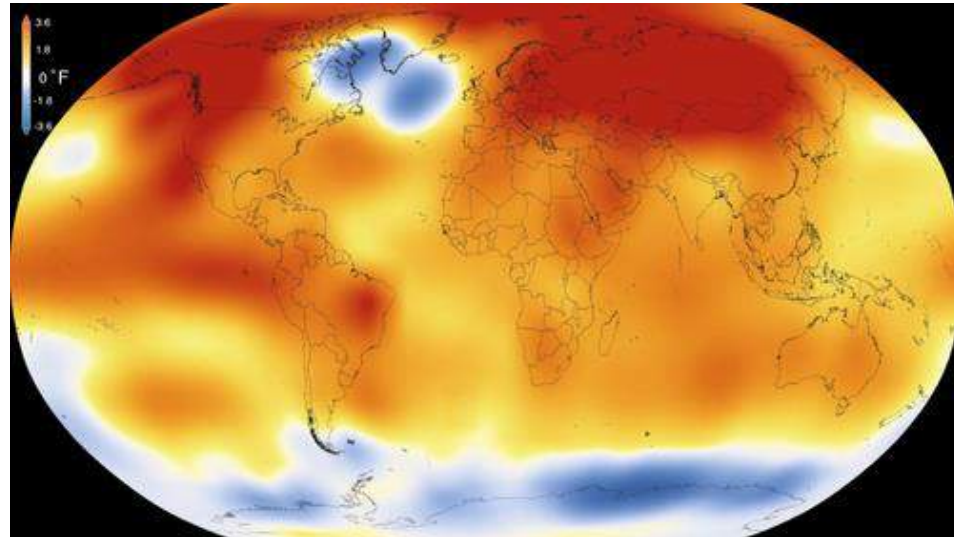


Seeing Together: Using Climate Change Science to Align Local Action in Cambridge, MA, USA

June 20, 2018

ICLEI World Congress 2018
Building Resilience at the Local Level



Climate Change Vulnerability Assessment

November 2015



City of Cambridge,
Massachusetts

The **CCVA** Report

1
Part

Climate Change Vulnerability Assessment

February 2017



City of Cambridge,
Massachusetts

The **CCVA** Report

2
Part



PREPAREDNESS HANDBOOK

City of Cambridge
11.15.2017



ALEWIFE PREPAREDNESS PLAN CITY OF CAMBRIDGE 11.15.2017



Completed *Climate Change Vulnerability Assessment (CCVA)*, Parts 1 & 2

Climate Change Preparedness & Resilience (CCPR) Plan underway

- First neighborhood plan completed for Alewife
- Second neighborhood plan in progress for The Port
- Citywide plan due Summer 2019

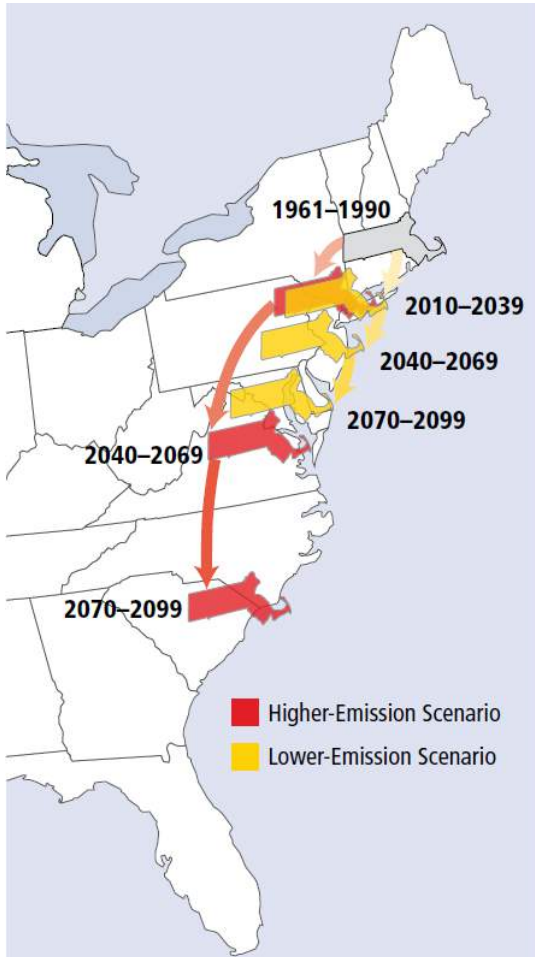
CCVA/CCPR Principles

- Use the best available climate science
- Bring the community and key stakeholders along with the City to develop a mutual understanding of climate change impacts
 - Involve stakeholders, residents, and businesses early through public meetings, presentations, focus groups, and advisory committees
 - Share all data and analyses
 - Make the debate about what actions to pursue
- Engage neighboring cities and the state to initiate and coordinate actions

Define Climate Scenarios

What to plan for?

Temperature



Precipitation



More extreme events



Sea Level Rise (SLR)



Process

- Interdisciplinary consultant team led by Kleinfelder
- Statistical downscaling of global climate models with Dr. Katharine Hayhoe to forecast 2030 and 2070 temperature, humidity, & precipitation
- Sea level rise projections from National Climate Assessment
- Expert Advisory Panel review
- Technical Advisory Committee

Increasing Temperatures – Increasing Heat Vulnerability

By 2030, the number of days above 90 F could triple

| S | M | T | W | T | F | S |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

1971 - 2000

(Baseline)

| S | M | T | W | T | F | S |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

2015 - 2044

(2030)

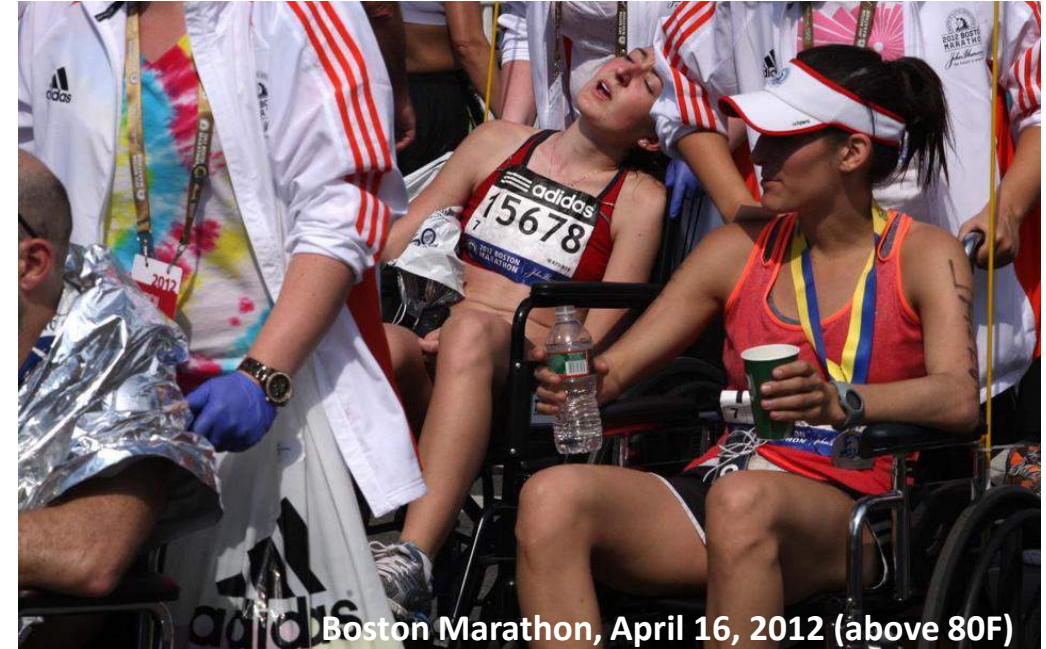
| S | M | T | W | T | F | S |
|----|----|----|----|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 24 | 25 | 26 | 27 | 28 | 29 | 30 |

2055 - 2084

(2070)

Above 90°F - Low Scenario
 Above 90°F - High Scenario
 Above 100°F - Low Scenario
 High 100°F - High Scenario

