Onwards from Climate Change Assessment to Implementation – City of Cambridge

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Cambridge Sustainability & Resiliency Timeline

1999: City of Cambridge joined ICLEI

DECEMBER 2002: City Council adopts Cambridge Climate Protection Plan

2003: Cambridge signs U.S. Mayors’ Climate Agreement

AUGUST 2002: 9-day heat wave hits metro Boston

2005: “Superstorm” Sandy wreaks havoc up the east coast

2008: City Council and citizens hold Climate Emergency Congress

2009: IPCC Report (AR4) warns some climate changes may be abrupt and irreversible

SEPTEMBER 2007: IPCC Report (AR4) warns some climate changes may be abrupt and irreversible

2011: Cambridge Climate Change Report kick-off

2012: OCTOBER 2012: City Council creates “Getting to Net Zero” Taskforce

2014: 2014 becomes hottest year on Earth on record beating out 2010

2015: Cambridge presents results of its climate change vulnerability assessment and preparedness plan

MAY 2013: Kendall Square Eco District & Compact for a Sustainable Future

JULY 2010: Intense rainfall causes severe flooding in Cambridge
Project’s Framework

Phase I: Vulnerability Assessment

Step 1
Climate Scenarios

Step 2
Vulnerability & Risk Assessment

Step 3
Preparedness Plan
Climate Scenarios

Temperature

Precipitation

Sea level rise

More extreme events
The Challenge

• Design criteria based on past events.

• Past is no longer a reliable indicator of present or future conditions.

How do you translate climate risk into planning and design?
Observed change in very heavy precipitation events (defined as the heaviest 1% of all daily events) from 1958 to 2012.
Source: Walsh et al. 2014a
Precipitation Projections

### Precipitation Projections (per 24 hr. event)

- **1971-2000 (Baseline)**
- **2015-2044 (2030s)**
- **2055-2084 (2070s)**

- **10-Year**
- **25-Year**
- **100-Year**

### Key Points
- Today’s 100 yr. storm comparable to 2070s 25 yr. storm.
- Today’s 25 yr. storm will be comparable to 2070s 10 yr. storm.

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**Inches of Water Per Storm**

- **0**
- **5**
- **10**

**Years**

- **1971-2000**
- **2015-2044**
- **2055-2084**
Expected Flooding Volume

Present 10-yr storm

10-yr storm by 2030
Additional 17 MG Flood Volume

100-yr storm by 2030
Additional 200 MG Flood Volume

Source: Kleinfelder, City of Cambridge Climate Change Preparedness & Resiliency (CCPR) Plan, November 2016
Expected Flooding Volume

Source: Kleinfelder, City of Cambridge Climate Change Preparedness & Resiliency (CCPR) Plan, November 2016
Increased Temperature and Urban Heat Island

Heat Index - Present Conditions
Heat Index - 2030s Scenario
Heat Index - 2070s Scenario

LEGEND:
Heat Index (°F)
-80
[80 - 90]: Caution
[90 - 103]: Extreme Caution
[103 - 124]: Danger
Identifying Critical Assets & Resources

The Built Environment
- Energy
- Transportation
- Water
- Telecommunication
- Critical Services
- The Urban Forest

The Social Environment
- Public Health
- Community Resources
- Vulnerable Population
- Economic Impact
Vulnerability and Risk of Urban Infrastructure & Services

**Flooding Stress Test**
- **Water**
  - Fresh Pond Reservoirs
- **Stormwater**
  - Low St Pump Station
- **Roadway**
  - Concord Ave, Broadway
  - Memorial Drive, Main St, Gilmore Ave, Driscoll St
- **Transit**
  - Airport/South, Porter/Mass Ave Line
  - Central Square St, JFK Jr Blvd
- **Critical Services**
  - Water: Water District, Fire Company 2
  - Gas: District
- **Energy**
  - North Cambridge Substation
  - Substation at New Boston
- **Telecom**
  - City Emergency Center

**2070 Scenario 15.7 inches rainfall in 24 hours**

**Heat Stress Test**
- **Water**
  - Storm Water
- **Roadway**
  - Porter/Storrow Drive Line
  - Harvard/Central Main Line
  - Central Square Station
- **Critical Services**
  - Police: Headquarters
- **Energy**
  - High Voltage Transformer Station

**2070s Scenario Estimated Ambient Temperature on 100 °F Day**
Climate Change Priority Planning Areas
Key Findings of CCVA Part 1

- **Heat vulnerability** and **inland flooding** are more imminent.
- **Social vulnerability** is not evenly distributed among neighborhoods or households
  - Heat stress, heat-sensitive disease, critical services, indoor air, food safety, housing/shelter, communications
- **Key infrastructure assets** are vulnerable in the near-term.
- **Economic losses** from a flood event or an area-wide power loss would be significant.
  - Disruption of **economic** activity could be greater than property damage.
- **Adaptation** will require coordination with other entities
Sea Level Rise and Storm Surge
Boston Harbor Flood Risk Model
Sea Level Rise Projections

