Climate Change Preparedness & Resilience Planning in Cambridge

Presentation to
Climate Resilience Zoning Task Force

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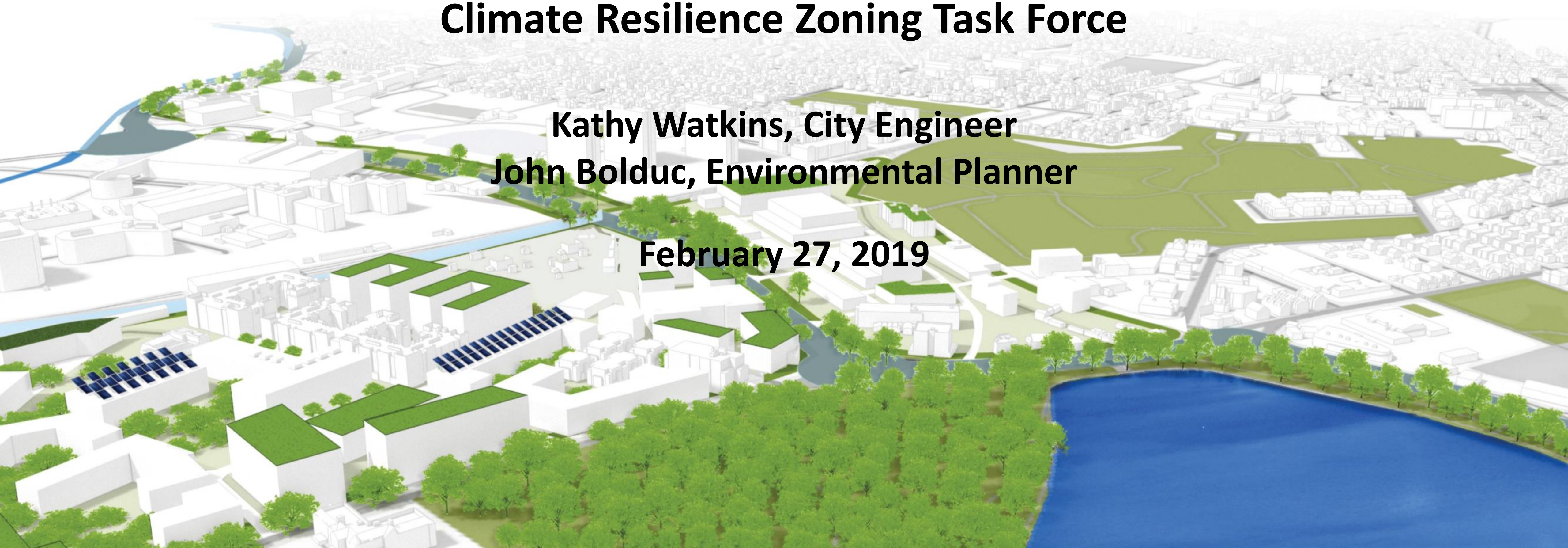
February 27, 2019



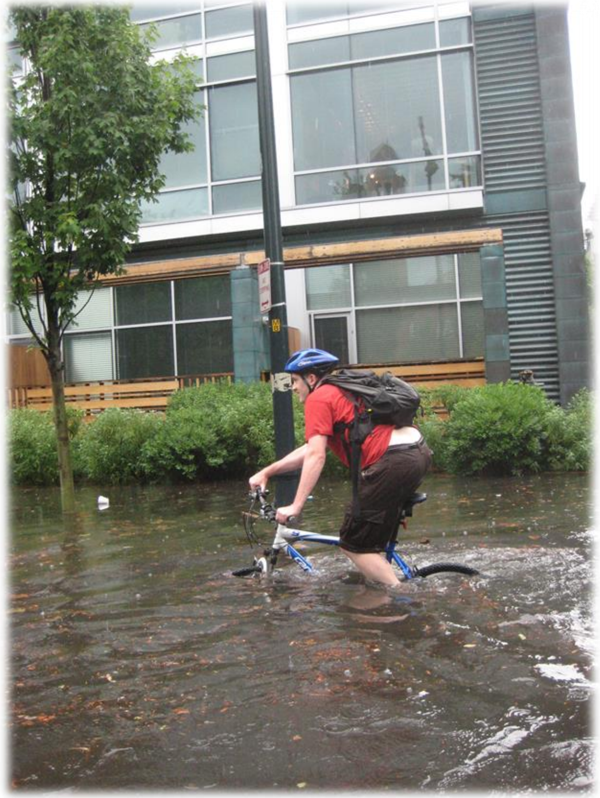
Climate Change Risks in Cambridge

Climate Stress Test for Cambridge

- Cambridge's climate is already shifting; historic data is no longer reliable; future climate will be different and continuing to shift
- Assuming Cambridge is as it is today and no action is taken, how might climate change affect the city; what are the City's physical and social vulnerabilities
- Projections of future climate change based on best available science
- 2030 and 2070 planning horizons
- Projections for temperature, humidity, and precipitation generated by climate change scientist who downscaled global climate models calibrated to local weather station data; sea level rise rates drawn from National Climate Assessment
- Projections are not meant to be precise predictions; uncertainties increase further out in time
- Projections of climate parameters are translated into impacts in geographic terms
- CCVA serves as the foundation for Climate Change Preparedness and Resilience Plan (CCPR)

