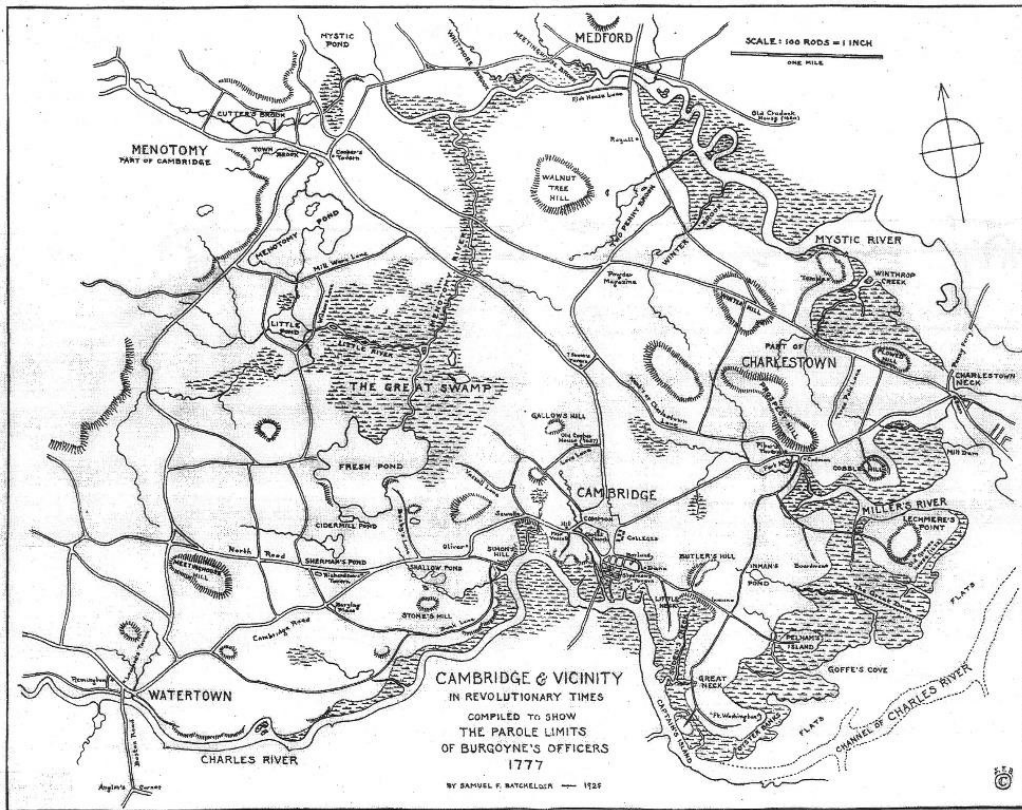


# Sea Level Rise / Storm Surge Protection

Indrani Ghosh, PhD  
Kleinfelder

Presentation as Part of Workshop “Responding to Local Climate Risk through Collaborative Action”  
Organized by Cambridge Compact for Sustainable Future and Kendall Square Association  
June 1, 2017

# Cambridge History



Cambridge – “The Great Swamp” [1777]



Cambridge – Alewife [1947]

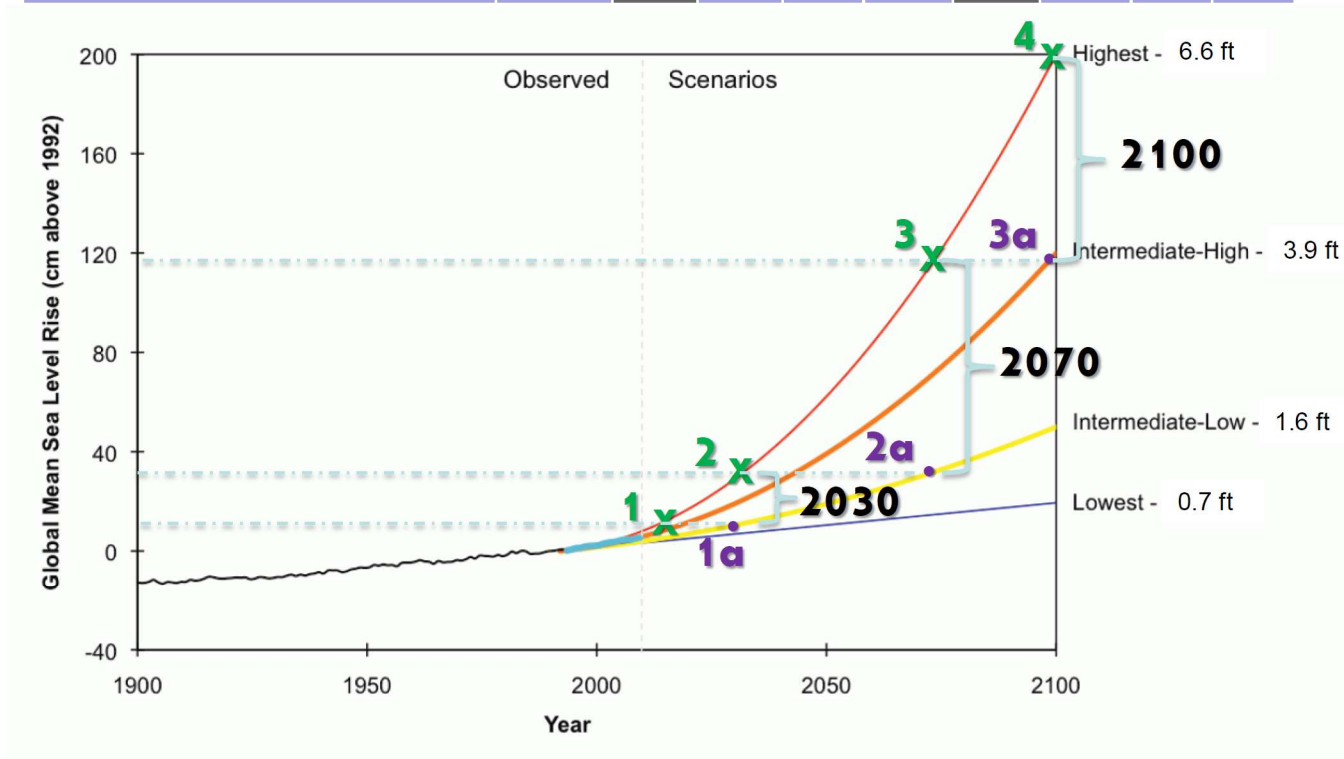


Alewife Brook channelized [1909]

