Appendix C

Report on Historic Rainfall Events

CCVA

Climate Change Vulnerability Assessment

City of Cambridge, Massachusetts

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Acknowledgements

City of Cambridge

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For more information on the project, please visit the City website at *http://www.cambridgema.gov/climateprep*

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Historic Rainfall Events

Drainage and flood protection systems owned by the City, State (MWRA), and private residents and businesses have been designed to withstand more commonly occurring storm events, such as those that happen every 2, 5, 10, or even 25 years, where rainfall is distributed over a period of 24 hours. However, in recent history there have been several instances where drainage systems and river floodplains have been overwhelmed by both long-duration low-intensity and short-duration high-intensity rainstorms, resulting in widespread flooding.

March 2010 Floods

The most severe recent flooding occurred during the long-duration low-intensity rainfall events of March 2010, when the City of Boston broke the record of 11 inches of rain set in 1953. During the month of March of 2010, a new total of 14.83 inches of rainfall accumulation was officially recorded by the National Weather Service (NWS). The weather pattern that caused these floods consisted of early springtime prevailing westerly winds that moved three successive storms, combined with tropical moisture from the Gulf of Mexico, across New England. Torrential rain falls lasting ten days caused March 2010 to be the wettest month on record for the City of Boston.

July 10, 2010 Flood

The short-duration high-intensity “cloud burst” event of July 10, 2010 caused significant flooding in Cambridge, considered to be one of the most severe floods in recent memory. It is specifically documented here to illustrate how such a storm could impact Cambridge. The flood was caused by an extremely intense storm event that dropped 3.58 inches of rain on Cambridge in only an hour, according to City records.[1] A rainfall event of that intensity has historically only happened on average every 100 to 200 years. That means the historic likelihood of such an event occurring in any given year is between one and one-half of a percent. Figure 1 compares the amount of rainfall distributed over time for this event with that of the City’s 25-year (4% annual chance) 24 hour design storm.

The City of Cambridge Department of Public Works responded to this flood event by conducting an area-wide flooding assessment of combined sewer overflow regulators along the Charles River. This assessment was carried out on baseline conditions to recommend outlet modifications for flood impact reductions.

[1] Memo on the July 10, 2010 Flooding from Public Works Commissioner and City Engineer to City Manager dated 09/08/2010

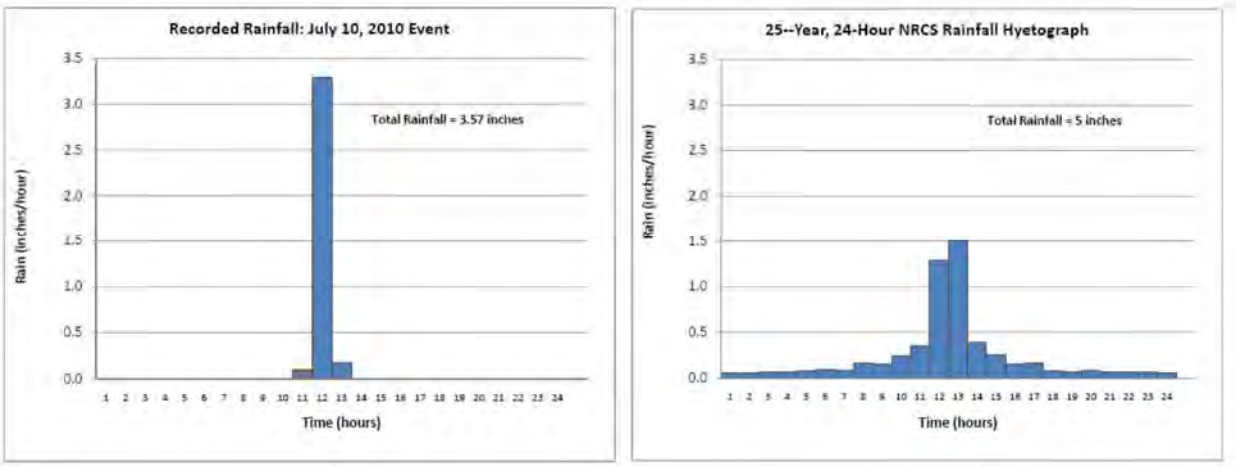


Figure 1: Comparison of the July 10, 2010 storm rainfall and Cambridge's 25-Year, 24-Hour design storm (Source: City of Cambridge[2])

