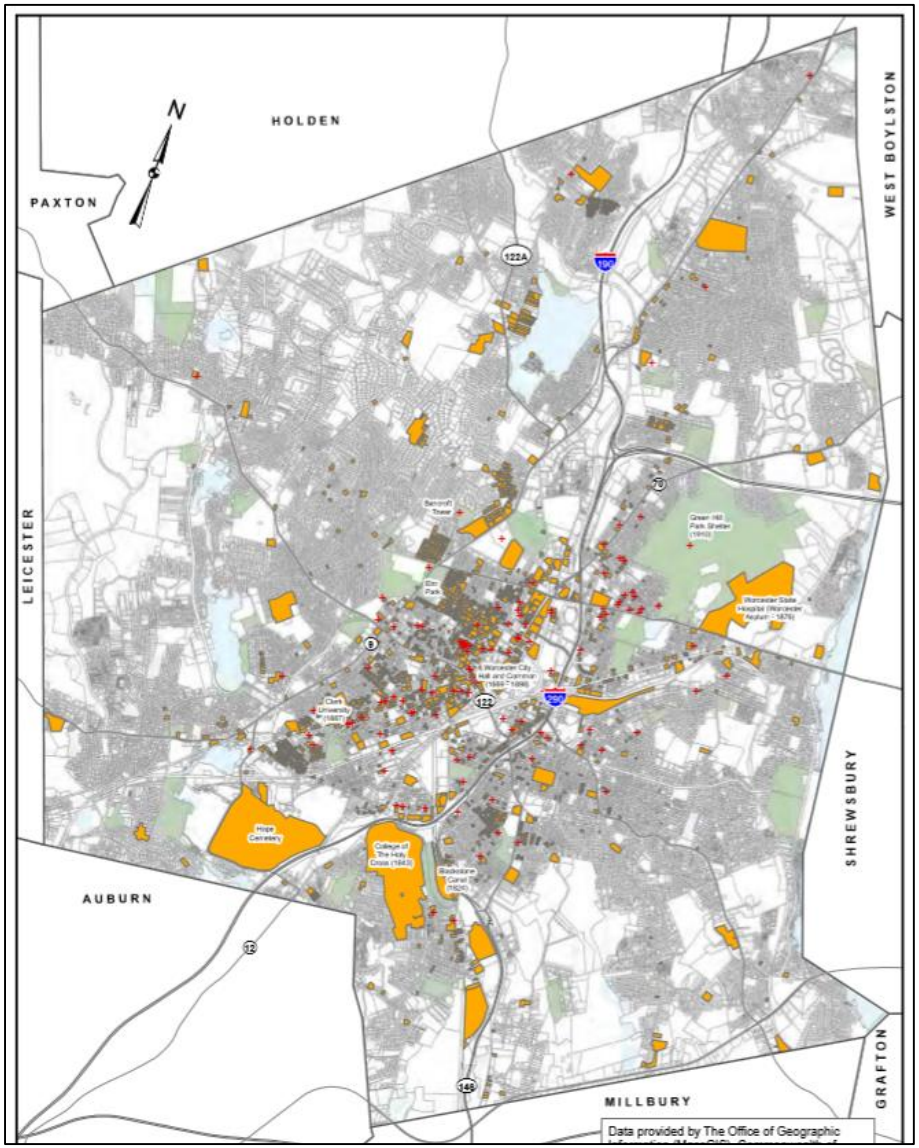
Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

INFRASTRUCTURE

Other important city infrastructure:

- Historic locations.
- Public parks.

Unique Features Map



Source: Weston & Sampson OSRP Report, 2013

Society

- Combination of factors and forces that affect the susceptibility of various groups within a community to harm, as well as their ability to respond positively after extreme events.

"The death toll was the result of distinct dangers in Chicago's social environment: an increased population of isolated seniors who live and die alone"– Eric Klinenberg

Society

2016 Data:

- City Population: 184,509
- Males: 91,316 (49.5%)
- Females: 93,193 (50.5%)

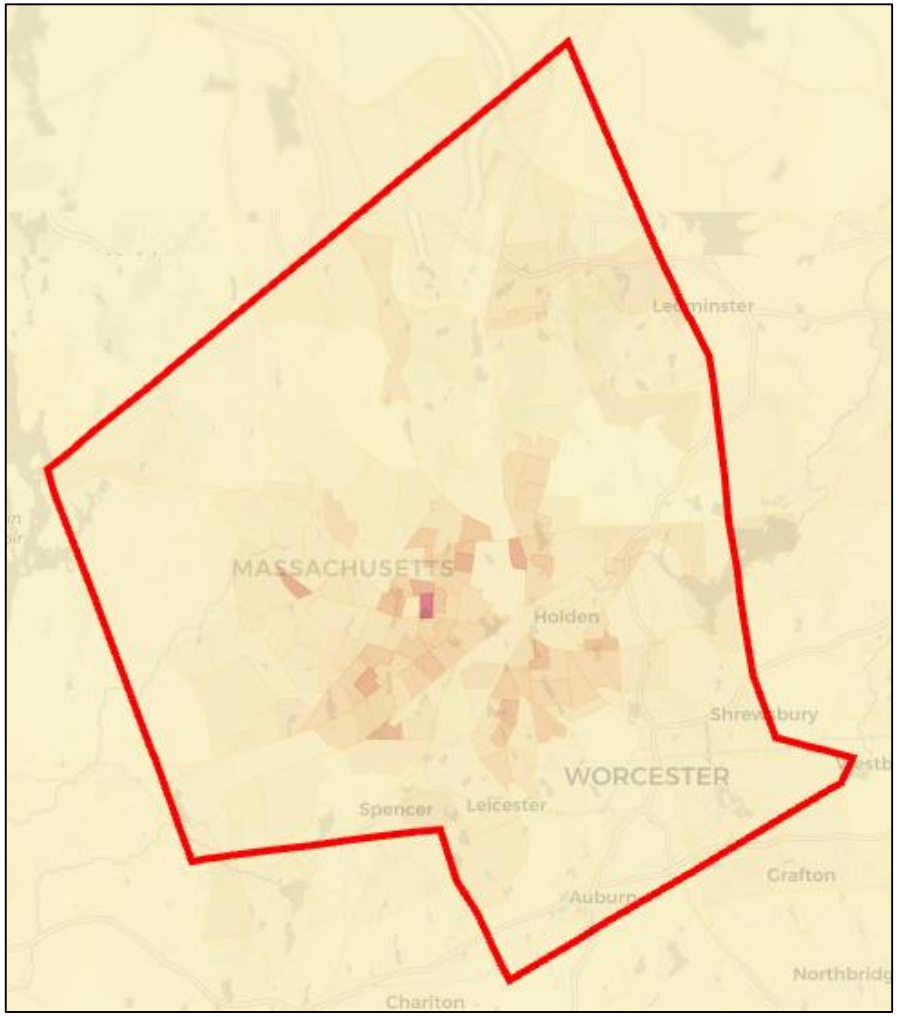
Source: www.city-data.com

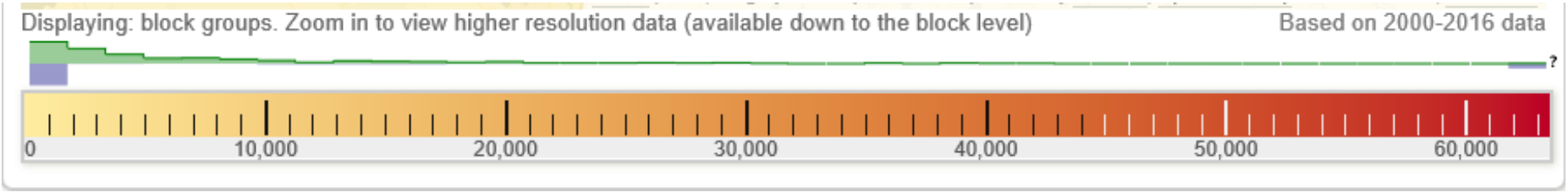
Age Stats for Worcester

- 25.5% under 19
- 12.5% over 65
- Median age 33.8
- MA median age 39.3

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

Worcester Population Density Graphic





Source: www.city-data.com

SOCIETY

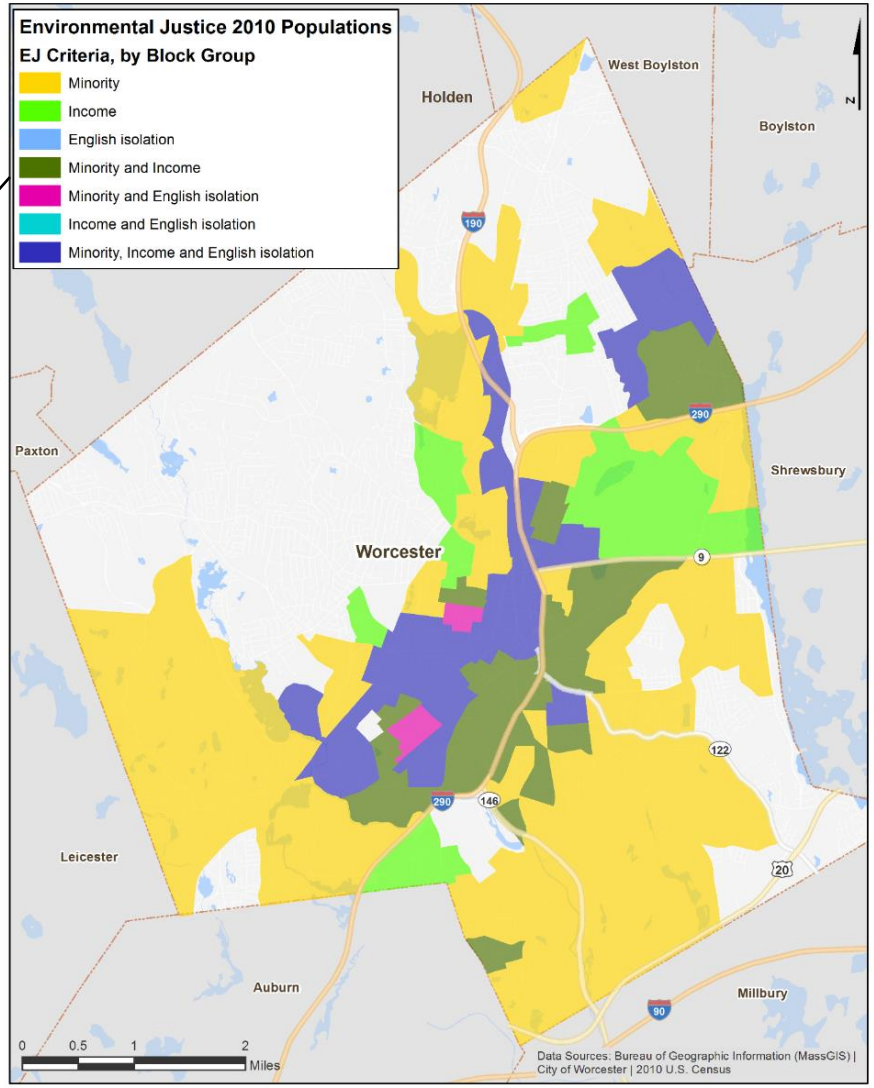
The location of vulnerable populations throughout the city.