**Alewife used to be tidal marshland**

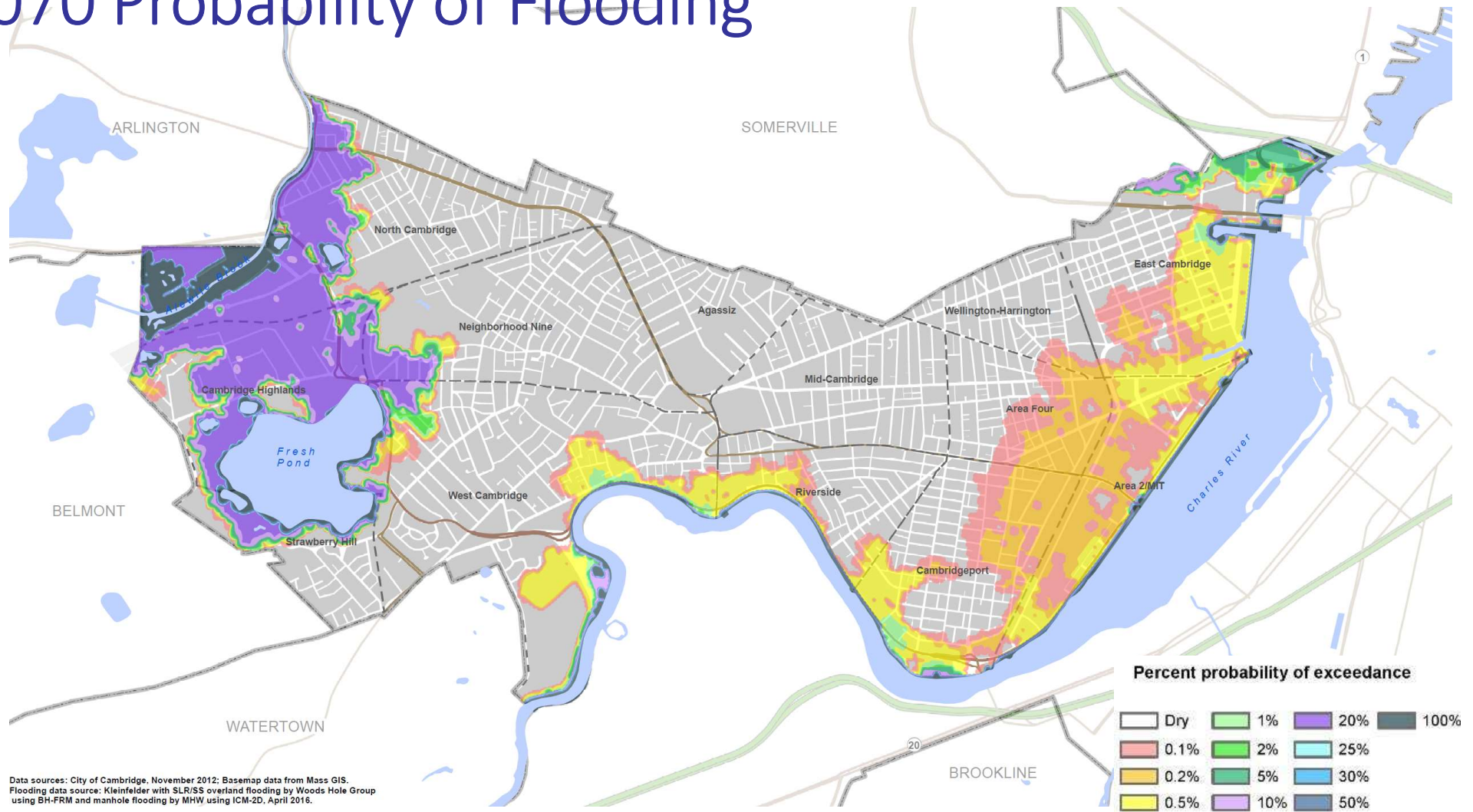
# Sea Level Rise Projections

Scenarios	2020	2030	2040	2050	2060	2070	2080	2090	2100
"Highest" Global SLR (from 2013-2020) (feet)	0.21	0.61	1.10	1.70	2.40	3.21	4.11	5.12	6.23
Land subsidence (feet) @ 0.003 ft/yr	0.02	0.06	0.09	0.12	0.15	0.19	0.22	0.25	0.29
"Highest" Relative SLR (from 2013-2020) - (feet)	0.24	0.66	1.19	1.82	2.56	3.39	4.33	5.37	6.52



NOAA (2012). Global Sea Level Rise Scenarios for the United States National Climate Assessment