*Summer is considered to be the 91 days of June through August

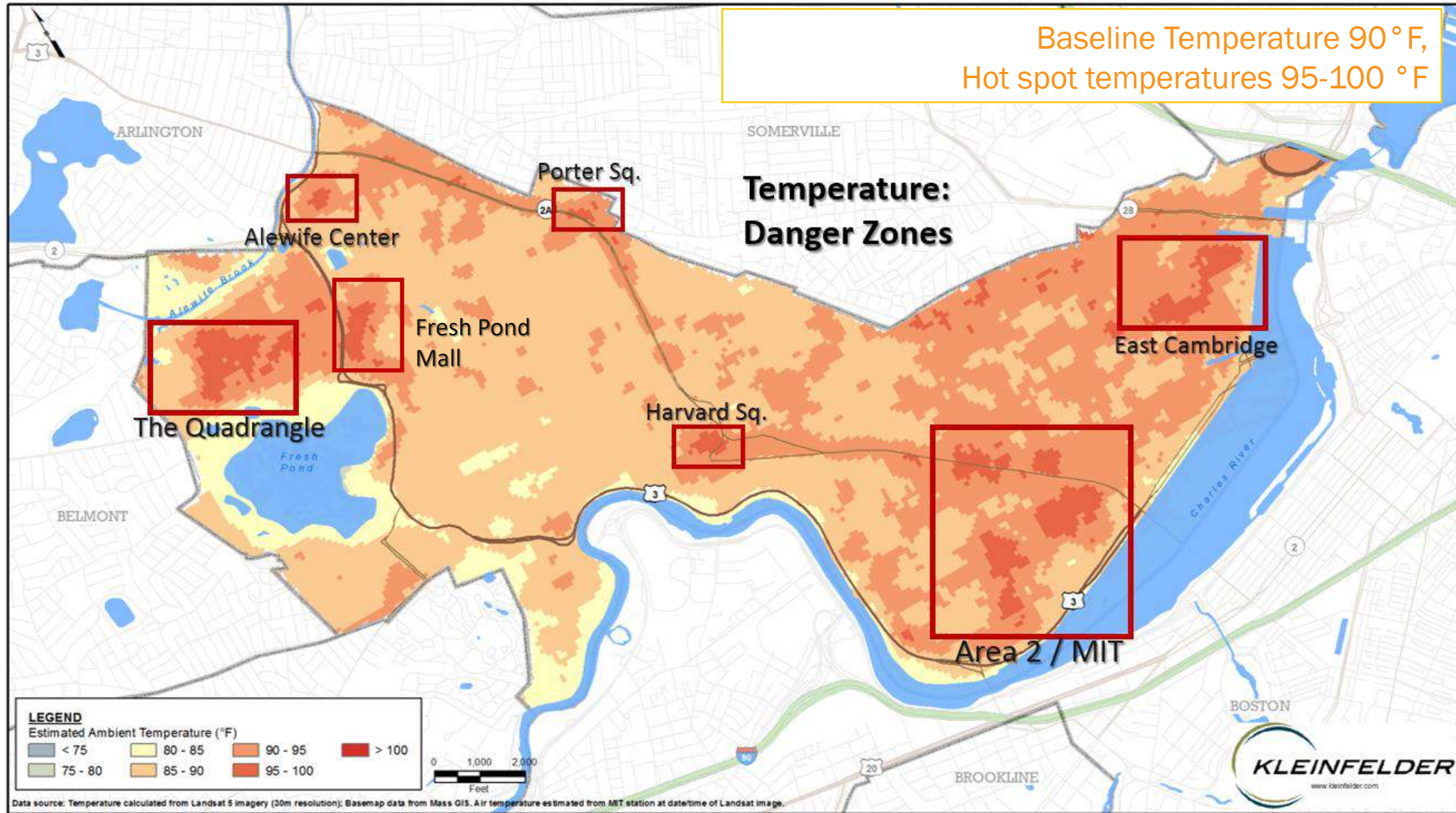


Boston Marathon, April 16, 2012 (above 80F)

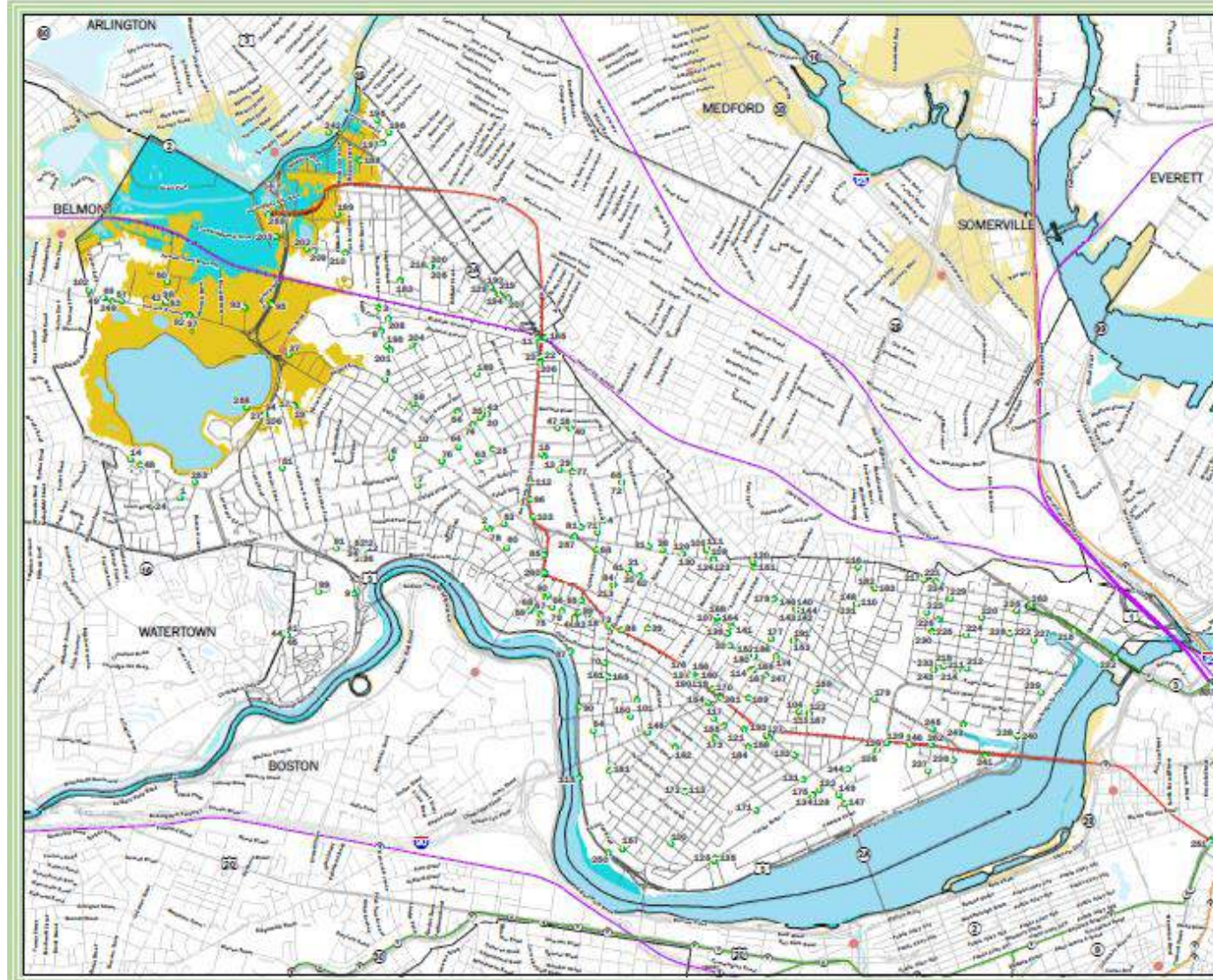
- More frequent & longer heat waves
- Temperatures exacerbated by urban heat island affect
- Extreme hot days will shift most areas from “cautious” for human health to “extreme caution”
- Average temperatures will be warmer

