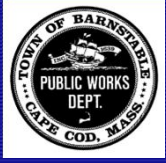


Department of Public Works

Commerce Road Flooding

September 12, 2018

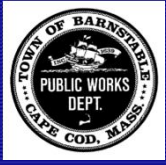


Outline



- *Background*
- *Existing Conditions*
- *What Have We Done*
- *What Are We Doing*
- *What Do We Expect To Do*
- *Discussion*





Background – Commerce Road Development



Aerial Photo:
1938/1941



Aerial Photo:
1968





Background – Commerce Road Development

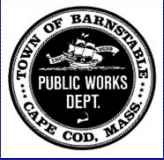


Aerial Photo:
1989



Aerial Photo:
2014





Background – Sea Level



Past and Projected Changes in Global Sea Level

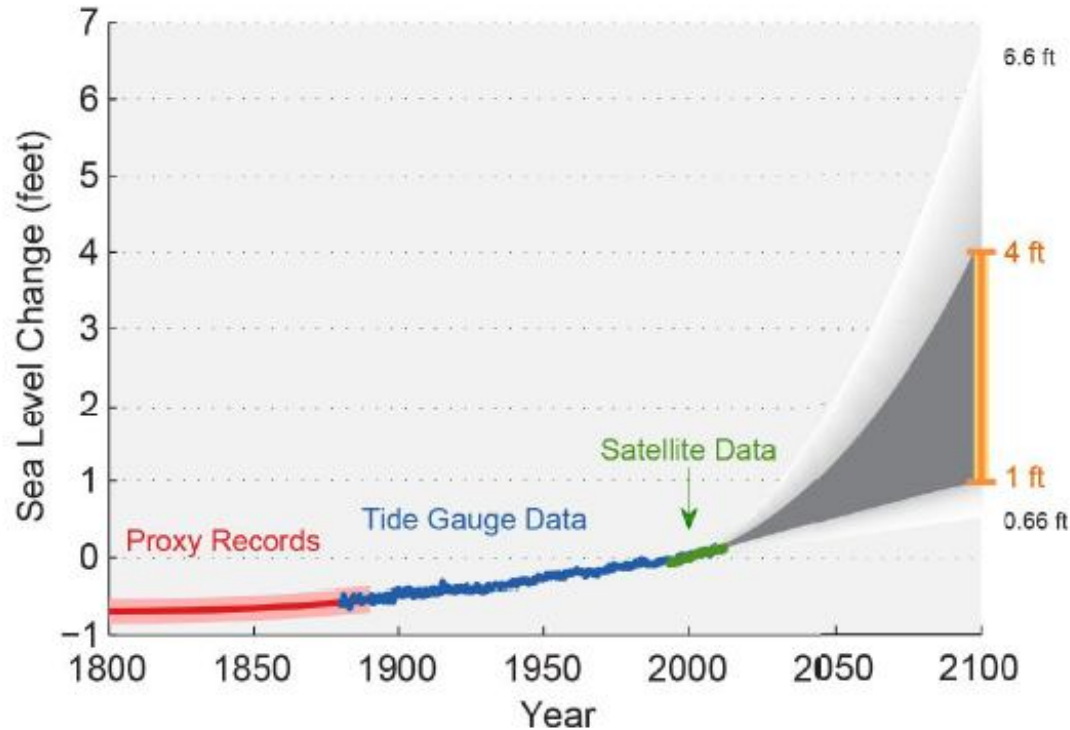
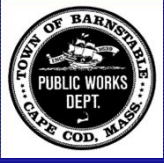


Figure 7: Estimated, observed, and possible future amounts of global sea level rise from 1800 to 2100, relative to the year 2000. The orange line at right shows the currently most likely range of sea level rise of 1 to 4 feet by 2100 based on an assessment of scientific studies, which falls within a larger possible range of 0.66 feet to 6.6 feet. Source: Melillo et al. 2014 and Parris et al. 2012.

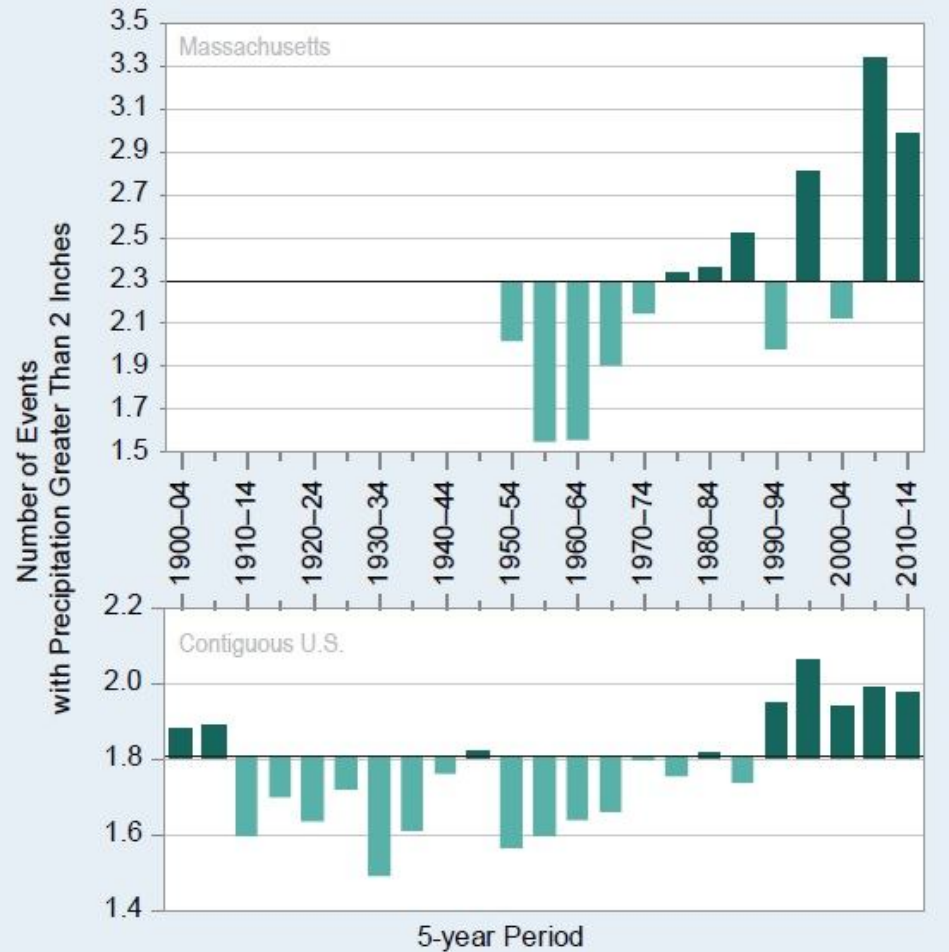
Source: NOAA National Centers for Environmental Information | State Summaries 149-MA