# 2070 Probability of Flooding





# Flooding Impacts at the Dams



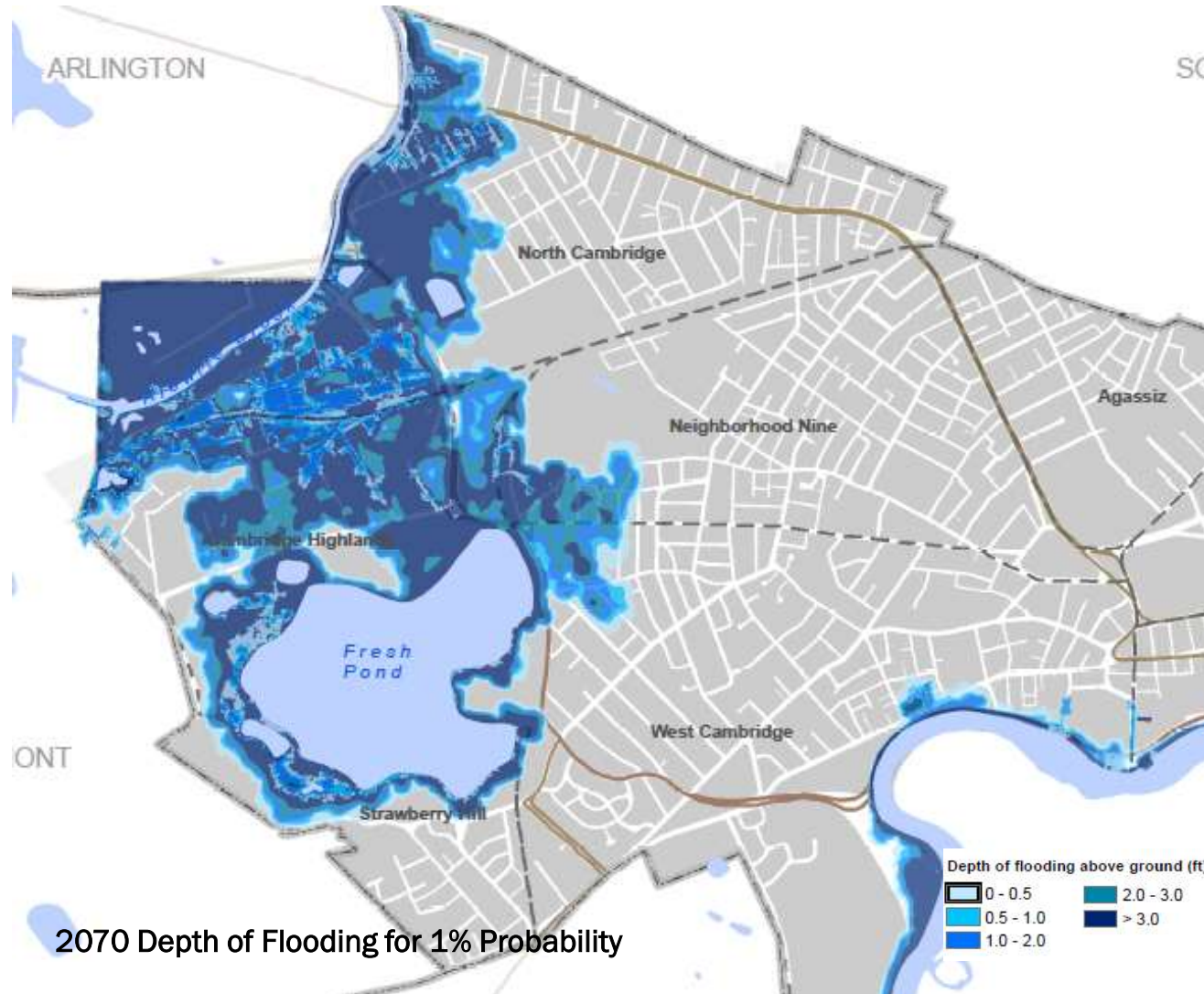
Amelia Earhart Dam

At 1% (100-yr):

- Flanked in 2045-2050
- Overtopped in 2055-2060

At 0.2% (500-yr):

- Flanked in 2030-2035
- Overtopped in 2040



# Flooding Impacts at the Dams



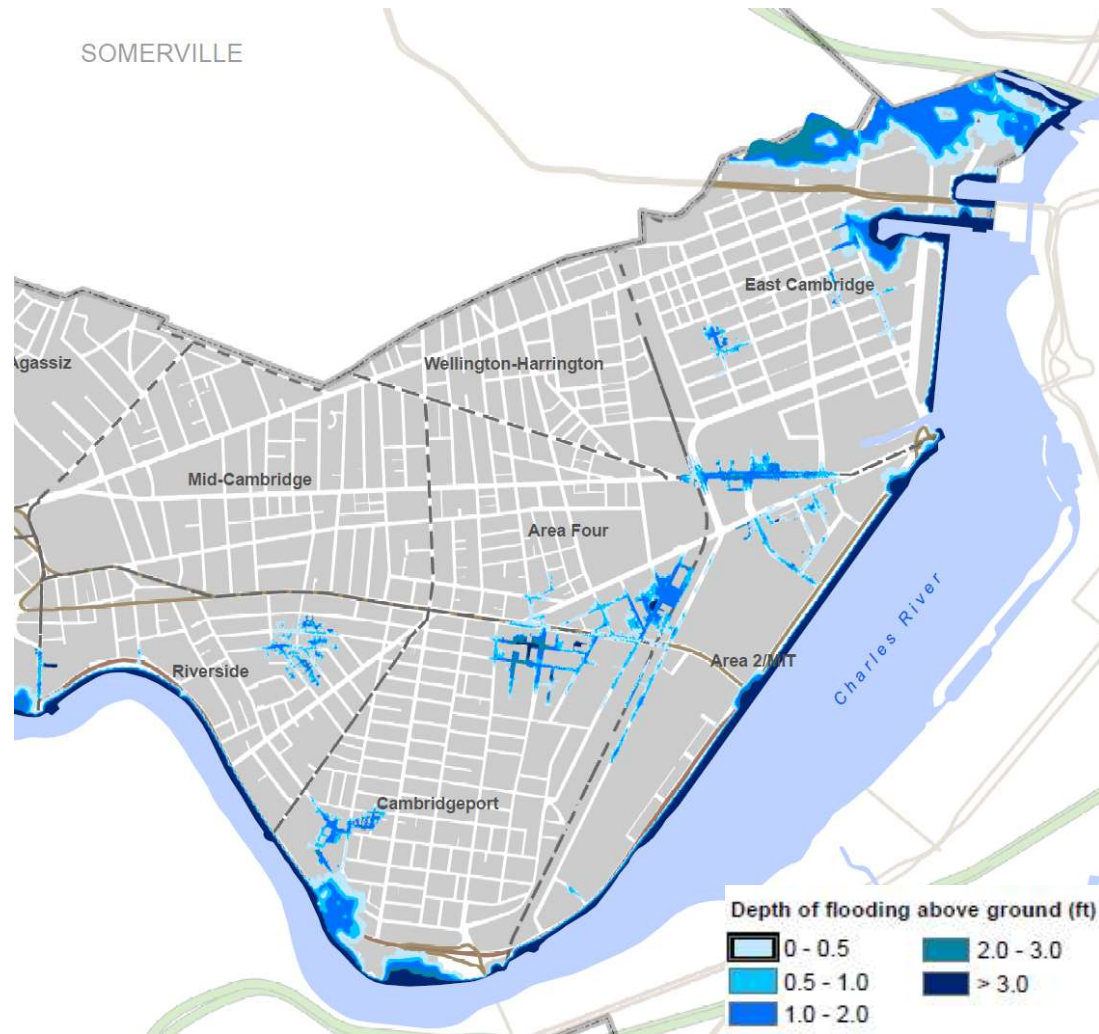
Charles River Dam

At 1% (100-yr):