Urban Heat Islands Exacerbate Heat Vulnerability

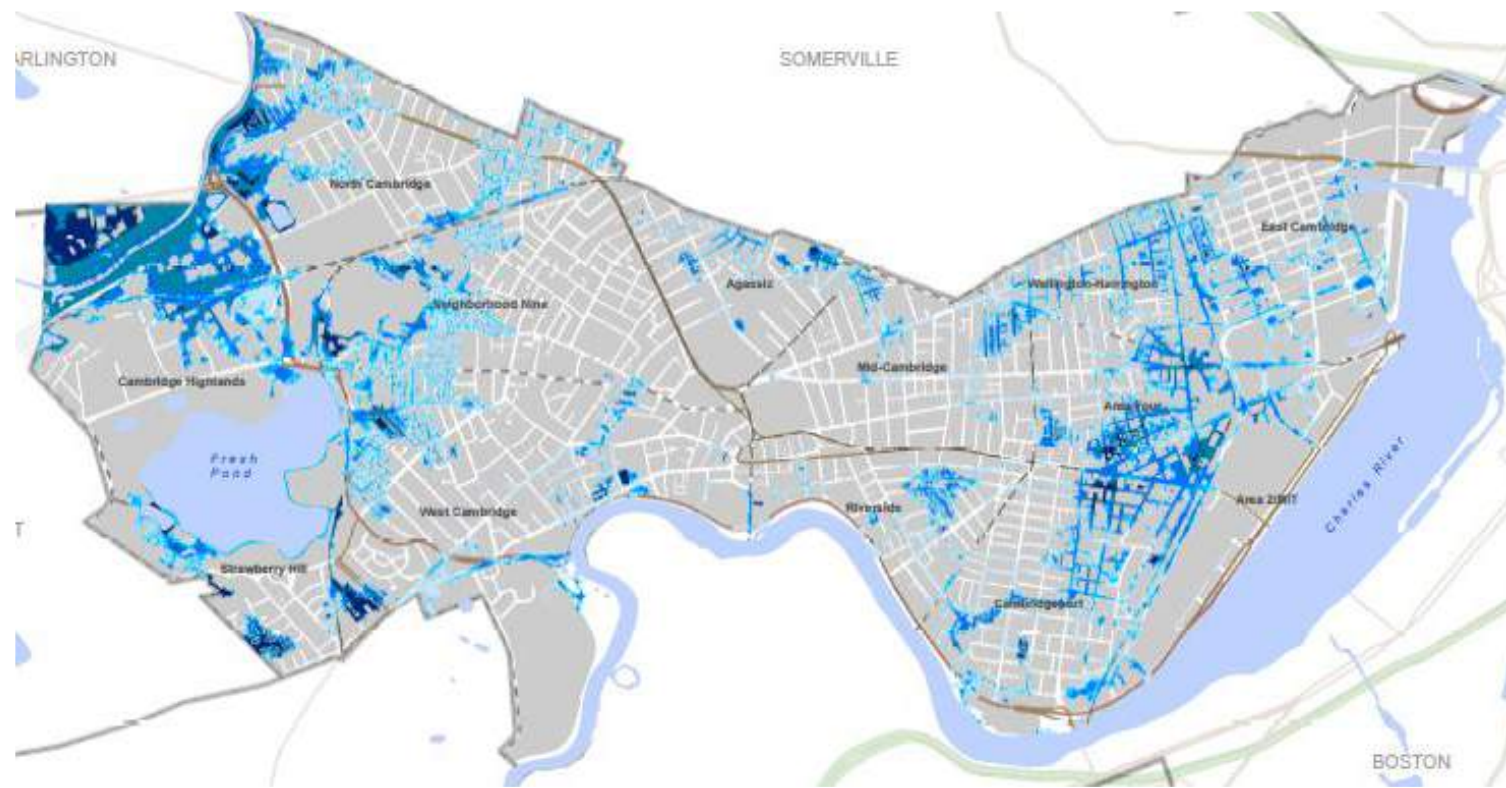
Based on Landsat data and modeling



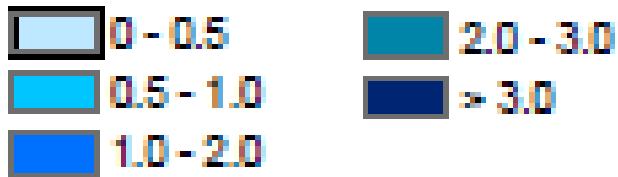
City of Cambridge – Historic Precipitation Flood Risk



FEMA maps showed limited precipitation based flooding, but did not account for future climate conditions

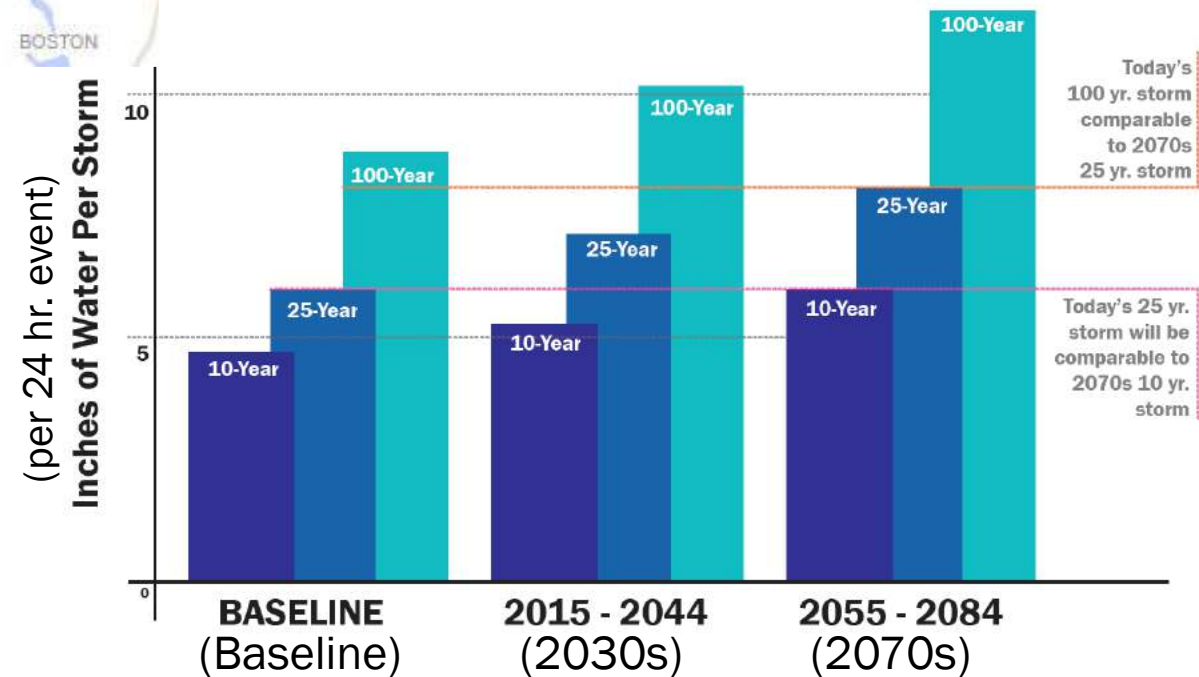


Depth of flooding above ground (ft)



Precipitation Flooding 2070

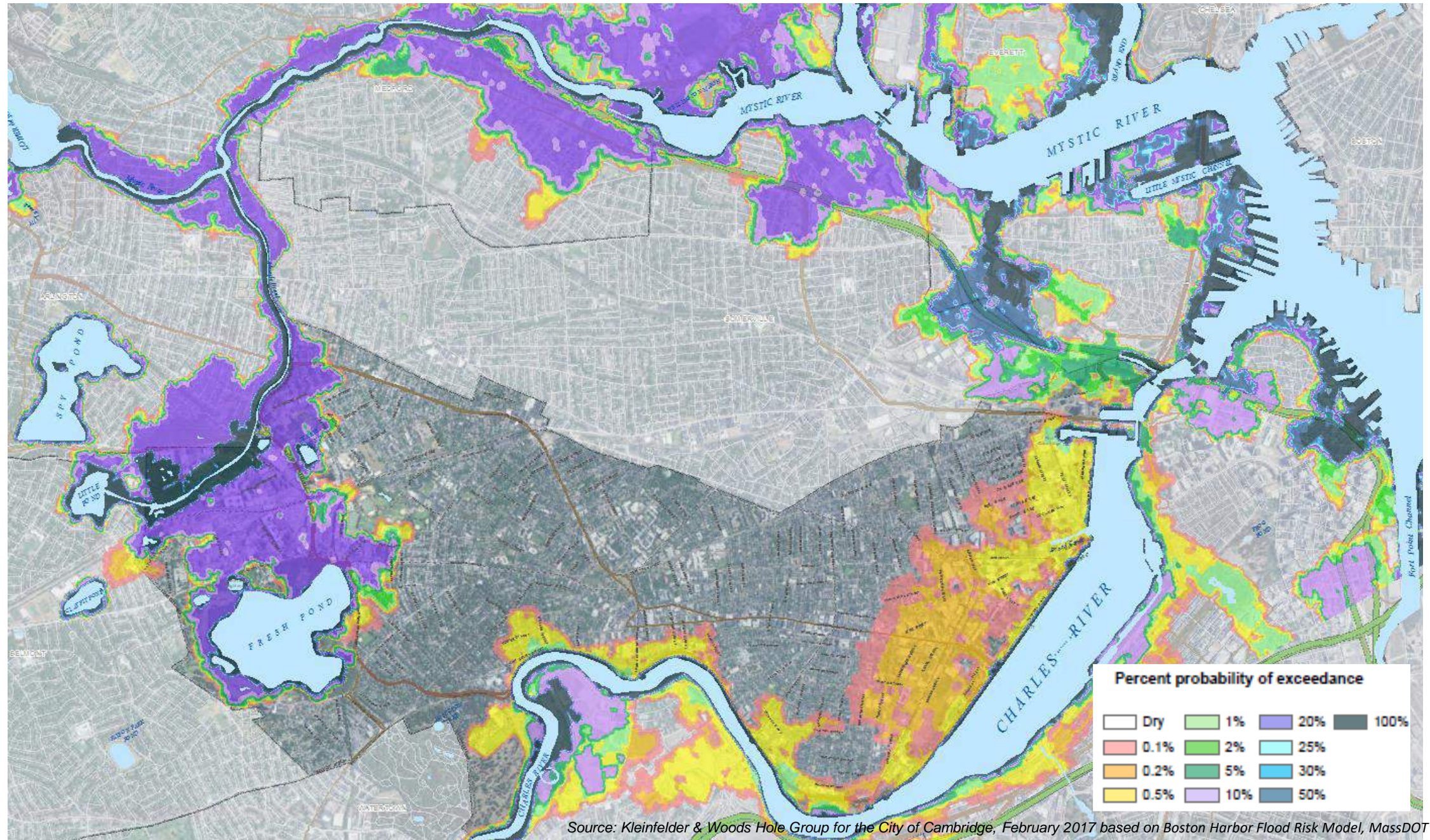
High Emissions Scenario
Based on ICM-2D Model