Background - Precipitation

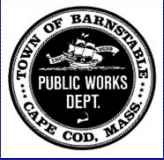


Observed Number of Extreme Precipitation Events



<https://statesummaries.ncics.org/ma>

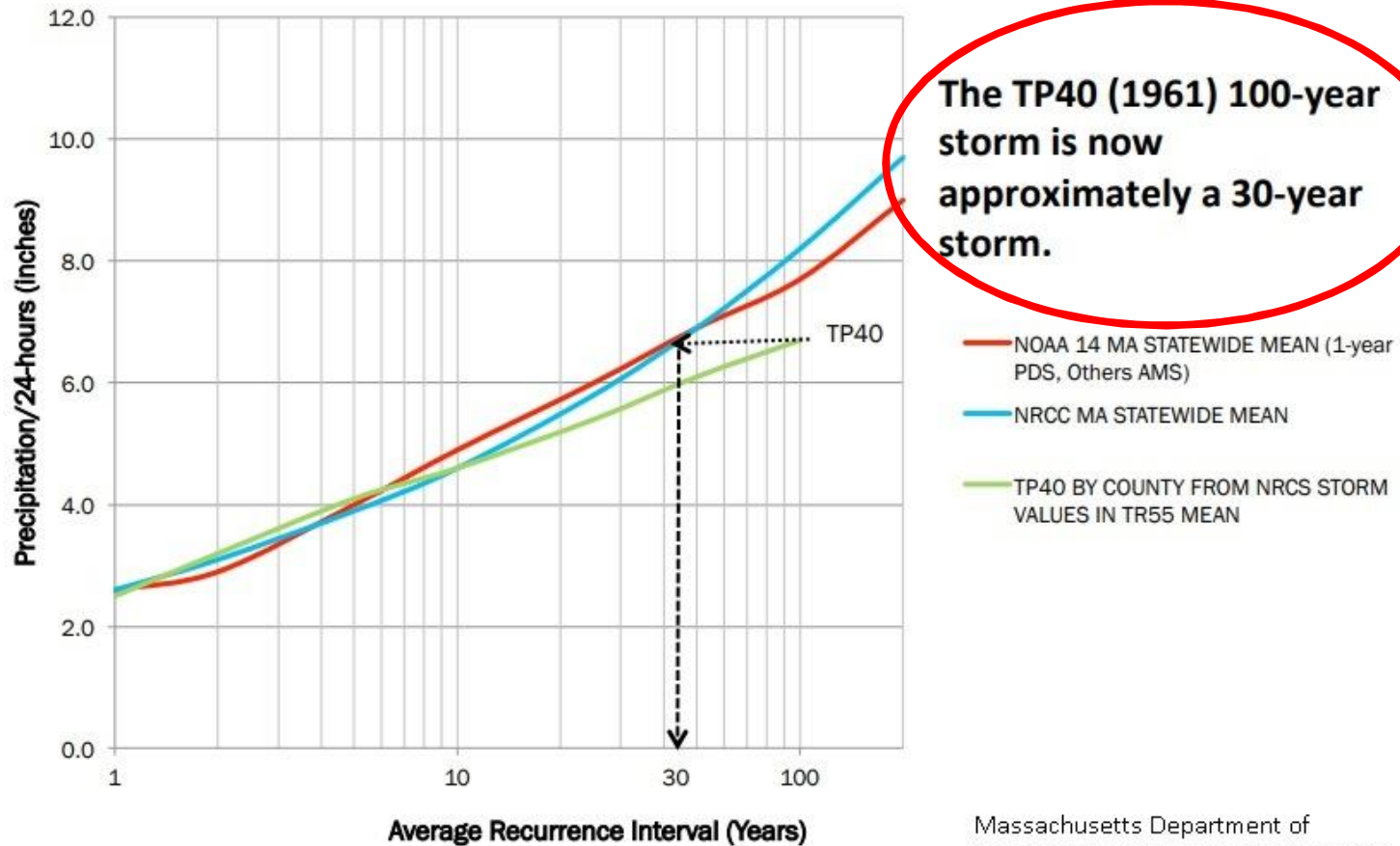
Source: Northeast Regional Climate Center at Cornell University



Background – Storm Recurrence Interval



Massachusetts - Statewide Average
Change in 100-Year 24-hour Duration Storm (NOAA 14 vs TP40)