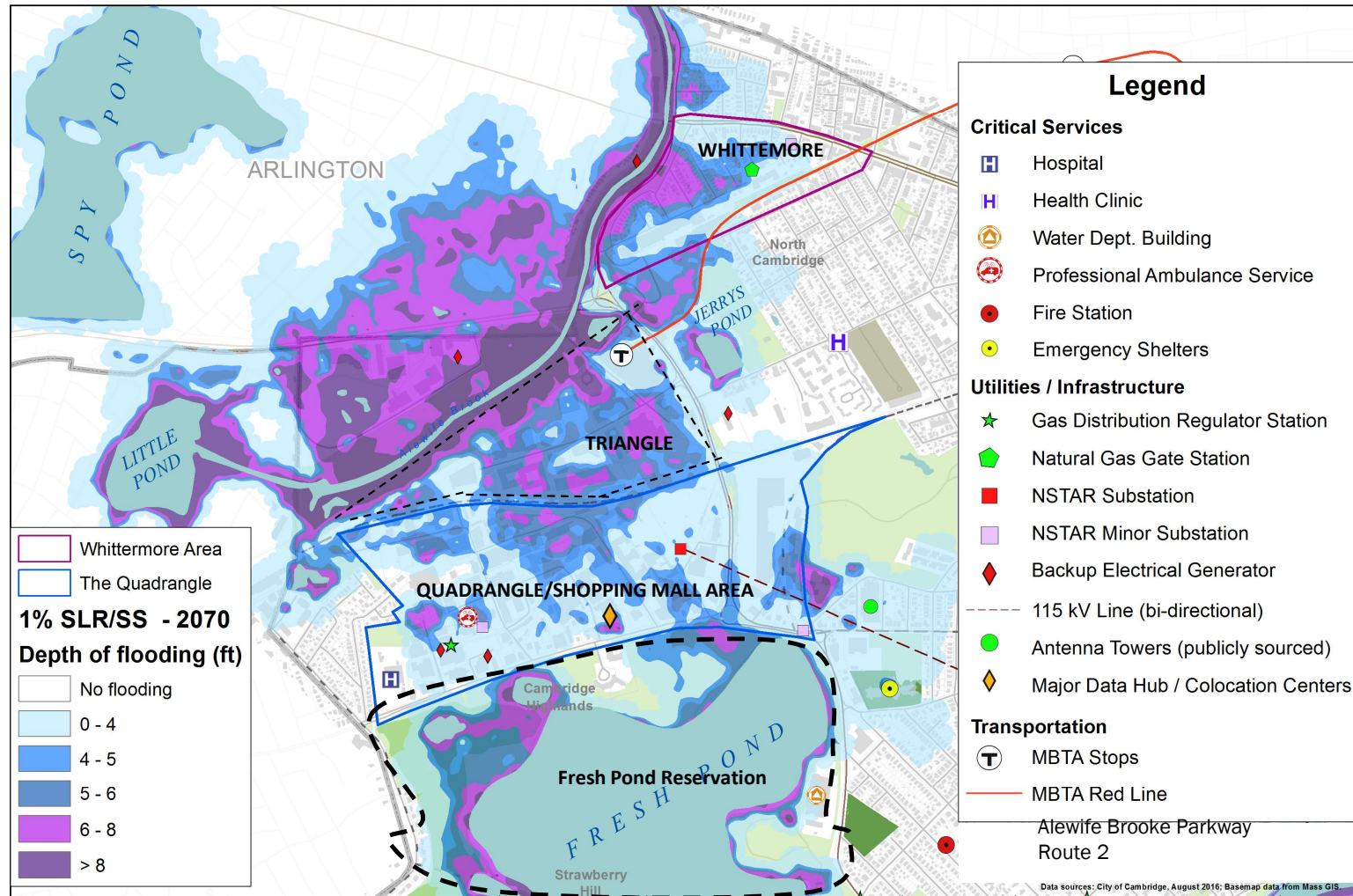
- Flanked in 2055-2060
- Overtopped in 2065

At 0.2% (500-yr):

- Flanked in 2045
- Overtopped in 2050



# Impacts on Critical Infrastructure and Services - Interdependencies





**100 Year Precip – 2070**

**Envision Test Plan**

- Residential
- Commercial
- Permitted Projects
- Recently completed (since 1995)
- Whittmore Area
- The Quadrangle

**2070 100-Year 24hr Precip Flooding**

**Depth of flooding (ft)**

- No Flooding
- 0 - 0.5
- 0.5 - 1
- 1.0 - 2.0
- 2.0 - 3.0
- 3.0 - 4.0
- 4.0 - 5.0
- 5.0 - 6.0
- 6.0 - 7.0
- 7.0 - 8.0
- > 8.0

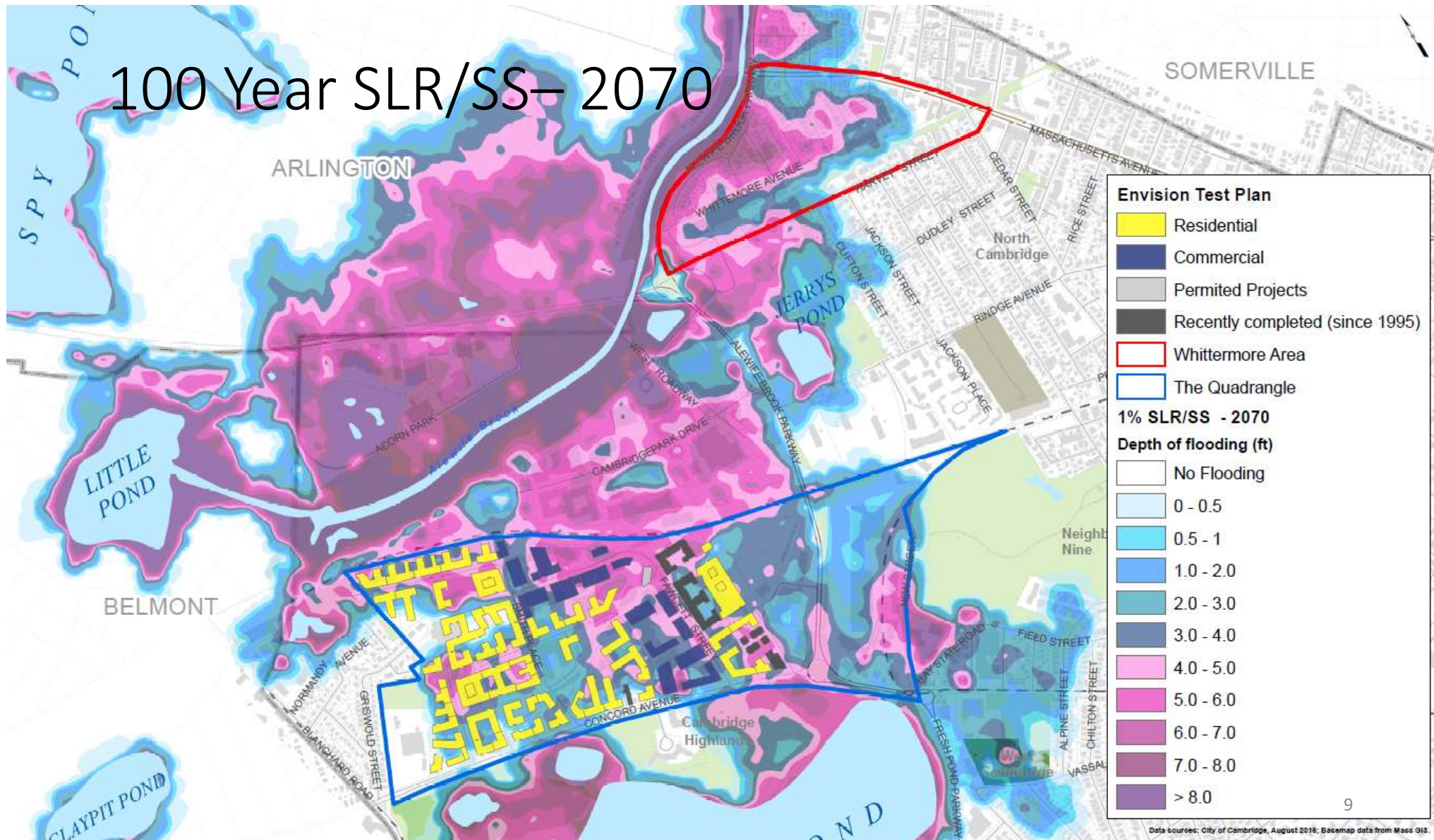
Map labels include: ARLINGTON, BELMONT, SOMERVILLE, JERRY'S POND, LITTLE POND, CLAYPIT POND, WHITTEMORE AVENUE, JACOBSON STREET, DUDLEY STREET, CEDAR STREET, RICE STREET, MASSACHUSETTS AVENUE, NORTH CAMBRIDGE, RINDGE AVENUE, JACKSON PLACE, WEST ROADWAY, CAMBRIDGE PARK DRIVE, ALPINE STREET, CHILTON STREET, VASSAL LANE, FRESH POND PARKWAY, BAY STATE ROAD, FIELD STREET, CONCORD AVENUE, CAMBRIDGE HIGHLANDS, GRISWOLD STREET, BLANCHARD ROAD, NORMANDY AVENUE, ACORN PARK, ALEWIFE BROOK, and SPY POND.