Cambridge Climate Change Risks

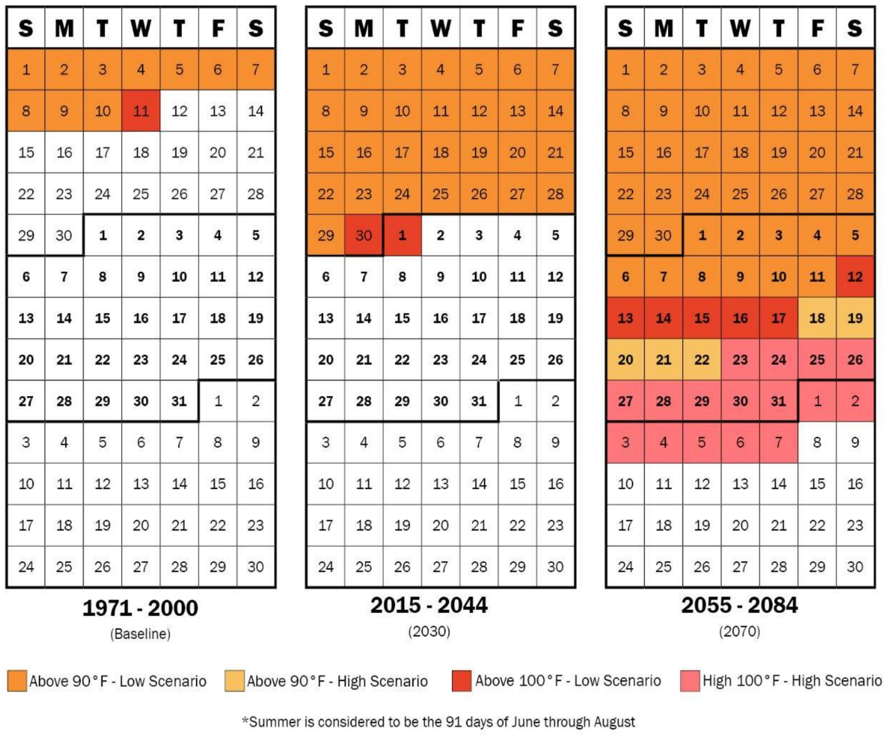
Increasing temperatures



Increasing Precipitation

Increasing Sea Level Rise & Emerging Storm Surge Risks

Increasing Heat: Warmer Averages, Greater Extremes, More Heat Waves

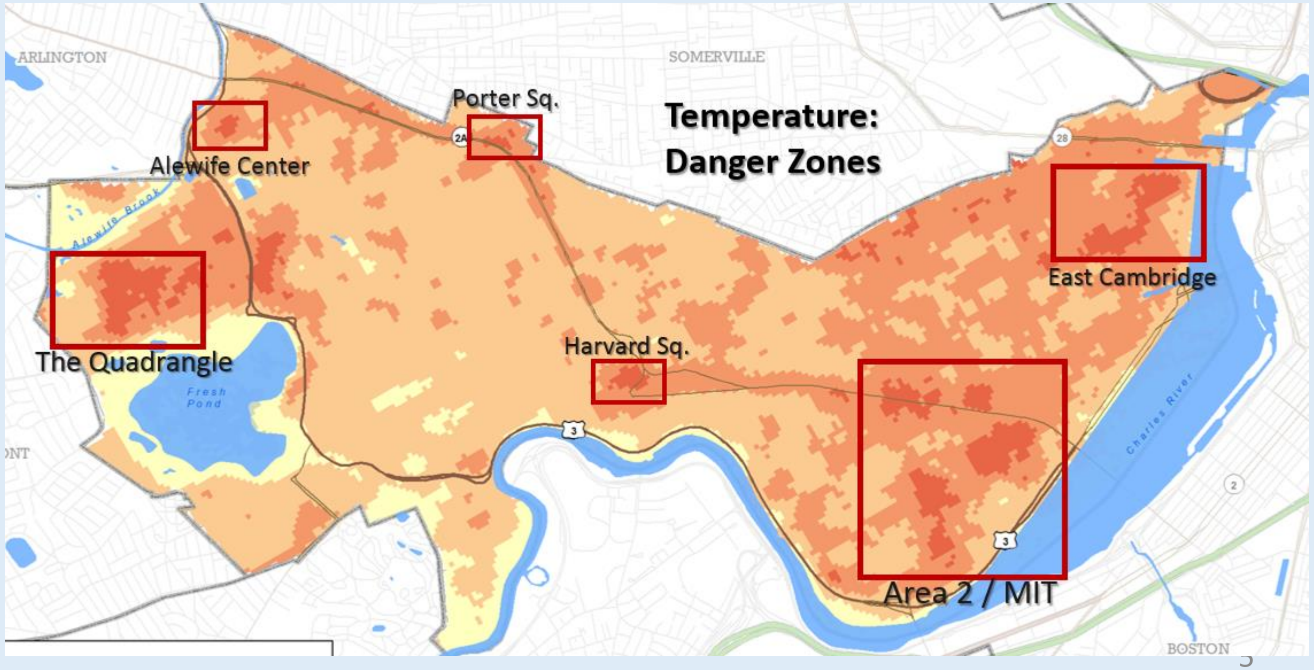


By 2030, the number of days above 90º F could triple

- Stress on human health
- Stress on infrastructure

Urban Heat Island Effect Magnifies Ambient Temperature

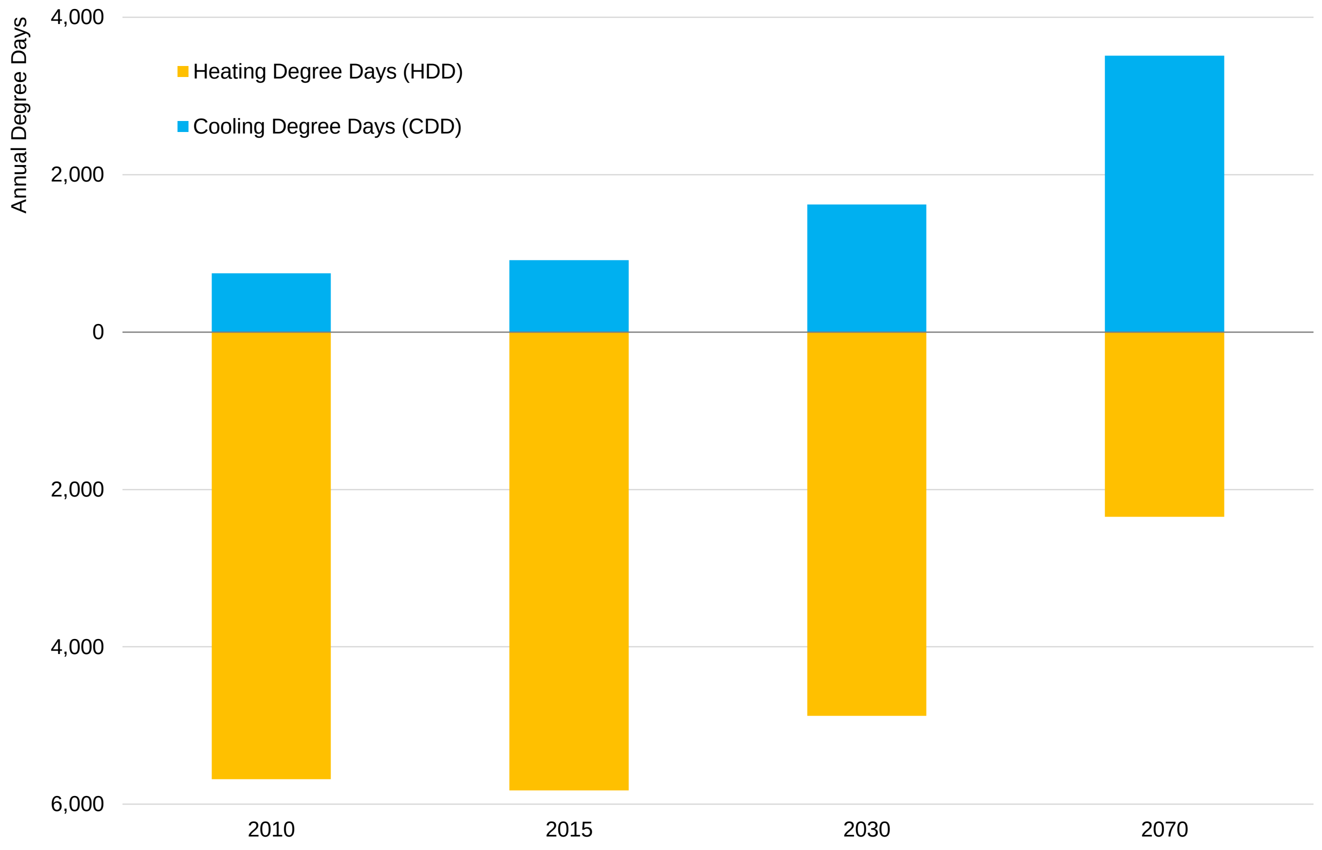
- Darker impervious surfaces – pavement & roofs -- absorb heat
- Areas with large amounts of impervious surface and lacking tree canopy tend to be heat islands



Flip to More Cooling Degree Days

- Our region shifts from a cold weather climate to one more like Maryland
- By approximately mid-century, energy will be used more to cool, rather than heat, buildings
- Extreme heat may strain electricity grids during peak demand periods
- Greenhouse gas reduction goals require electrifying most buildings

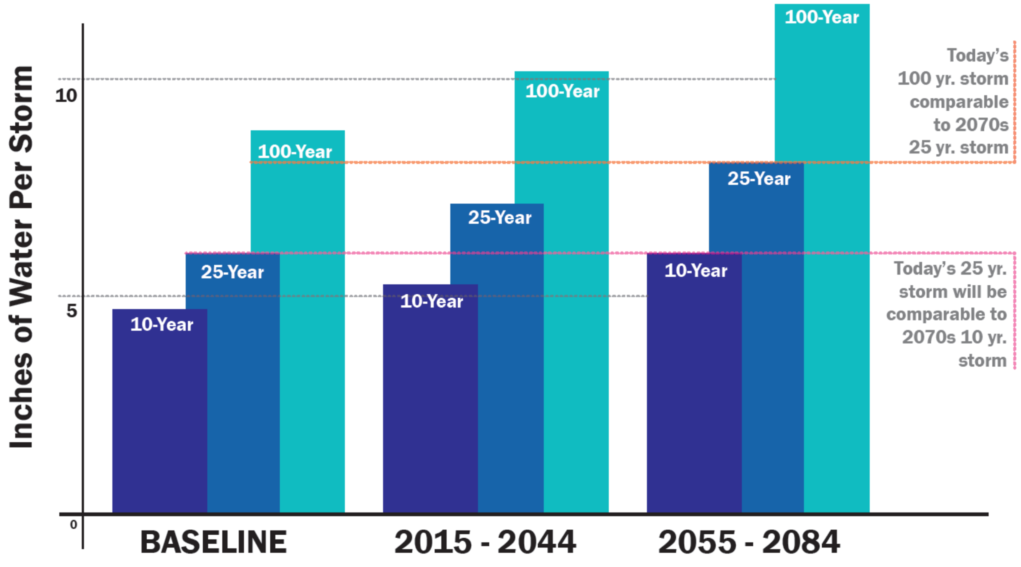
Projected Annual Heating and Cooling Degree Days



Source: Petri, Y. and Caldeira, K. Impacts of global warming on residential heating and cooling degree-days in the United States (2015), and BuroHappold analysis

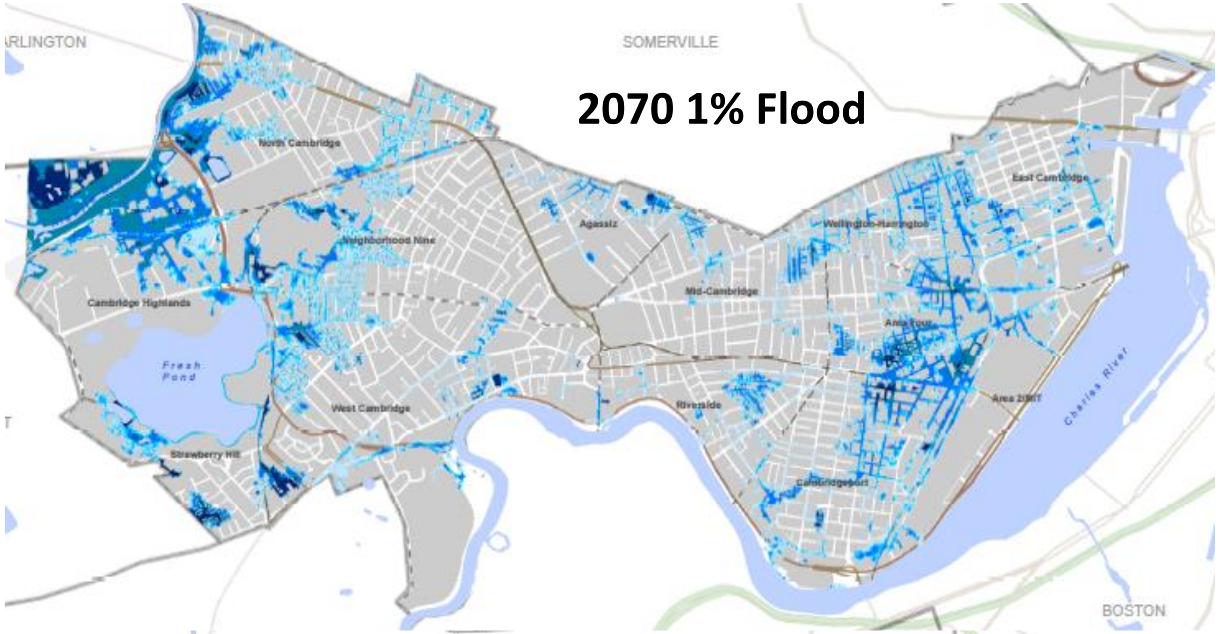
Rates of Precipitation Increasing

- For 24-hour storms, 1% annual risk is associated with ~8 inches in the present and ~12 inches in 2070
- Frequency of larger storms increases – today's 1% annual event becomes 4% by 2070
- Cumulative risk for 1% annual event over 50 years is 39%; 10% annual is 99+% cumulative
- Extent and depth of flooding increases if we do nothing
- Cannot fully store and convey floodwater