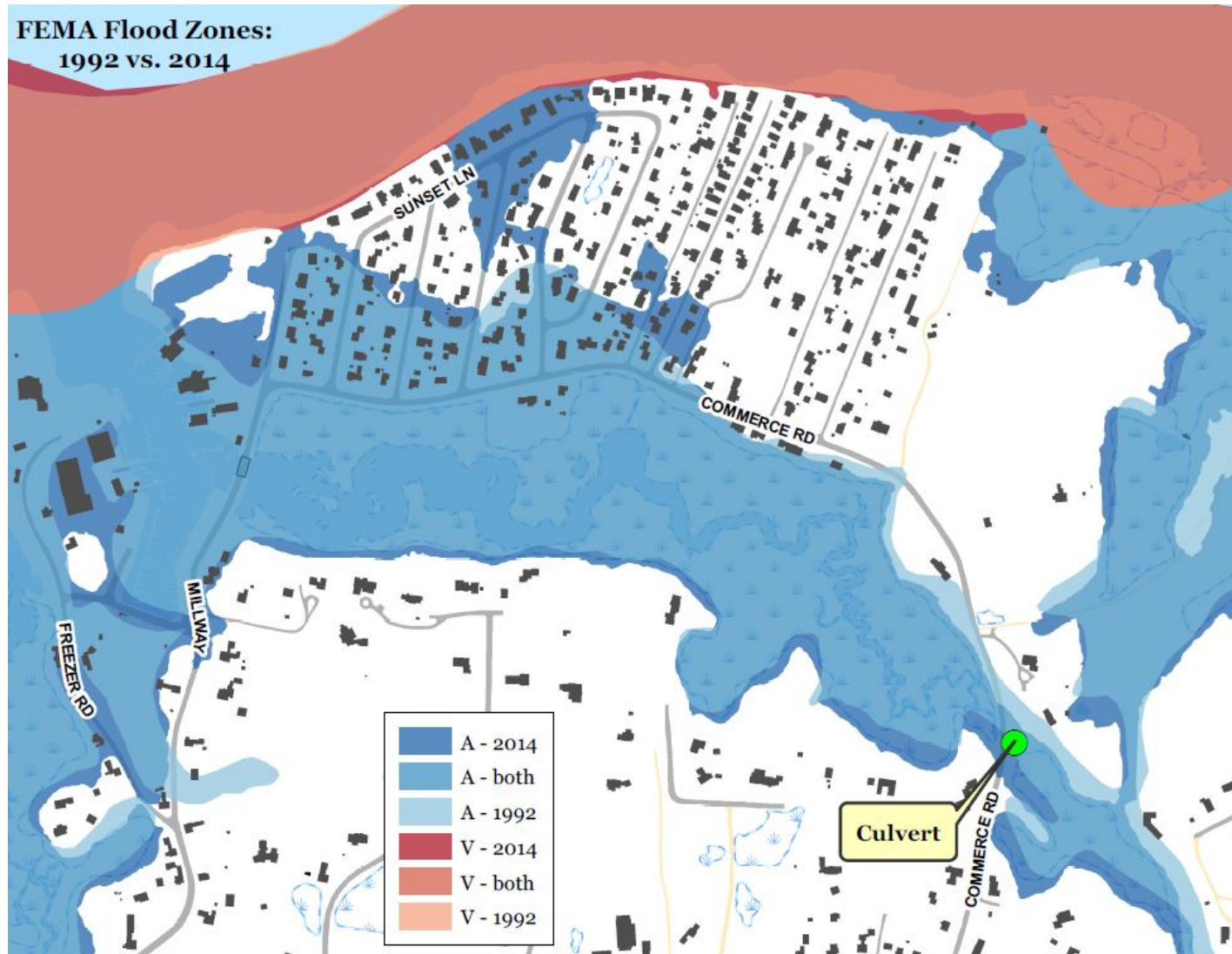
Massachusetts Department of Environmental Protection (May 2017)