Data sources: City of Cambridge, August 2016; Basemap data from Mass GIS.

Data sources: City of Cambridge, August 2016; Bacemap data from Mass GIS.



# 100 Year SLR/SS– 2070

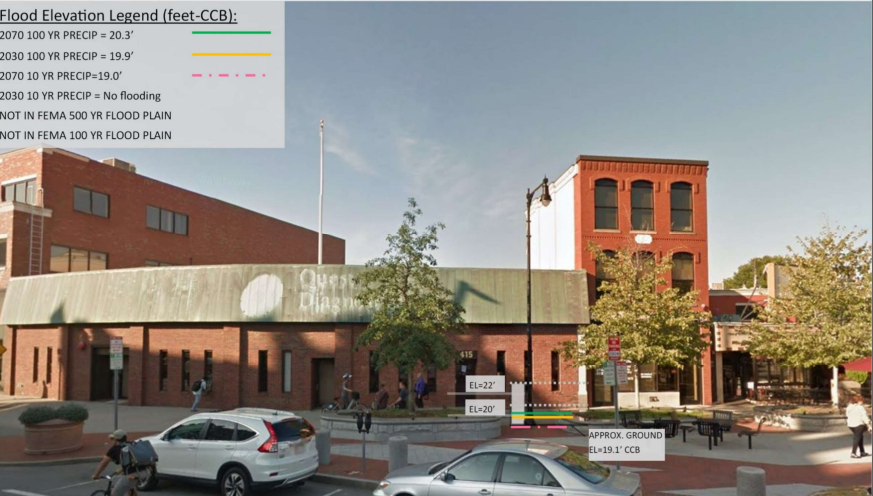




# The Challenge



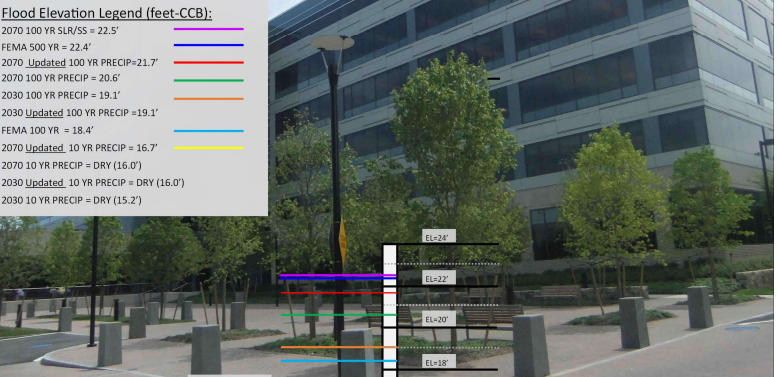
Mass+Main Development