Roadways, basements, and even cars were flooded in neighborhoods throughout the city, as documented in the maps and images presented in Figures 12 – 23. Surface flooding was greatest in topographically low areas of the City, where water flowed and subsequently ponded, and where the amount of surface runoff exceeded the drainage systems' capacities. This resulted in damage to public infrastructure such as roadways and storm drains, as well as to private property located at or below ground level, including buildings, vehicles, and their contents.

Areas of the City where sewage and stormwater are collected and conveyed in the same pipe system were also overwhelmed, causing overflows into streets and waterbodies and "back-ups" into buildings. Back-ups are when combined waste water actually flows out of toilets and other openings in the domestic sewer system instead of into them due to the pressure created by the system filling up with stormwater. Back-ups are a particularly common problem for below ground living and working spaces in the City that do not have adequate plumbing protection equipment ("backflow preventers") installed. In 2010, 58% of the City was connected to combined sewer and stormwater systems, while much of the rest of the City's systems acted much like a combined system would due to flaws in the design used during the era in which they were built (1920s-1930s).[3]

Figure 2 shows the locations from which telephone and email reports of surface flooding, back-ups, and other impacts were sent to the City's Department of Public Works (DPW) in the aftermath

[2] Memo on the July 10, 2010 Flooding from Public Works Commissioner and City Engineer to City Manager dated 09/08/2010
[3] Memo on the July 10, 2010 Flooding from Public Works Commissioner and City Engineer to City Manager dated 09/08/2010

of the July 2010 storm. Reports of flooding came from all 13 Cambridge neighborhoods. However, very few reports (one report of surface flooding each) were made from Area 2/MIT and Cambridge Highlands. Of the 243 calls and emails received by the DPW, approximately 40% reported sewer backups, 38% reported overland flooding, and 22% reported flooding impacts without identifying a specific cause.[4]

In the maps and photographs that follow (Figures 3 - 13), further evidence is provided supporting the geographic distribution of flooding impacts captured in Figure 2. In addition, a cross-comparison revealed that the record of where surface flooding and backups were reported during the July 2010 flood closely matched the locations identified in the City's 2008 Annex to the Metro-Boston Multi-Hazard Mitigation Plan as having been impacted by previous floods.

[4] Memo on the July 10, 2010 Flooding from Public Works Commissioner and City Engineer to City Manager dated 09/08/2010