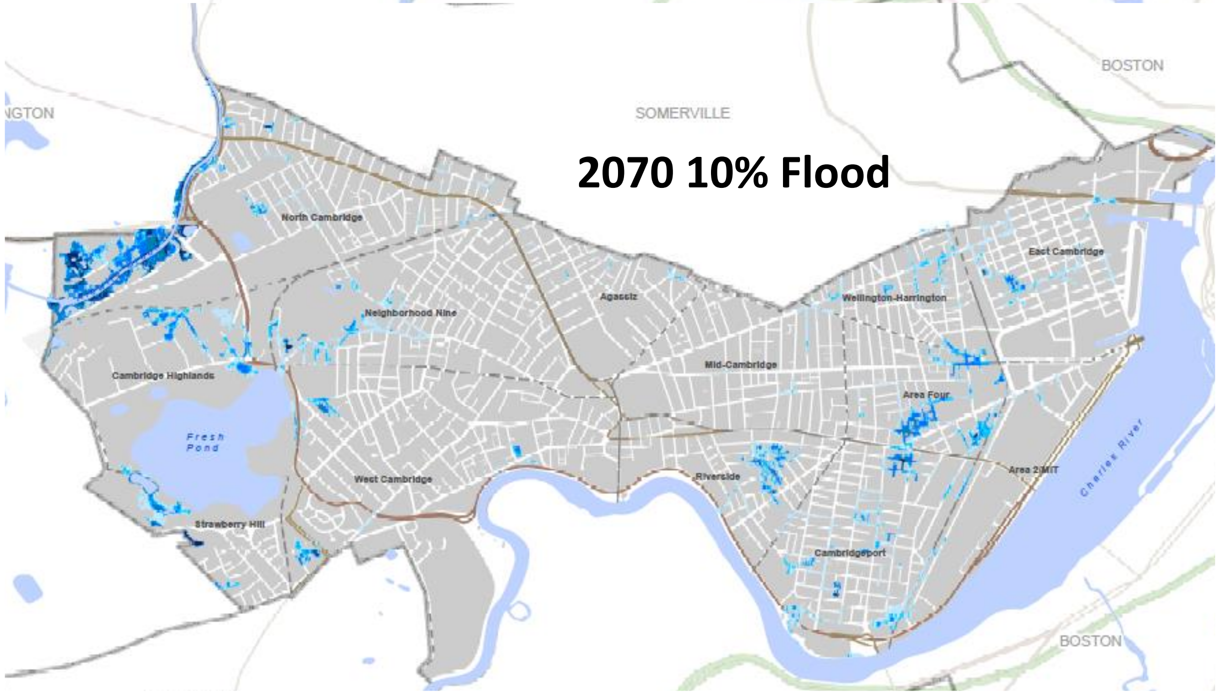


(Source: *Kleinfelder based on ATMOS projections November 2015)*

(per 24 hr. event)

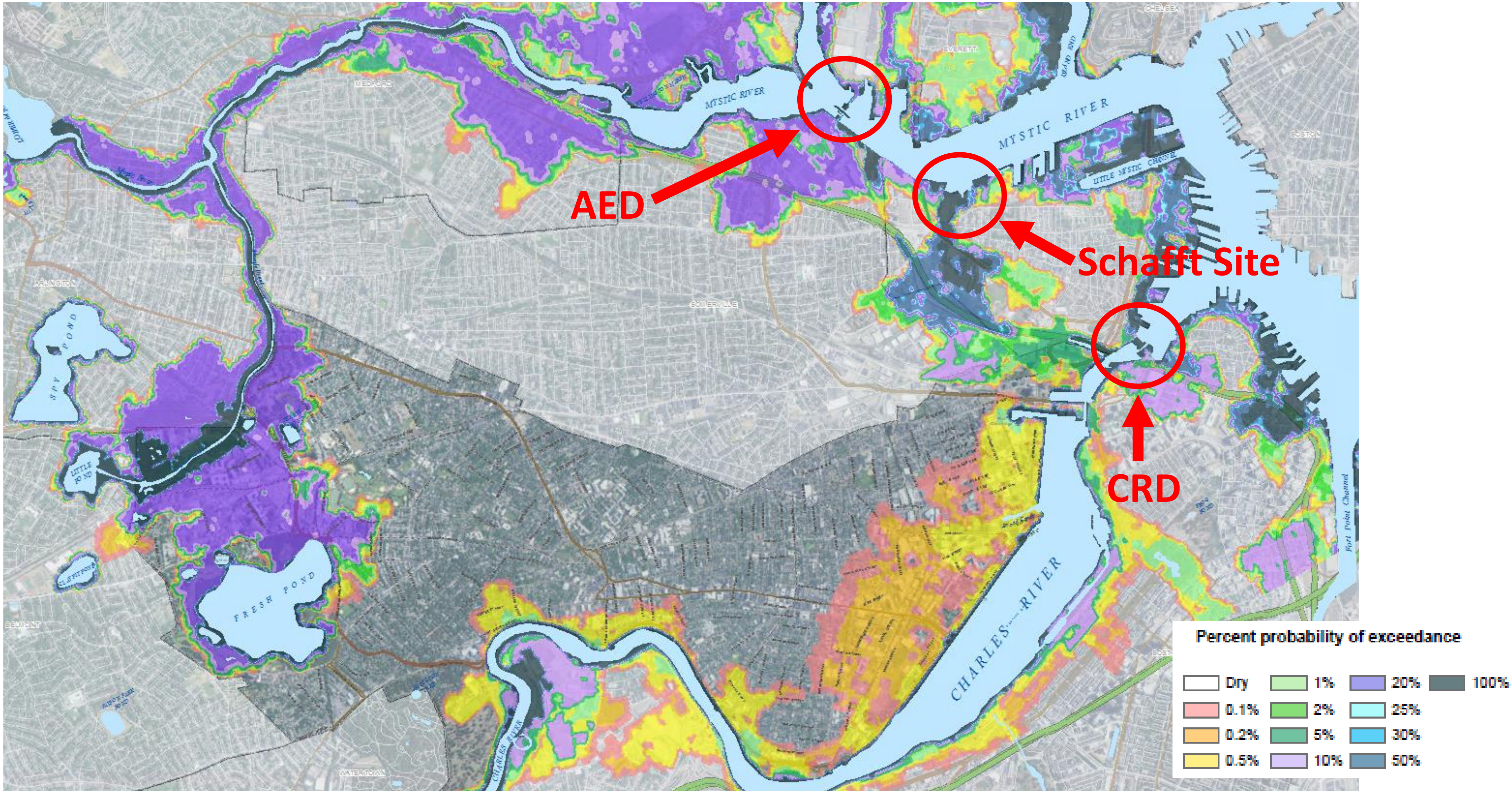


(per 24 hr. event)



Storm Surge Risk Becomes a Significant Risk Mid-Century

Storm Surge Flooding Probabilities in 2070 with 3.4 feet SLR

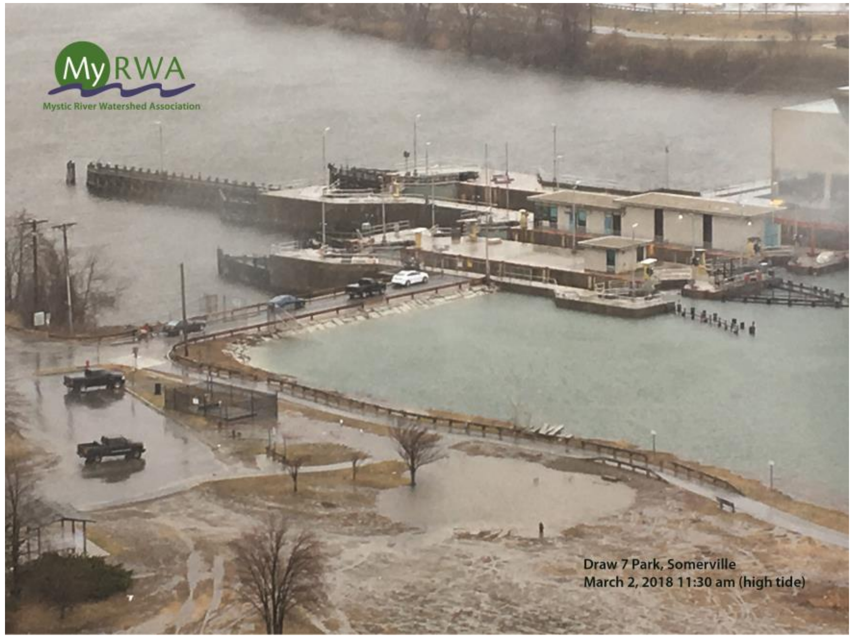


Source: Kleinfelder & Woods Hole Group for the City of Cambridge, February 2017 based on Boston Harbor Flood Risk Model, MassDOT

Character of Flood Risks in Cambridge

Precipitation Driven Flooding

- Riverine (overbank from streams) & urban street (piped infrastructure back up) flooding already a problem in some areas
- In Alewife, flooding influenced by Amelia Earhart Dam
- Flood duration expected to be on order of 1 day or less – if AED pumps work
- No velocity
- Contaminants in water a concern



Sea Level Rise/Storm Surge Flooding

- No experience in Cambridge yet
- Projected to be significant about mid-century if no action
- Alewife/Fresh Pond area more exposed
- Salt water intrusion possible
- Flood duration expected to be on order of 1 day or less – if AED pumps work
- No velocity

Flood Risk for Existing Properties

CCPR Alewife Study Area Properties

TABLE 3. ALEWIFE AREA STORM EVENT FLOODING			
YEAR	STORM EVENT	% FLOODED LAND AREA	% FLOODED PROPERTIES
Present	10-year 24-hour precipitation event	3%	5%
	100-year 24-hour precipitation event	11%	18%
2030	10-year 24-hour precipitation event	5%	7%
	100-year 24-hour precipitation event	13%	21%
2070	10-year 24-hour precipitation event	6%	9%
	100-year 24-hour precipitation event	19%	**28%**
	10-year SLR/SS event	31%	12%
	100-year SLR/SS event	34%	**14%**