- Downtown areas have the highest concentration.

Environmental Justice 2010 Populations
EJ Criteria, by Block Group

- Minority
- Income
- English isolation
- Minority and Income
- Minority and English isolation
- Income and English isolation
- Minority, Income and English isolation

Environmental Justice Populations Map



Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

SOCIETY

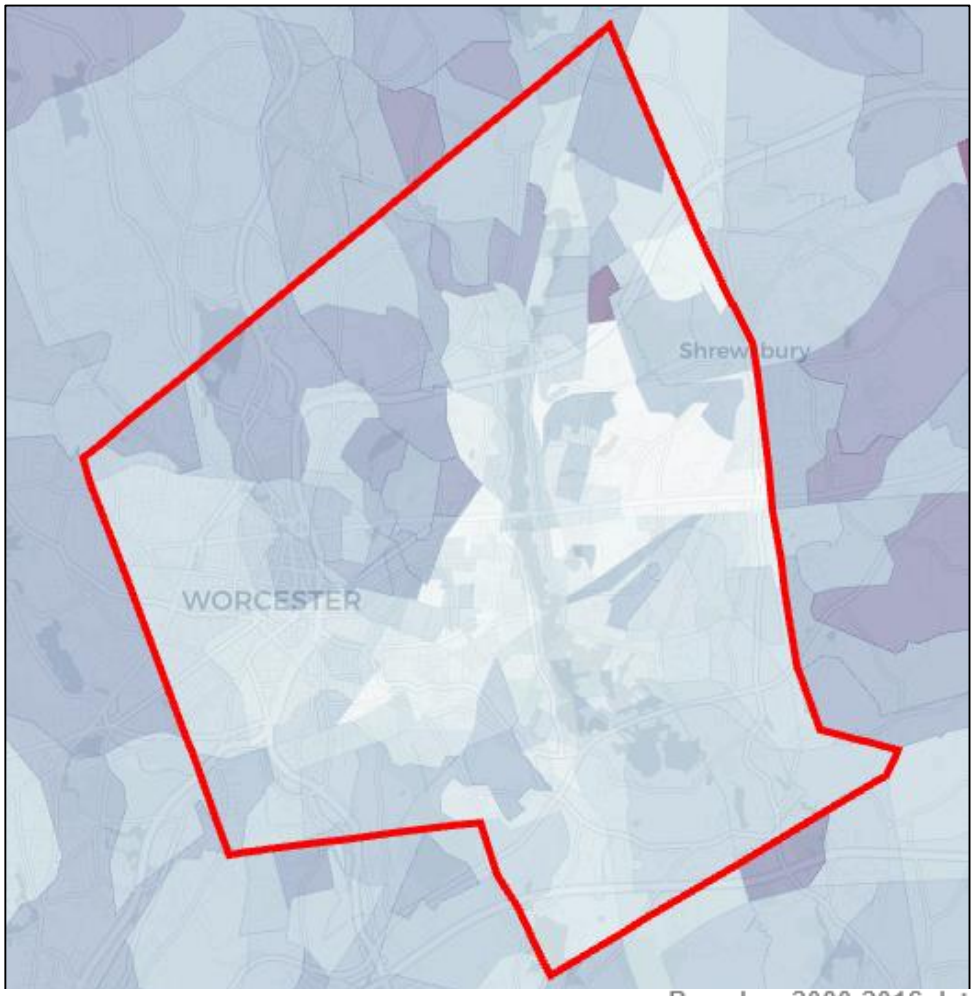
Vulnerable populations, post-incident are most likely to be effected by lack of access to recovery services, displacement, injury, illness, loss of employment, and property damage.

Worcester Stats : Income

- Median Income: $56,221
  - MA median income: $68,563.
  - County median income: $65,313
- Poverty: 22.4%
  - MA poverty: 11.6%
  - County poverty: 11.8%

Source: Worcester Hazard Mitigation Plan [DRAFT], 2018

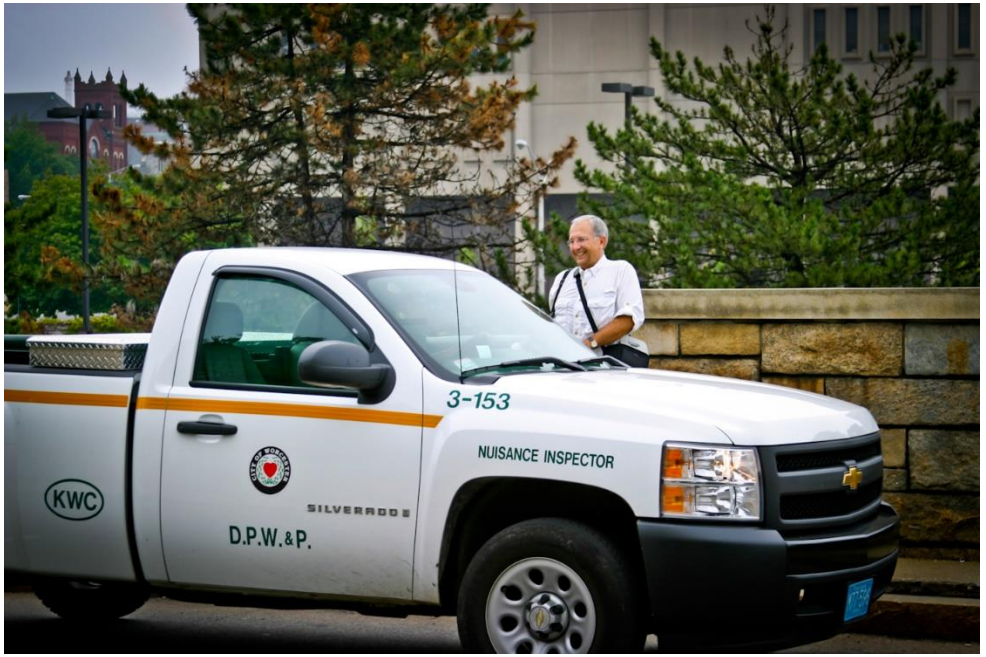
Median Household Income Graphic



Source: www.city-data.com

Society


854


3-153
NUISANCE INSPECTOR
KWC
D.P.W.&P.
SILVERADO


8403
WRTA
Not $40-ish, $40.
Unlimited talk, text, web.
metroPCS
© 2011 Scott Erb ~ Erb Photography

Environment

Benefits of natural systems include:

- Flood storage
- Recreation and tourism
- Cooling during heat waves
- Biodiversity conservation
- Water filtration
- Mobility Vulnerabilities
- Water quality and quantity
- Air Quality

Environment – Parks and Open Space

- Parks and open space are essential for cooling and air quality in the city.
- Encourage outdoor activity for residents.

Local Government
- City of Worcester Parks Department
- City of Worcester Conservation Commission
- City of Worcester School Department
- Town of Auburn Conservation Commission
- Cemeteries Public & Private
- City of Worcester - Proper Custody TBD

Non-Profit
- Greater Worcester Land Trust
- Massachusetts Audubon Society

Private Ownership
- Private Ownership

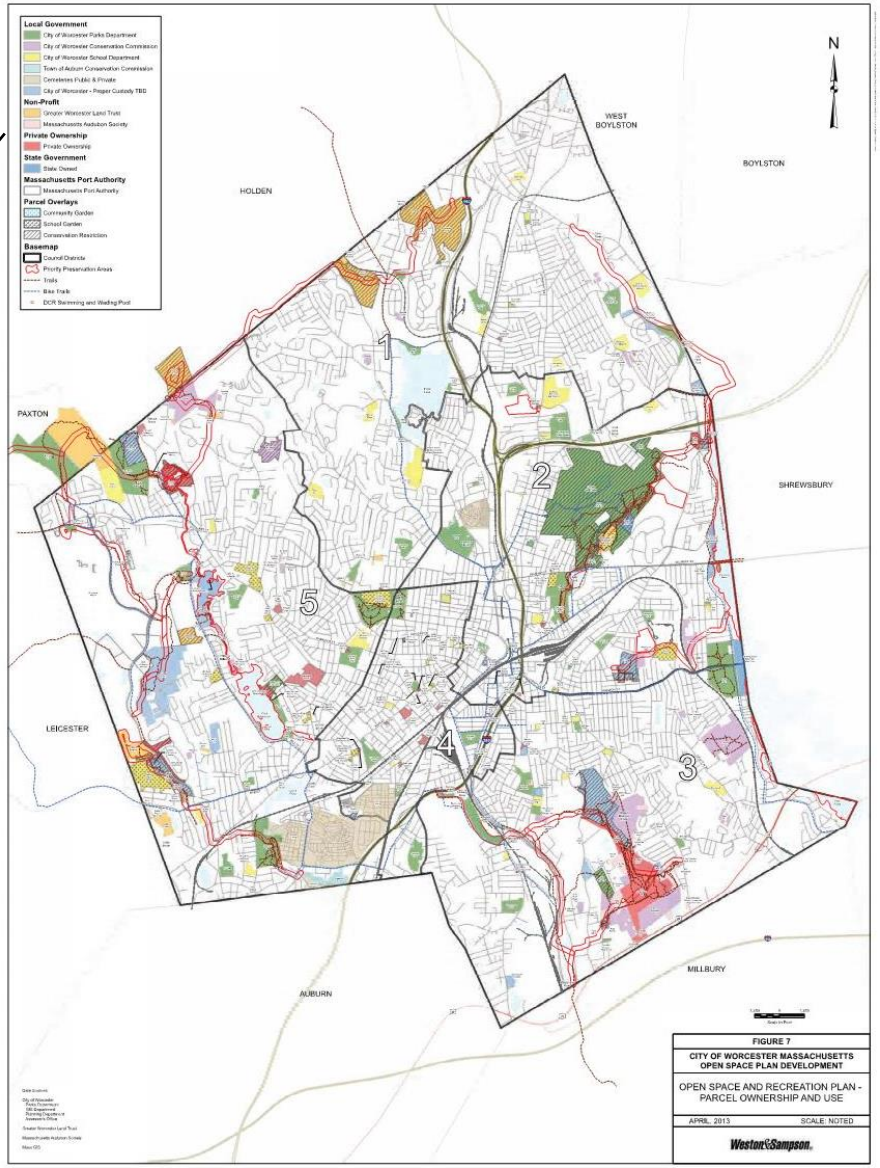
State Government
- State Owned

Massachusetts Port Authority
- Massachusetts Port Authority

Parcel Overlays
- Community Garden
- School Garden
- Conservation Restriction

Basemap
- Council Districts
- Priority Preservation Areas
- Trails
- Bike Trails
- DCR Swimming and Wading Pool