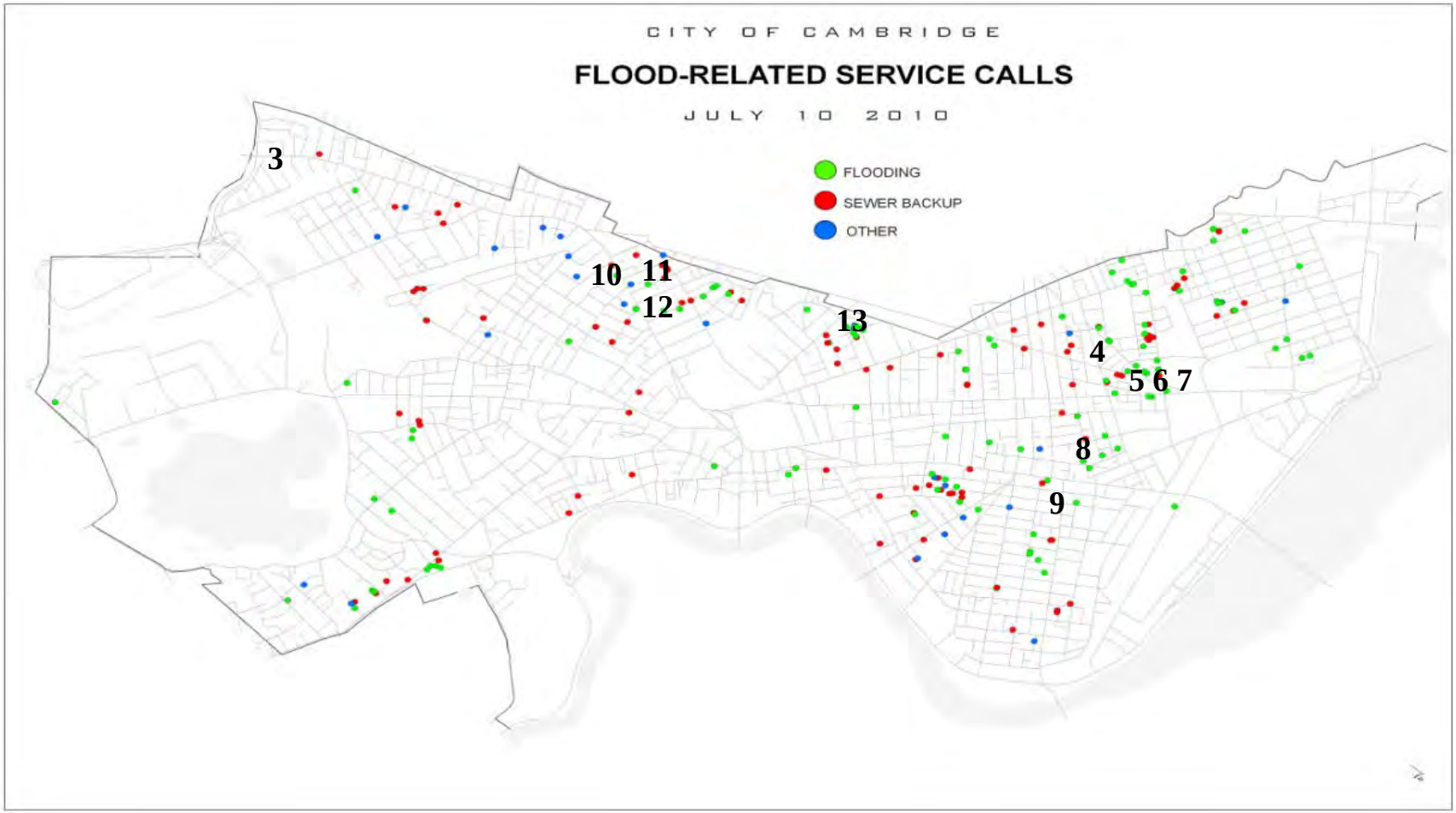


Figure 2: Flood-related service calls July 10, 2010 (Source: City of Cambridge)[5]

[5] Memo on the July 10, 2010 Flooding from Public Works Commissioner and City Engineer to City Manager dated 09/08/2010. This map serves as a key for the smaller scale maps and images that follow.