CCPR The Port Study Area Properties

Storm	Total Rain (inches)	Peak Intensity (inches/hour)	Storm referenced in the text as:	% Port Area Flooded	% Port Properties Flooded
Present 10-yr[1] 24-hr	4.9	1.2	Smaller, more frequent	6%	15%
2030 10-yr 24-hr	5.6	1.4	Near future smaller, more frequent	10%	22%
2070 10-yr 24-hr	6.4	1.6	Future smaller, more frequent	15%	29%

Planning Climate Change Preparedness & Resilience: Approach and Challenges

Approach to climate change preparedness & resilience

Reduce Risk ✚ Prepare for Unavoidable Risks

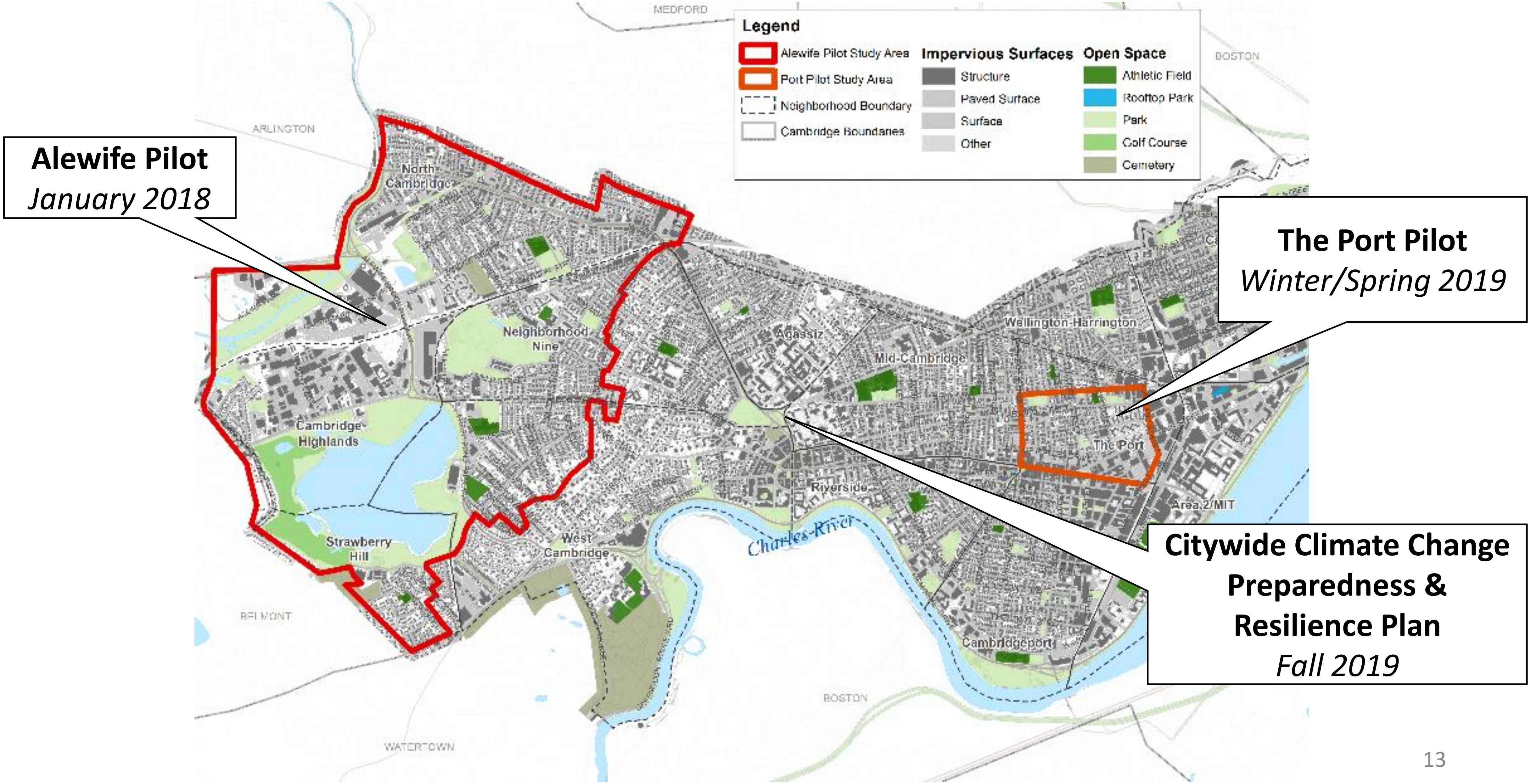
Reduce Risk

- Reduce urban heat islands
- Increase flood storage & conveyance
- Develop storm surge barriers
- Elevate structures

Prepare for Unavoidable Risks

- Be transparent and open about risks, share data
- Plan for extremes and new normals
- Coordinate planning initiatives
- Engage stakeholders & community
- Develop strategies for people, buildings, infrastructure, and ecosystem
- Implement at different scales
- Coordinate and engage regionally

Sequence of CCPR Planning



CLIMATE CHANGE PREPAREDNESS & RESILIENCE

Resilience Strategies

Ⓐ **Prepared Community**: Strategies to strengthen community, social, and economic resilience.

Ⓑ **Adapted Buildings:** Strategies to protect buildings against projected climate change impacts.

Ⓒ **Resilient Infrastructure:** Strategies to ensure continued service or a speedy recovery from community-wide infrastructure systems.

Ⓓ **Resilient ecosystems:** An enhanced living environment integrating air quality, waterways, green infrastructure, and the urban forest as a system resilient to climate impacts.

Integrating Planning Initiatives

Planning Challenge: Uncertainty

What We Know

- Future climate will be different than the present and will continue shifting toward a warmer, wetter regime
- Climate is no longer stable; the past does not predict the future; temperature, precipitation rates, and sea level will continue to shift; there is no single scenario to plan for

Sources of Uncertainty

- Science is evolving; projections change
- Models continue to be refined and input data continues to improve
- Some potential sources of risk are not understood, e.g. joint probabilities of storm surges and heavy precipitation, catastrophic precipitation
- How will greenhouse gas reductions alter future climate parameters and when
- How will actions to reduce risk modify flooding and heat vulnerability, e.g. blocking flows at the dams and in Charlestown

What is Happening to Reduce Exposure

Regional Collaboration

Metro Mayors Climate Preparedness Commitment

- 15 inner core communities
- Written commitment recognizing climate crisis and agreement to work together toward regional actions
- Staff task force meets quarterly, managed by MAPC
- Facilitating collaboration with Somerville to raise Draw 7 Park at AED by DCR