Open Space and Recreation Map



Source: Weston & Sampson OSRP Report, 2013

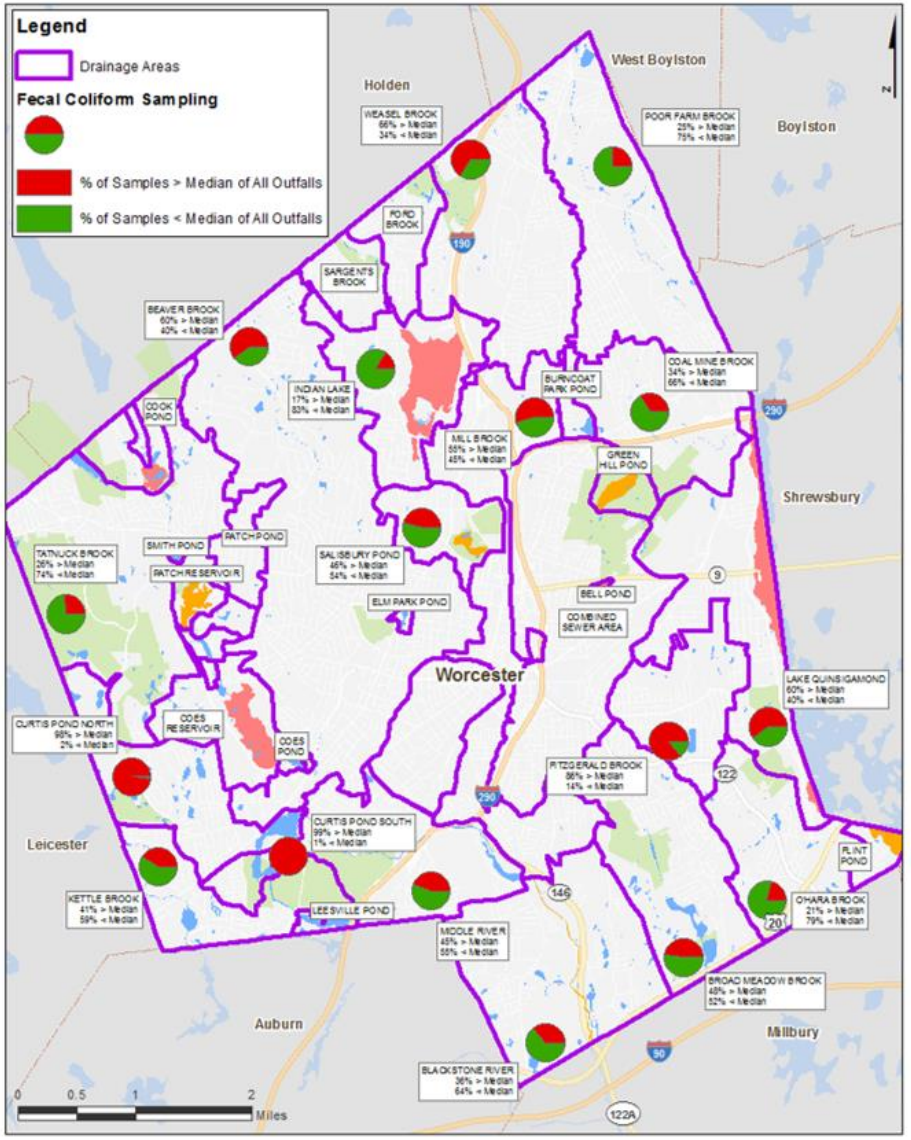
Environment – Polluted Waterways

Drainage Areas and Fecal Coliform Sampling Locations (1999-2016)

Nutrient loads in Worcester waterways can cause dangerous cyanobacterial (blue-green algal) blooms:

- Some pollution comes from storm water and sewer management.
- Other pollution comes from nutrient release from sediment (difficult to pinpoint and address).
- Cyanobacteria in high levels is dangerous to humans and pets and is difficult to detect.

Source: Worcester watershed advocacy group



Source: Worcester Integrated Plan [DRAFT], Kleinfelder 2018

Environment

Environmental Challenges:

- Erosion
- Invasive plant material
- Chronic flooding
- Sedimentation
- Ground and Surface Water Pollution
- Impaired Water Bodies

Environment – Urban Forest

The urban forest is essential for cooling the city. "The average percentage increase in kWh/CDD is 1.17 due to an average one-percentage decrease in canopy cover".

Block (N = 6)	Percentage Decrease in Canopy Cover (2008-2009)	**Percentage Increase** (kWh/CDD Usage) after tree removal
1	92	87
2	82	79
3	82	99.6
4	78	116
5	83	140
6	88	67

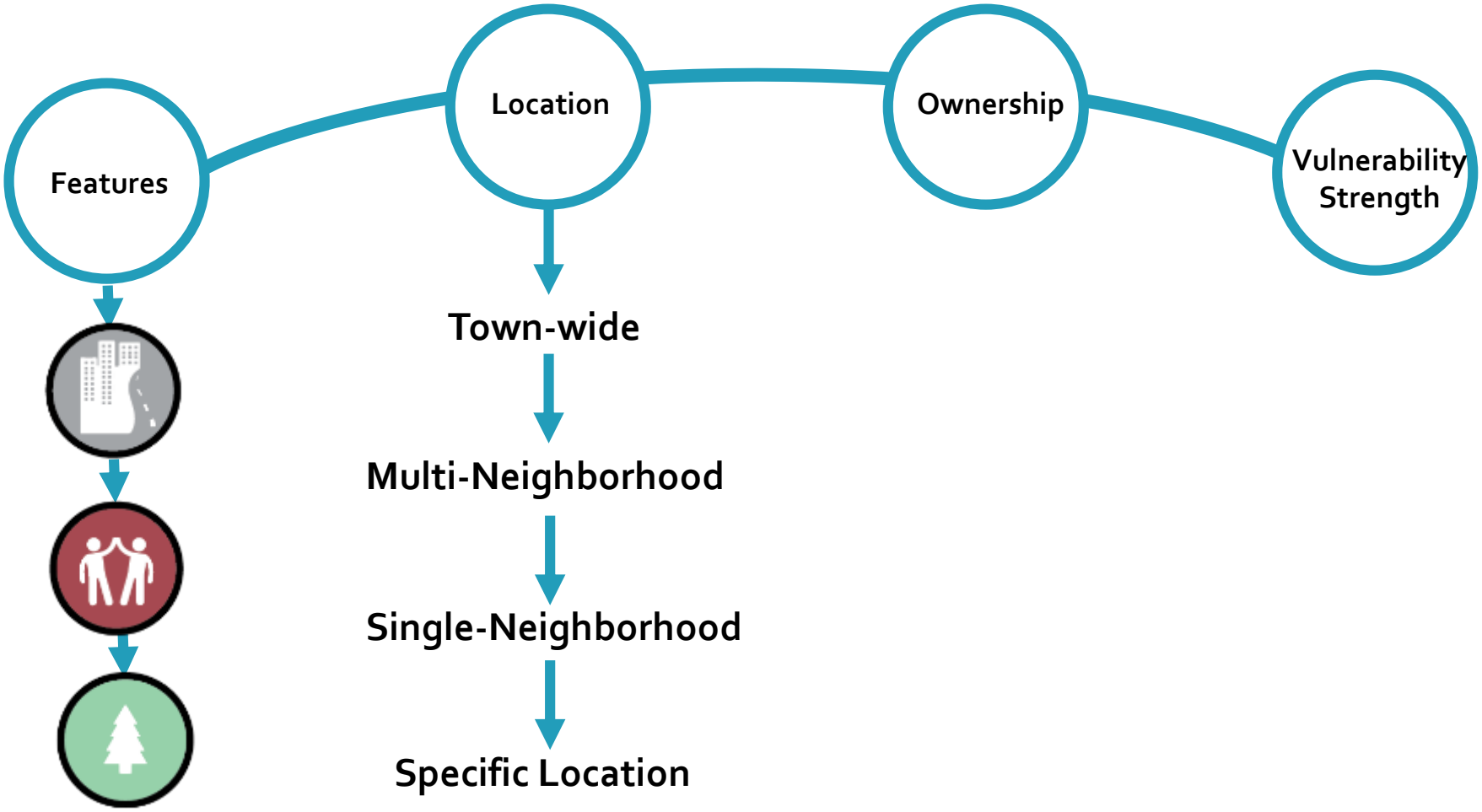
Table 3: Percent Canopy Cover Difference and Percent kWh Difference between 2008 and 2009.

Burncoat Neighborhood Tree Removal/Energy Use Study
Worcester, MA

Emma Morzuch, Ben Weil, Simi Hoque
University of Massachusetts, Amherst

IV. Resilience & Vulnerabilities

What are Worcester's infrastructural, societal, and environmental strengths and vulnerabilities?