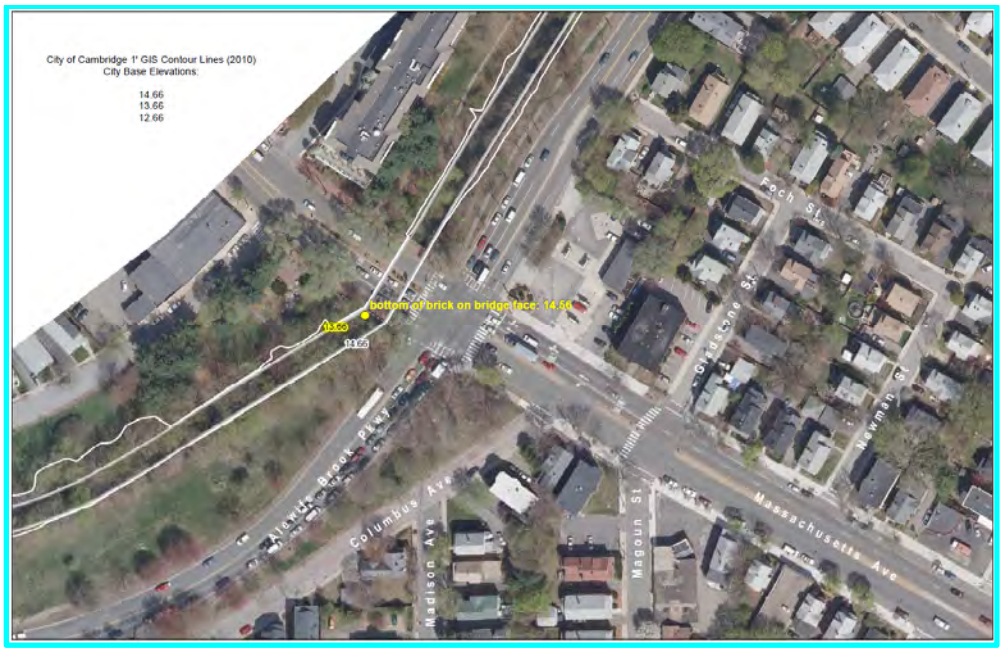
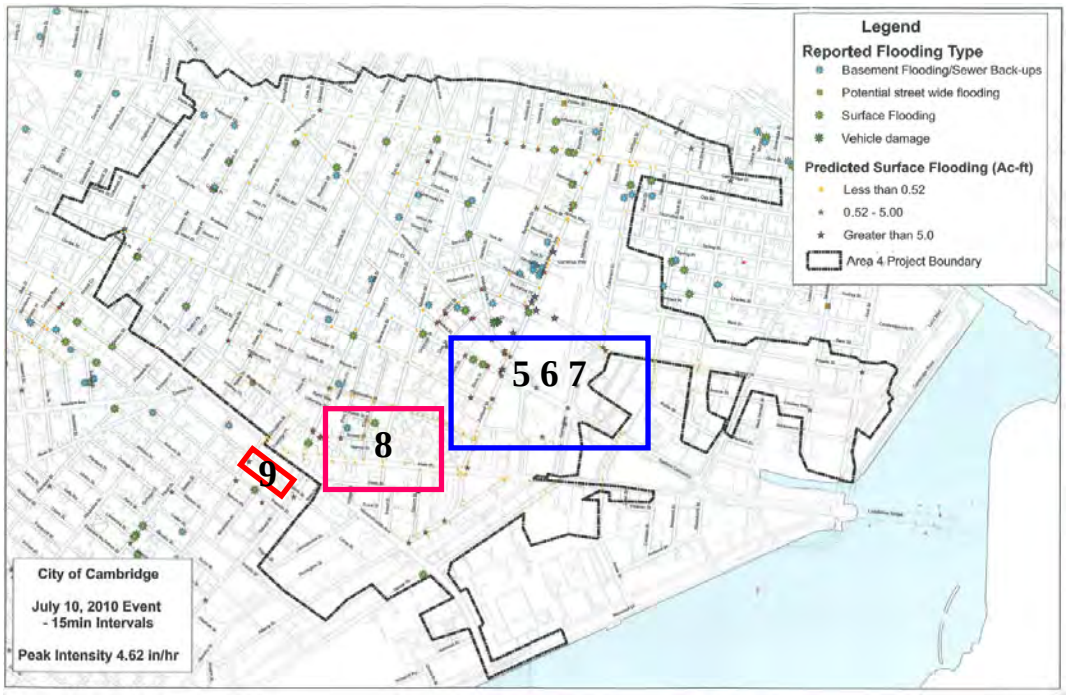


Figure 3: High water elevation from July 10, 2010 flood at Massachusetts Ave and Alewife Brook Pkwy (Source: City of Cambridge)[6]



[6] Map provided by Owen O'Riordan, City Engineer, on October 24, 2013. Yellow highlights indicate that the area within the highlighted elevation contour would have been flooded, based on elevations of recorded high water marks.