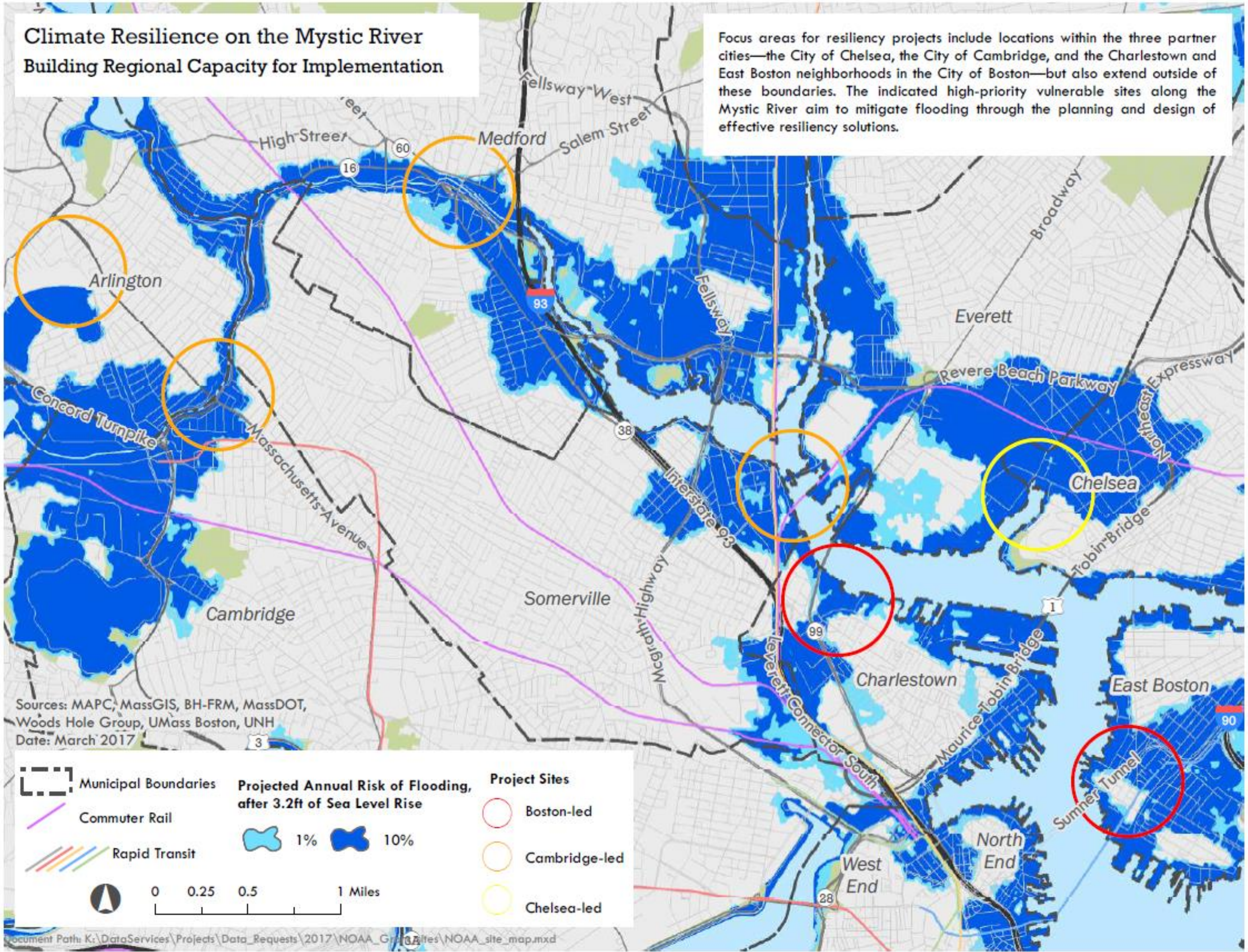
Resilient Mystic Collaborative

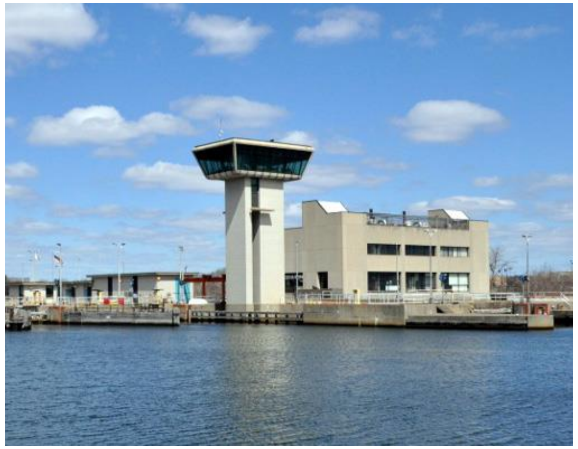
- Led by Mystic River Watershed Association
- 10 active communities, including Cambridge
- Focused on watershed scale climate resilience
- Supported $5 million authorization in Environmental Bond for AED pump
- Facilitating engagement with EOEEA & DCR on improvements to AED

Climate Ready Boston

- Charlestown storm surge barrier design
- Cambridge participated on advisory committee

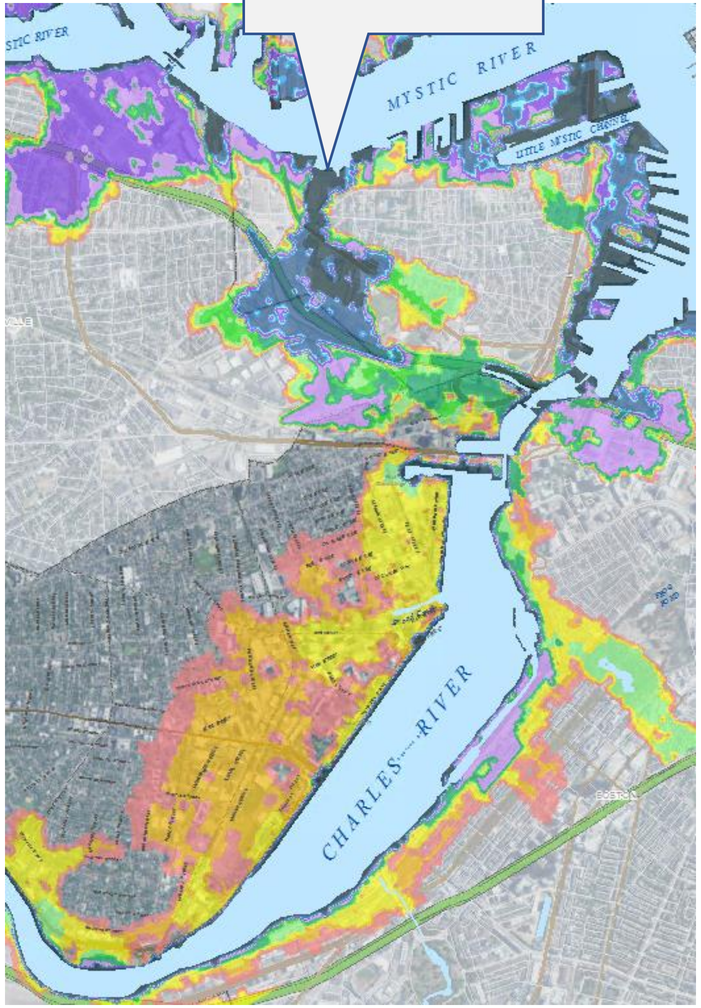
Regional Flood Risk Mitigation Planning





Amelia Earhart Dam (Source: MaUSHarbors.com)

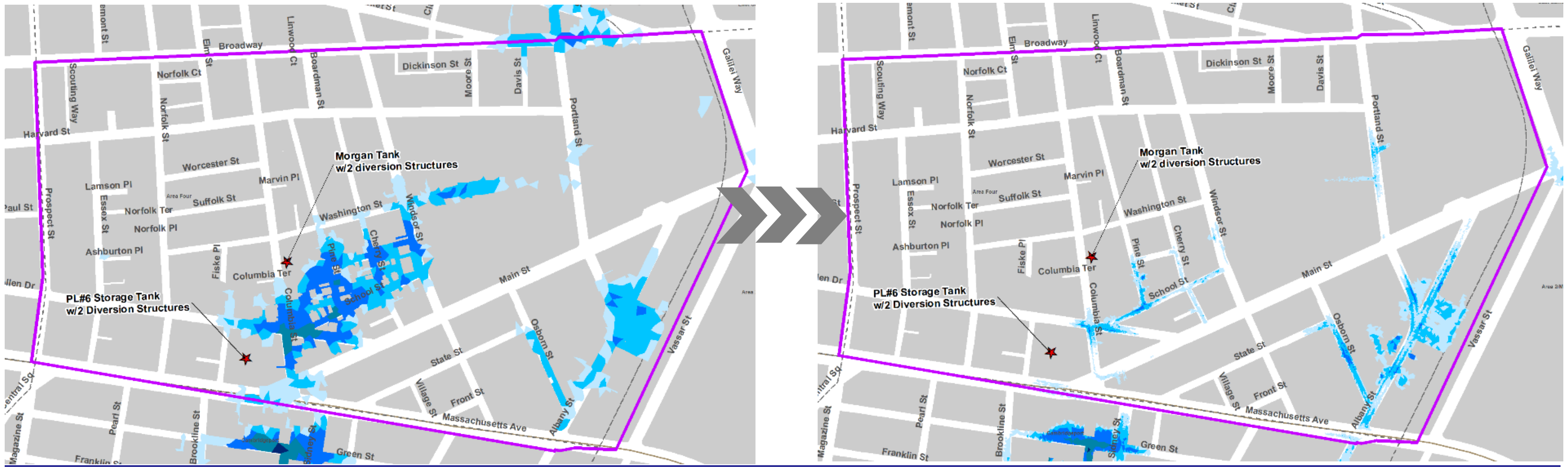
Climate Ready Boston: Schrafft's Center Waterfront Park – Storm Surge Barrier



Benefit to Charlestown, Somerville, and Cambridge

The Port Infrastructure Project

Existing Infrastructure Conditions | **Storage Tanks Installed**



Anticipated flooding for a 2030, 10 year / 24 hour storm

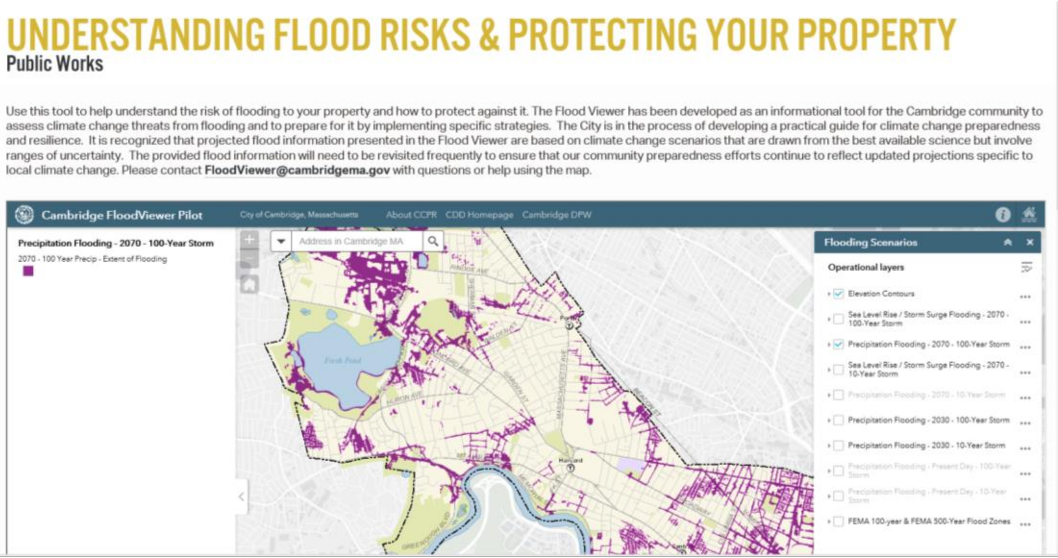
Anticipated flooding for a 2070, 10 year / 24 hour storm

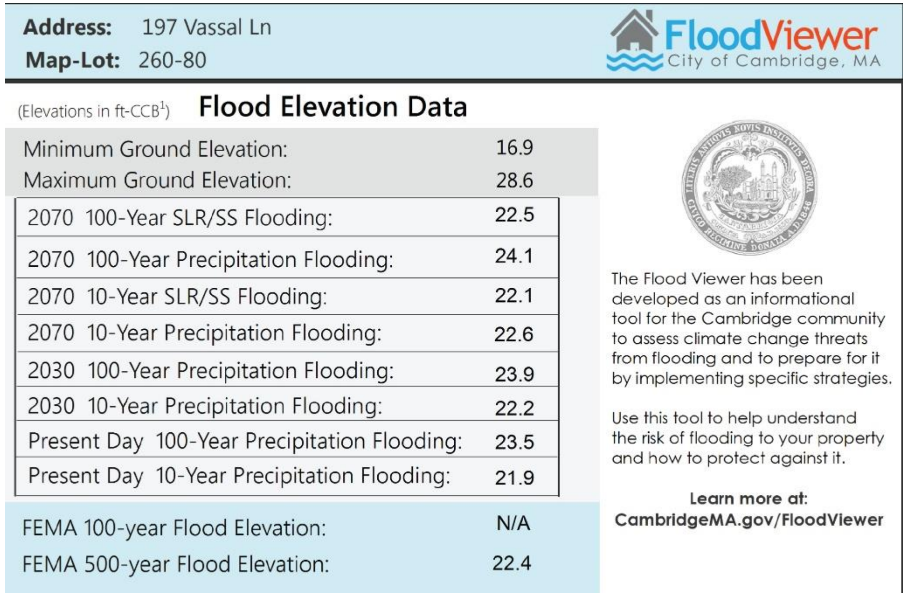
Planned installation of underground storage tank at PL-6 parking lot.