Background – FEMA Flooding

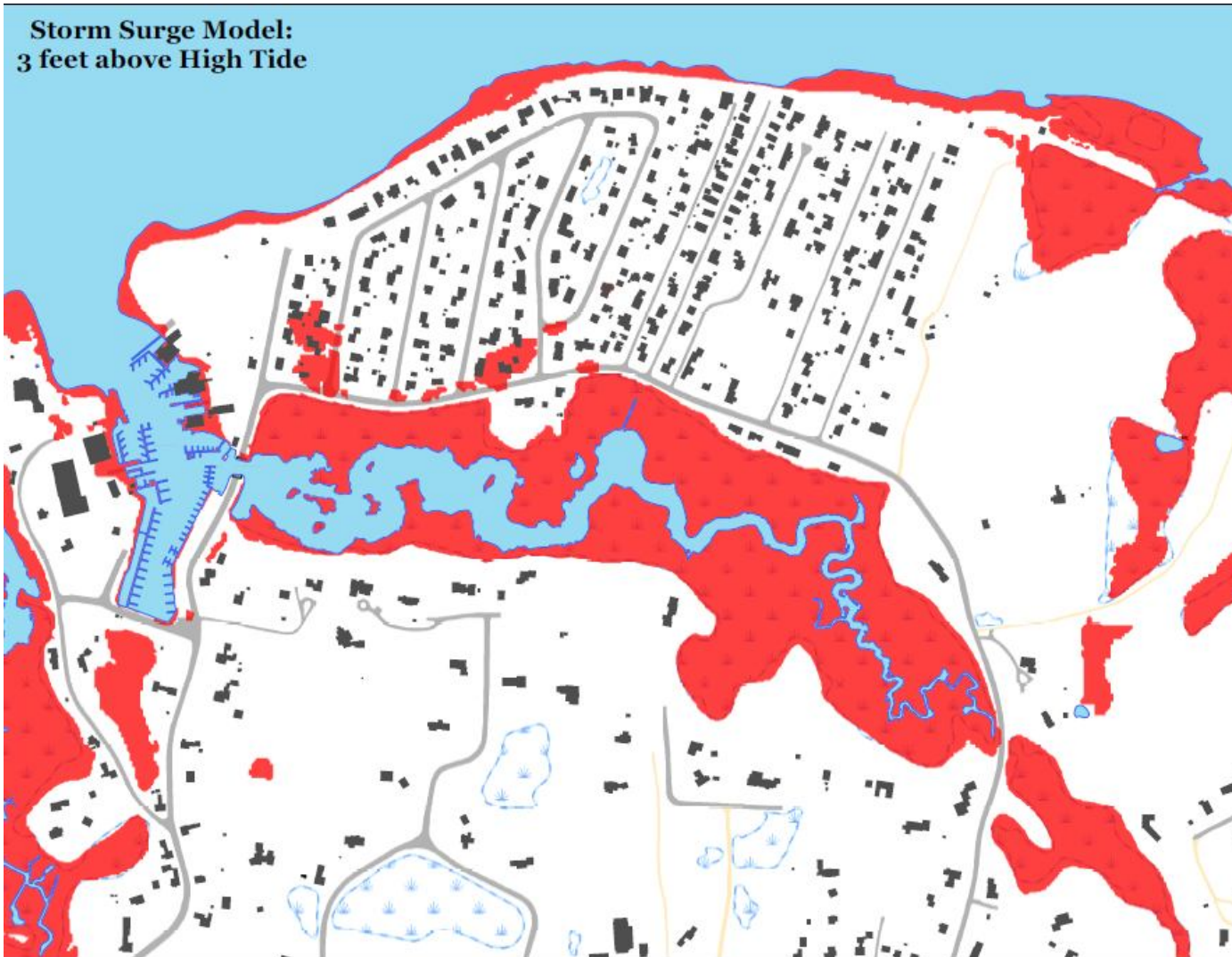


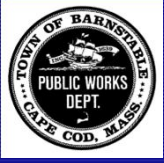
FEMA Flood Zones:
1992 vs. 2014





Background – Storm Surge

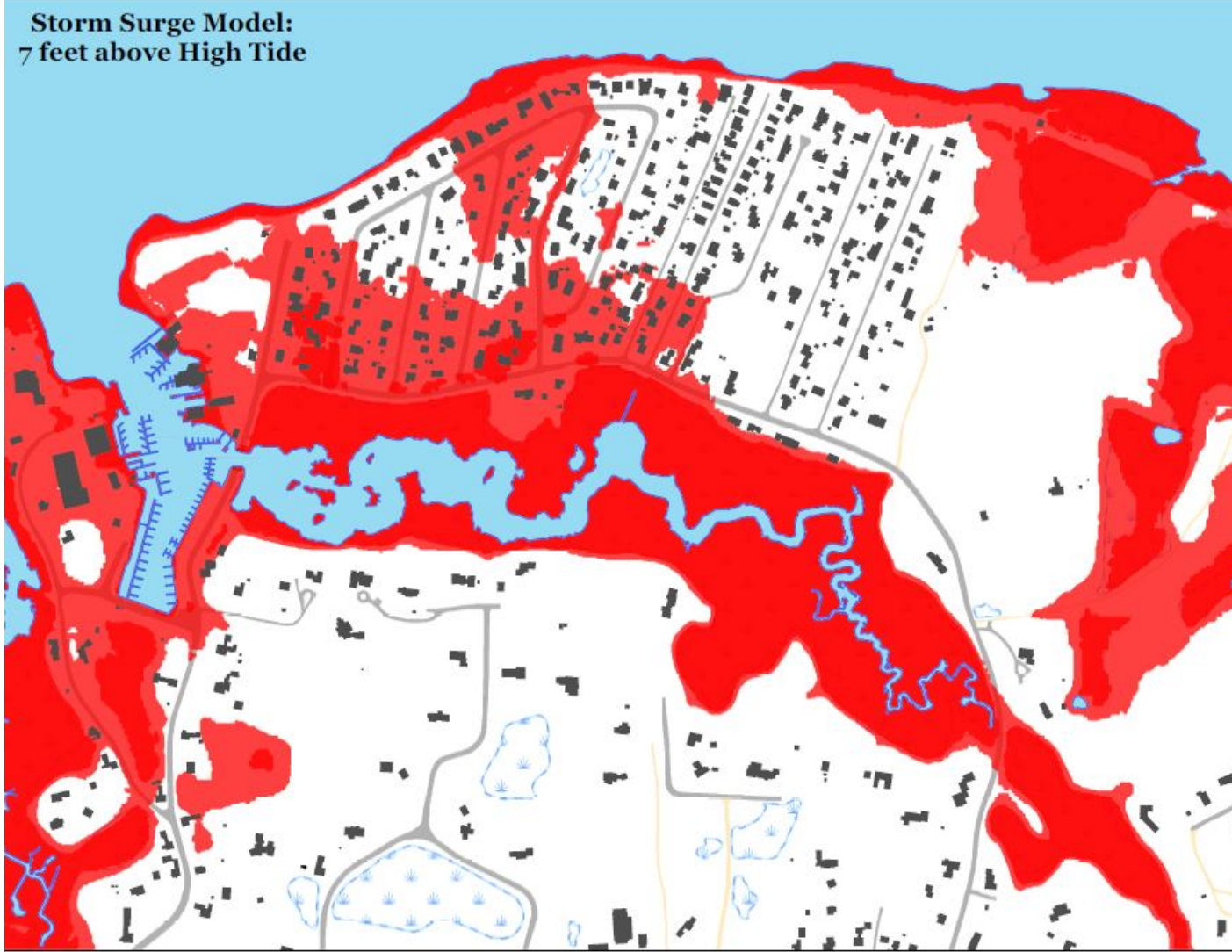