Figure 4: Map of reported flooding locations and predicted surface flooding depths based on modeling in Area 4 (Source: MWH[7])

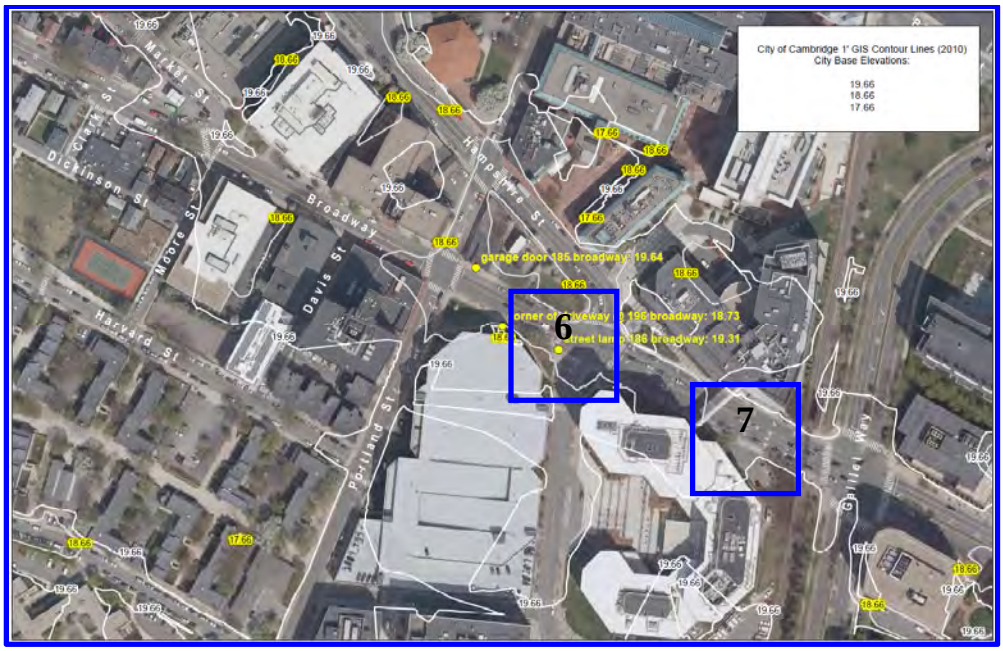


Figure 5: High water elevation from July 10, 2010 flood on Broadway (Source: City of Cambridge)[8]

[7] Memo to Cambridge Department of Public Works, from MWH regarding "Review Impact of CSO Regulator Modifications (Charles River)", dated October 11, 2010

[8] Map provided by Owen O'Riordan, City Engineer, on October 24, 2013. Yellow highlights indicate that the area within the highlighted elevation contour would have been flooded, based on elevations of recorded high water marks.

Figure 6: Surface flooding at Broadway and Hampshire St on July 10, 2010 (Source: City of Cambridge)[9]

Figure 7: Surface flooding at Broadway and Portland St on July 10, 2010 (source: City of Cambridge)[10]