Source: Kleinfelder for the City of Cambridge, 2017

(Source: Kleinfelder based on ATMOS projections November 2015)

Sea Level Rise / Storm Surge Risks – 2070 Boston Harbor Flood Risk Model



Source: Kleinfelder & Woods Hole Group for the City of Cambridge, February 2017 based on Boston Harbor Flood Risk Model, MassDOT

Climate Stress Test

Flooding stress test

Water

Fresh Pond Reservoir
New St Pump Station



Storm Water

Separated Stormwater
CAM 400 (Alewife)
CAM 004 (Alewife)
Western Flagg (Charles)
Lechmere (Charles)
D46 (Alewife)

Combined Sewer
CAM 017 (Charles)
Cam 001

Roadway

Concord Tpke, Broadway
Memorial Drive, Land Blvd
BU Rotery / Reid Overpass
Cambridge St Underpass
Mansignor O'Brien Hwy
Alewife Brook Pkwy
Massachusetts Ave
Lars Anderson Bridge
Longfellow Bridge
Eliot Bridge
Fresh Pond Pkwy



Transit

Alewife-Davis-Porter Rail Line
Fitchburg Commuter Rail
Central-Kendall Rail Line
Central Square Bus Hub
MBTA #66 Bus Route
Lechmere T & Rail Line
Central Square T Station
Kendall T Station
Alewife T Station
Porter Square Station

Critical Services

Youville Hospital
Fire Company 2
Fire Department
Headquarters



Critical Services

Windsor Street Health Center
& Public Health Department

Police Headquarters

Professional Ambulance
Services Office

Energy

North Cambridge Substation
Brookford St Take Station
Third St. Regulator Station
MIT Cogeneration Plant
Putnam Substation
Prospect Substation



Communication

City Emergency Com
Center (Police HQ)
AT&T Data Hub/300 Bent St
BBN Data Hub/CO-LOC,
10-12 Moulton St
AT&T Office/Long Line
Switch: 250 Bent St



2070s Scenario
11.7 inches
rainfall in
24 hours



Flood Risk

Depth of flooding (ft)

| | |
|---------|---------------|
| 0-0.5 | Lightest Blue |
| 0.5-1.0 | Light Blue |
| 1.0-2.0 | Medium Blue |
| 2.0-3.0 | Dark Blue |
| >3.0 | Black |

Heat stress test

Water



Storm Water

Roadway



Transit

Porter-Harvard Rail Line

Lechmere-Science
Park Rail Line

Alewife-Davis-Porter
Rail Line

Fitchburg Commuter
Rail Line

Critical Services

Cambridge Water
Department building
(the City's Emergency
Operations Center)



Critical Services

Public Health Department
building on Windsor Street

Police Headquarters

Professional Ambulance
Services office

Fire Department
headquarters

Energy

Third Street
Regulator Station



Communication

City Emergency
Communications
Center (Police HQ)



Heat Risk

Temperature in °F

| | |
|---------|-----------------|
| <80 | Lightest Yellow |
| 80-85 | Light Yellow |
| 85-90 | Yellow |
| 90-95 | Orange |
| 95-100 | Dark Orange |
| 100-110 | Red |
| >110 | Dark Red |



2070s Scenario
Estimated
Ambient
Temperature on
100°F Day

A Plan for Action on Climate Change

October 21, 2015

A joint statement

President L. Rafael Reif

Provost Martin Schmidt, SM '83, PhD '88

Vice President for Research Maria Zuber

Chancellor Cynthia Barnhart, SM '85, PhD '88

Executive Vice President & Treasurer Israel Ruiz, SM '01



In 2015, MIT adopted climate action plan to minimize greenhouse gas emissions and devise pathways to adapt to climate change