Massachusetts Ave. and Alewife Brook Parkway



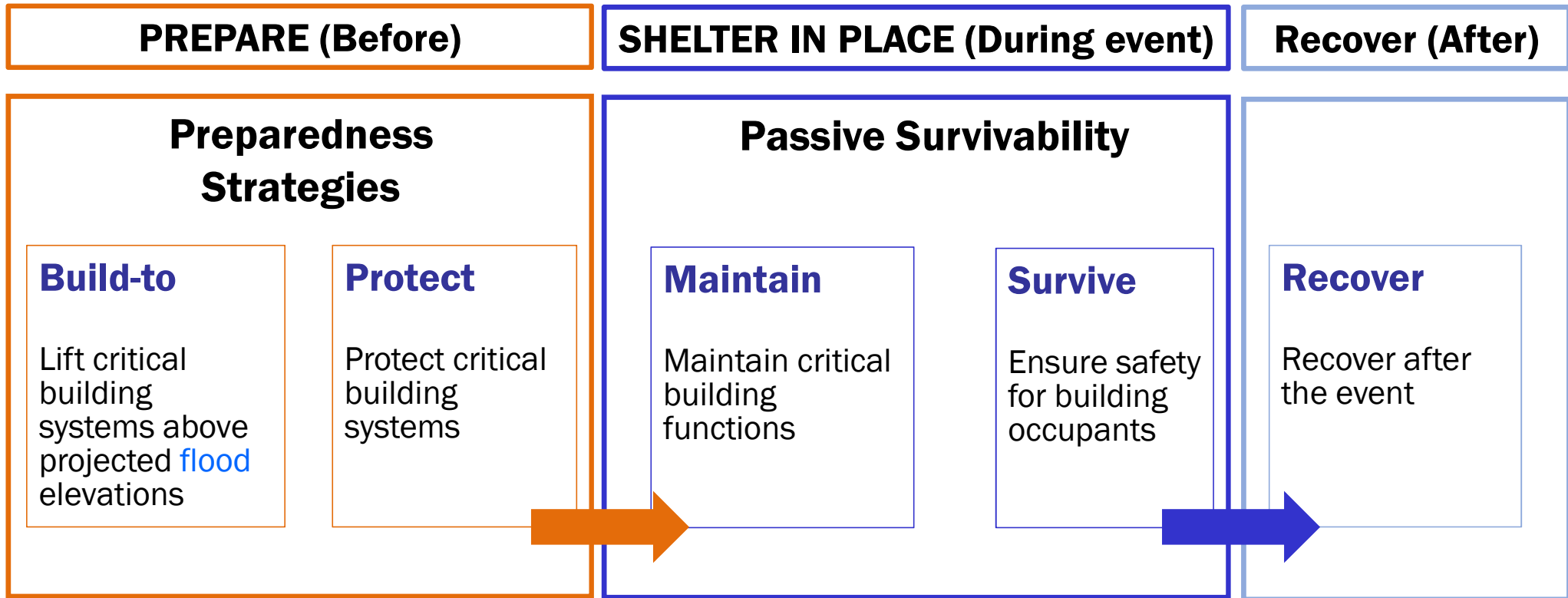
C. ACORN PARK DRIVE FLOOD ELEVATIONS



# Types of Resiliency Strategies

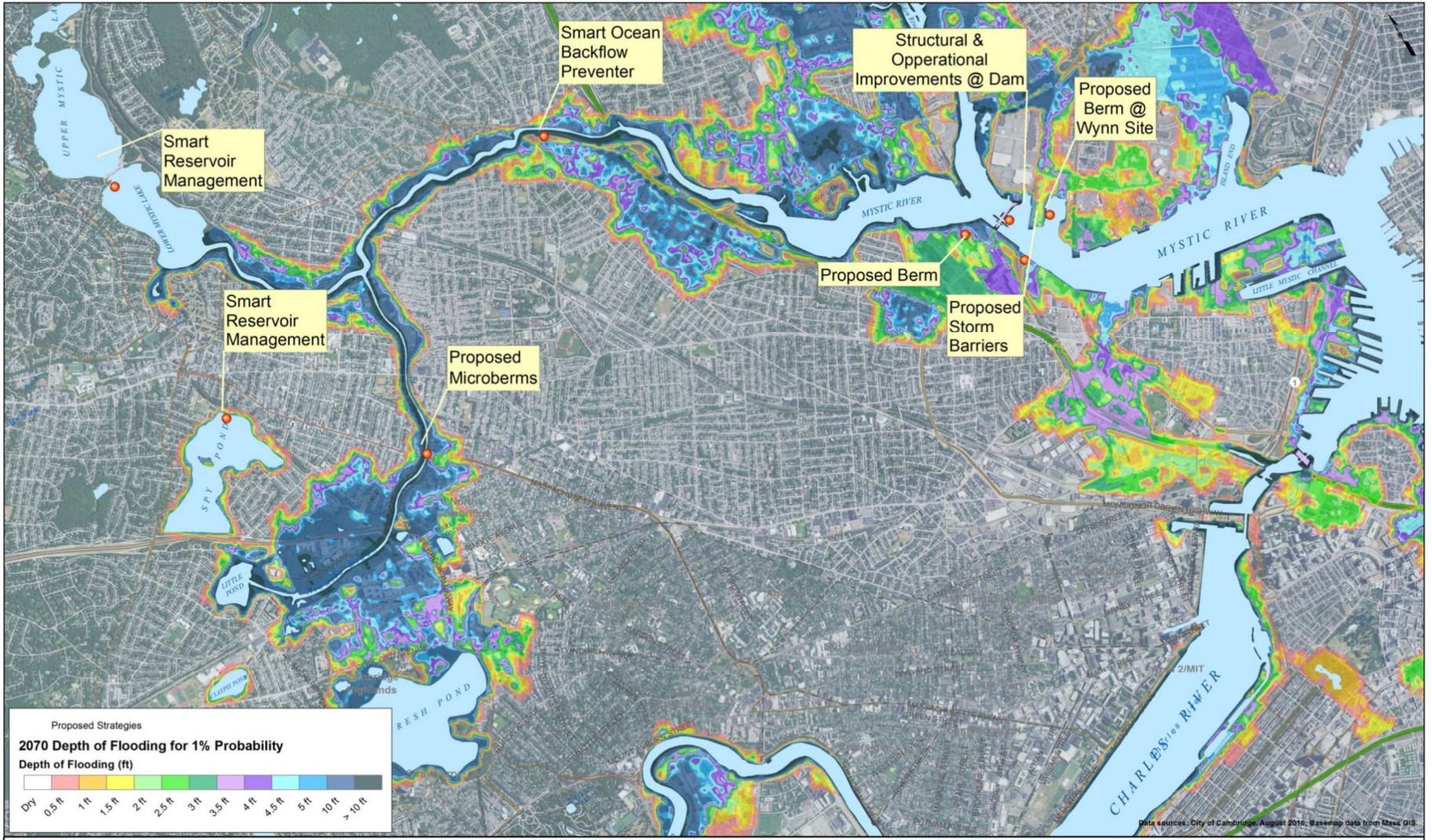
Resilience is the capacity to recover quickly from difficulties; toughness.

Preparedness is the quality or state of being prepared.