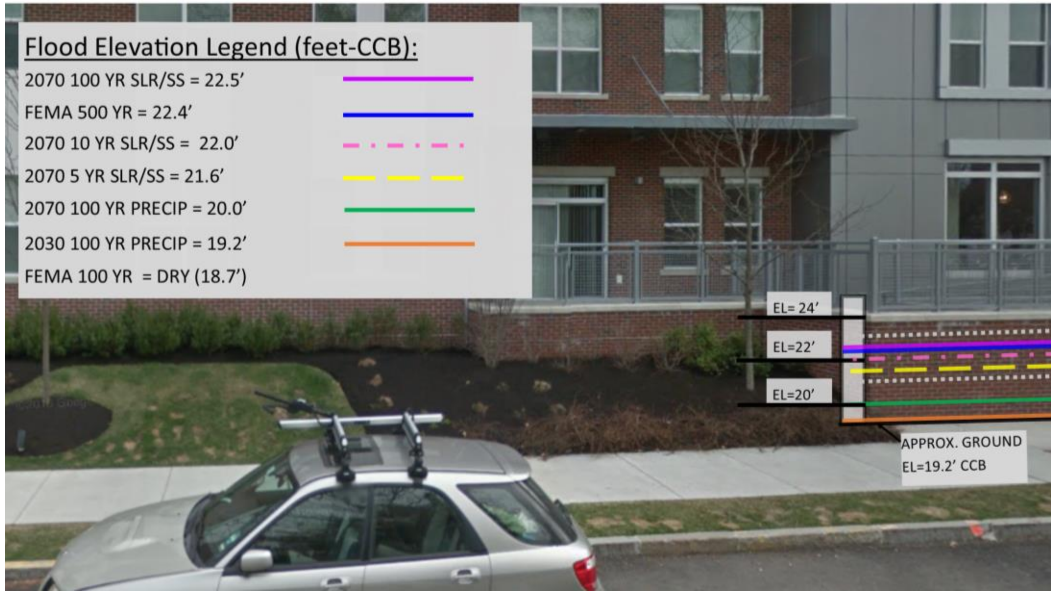
What is Happening to Adapt

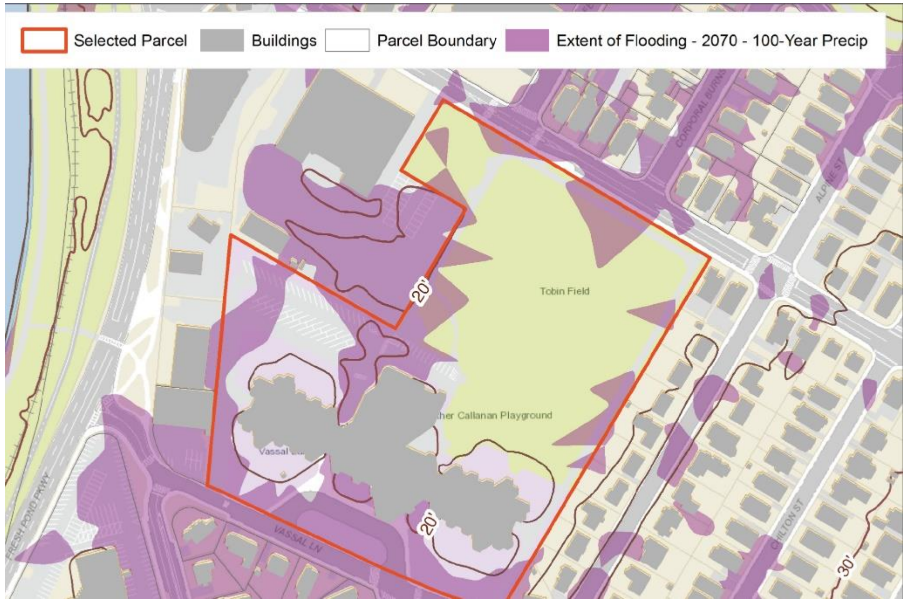
Current City Flood Protection Guidance

Cambridge FloodViewer – Accessible Flood Extent & Elevation Data







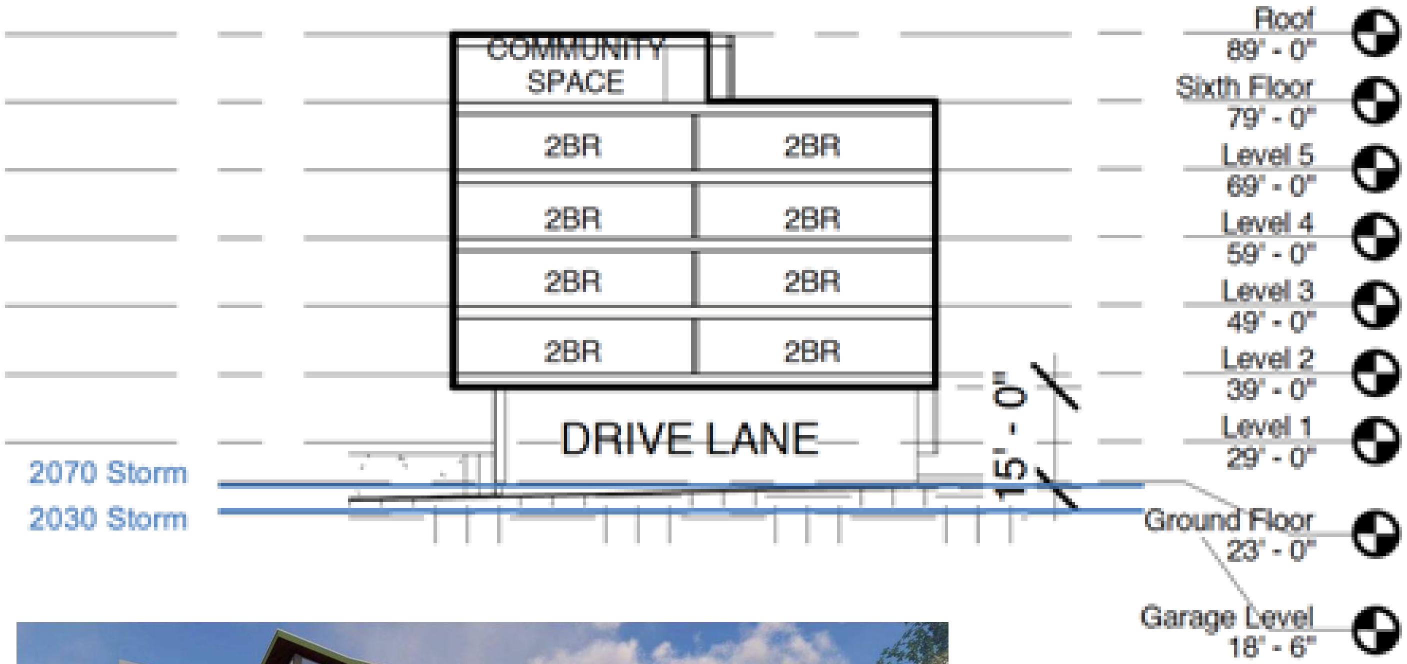


Cambridge Design Flood Elevation Guidance

- Build/protect to 2070 10% annual risk
- Recover from 2070 1% annual risk

Adapted Buildings: HRI Cambridge Highlands Affordable Housing

1. High performance building envelope and cool roof (**project will be Passive House certified** under the PHIUS+ 2015 system); **can stay in 55-85˚ F range for 4 days passively**.
2. Heat recovery ventilation system
3. VRF heat pump and efficient central hot water system
4. **83 kW Solar PV on roof Sub-metered utilities and separate sub-panel for life safety loads** (above flood elevation)
5. Sub-metered utilities and **separate sub-panel for life safety loads (above flood elevation)**
6. Building energy management
7. **Top floor community room and residential units elevated above flood elevation**



HRI's Concord Highland property
ICON Architecture
NEI Energy Expertise

Adapted Buildings: 50 Cambridgepark Drive

SOLAR-READY ROOF

- Over 14,000 sq feet of solar-ready space on building roof.
- Conduit infrastructure installed in advance

GREEN BUILDING DESIGN

- Investment in training Construction and Operations Teams in green building practices
- Building anticipates meeting LEED Gold standards

REDUCE URBAN HEAT ISLAND EFFECT

- Energy efficient white roofing materials to be used.
- Permeable paving materials to be used at street level.

LANDSCAPE FEATURES

- Increase tree canopy through inclusion of 51 new street shade trees.
- Planting along streetscape and pedestrian amenities. (street furniture, lighting, bicycle racks, etc.)

RESILIENT DESIGN MEASURES

- Increase on-site flood storage. (under building)
- Increase stormwater infiltration/groundwater recharge. (220 stormwater chambers)
- Site Action Plan, including flood protection measures, to prepare for a changing climate.

ALTERNATIVE TRANSPORTATION

- Provide new bicycle racks and 'Blue Bikes' in public realm.
- Construct new bicycle lanes in Triangle neighborhood.
- Provide TDM benefits to encourage use of MBTA public transit (across from Alewife T Station)

SOCIAL COHESION

- Build a community through engaging public spaces and neighborhood businesses.
- Social programming for residents and visitors.
- Educate through "Triangle Neighborhood Initiative" for a climate-ready community.