Massachusetts Institute of Technology

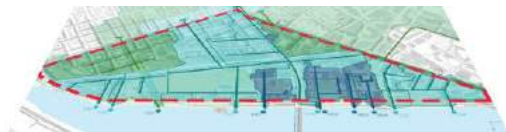
MIT Campus Resiliency Framework



COMMUNITY 22,000 people



BUILDINGS / EQUIPMENT 170 buildings



UTILITIES 15 utilities



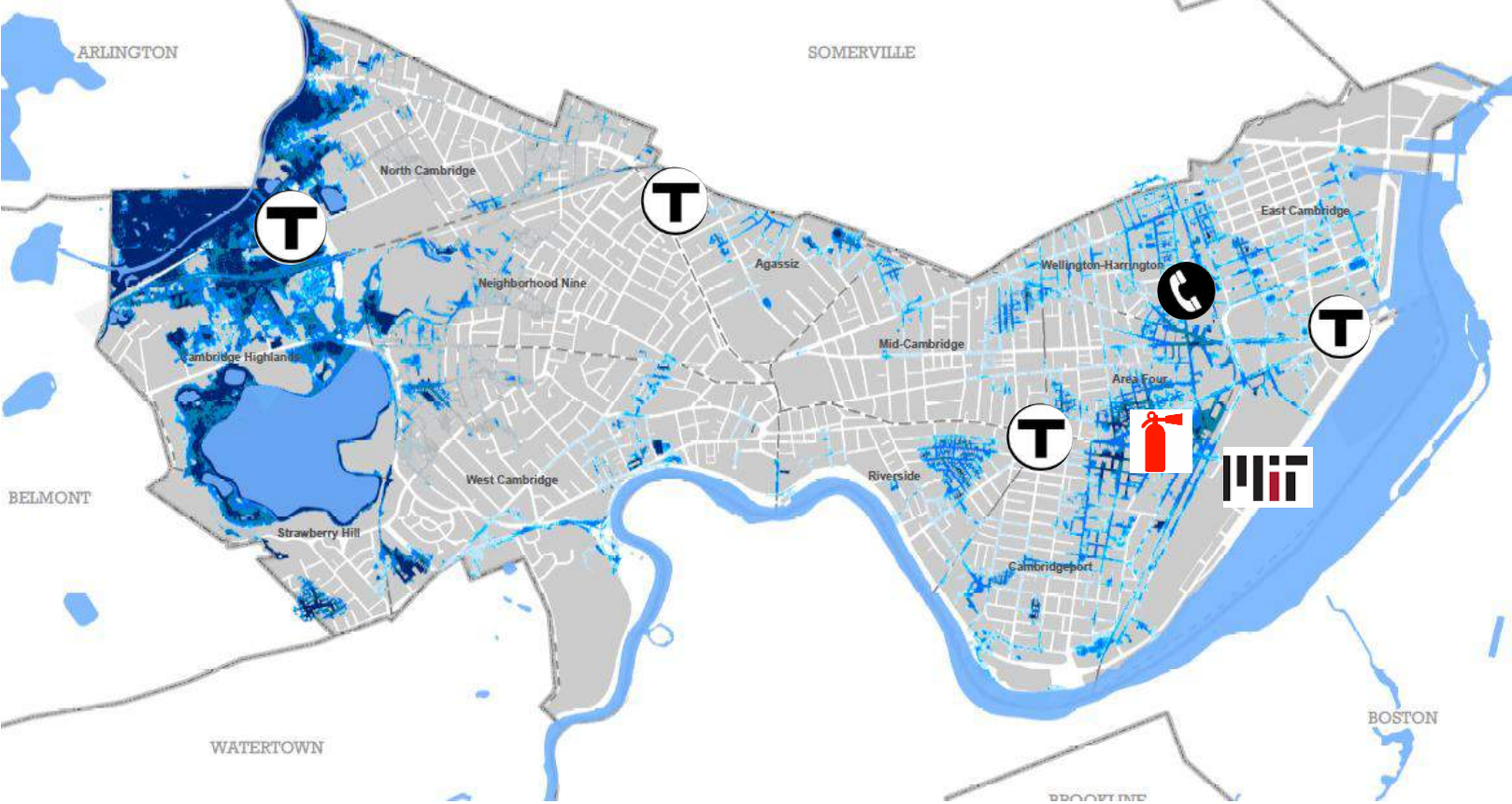
SITE SYSTEMS 168 acres



Inter-dependent Systems: Campus and City Scale

Source: Brian Goldberg, MIT

Inter-dependent Systems: Campus and City Scale



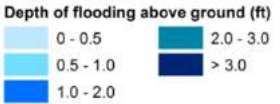
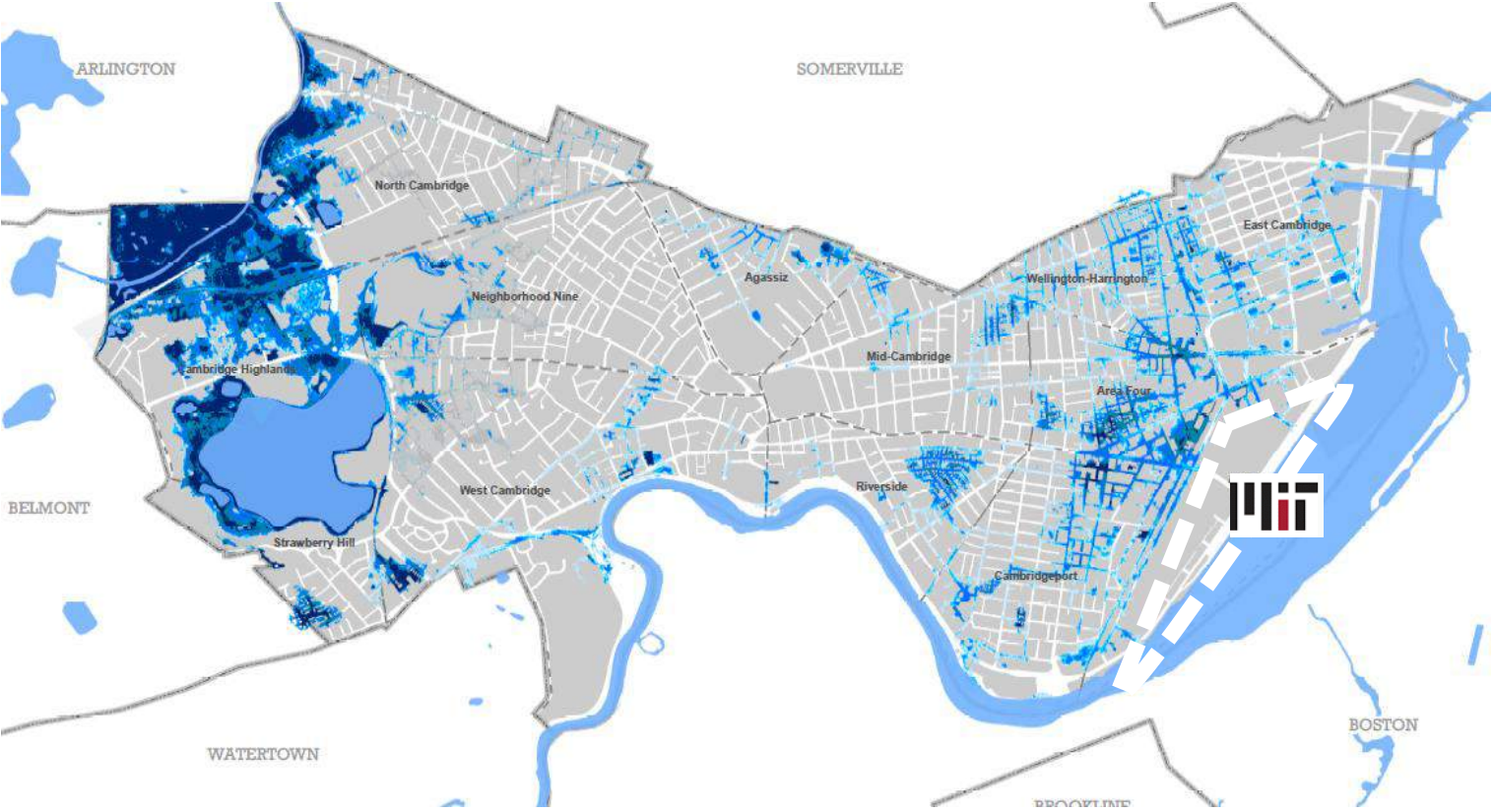
Depth of flooding above ground (ft)

| | |
|-----------|-----------|
| 0 - 0.5 | 2.0 - 3.0 |
| 0.5 - 1.0 | > 3.0 |
| 1.0 - 2.0 | |

| | | |
|-------------------------------------|--|-----------------------------|
| <p>COMMUNITY</p> | | <p>22,000 people</p> |
| <p>BUILDINGS / EQUIPMENT</p> | | <p>170 buildings</p> |
| <p>UTILITIES</p> | | <p>15 utilities</p> |
| <p>SITE</p> | | <p>168 acres</p> |

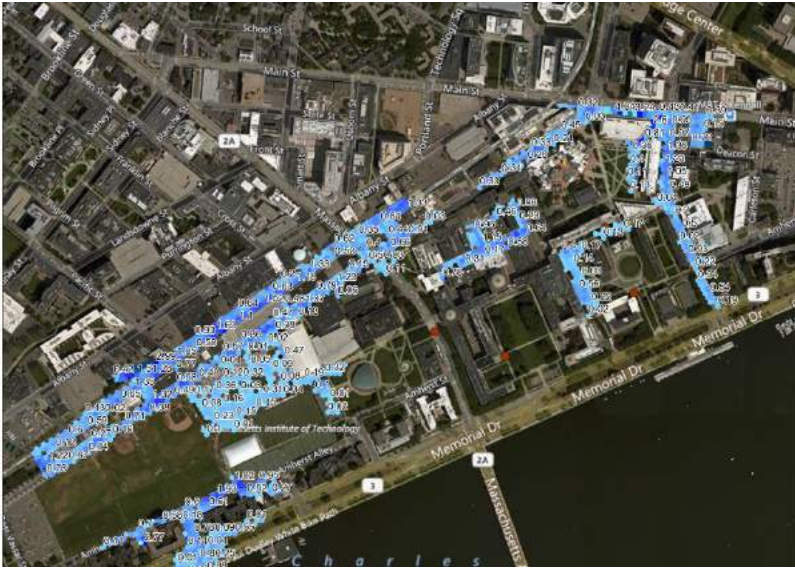
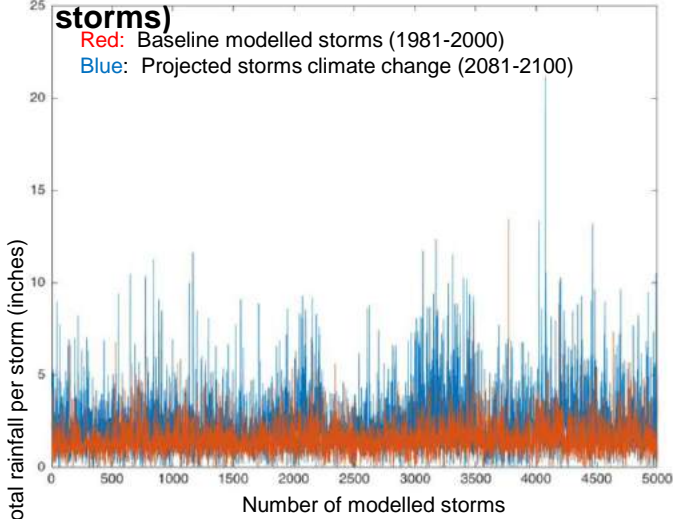
- City of Cambridge Climate Vulnerability Assessment, 2015