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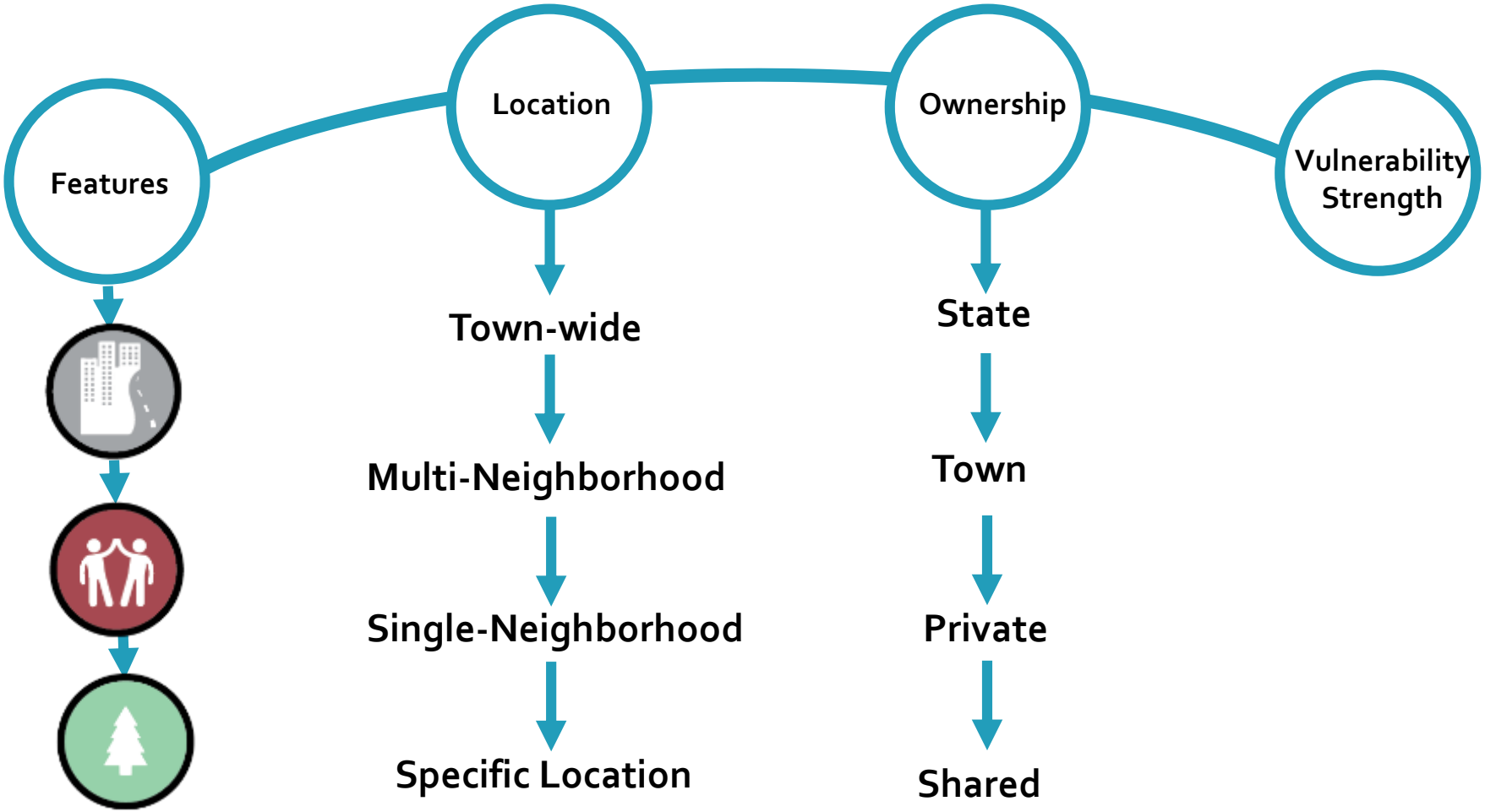

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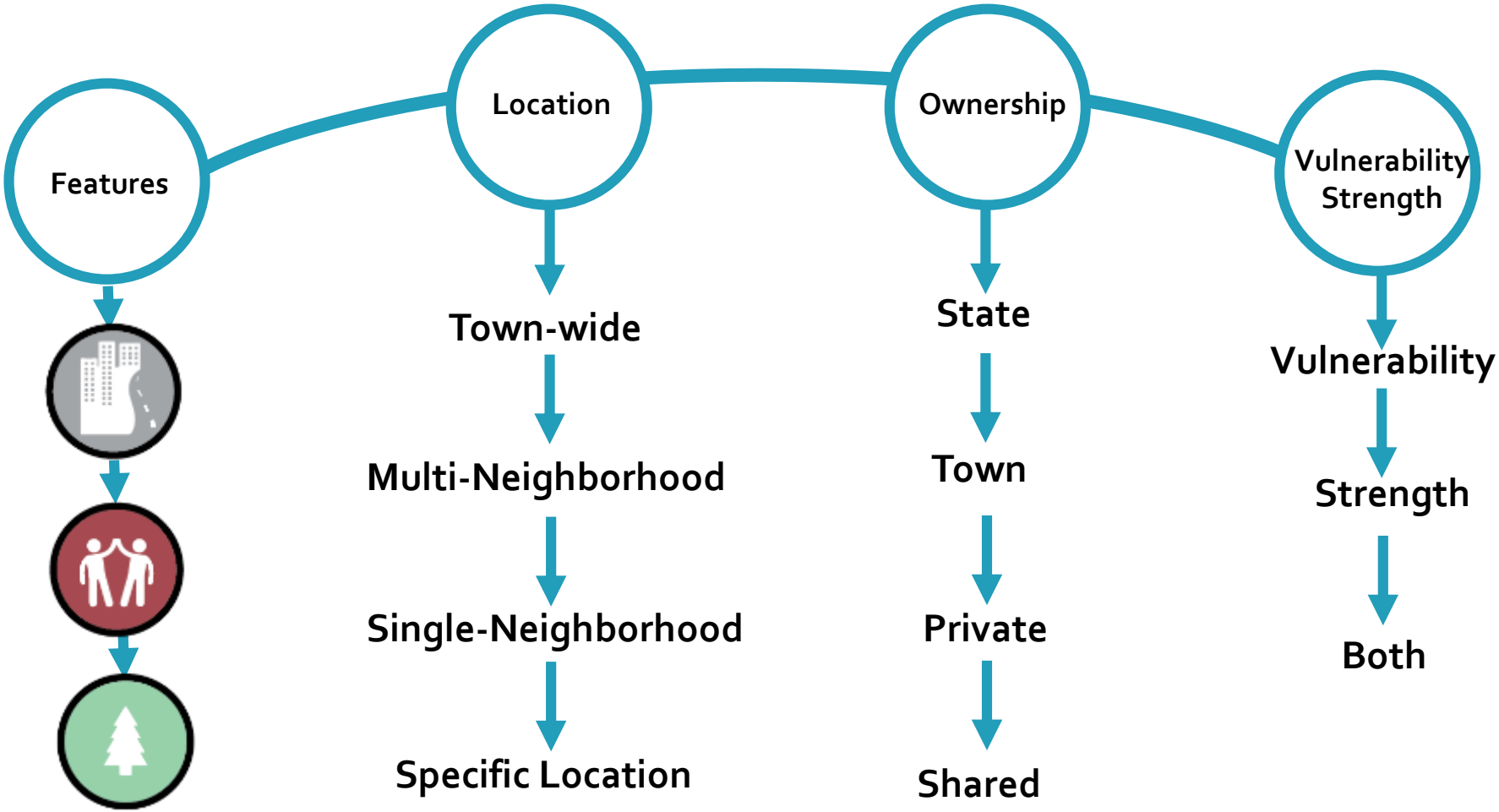
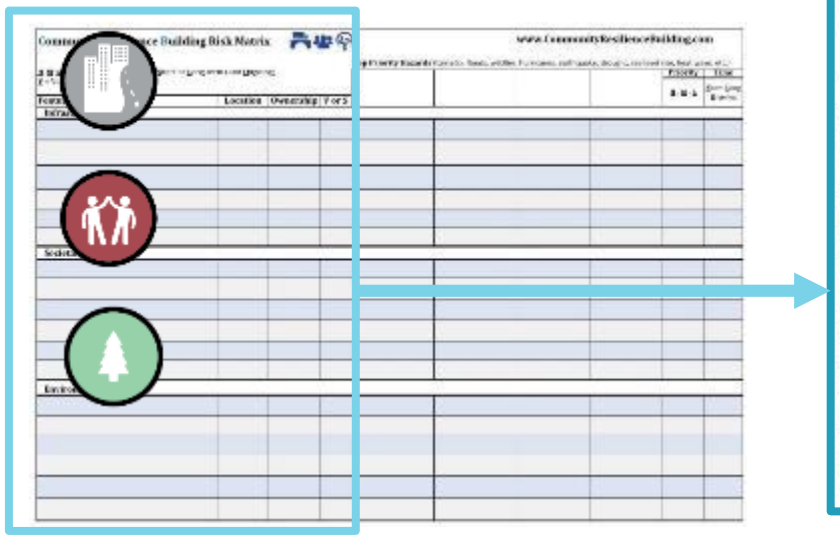


IV. Resilience & Vulnerabilities

Small Group Exercise

- What infrastructure, societal features, or important natural resources are exposed to current and future hazards?
- What makes them vulnerable?
- What makes them resilient?
- What are the consequences if the existing vulnerabilities are not addressed?
- *Note: We are working off of provided HMP maps - supplementing work already completed, not starting from scratch.*