SUSTAINABLE AND RESILIENT DESIGN MEASURES AT 50 CAMBRIDGE PARK DRIVE

BSC GROUP

CUBE3 STUDIO architecture interiors planning

Envision Cambridge Design Approach for Flood Risk in Alewife Quadrangle – Raised Plinths

Envision Cambridge - Alewife
Coordinating Building and Street Design

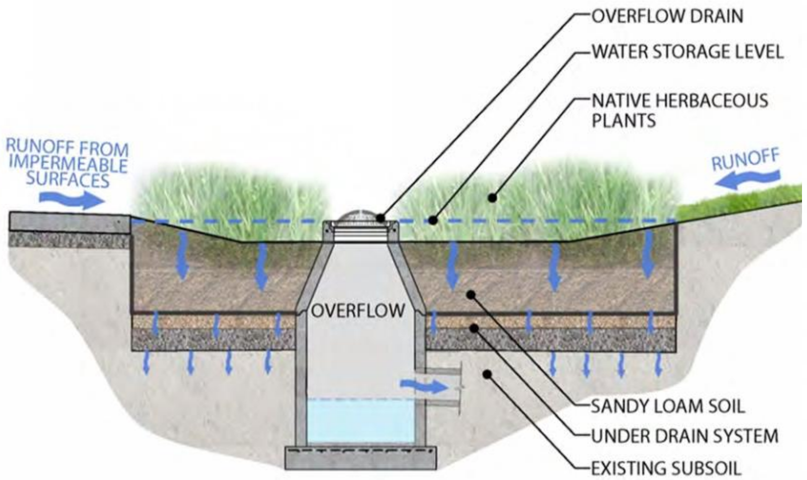
Green Infrastructure
Tool Box

Green Infrastructure Selected in The Port

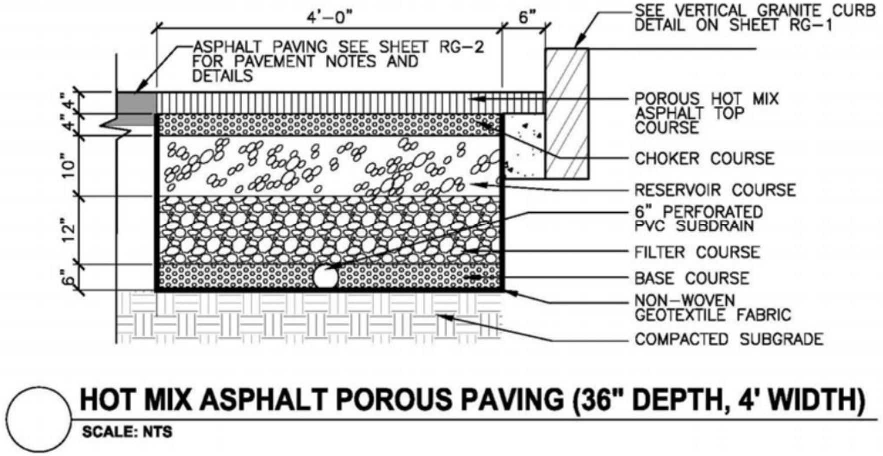
Bioretention basin in low- and medium-density residential

Porous asphalt in parking lots, driveways, sidewalks

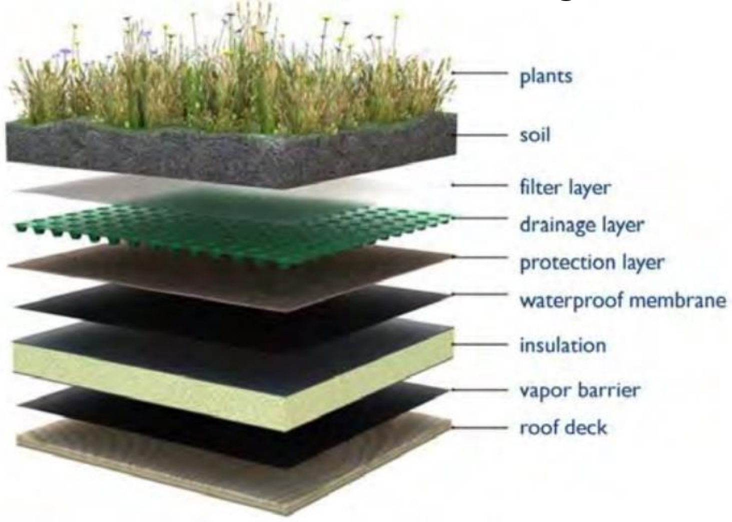
Green roofs on all flat roof buildings



Typical section of a bioretention basin

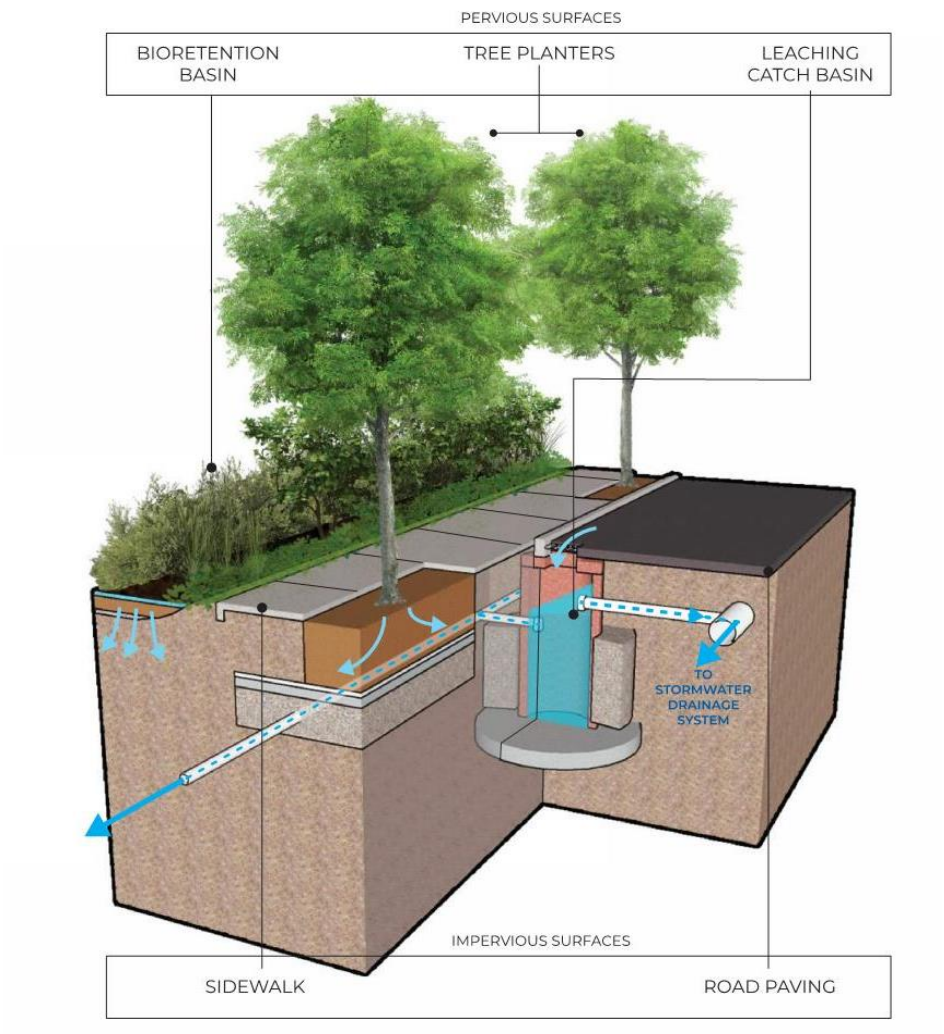


Typical porous pavement detail



Typical green roof section

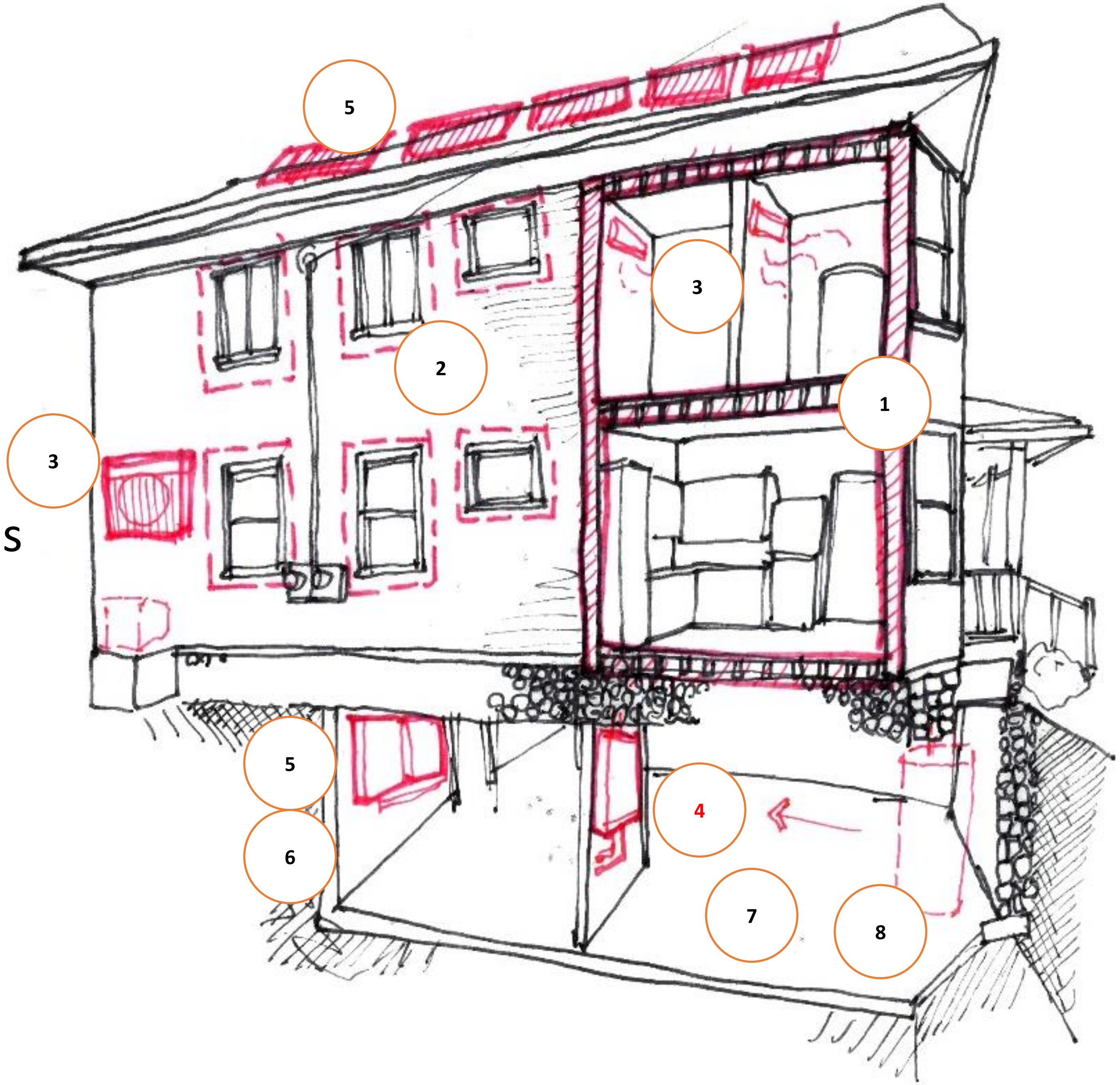
GREEN Infrastructure: What the City is doing?