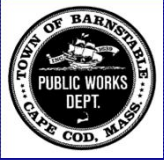


Background – Storm Surge

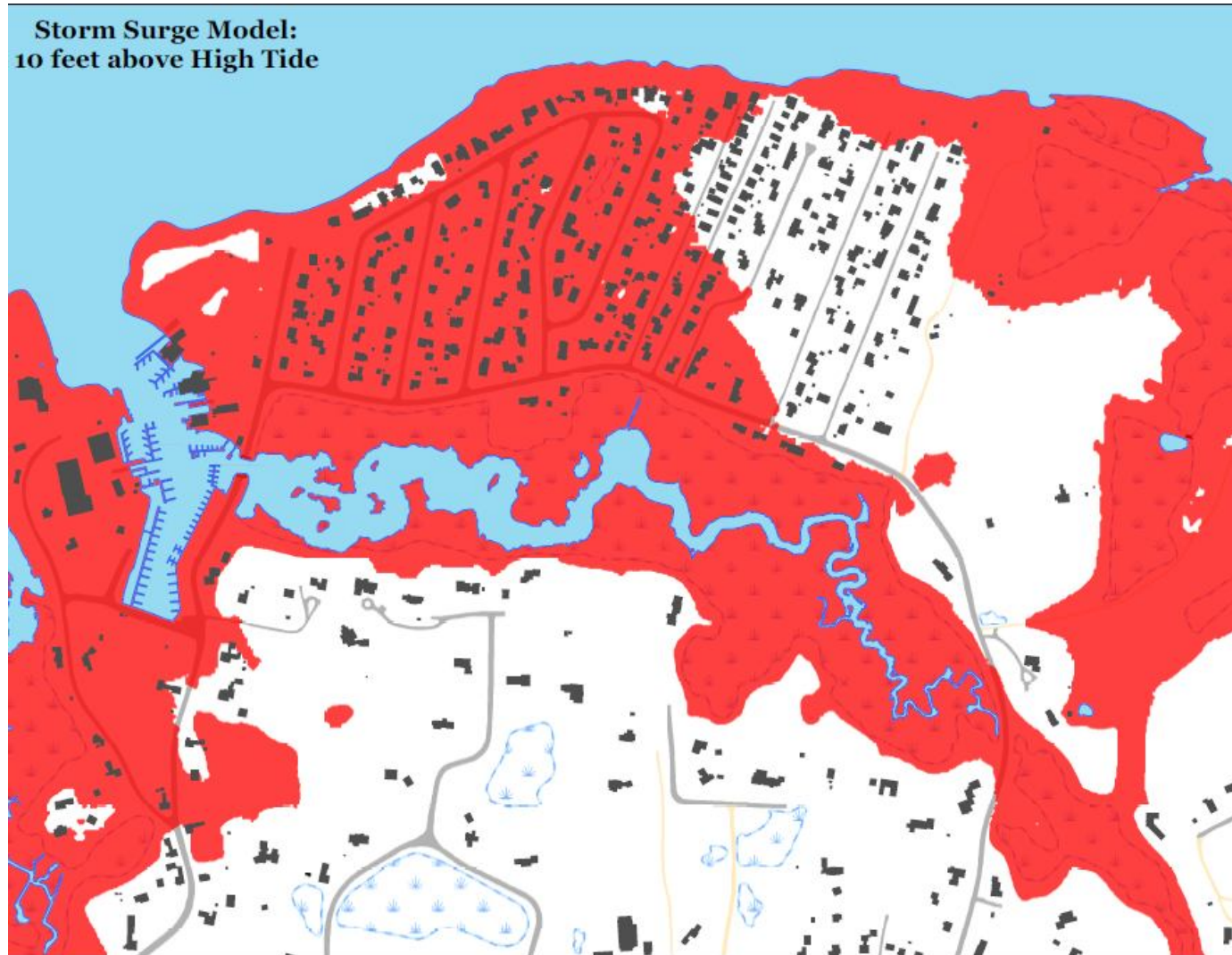


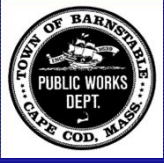
Storm Surge Model:
7 feet above High Tide