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

NOAA (2012). Global Sea Level Rise Scenarios for the United States National Climate Assessment
2070 Depth of Flooding for 1% Probability

Scenario for Vulnerability and Risk Assessment
SLR/Storm Surge + propagation through piped infrastructure

Source: Kleinfelder based on WHG & MWH analyses, October 2015
Comparison of Storm Surge and Precipitation Flooding

Extent of flooding from 1% flood by 2070 with SLR and storm surge and propagation through piped infrastructure (no rain)

Extent of flooding from 100-yr 24 hr rain storm by 2070
Flood Elevations

Flood Elevation Legend (feet-CCB):
- 2070 100 YR SLR/SS = 22.5 FT
- FEMA 500 YR = 22.4 FT
- 2070 100 YR PRECIP = 20.56 FT
- 2030, 100 YR PRECIP = 19.84 FT
- FEMA 100 YR = 18.42 FT

Approx. Ground EL = 17.99 FEET CCB

EL = 22' and EL = 24'
What We Learned About SLR/ Storm Surge

- Dams effectively protect Cambridge until at least 2030
- Both dams would be flanked before they are overtopped. For the 1% probability level (100-yr flood) by 2070, both dams are overtopped.
- Ability of the dams to pump after an event will affect the duration of flooding in the City
- Storm surge risks more significant in
  - Alewife/Fresh Pond area by 2050
  - North Point area by 2070
- Storm surge flooding would be a new experience for Cambridge
Goals and Objectives [CC Preparedness & Resiliency Plan]

• Provide a **vision for a climate-resilient Cambridge**

• Propose a **realistic set of strategies and recommended actions** to guide the City, stakeholders and community in implementing the goals of the Plan.

• **Engage the community** to help understand the strategies and the level of effort needed to create a climate-resilient and prepared community that engages stakeholders and residents in the development of recommended actions.

• **Program early actions for area(s) of focus:** Alewife Area by conducting pilot study early in the process.
Scale of Interventions

Regional [R], Neighborhood [N], Sub-neighborhood [SN] & Parcel [P]
N1: Reduce Urban Heat Island (UHI) effect by increasing tree canopy in Alewife areas deprived of vegetation. This will also improve stormwater management.
N2: Continue Sewer Separation in Alewife Area to Reduce Flooding and Adverse Public Health Impacts
SN1: Apply the “2030 25:2” Compensatory Flood Storage Requirement at the Sub-Neighborhood Scale

The peak flow from the site for the 2030 25-year storm under post-development conditions should be less than or equal to the present 2-year storm under pre-development conditions.
SAMPLE QUADRANGLE PARCEL: EXISTING COMMERCIAL PARCEL

SAMPLE QUADRANGLE PARCEL: NEW DEVELOPMENT UNDER CURRENT CODE

SAMPLE QUADRANGLE PARCEL: NEW DEVELOPMENT WITH INTEGRATED RESILIENCY STRATEGIES
1. Use flood resilient materials
2. Build exterior floodwalls
3. Install backwater valves
4. Elevate / relocate utilities

**Parcel [P] Scale: Retrofit Existing Development**

**Revised requirements (larger storage)**

<table>
<thead>
<tr>
<th>Volume Requirement</th>
<th>Volume (gallons)</th>
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<tbody>
<tr>
<td>25:2 Present</td>
<td>564</td>
</tr>
<tr>
<td>25:2 2030</td>
<td>880</td>
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**How it can be achieved**

<table>
<thead>
<tr>
<th>POSSIBLE GI BMP</th>
<th>Volume Stored (gallons)</th>
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<tbody>
<tr>
<td>Rain Barrel - 2</td>
<td>100</td>
</tr>
<tr>
<td>Above-ground Planter</td>
<td>75</td>
</tr>
<tr>
<td>Bioretention Basin</td>
<td>1,047</td>
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<tr>
<td>Total Stored</td>
<td>1,222</td>
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Continue coordination on regional climate resiliency efforts:

- Dam operations (DCR)
- Reducing runoff across community boundaries (ABC Flood Group)
- Explore shared responses to sea level rise and storm surge (Metro Boston Climate Preparedness Task Force)
- Ongoing flooding analyses (e.g., concurrent studies of the Mystic River, such as Senator Brownsberger’s Project)
Thank You for your attention!

Link to Project information on City of Cambridge website:
http://www.cambridgema.gov/CDD/Projects/Climate/climatechangeresilienceandadaptation.aspx
How to assess vulnerability & risk for assets?

- **Exposure**: Direct contact with hazard (flood/heat)

- **Vulnerability**: function of asset *Sensitivity* and *Adaptive Capacity* in relation to *Exposure*

- **Risk**: function of *Probability of Occurrence* and *Consequence of Failure*
Flood elevations