Complete Street in strategic locations (Western Avenue)

Tool box: Buildings

1. Upgrade windows and insulate roof, basement, and exterior walls
2. Perform air sealing for new windows and exterior doors
3. Replace asphalt roofing with light-colored reflective shingles
4. Install sub-panel to isolate critical loads for backup power
5. Install solar PV on roof and battery storage to provide backup power
6. Replace and elevate utility meter, elevate main circuit breaker panel
7. Replace boiler with ductless mini-split system in each unit
8. Replace storage water heater with in-unit hot water systems

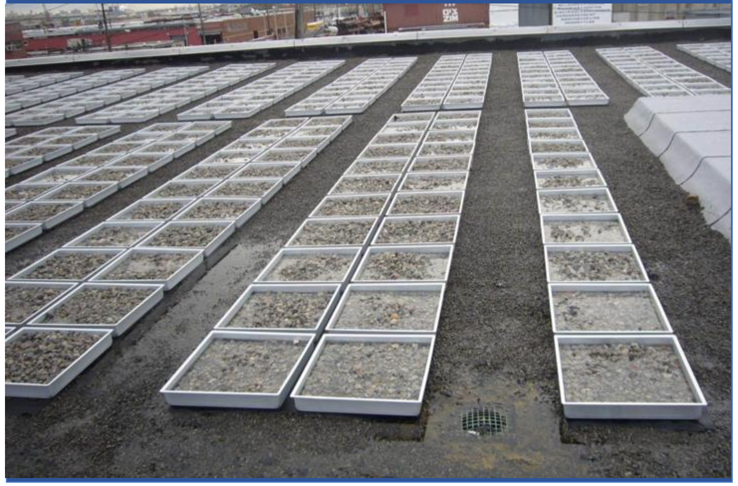


Tool box: Roof

White Roofs

- GOOD FOR RETROFITING
- PITCHED AND FLAT ROOFS
- ADDRESSES UHI
- Example: Washington Elms Apartments

Blue Roofs



- IDEAL FOR NEW/COMMERCIAL BUILDINGS
- FLAT ROOFS
- ~ 1 GALLON/SQ FT
- Example: Alexandria buildings in Kendall Square

Green Roofs

- IDEAL FOR NEW/COMMERCIAL BUILDINGS
- FLAT AND LOW PITCHED ROOFS
- UHI AND 0.9 GALLON/SQ. FT
- Example: Cambridge Center Roof Garden

Tool box: Ecosystem

Low SRI / Porous Pavement

- GREAT FOR PRIVATE PARKING LOTS AND DRIVEWAYS
- LOW SRI ADDRESSES UHI
- REDUCES RUN-OFF

Rain Garden

- GREATEST BENEFIT IS UHI REDUCTION
- CITY BEAUTIFICATION
- REDUCES FLOODING AND RUN-OFF

Trees

- ADDRESSES UHI
- TREE BOXES CAN REDUCE OR DIVERT FLOODING

Tool box: Infrastructure

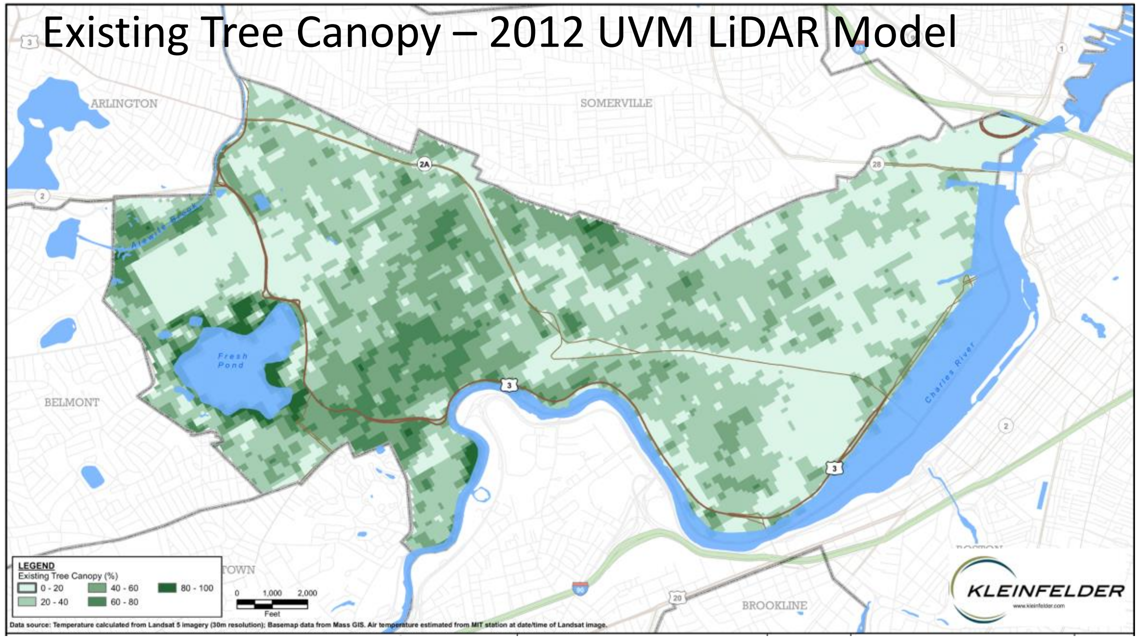
Stormwater Storage Tank

Holds water until there is more room in the sewer

Leaching Catch Basins

Move water off the surface of the street

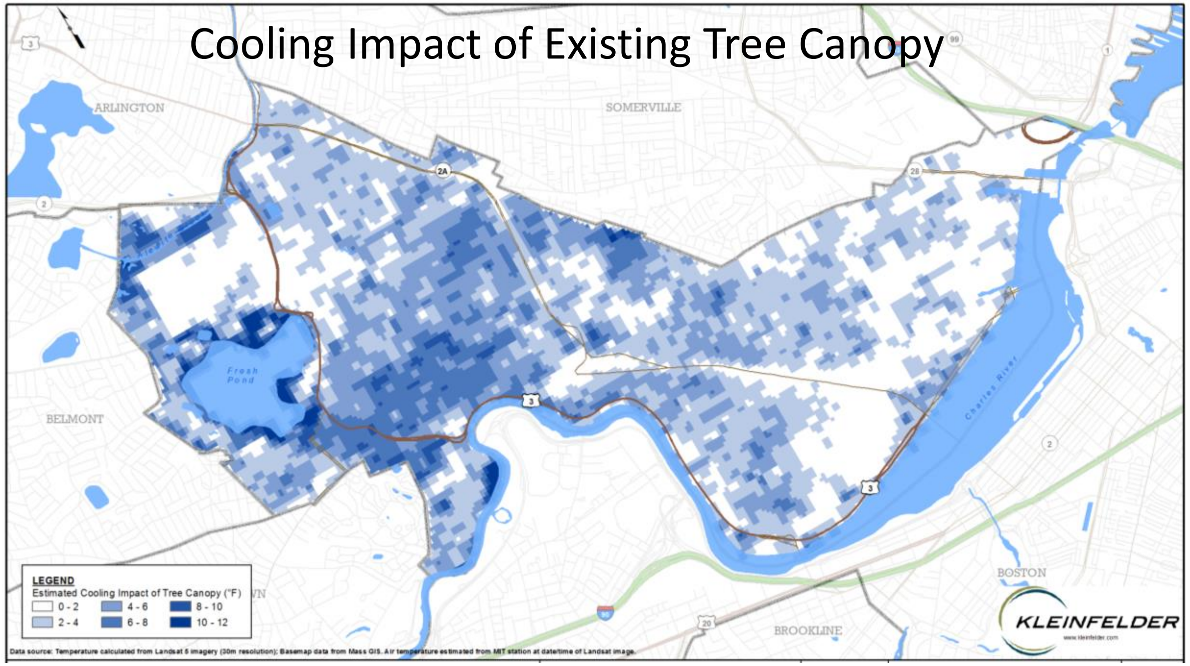
Estimating Cooling Impact of Existing Urban Forest Canopy



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



Source: Appendix D Urban Heat Island Protocol for Mapping Temperature Projections, Kleinfelder for the City of Cambridge, November 2015

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