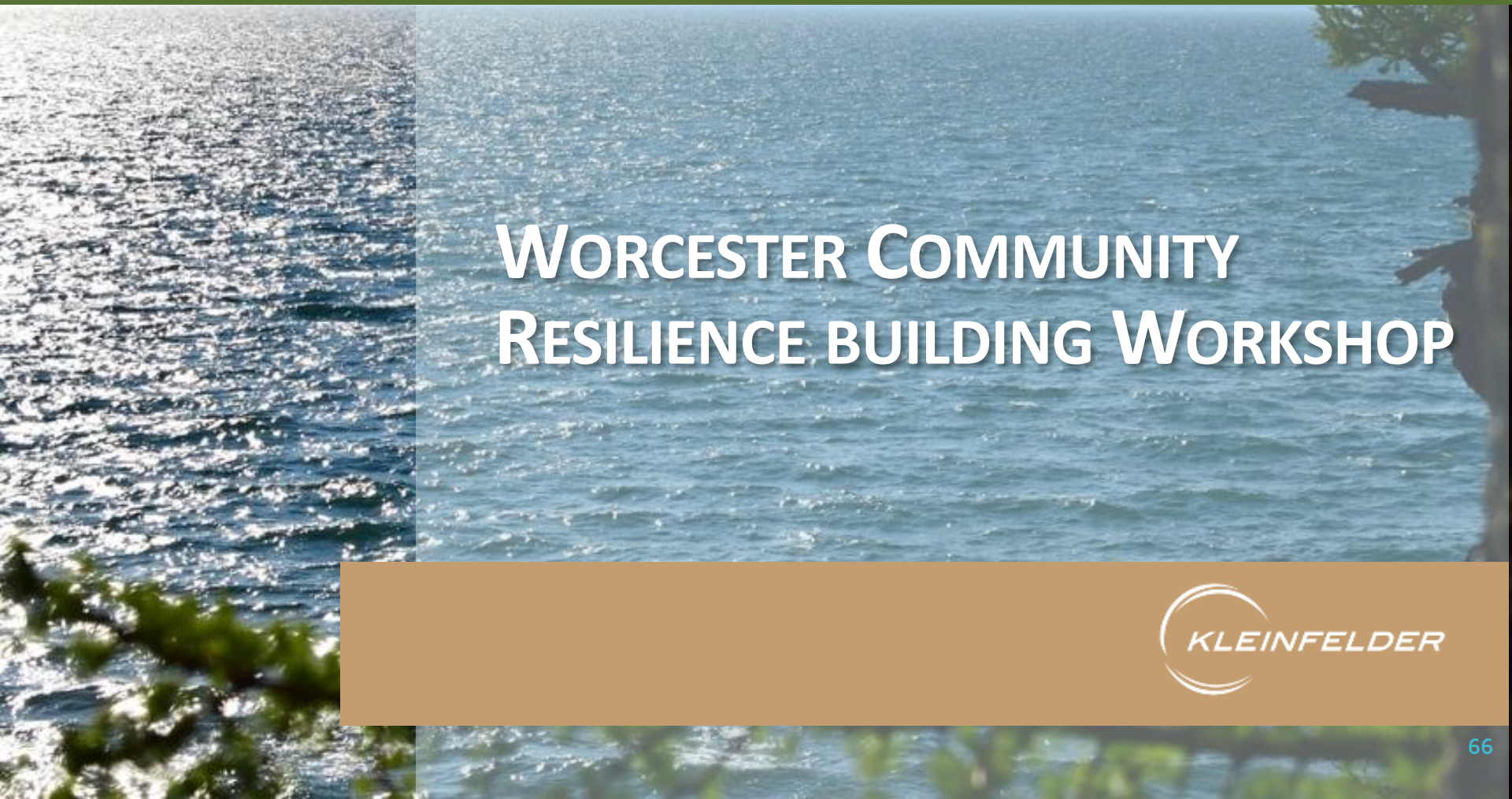


Community Resilience Building Workshop Risk Matrix

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

Features	Location	Ownership	V or S
Infrastructural			
Town Campus	Specific	Town	V
Evacuation Routes - Roads	Town-wide	Town/State	V
Electrical Distribution System	Multiple	CL&P/Town	V
Dams (inland and coastal)	Multiple	Private	V
Railway and State Bridges	Multiple	Amtrak/State	V
State Roads/Intersections	Town-wide	State/Town	V
Wharves and Shore Infrastructure	Shore	Town-State-Private	V
Waste Water Treatment Facility	Specific	Town	V
New Ambulance Center	Specific	Town	S
Zoning Regulations (maintain large lot size)	Multiple	Town	S

V. Lunch – 1 Hour



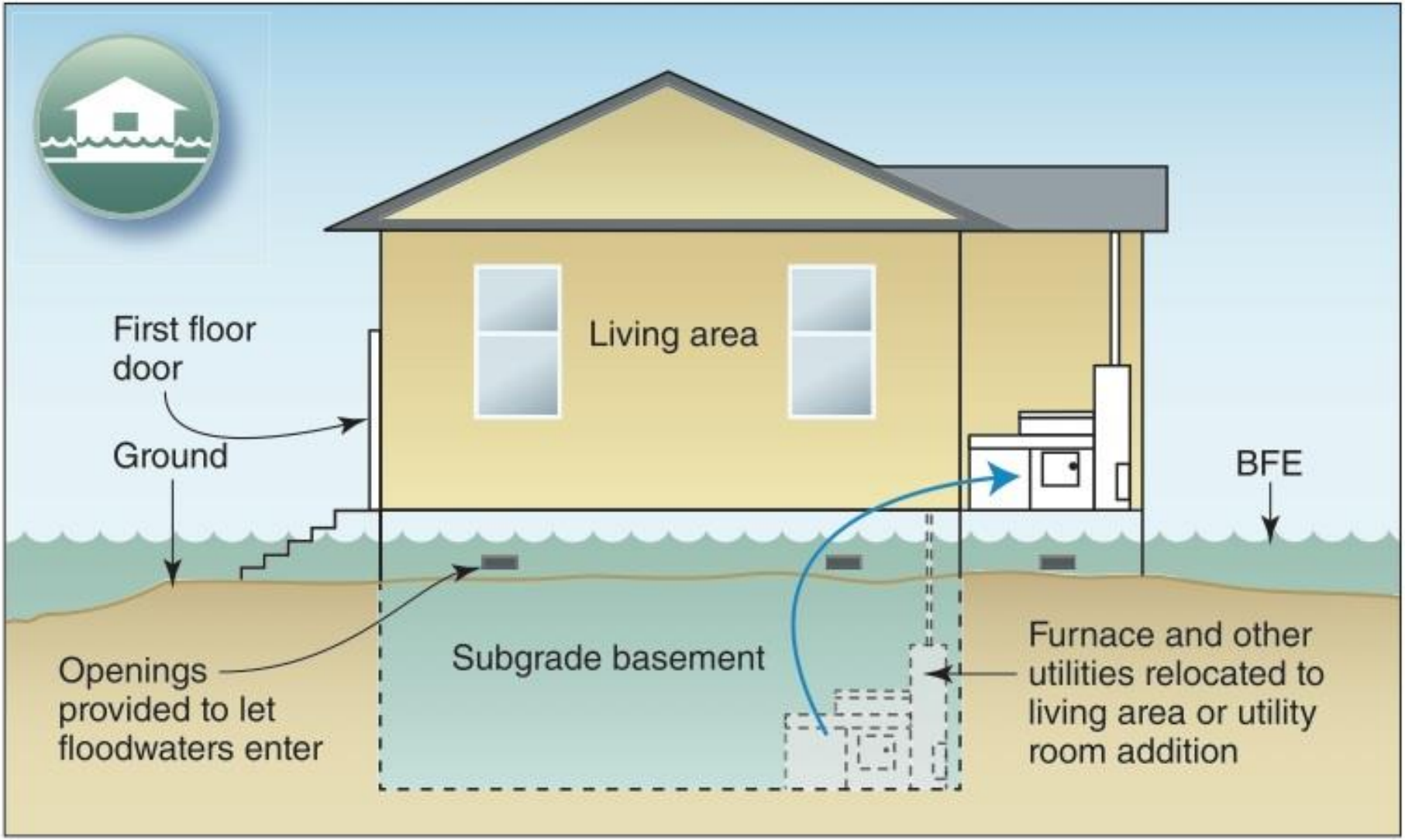
VI. COMMUNITY ACTIONS

Case Studies

KLEINFELDER

Wet Floodproofing

Community Action



RAISED BUILDINGS

Community Action

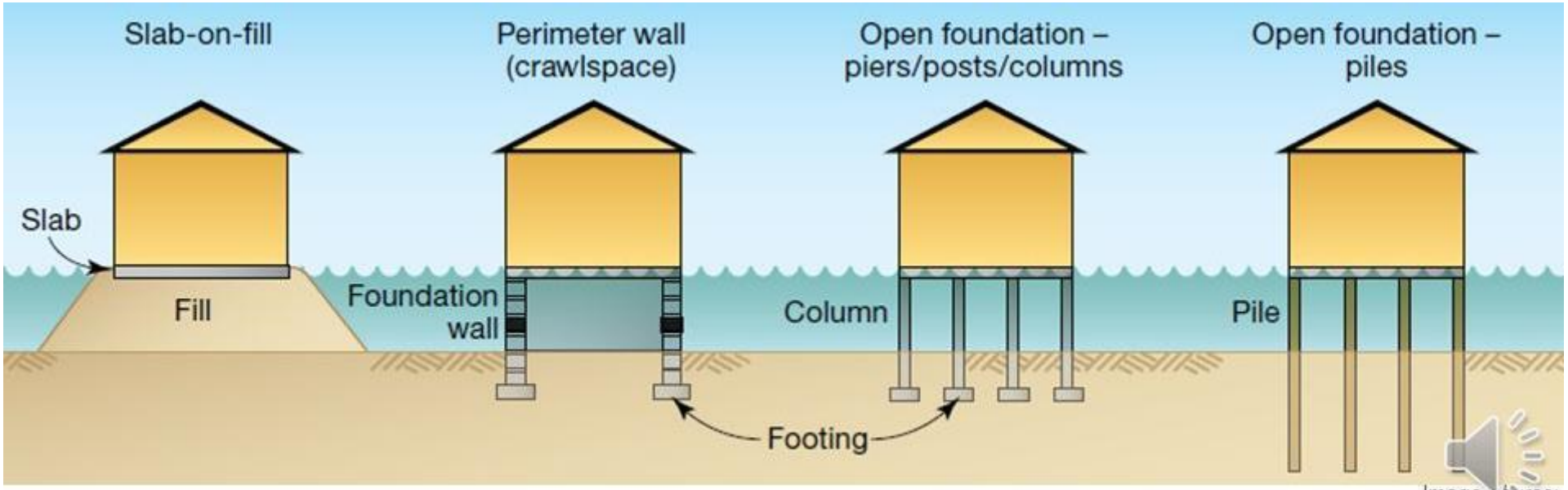


Image source:
FEMA Quick Reference Guide: Comparison of Select NFIP & Building Code Requirements