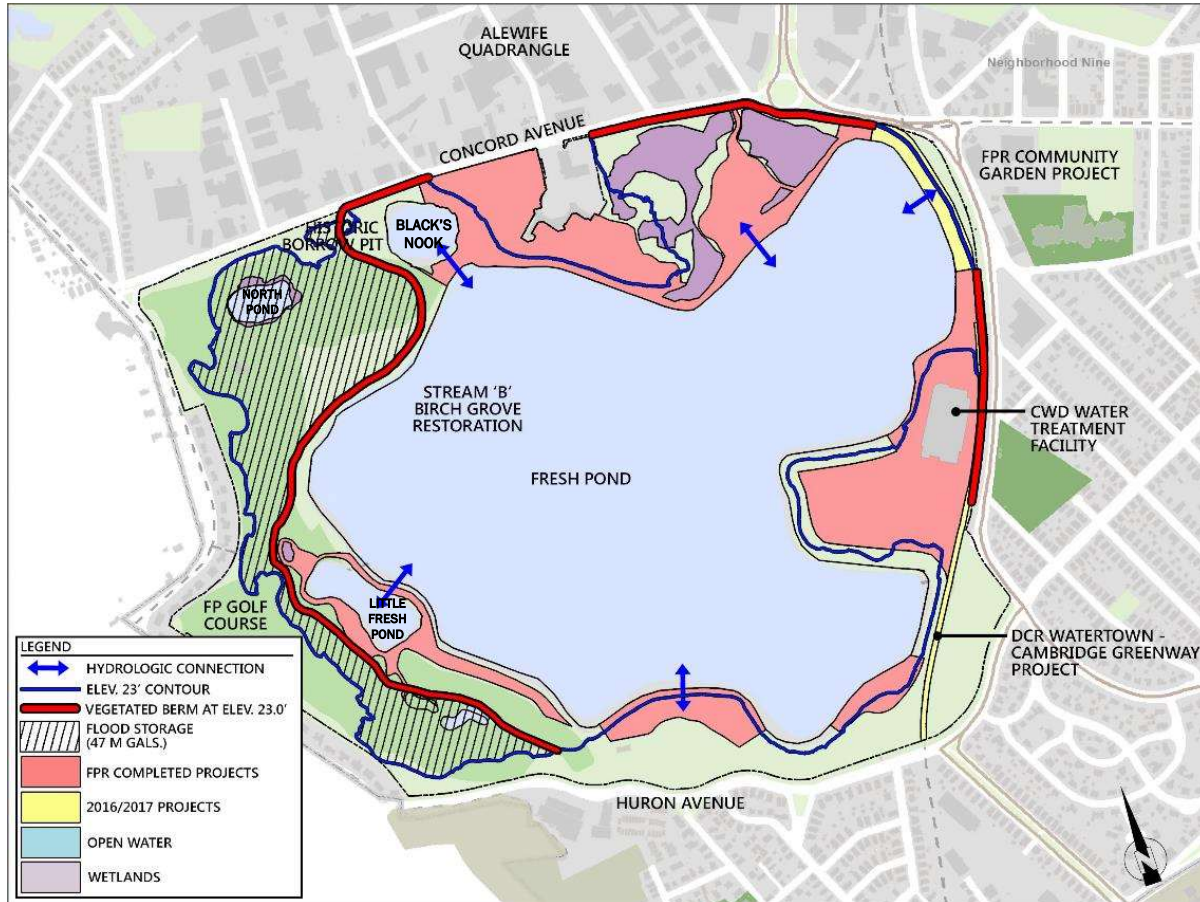


# Regional Scale Interventions





# Neighborhood Scale Interventions



*\*Note: Minimum available storage is based on capacity lost due to 100-yr 2070 precip flooding, and maximum storage is based on capacity lost due to 10-yr 2030 precip flooding at these locations.*

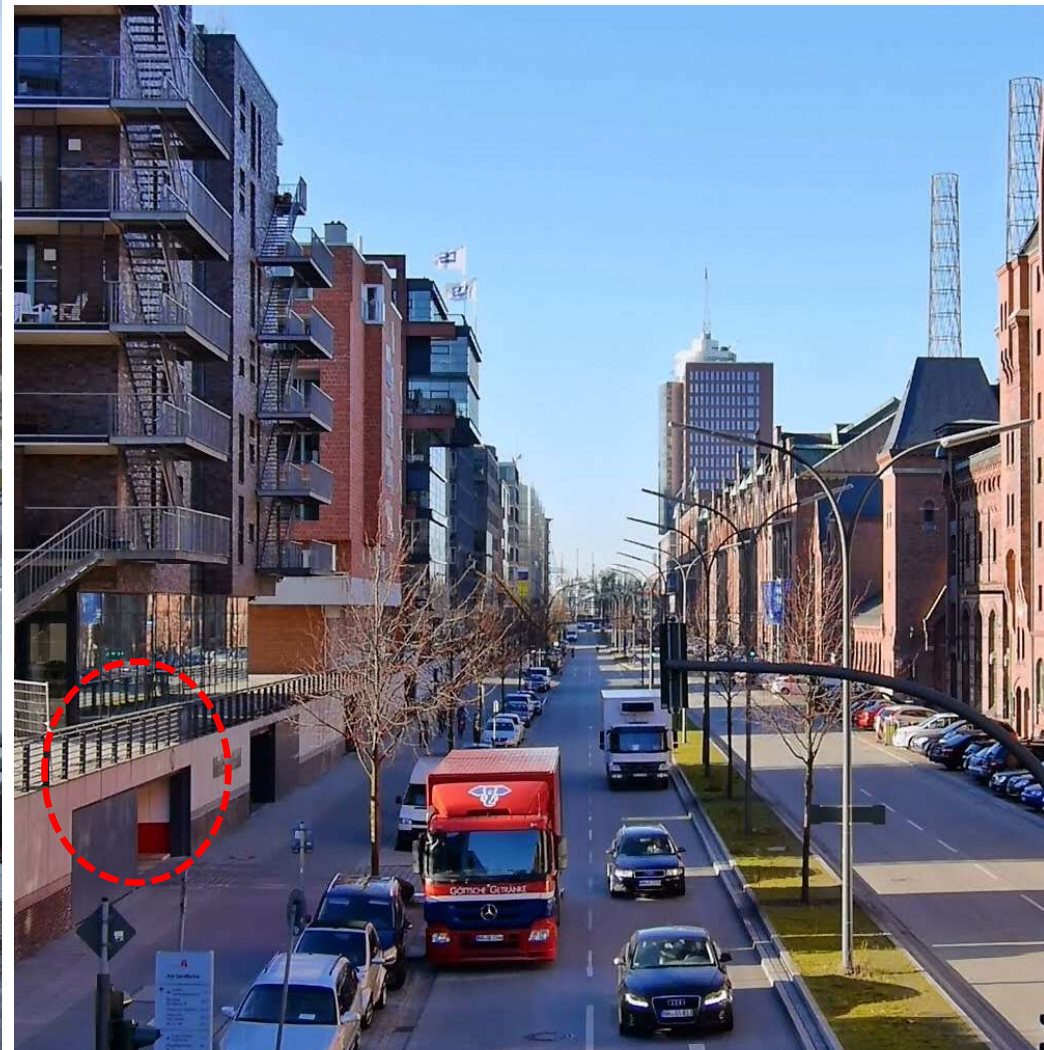
Protect Fresh Pond from 1%  
2070 Storm Surge Flood  
Event