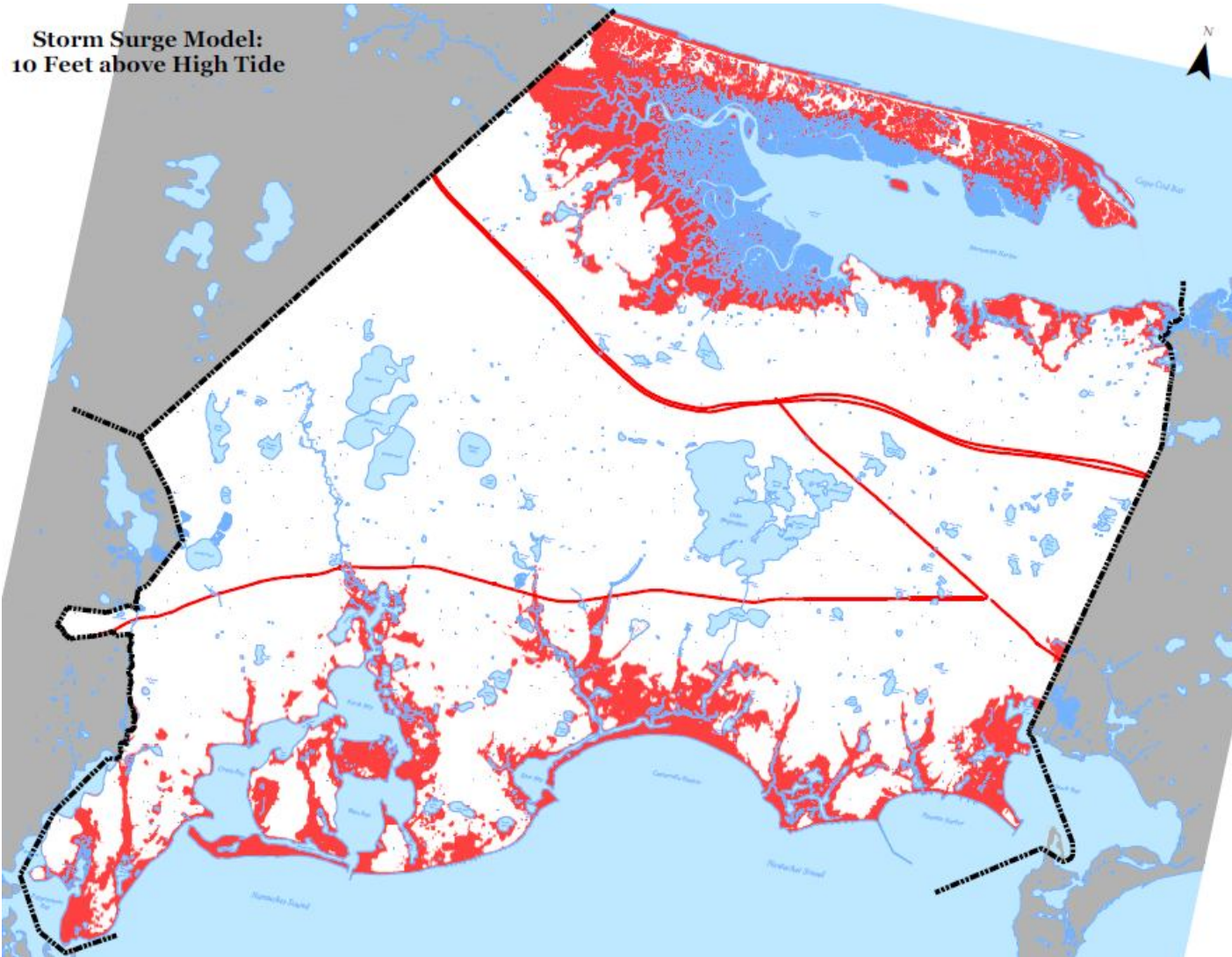


Background – Storm Surge



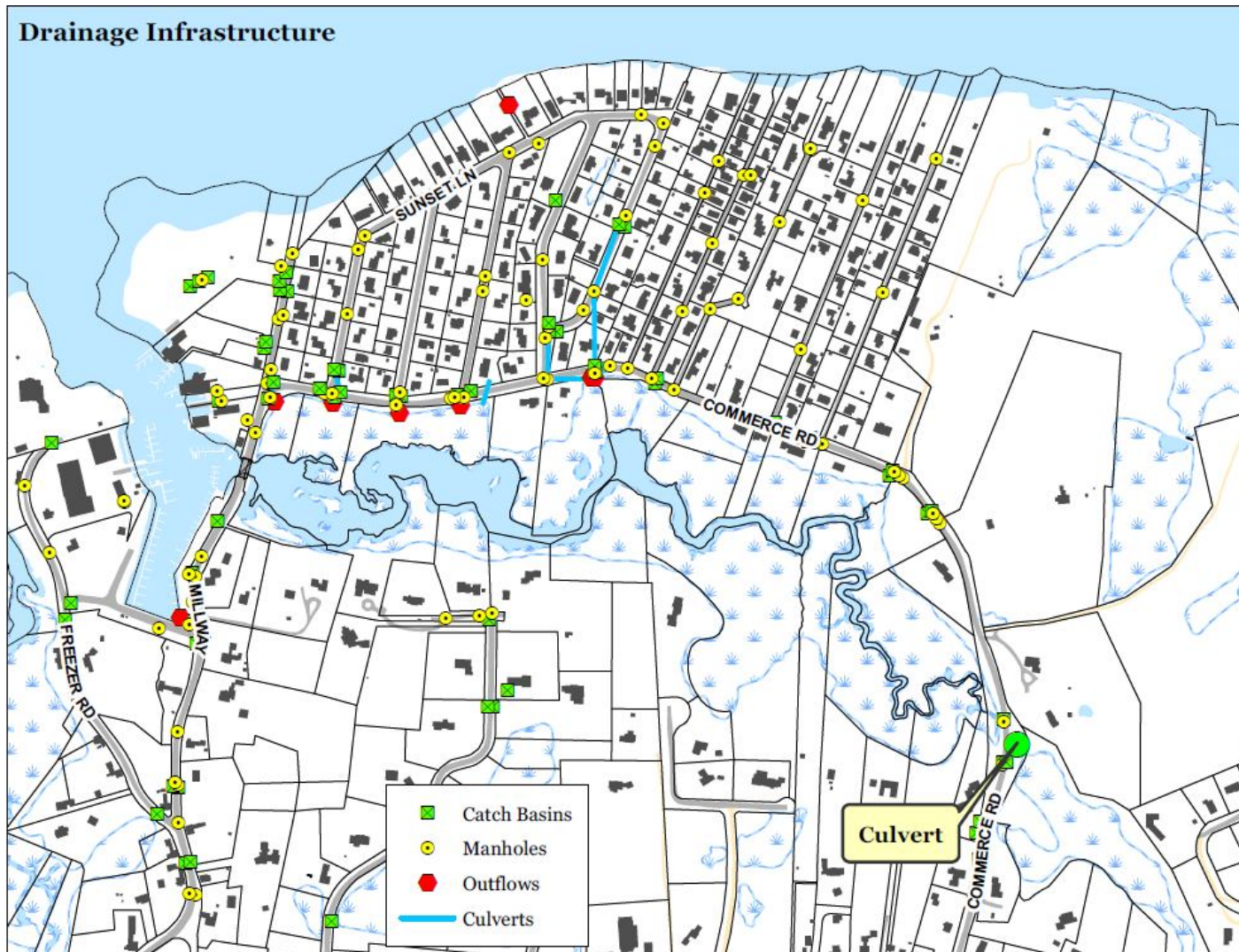


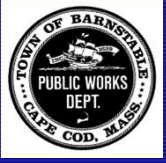
Background – Storm Surge Town Wide



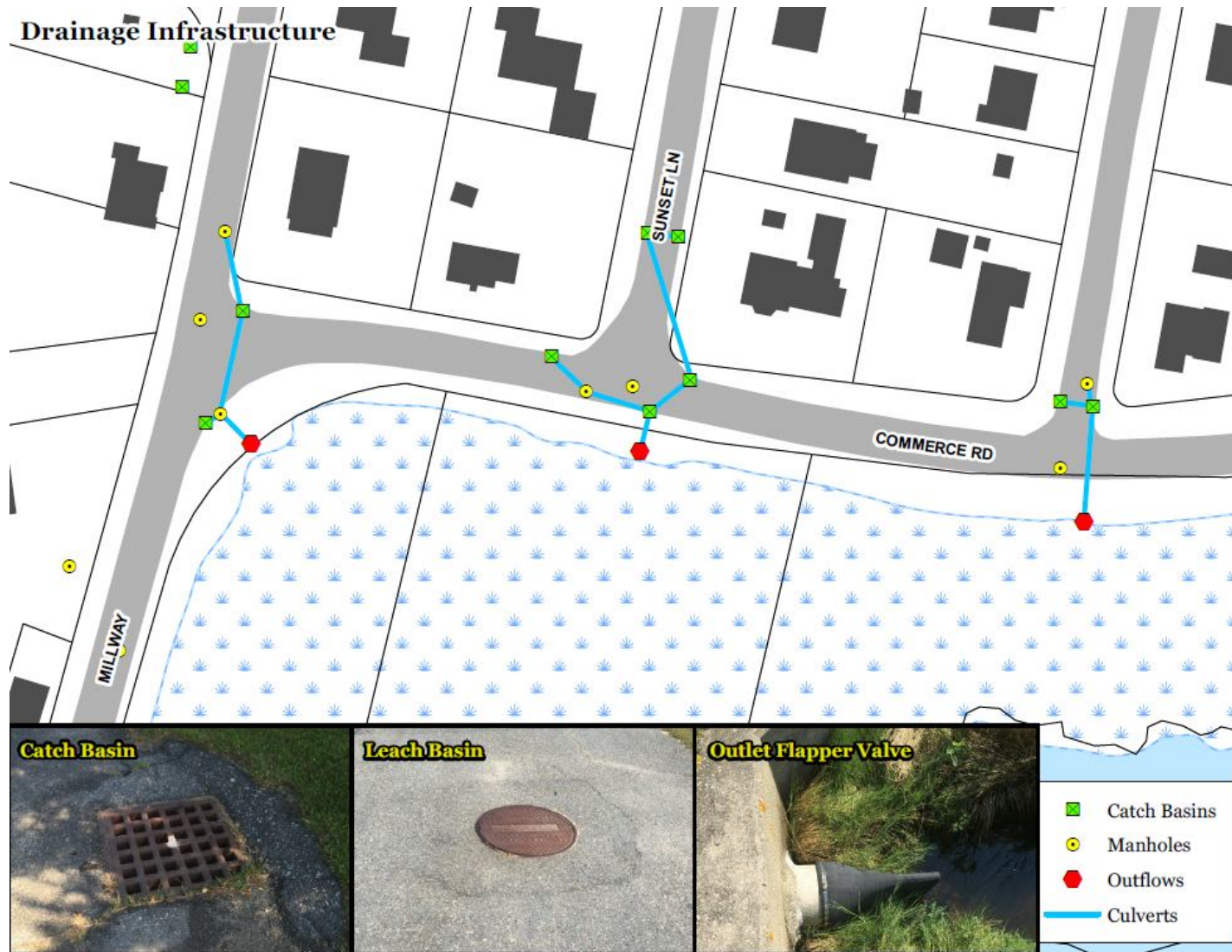


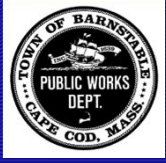
Exiting Conditions – Road Storm Drain System