ZONING ORDINANCE

Community Action

City of Worcester

Zoning Ordinance

Ordained in City Council April 2, 1991

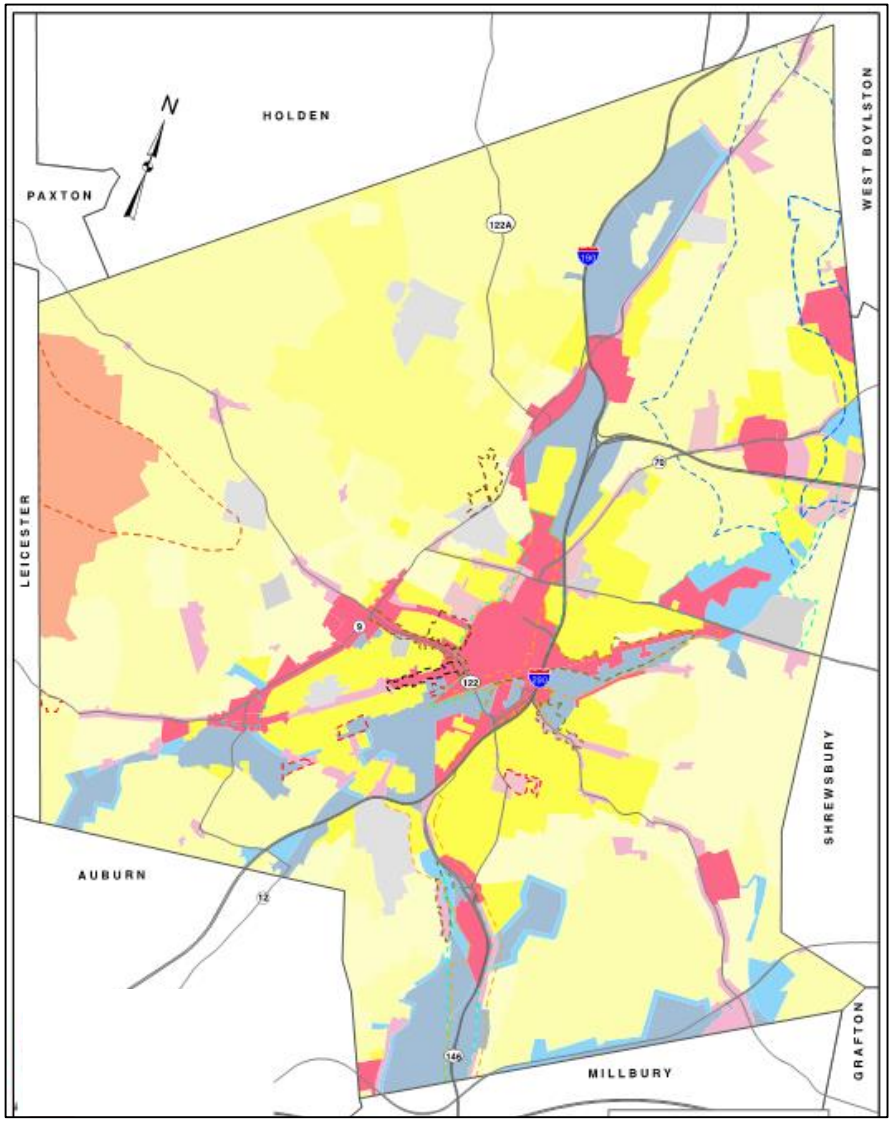
As amended through June 26, 2018

Current Zoning Ordinance, amended June 2018 as an ARTICLE VI – FLOODPLAIN OVERLAY DISTRICT
Source: http://www.worcesterma.gov/uploads/9a/bc/9abcc0ac3b139cc162db2867ae374da8/zoning-ord.pdf

ZONING

Land use breakdown for the city of Worcester

Zoning and Overlay Map



Source: Weston & Sampson OSRP Report, 2013

Decorative Flood Walls

Community Action

Source: ABC News, KAAL TV

Source: FloodBreak

Source: Terrascapes Landscape Design

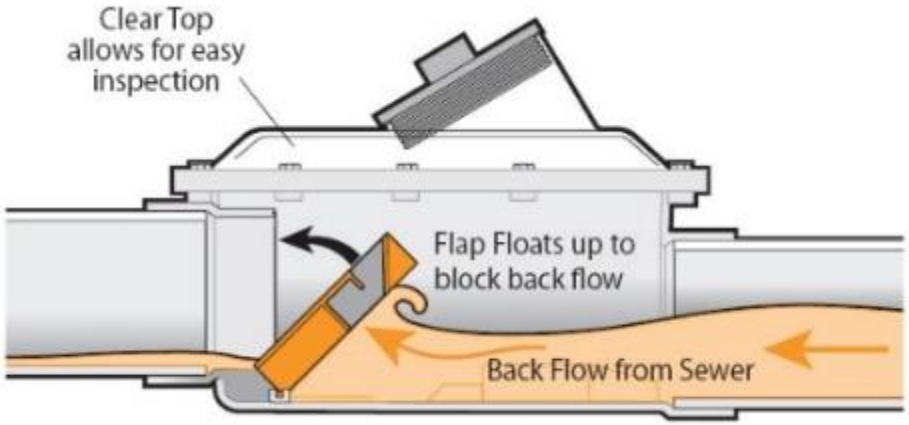
Demountable Flood Panels

Community Action

Preventing Sewer Backflow

Community Action

Backflow Preventer Valve



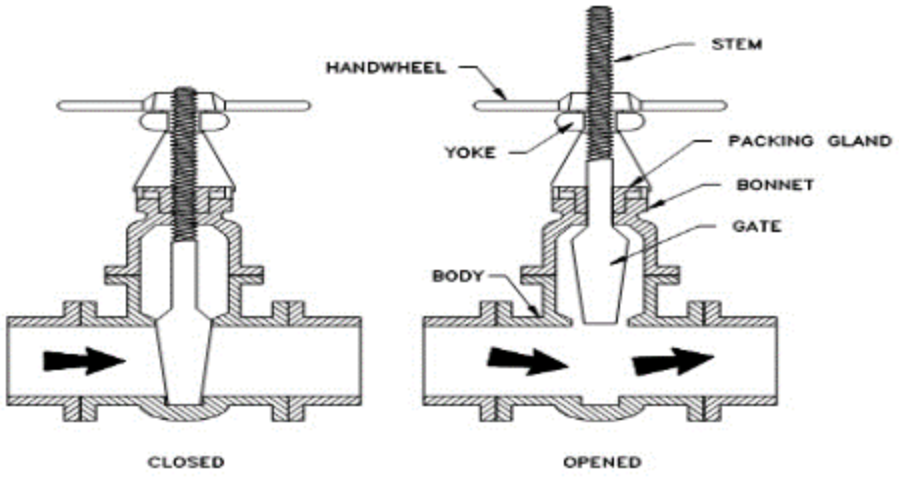
Pros:

- Closes automatically

Cons:

- Flap can get stuck (fail)
- Requires maintenance

Sewer Shutoff Valve



Pros:

- Reliable

Cons:

- Someone has to close it

BERMS WITH BENEFITS

Community Action

PROTECTING FRESH POND

[SOURCE: CCPR, 2017]

Evaluate building a vegetated berm at elevation 23.15 feet CCB* along the Fresh Pond Golf Course. This strategy could effectively protect the Fresh Pond Reservoir for up to the 2070 100-year sea level rise / storm surge flooding.

*Cambridge city-base datum

[SOURCE: CCPR, 2017]

Evaluate building a flood wall at elevation 22.5 feet CCB South of the railroad track along the Alewife Quadrangle. Building a flood wall at this location can protect the Fresh Pond Reservoir, as well as the Alewife Quadrangle neighborhood.

Green Infrastructure

Community Action

Benefits of Low Impact Development (LID)

- Flow Control
- Detention
- Retention
- Filtration
- Infiltration
- Treatment

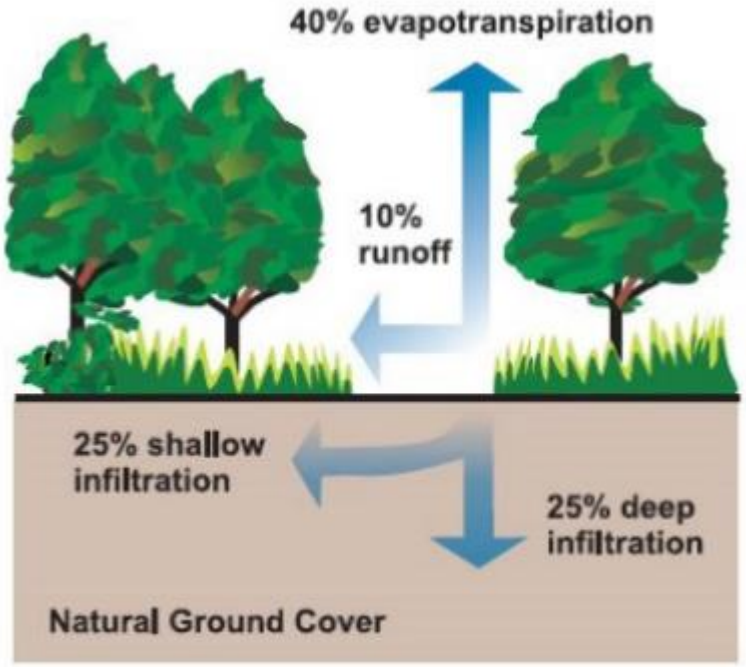
Source: Garbini & Garbini Landscape Architecture, Inc.k

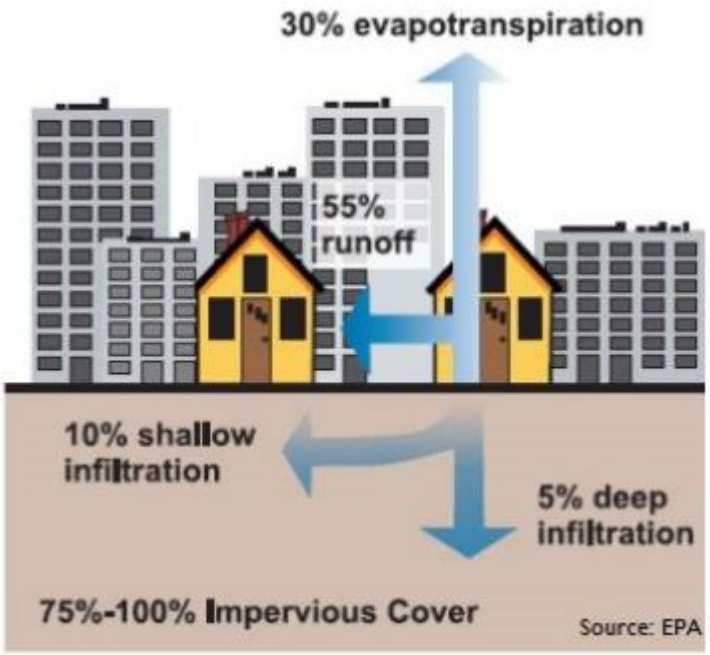
Green Infrastructure

Community Action

Local example: Broad Meadow Brook

- Rainfall runoff from impervious surfaces, such as roads, rooftops and parking lots pick up harmful pollutants and flow into local waterways like Broad Meadow Brook.