Understanding Precipitation Flood Risks



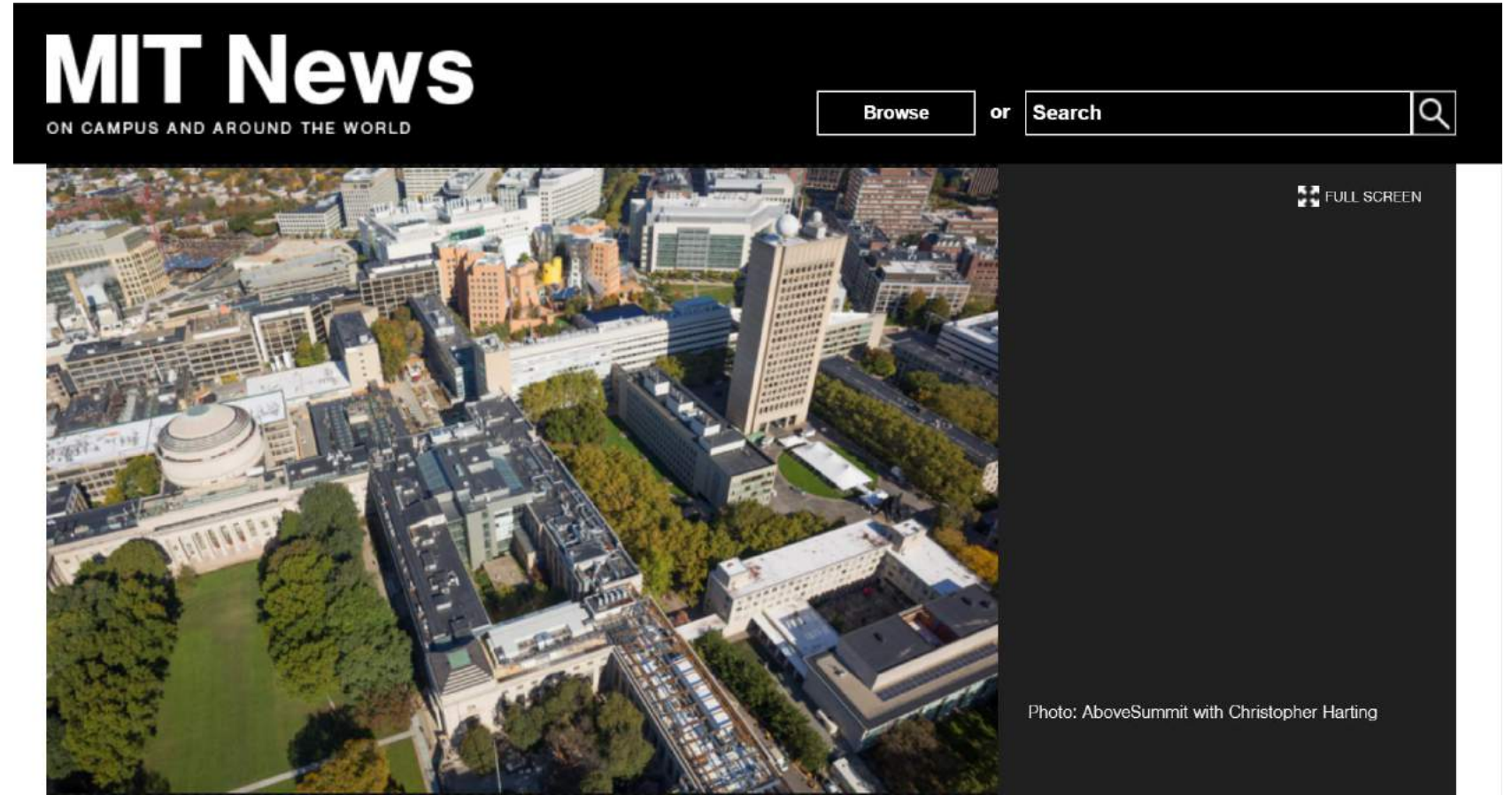
- 1% or 100 year storm (2070); 11.7 inches over 24 hours
- City of Cambridge Climate Vulnerability Assessment (2015)

Modelling of Future Cambridge Precipitation Totals (24 hour storms)





- City of Cambridge
- Harvard University
- MIT
- Novartis
- Boston Properties
- Biogen
- Alexandria Real Estate
- BioMed Realty
- Cambridge Redevelopment Authority
- Eversource
- Homeowner's Rehab, Inc.
- Amgen
- CDM Smith
- Draper Laboratory



MIT embarks on collaborative climate resiliency planning

MIT and Novartis are co-chairing a new working group on Cambridge climate resiliency.

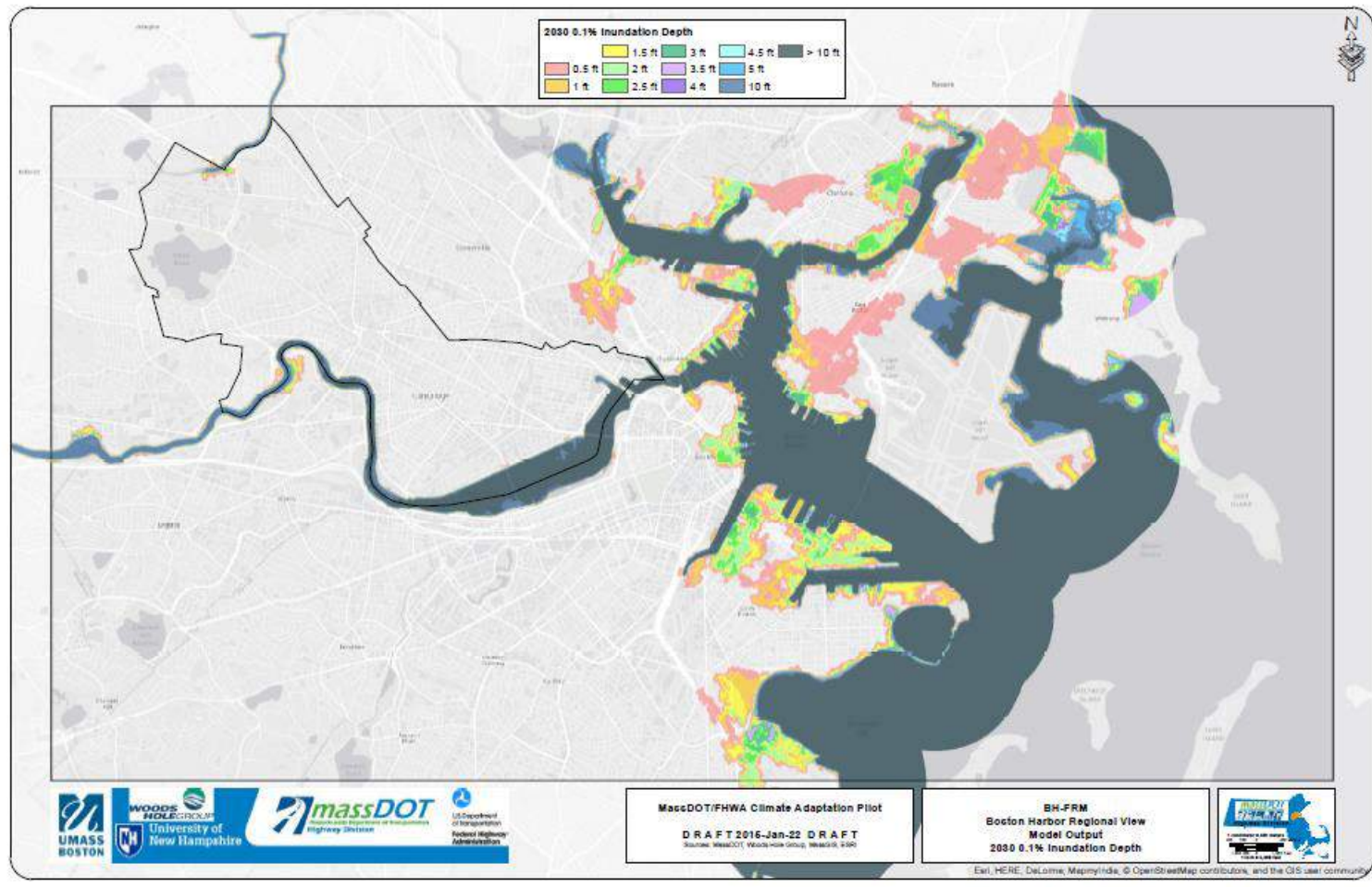
**MassDOT-FHWA
Pilot Project Report:
Climate Change and Extreme
Weather Vulnerability Assessments
and Adaptation Options for the
Central Artery**

Project Team:
 Kirk Bosma, P.E., Woods Hole Group, Inc.
 Ellen Douglas, P.E., Ph.D., UMass Boston
 Paul Kirshen, Ph.D., University of New Hampshire
 Katherine McArthur, MassDOT
 Steven Miller, MassDOT
 Chris Watson, M.Sc., UMass Boston