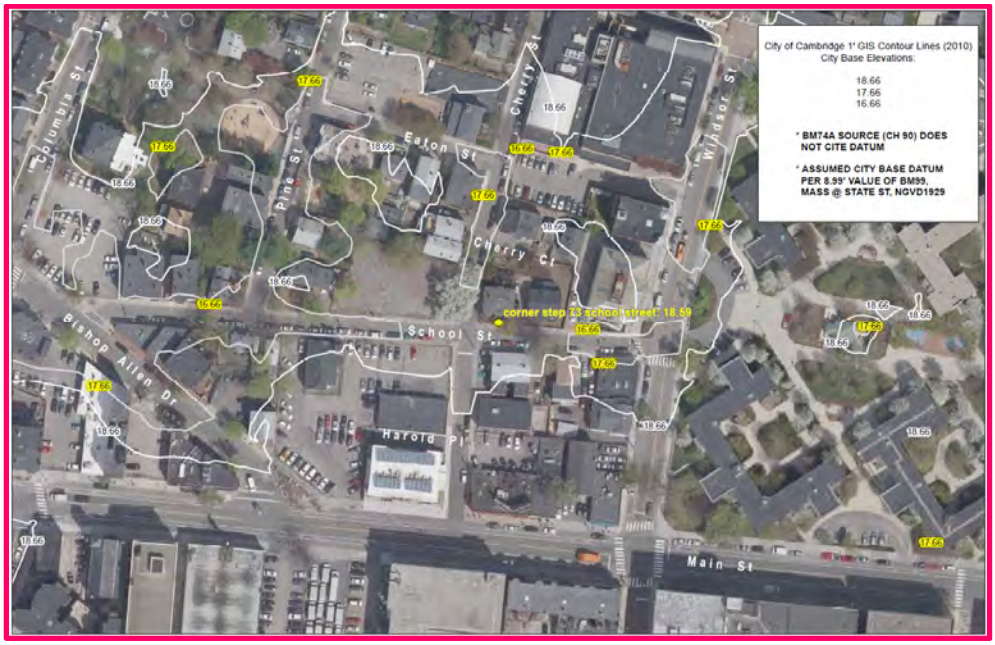


Figure 8: High water elevation from July 10, 2010 flood on School St (Source: City of Cambridge)[11]

[9] Department of Public Works
[10] Department of Public Works
[11] Map provided by Owen O'Riordan, City Engineer, on October 24, 2013. Yellow highlights indicate that the area within the highlighted elevation contour would have been flooded, based on elevations of recorded high water marks.

Figure 9: Surface flooding on Green St on July 10, 2010 (Source: Gilad Lotan[12])

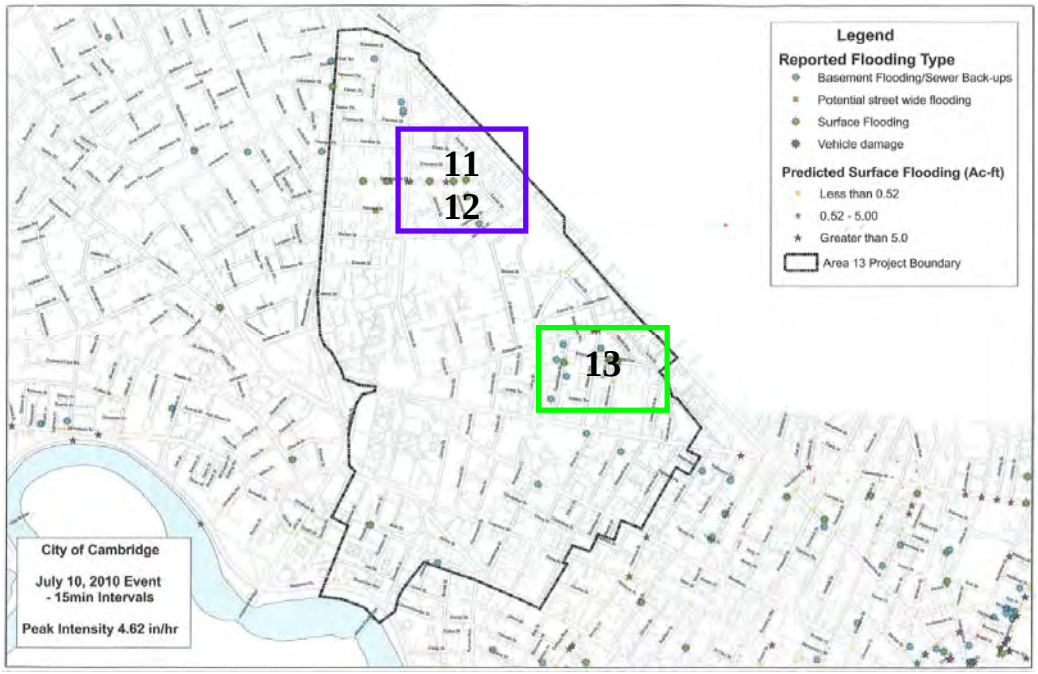


Figure 10: Map of reported flooding locations and predicted surface flooding depths based on modeling in Area 4 (Source: MWH[13])