Source: https://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/broad-meadow-brook/about/green-features/water-conservation

Green Infrastructure

Community Action

Broad Meadow Brook: LID strategies implemented

Stormwater Capture

Rain Gardens

Rain Barrels

No-Mow Open Space

Source: https://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/broad-meadow-brook/about/green-features/water-conservation

Permeable Pavement

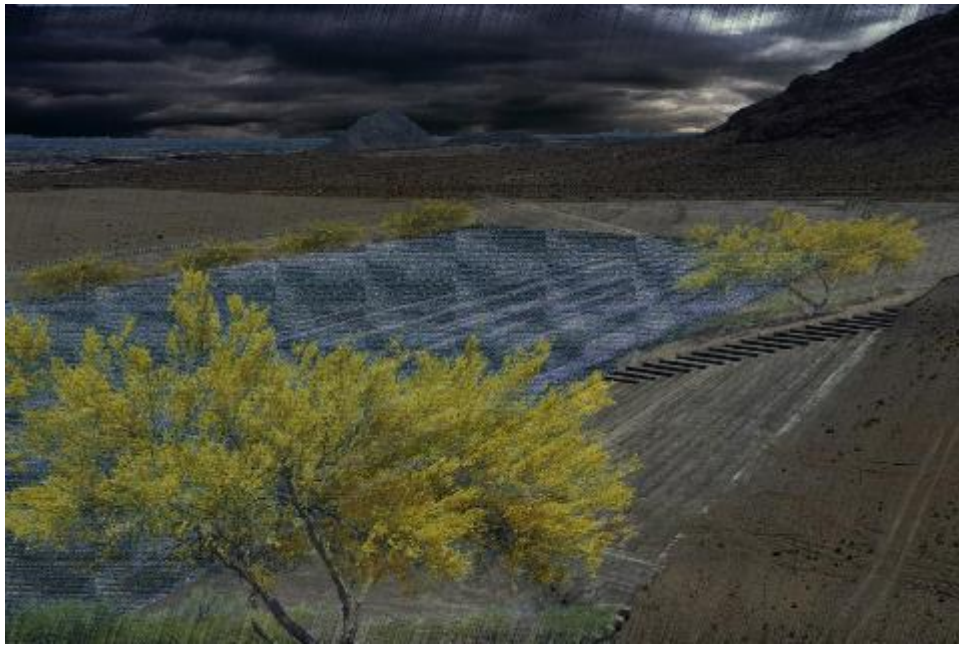
Community Action

Source: Green Planet Ethics

Dual-Use Flood Storage

Community Action

Athletic Field



Flood Storage

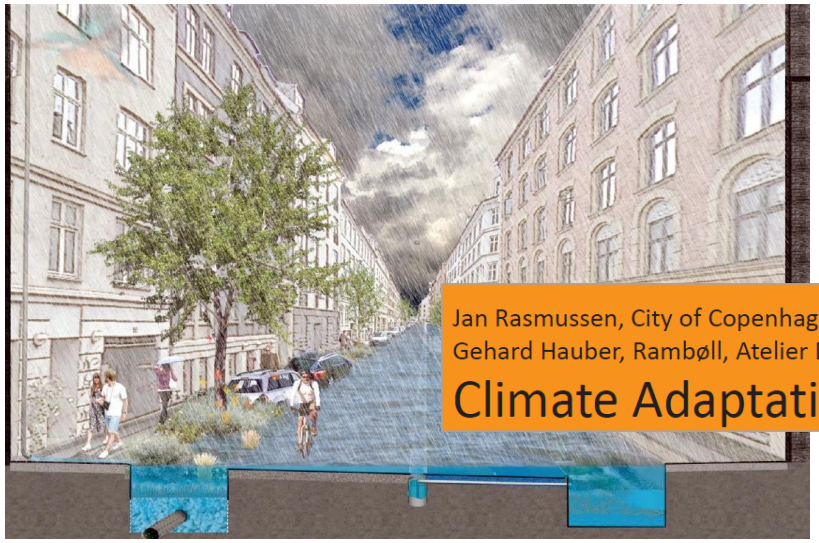
Dual-Use Flood Storage

Community Action

Canal Streets

Explore innovative options for managing stormwater

Open Spaces



Jan Rasmussen, City of Copenhagen
Gehard Hauber, Rambøll, Atelier Dreiseitl

Climate Adaptation

North Point Park

Multi-Benefit Water Infrastructure

Community Action

Single Purpose

Multi-Benefit

Multi-Use Levees

Community Action

Flood Protection

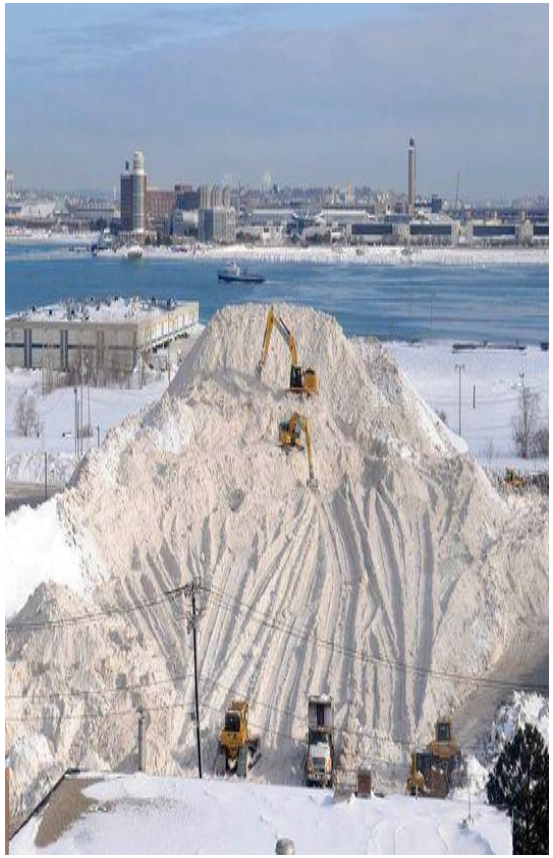
Mobility

PREPARE
Community Action

Equipment

Contracts

Storage



CLEAR COMMUNICATION
Community Action

DEICING ROADS
Community Action

Equipment

15 million tons of deicing salt are used each year in the United States

Alternative Options

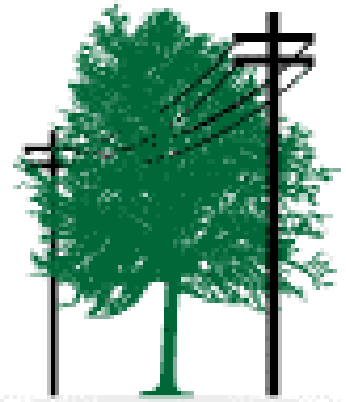
Community Action

Other options?

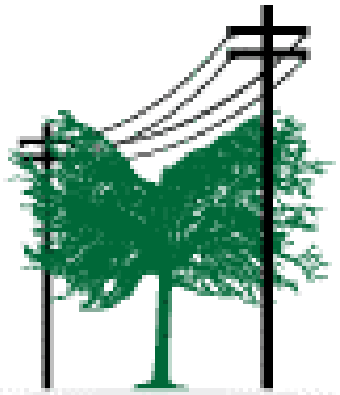
What would Dwight Schrute do?

STAY ON TOP OF MAINTENANCE

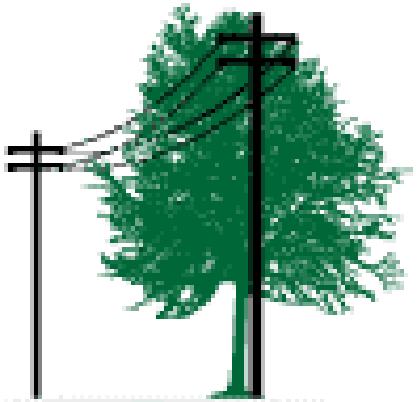
Community Action



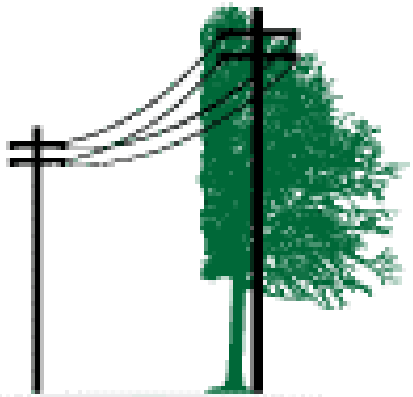
BEFORE "V" PRUNING



AFTER "V" PRUNING



BEFORE SIDE PRUNING



AFTER SIDE PRUNING

Street Trees/ Urban Forest

Community Action

Source: Conservation Magazine

In Worcester – A study in the Burncoat Neighborhood showed that urban tree removal resulted in 98% increase in mean energy use during the summer of 2009.

Source: University of Massachusetts, Amherst

Reduce Pavement

Community Action

Reduce Asphalt with:

- Infill development
- Native Landscaping
- Solar power canopy devices

Source: Almaden Solar

Source: Tree Link News

Cooling Centers

Community Action

Cooling centers are:

Air-conditioned public facilities where people may go for relief during periods of extreme heat.