Exiting Conditions – Road Storm Drain System



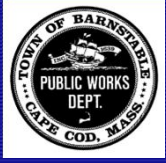


What Have We Done?



- *Cleaned and Inspected all drainage basins*
- *Inspected the Maraspin Creek culvert including an internal video inspection*
- *Evaluated the drainage system capacity*
- *Begun a Hydrologic & Hydraulic study for the Maraspin Creek System*

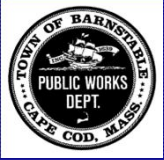




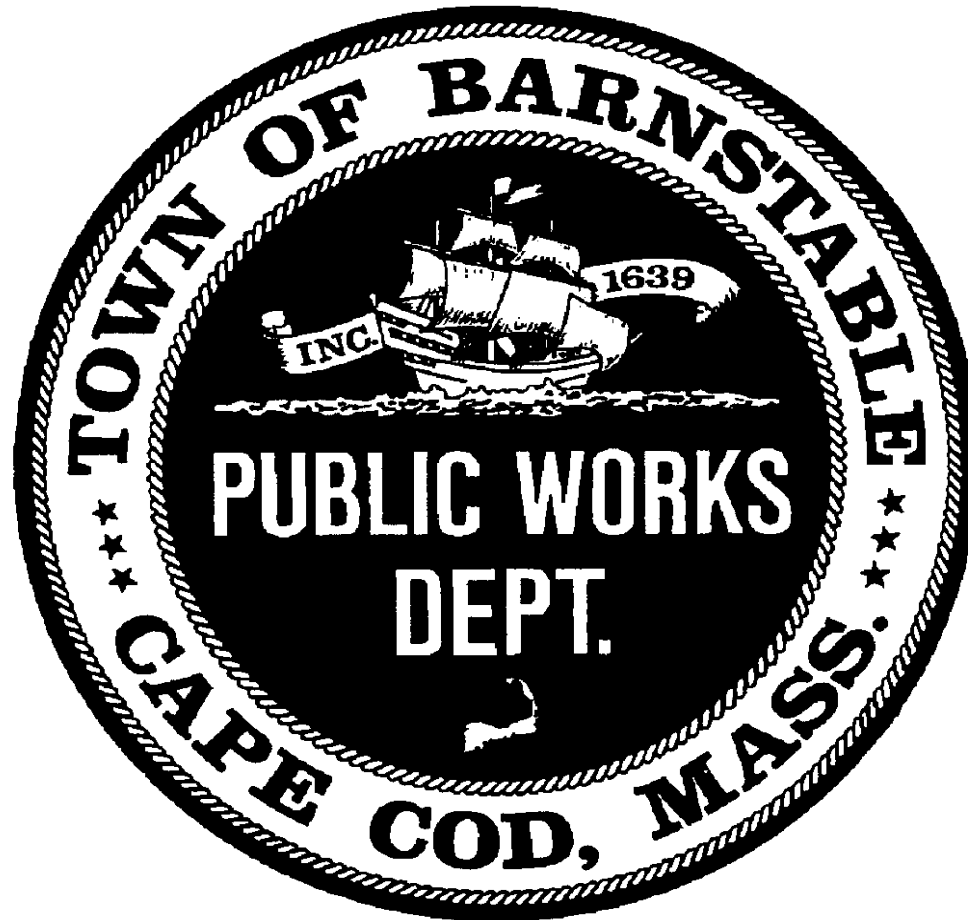
What Are We Expecting To Do?

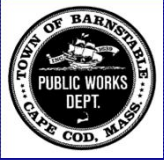


- *With modeling results, investigate engineering solutions that could mitigate some storm surge issues*
 - *Enlarging the culvert*
 - *Gating the end of the creek and extending the bulkhead*
 - *Raising the road/Installing a berm*