Sketch of the Proposed Berm (TOB 23.15')  
at Fresh Pond Golf Course



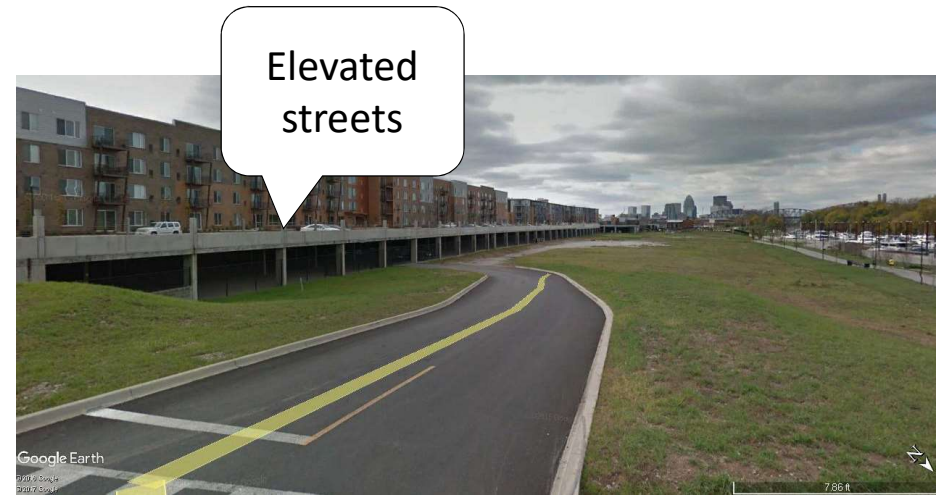
# Protect



FULLY ELEVATED MIXED-USE BUILDING HAFEN CITY HAMBURG

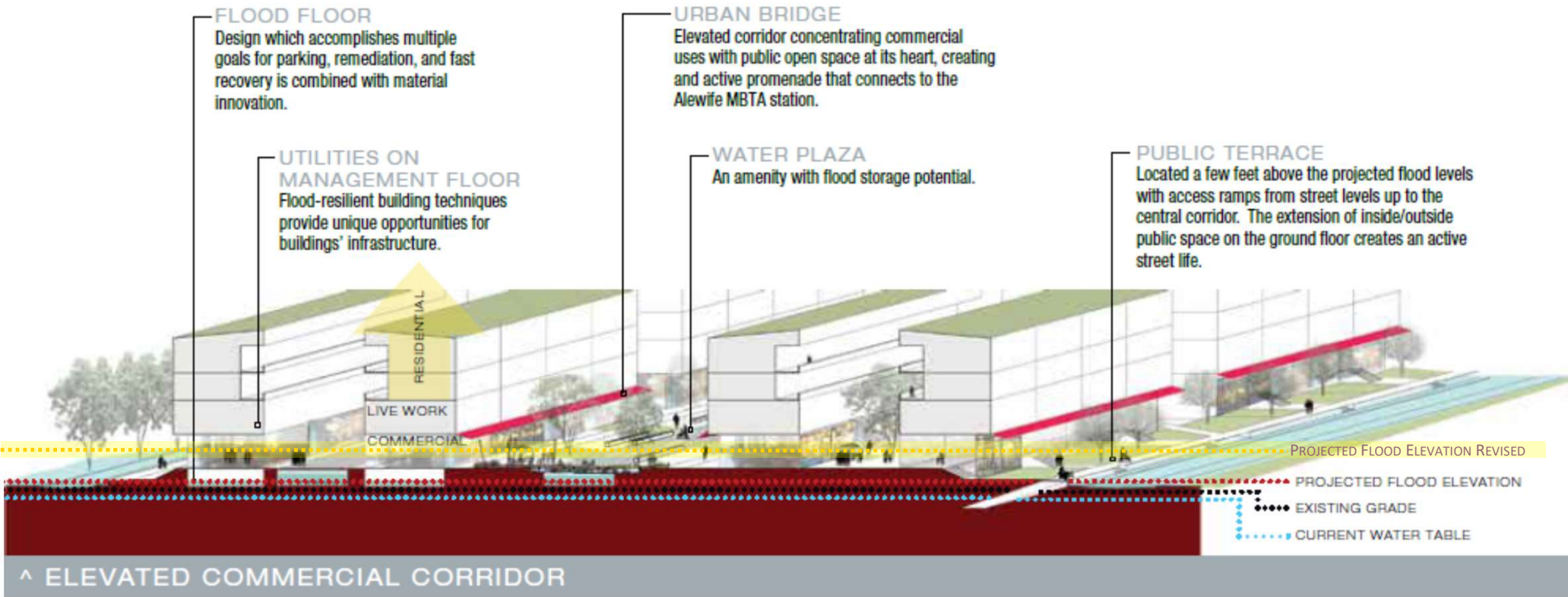


## Build to



FULLY ELEVATED WITH ELEVATED STREETS: RESIDENTIAL LOUISVILLE, KY

# Build-to/Protect



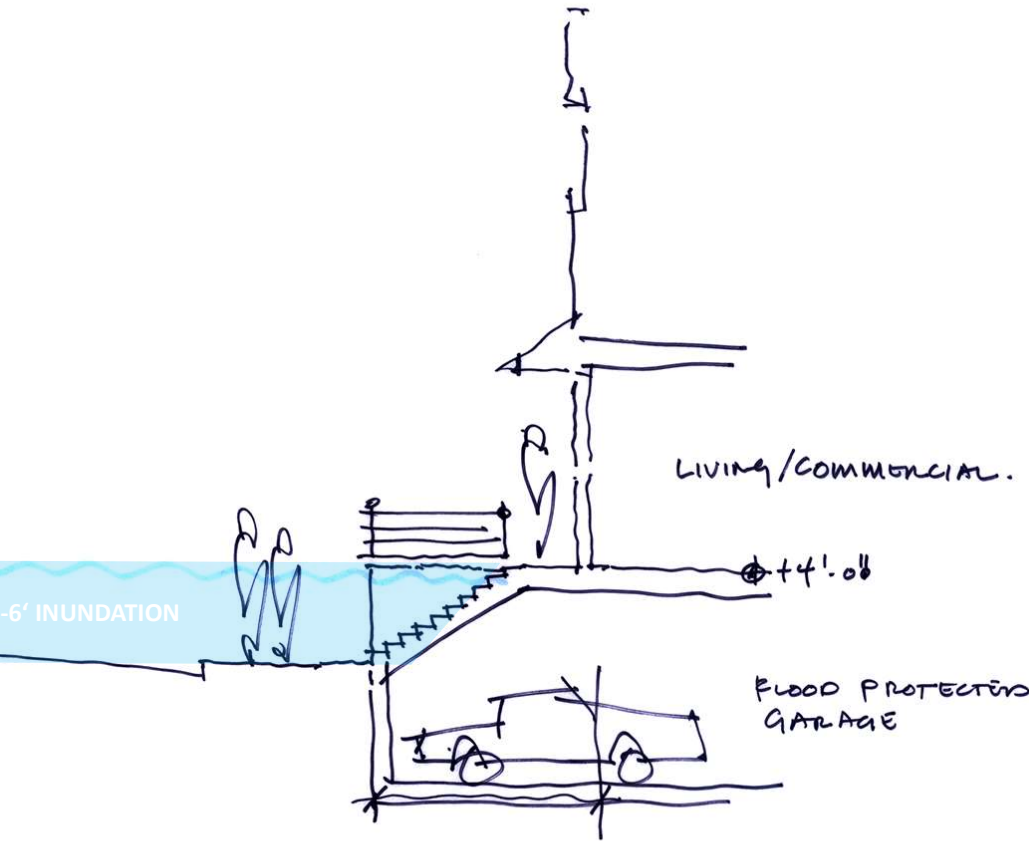
**ABOVE** The Elevated Commercial Corridor section depicts an infrastructure strategy that constructs an activated pedestrian route that increases in elevation to ultimately bridge across the MBTA commuter rail lines.

*Image credit: Ager Group The Boston Studio*

[http://boston.uli.org/wp-content/uploads/sites/12/2012/04/ULI\\_LivingWithWater-Final1.pdf](http://boston.uli.org/wp-content/uploads/sites/12/2012/04/ULI_LivingWithWater-Final1.pdf)



Build-to/Protect



\* REQUIRES ANCHORING TO PREVENT FLOTATION





## Build-to/Protect

### Case Study: American Copper Buildings

- Two residential buildings with a total of 760 apartments
- Located along East River in NYC
- Lobby walls use stone to prevent flood damage
- Stormwater detention pit under basement floor
- Mechanical systems on 2<sup>nd</sup> floor
- Five natural gas emergency generators on 48<sup>th</sup> floor



## B1. Retrofit existing building/ parcel for enhanced flooding protection





## B1. Retrofit existing building/ parcel for enhanced flooding protection



**Dry Floodproofing**



# Conceptual Framework