ALTERNATIVE ROOFS

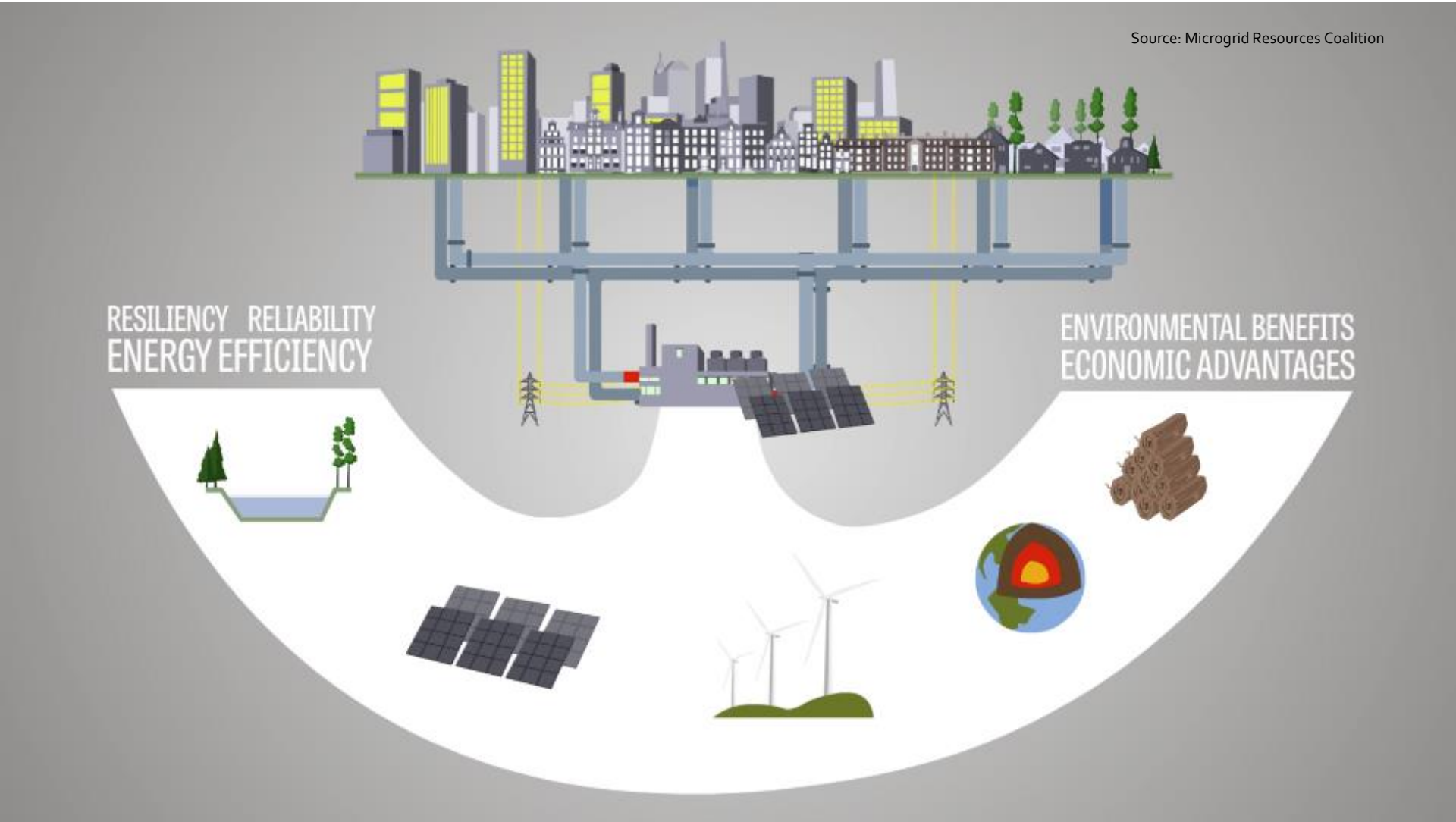
Community Action

White Roofs

Green Roofs

Renewable Micro-Grids

Community Action



VII. Water Restriction Advisory

Community Action

Drought Action Level Response signs are located around the Town of Harwich. These signs, as well as our website, are updated when an action level is active.

HARWICH WATER DEPARTMENT

DROUGHT ACTION LEVEL RESPONSES

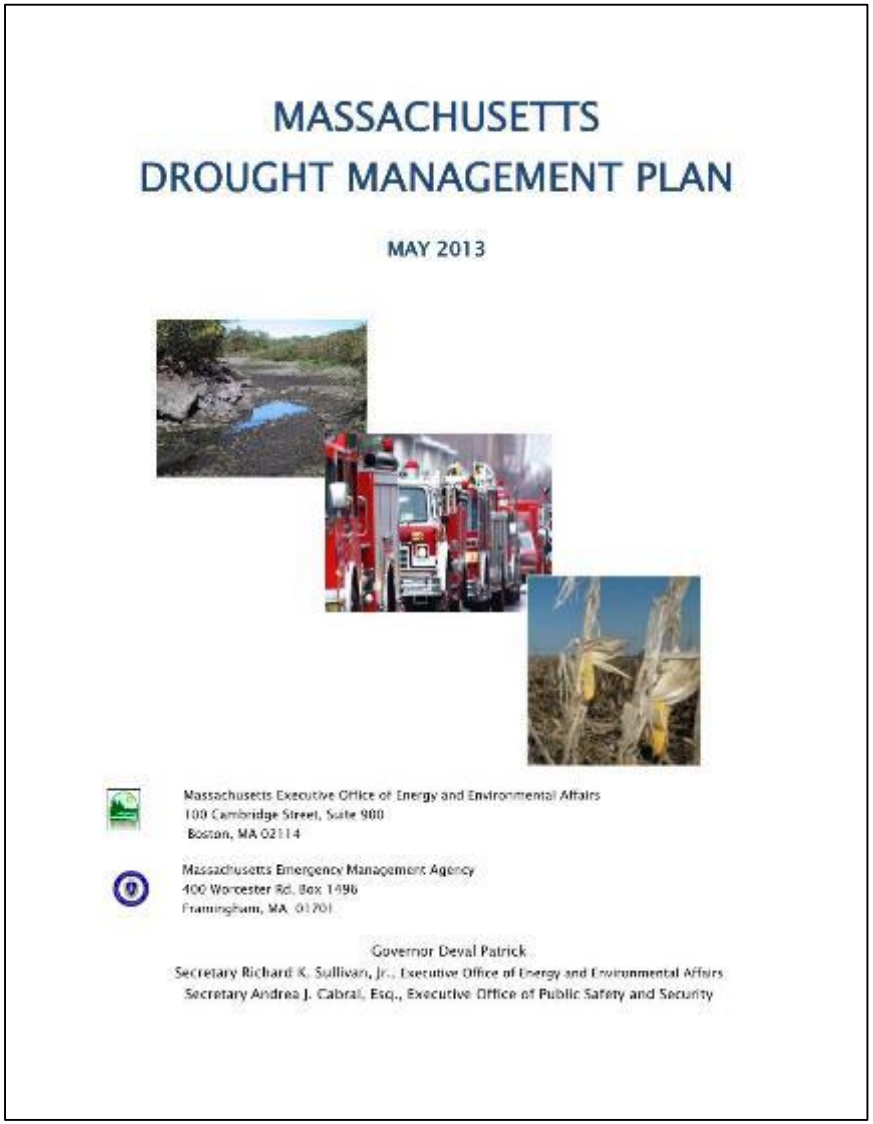
ACTION LEVEL	RESPONSE	FREQUENCY OF MONITORING
NORMAL	NORMAL WATERING CONDITIONS	
ADVISORY	VOLUNTARY WATER RESTRICTIONS ODD/EVEN DAYS	
WATCH	MANDATORY: ODD/EVEN LAWN WATER & OFF-PEAK HOURS	
WARNING	MANDATORY: 2 DAY PER WEEK OUTDOOR USE & OFF-PEAK HOURS	
EMERGENCY	MANDATORY: BAN ON ALL NON-ESSENTIAL OUTDOOR WATER USE	

Learn More ▸

Source: Harwich Water Department

VII. Drought Management Plans

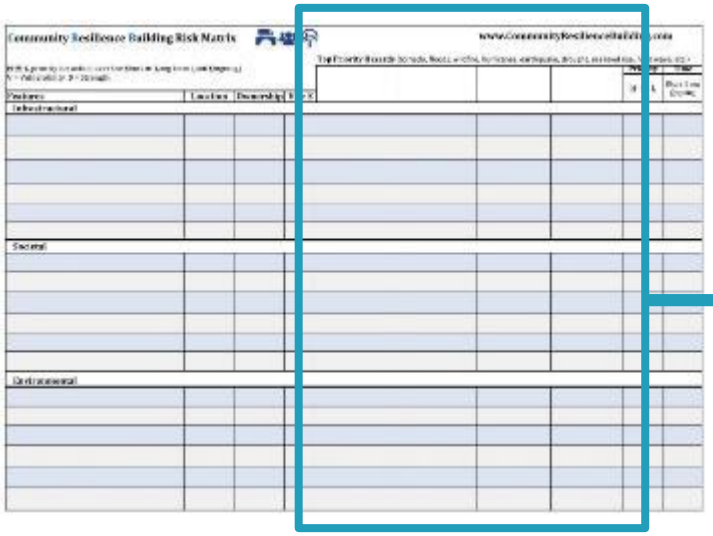
Community Action

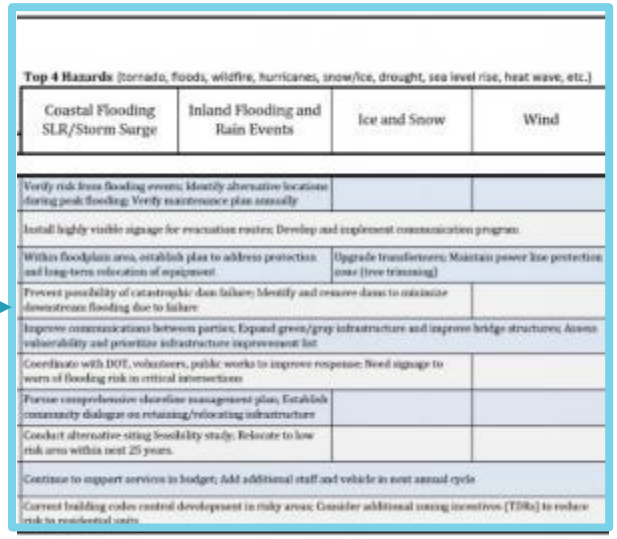


VI. Community Actions

Small Group Exercise

- What actions will reduce vulnerabilities or reinforce strengths?
- Do they address single or multiple hazards?
- Are there intermediate steps to implement the actions?
- Are there existing programs, plans, or projects that the actions could strengthen?





VII. Break – 15 mins

Worcester Community Resilience building Workshop

KLEINFELDER

VIII. Priority Actions

Factors to consider:

- Funding availability and terms
- Agreement on outstanding impacts from recent hazard events
- Necessity for advancing longer term outcomes
- Contribution towards meeting existing local and regional planning objectives

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VIII. Priority Actions

Small Group Exercise

Community Resilience Building Risk Matrix www.CommunityResilienceBuilding.org **1**

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	Hazard	Actions	Priority H-M-L	Time Short Long Ongoing
Infrastructural							
Societal							
Environmental							
Part 1					**Part 2**		**Part 3**

Priority H-M-L	Time Short Long Ongoing
H	S
H	S
H	O-L
H	L
M	S
M	L
L	S
L	L
	Ongoing
	Ongoing

VIII. Priority Actions – Group Activity

- Small group presentation of Top Infrastructural, Societal, and Environmental features

Results – Group 1

- Infrastructure
- Societal
- Environmental

RESULTS – GROUP 2

- Infrastructure
- Societal
- Environmental

Results – Group 3

- Infrastructure
- Societal
- Environmental

Results – Group 4

- Infrastructure
- Societal
- Environmental

Results – Group 5

- Infrastructure
- Societal
- Environmental

RESULTS – GROUP 6

- Infrastructure
- Societal
- Environmental

IX. Summary and Closing

- Reflections
- Next Steps
- Ways to stay involved

THANK YOU!!!!

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