[12] Photos and videos of the Green Street flooding taken by Gilad Lotan, available online at: http://www.flickr.com/photos/giladlotan/4785178080/in/photostream/

[13] Memo to Cambridge Department of Public Works, from MWH regarding "Review Impact of CSO Regulator Modifications (Charles River)", dated October 11, 2010

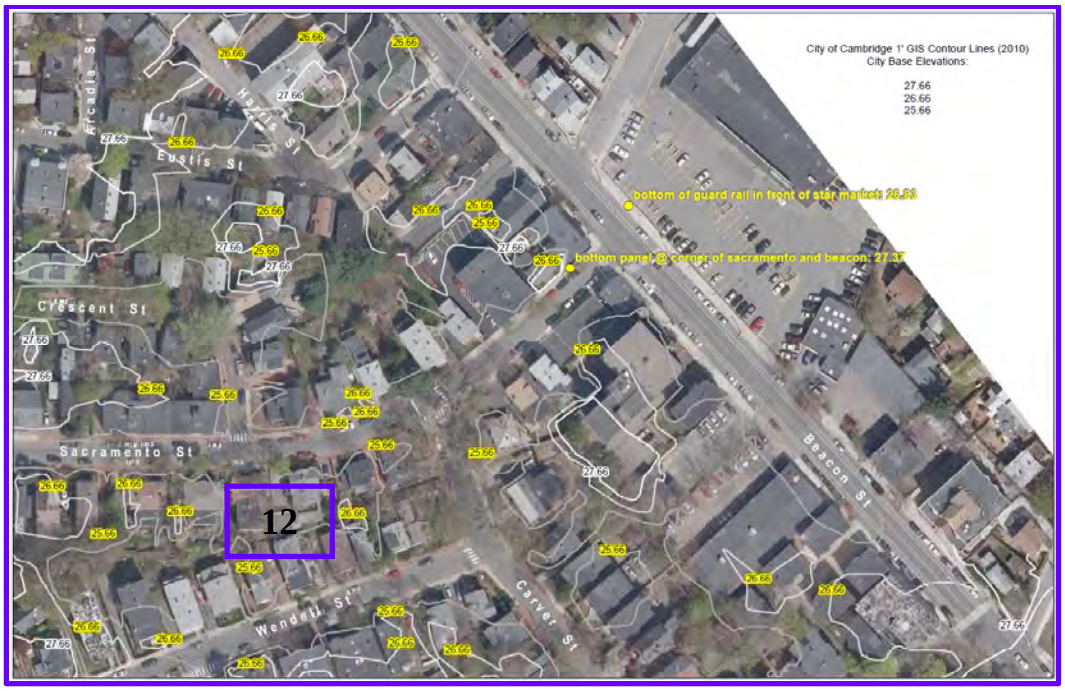


Figure 11: High Water Elevation from July 10, 2010 Flood on Sacramento St and Beacon St

(Source: City of Cambridge)[14]

Figure 12: Surface Flooding at the Intersection of Sacramento St and Crescent St on July 10, 2010

(source: City of Cambridge)[15]

[14] Map provided by Owen O'Riordan, City Engineer, on October 24, 2013. Yellow highlights indicate that the area within the highlighted elevation contour would have been flooded, based on elevations of recorded high water marks.
[15] Department of Public Works

Figure 13: High water elevation from July 10, 2010 flood on Myrtle Ave (Source: City of Cambridge)[16]

[16] Map provided by Owen O'Riordan, City Engineer, on October 24, 2013. Yellow highlights indicate that the area within the highlighted elevation contour would have been flooded, based on elevations of recorded high water marks.