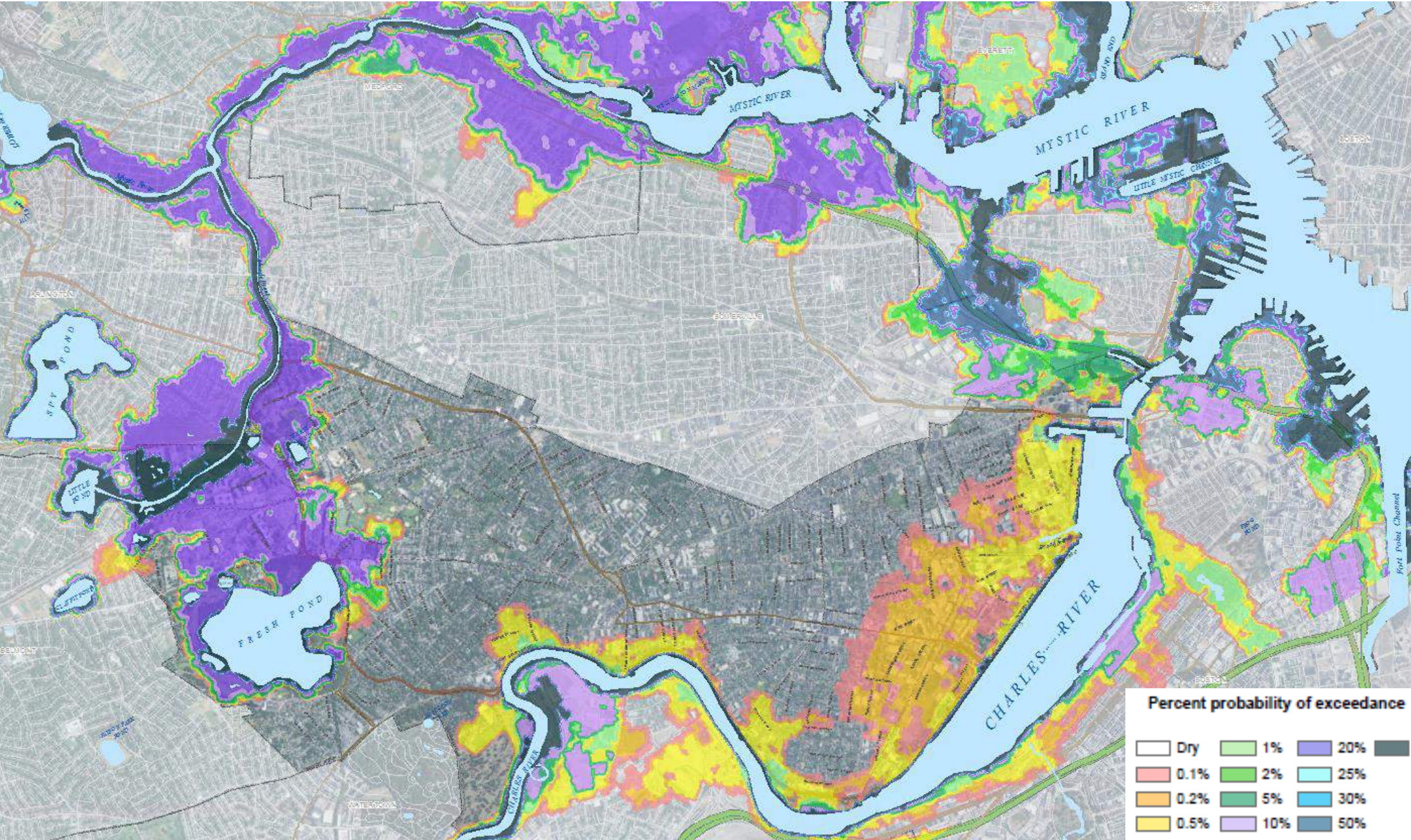
Logos at the bottom include: UMass Boston, Woods Hole Group, massDOT (Massachusetts Department of Transportation), University of New Hampshire, U.S. Department of Transportation Federal Highway Administration, and U.S. Department of the Interior National Highway Traffic Safety Administration.

MassDOT – Boston Harbor Flood Risk Model

- Extended model to Mystic River and Cambridge
- Consistent regional model of sea level rise & storm surge flood risks



Storm Surge: A New, Future Flood Risk for Cambridge in 2070



Source: Kleinfelder & Woods Hole Group for the City of Cambridge, February 2017 based on Boston Harbor Flood Risk Model, MassDOT

Regional Coordination & Engagement

Metro Mayors Climate Change Preparedness Commitment

- 15 metro Boston cities and towns
- Coordinated by regional planning agency – MAPC
- Capacity building
- Vulnerability assessments
- Best practice and information sharing
- Joint implementation

Projects

- Trust for Public Land Climate Smart Cities
- Regional urban forest canopy mapping & USFS training
- Mystic River Coastal Resilience Project
- Climate Ready Boston plans for Charlestown & East Boston



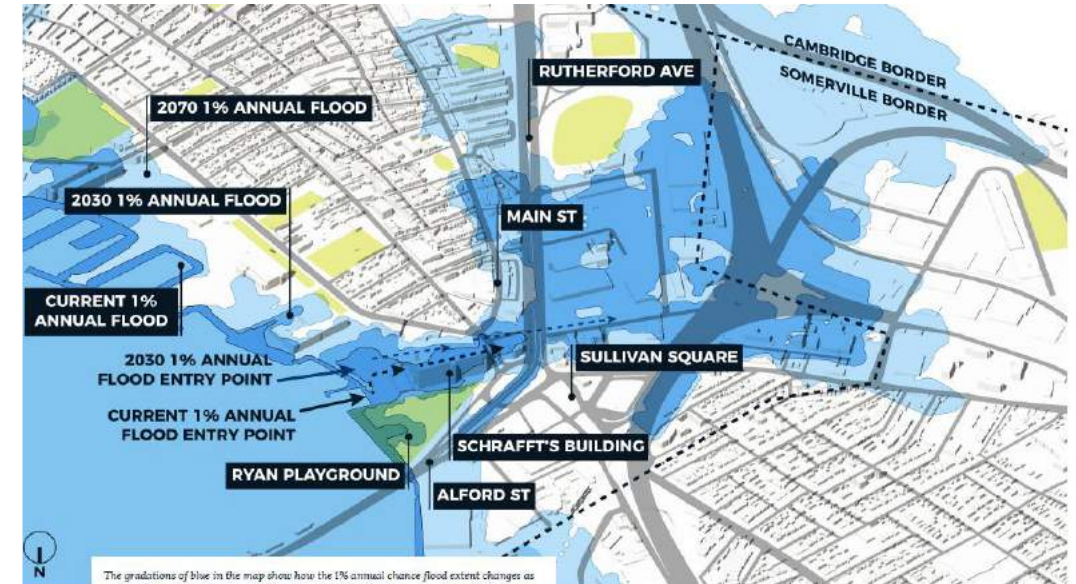
<http://www.mapc.org/climate-preparedness>

Regional Opportunities to Build Storm Surge Barriers

Draw 7 Park, Somerville at Amelia Earhart Dam on Mystic River



Charlestown (Boston) at Schrafft Center

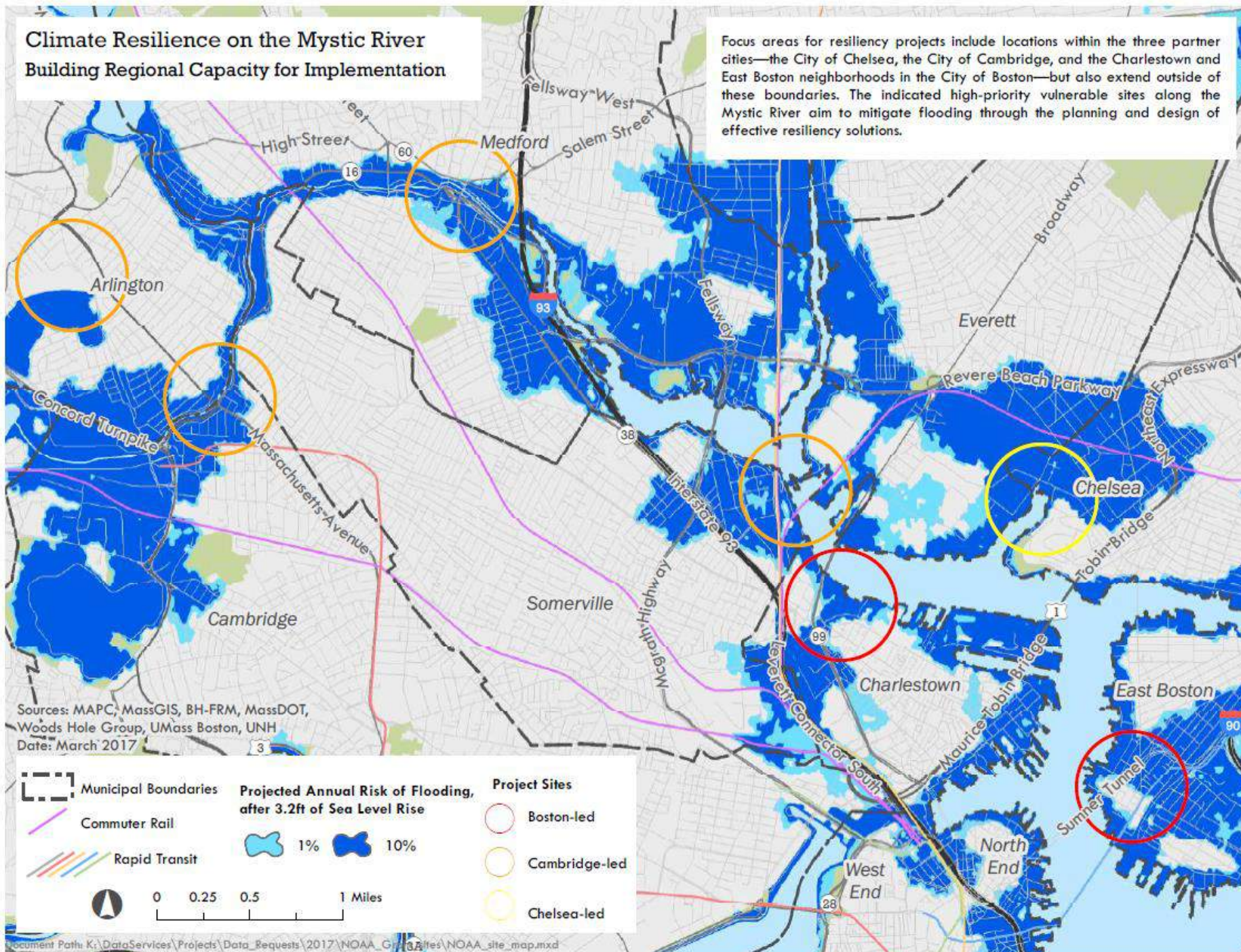


The gradations of blue in the map show how the 1% annual chance flood extent changes as sea levels rise. The colors do not indicate depth of flooding. The arrows show the flood entry points and pathways with current sea levels, 9 inches of sea level rise (2030s), and 36 inches of sea level rise (2070s).

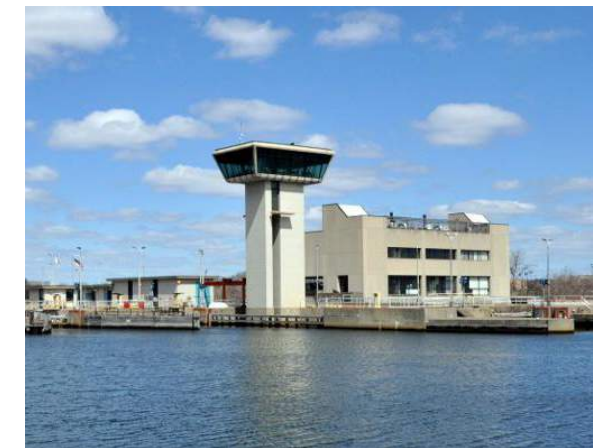


Climate Resilience on the Mystic River Building Regional Capacity for Implementation

Focus areas for resiliency projects include locations within the three partner cities—the City of Chelsea, the City of Cambridge, and the Charlestown and East Boston neighborhoods in the City of Boston—but also extend outside of these boundaries. The indicated high-priority vulnerable sites along the Mystic River aim to mitigate flooding through the planning and design of effective resiliency solutions.

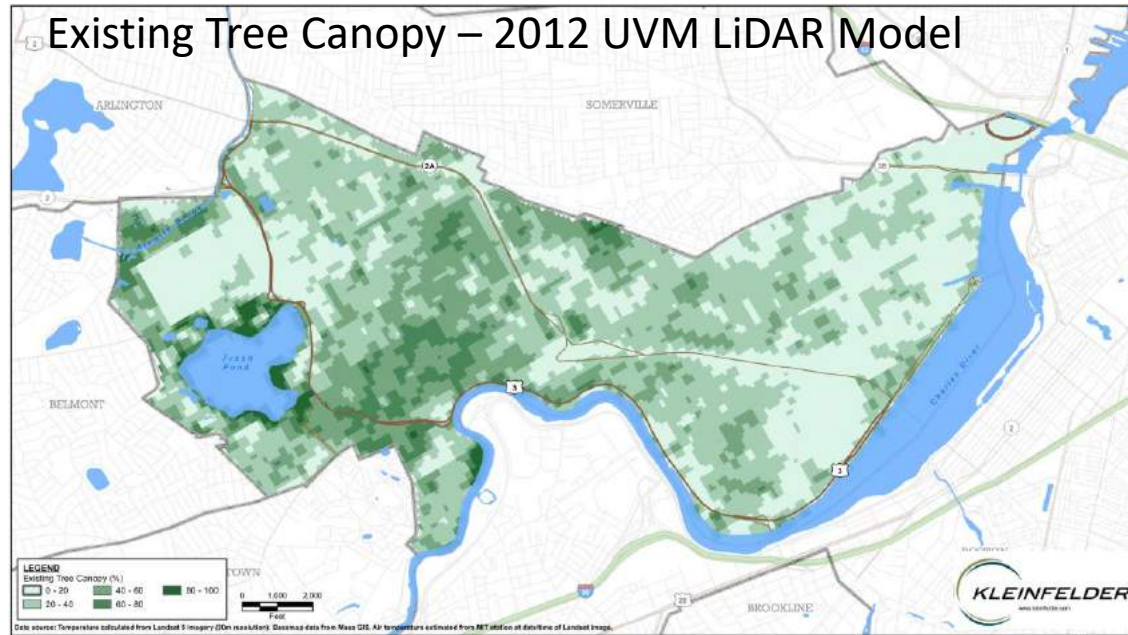


Regional Flood Risk Mitigation Planning



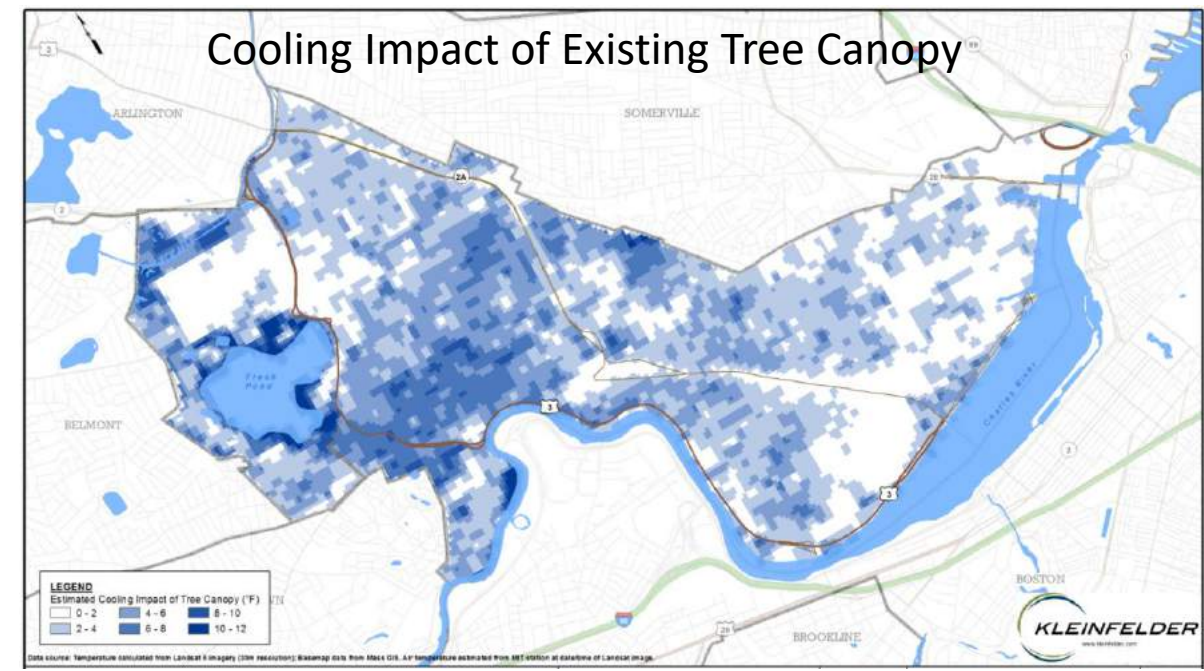
Amelia Earhart Dam (Source: MaUSHarbors.com)

Estimating Cooling Impact of Existing Urban Forest Canopy



Cell Resolution: 30 meters x 30 meters (100' ft x 100' ft)

Calculated Cooling Impact:
+1% tree canopy increase relates to 0.12°F
of cooling



The Trust for Public Land | More predicted sea-level | CREW

Secure | <https://web.tplgis.org/bostonmetromayorsecure/viewer/>

Apps | Send Link

Climate-Smart Cities

Boston Metro Mayors Region

Enter an address or place

Help | Logout

Basemaps

Group Parcel Selection

Query Data

Layers

Overlay Data

- Parcels and Modeled ROW
- Study Area
- Administrative Boundaries
- Connect
- Cool
 - Average Daytime Land Surface Temperature (LandSat)
 - Daytime Average Land Surface Temperature (MODIS)
 - Nighttime Average Land Surface Temperature (MODIS)
 - Impervious Surface
 - Tree Canopy (NLCD)
 - Vegetation Index (NDVI)
 - Tree Canopy (UVM)
- Absorb
- Protect
- Critical Infrastructure
- Climate Equity
- Green Infrastructure Suitability

Analysis Results

- Turn off all Results
- Overall Climate Smart Cities Priorities
- Connect

esri

5:01 PM
2/21/2018

Boston Metro Mayors Climate Smart Cities Tool

- Tree canopy cover – 2014
- Developed by Trust for Public Land with Metropolitan Area Planning Council

Cambridge Climate Change Preparedness & Resilience
<http://www.cambridgema.gov/climateprep>

Contact: John Bolduc, Environmental Planner
jbolduc@cambridgema.gov