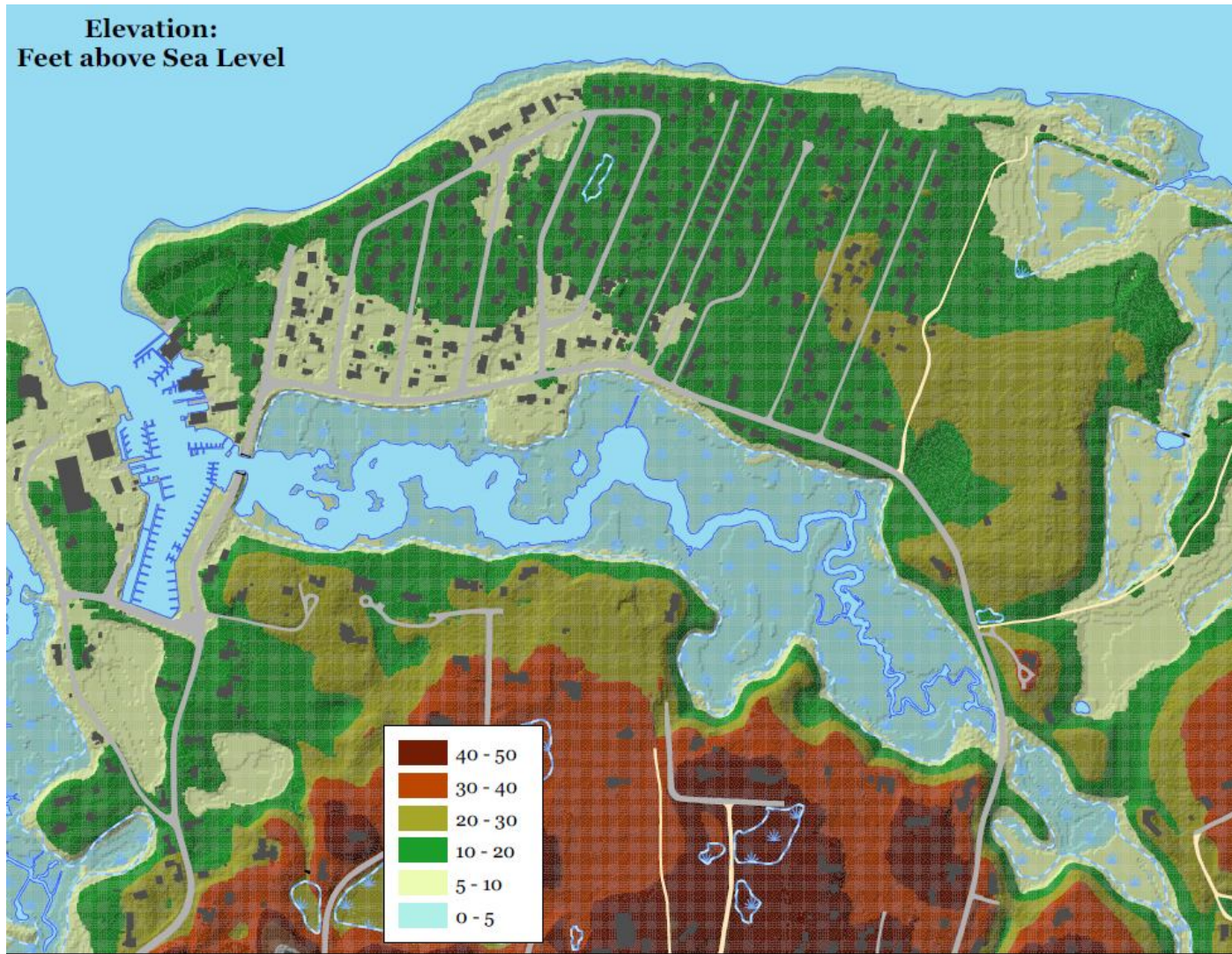


Discussion?





Topo

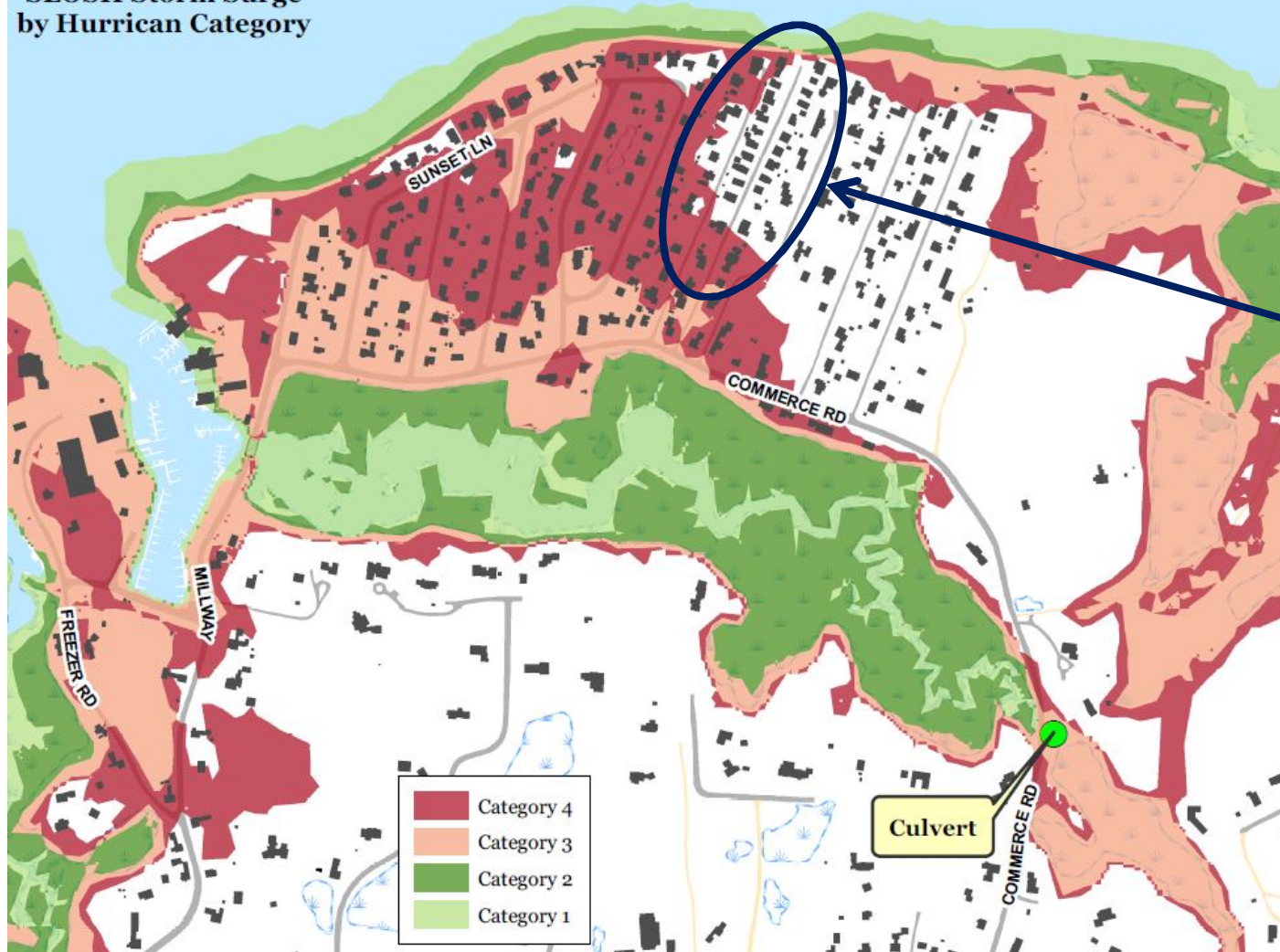




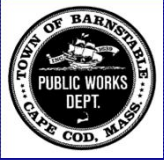
Predicted Hurricane Flooding



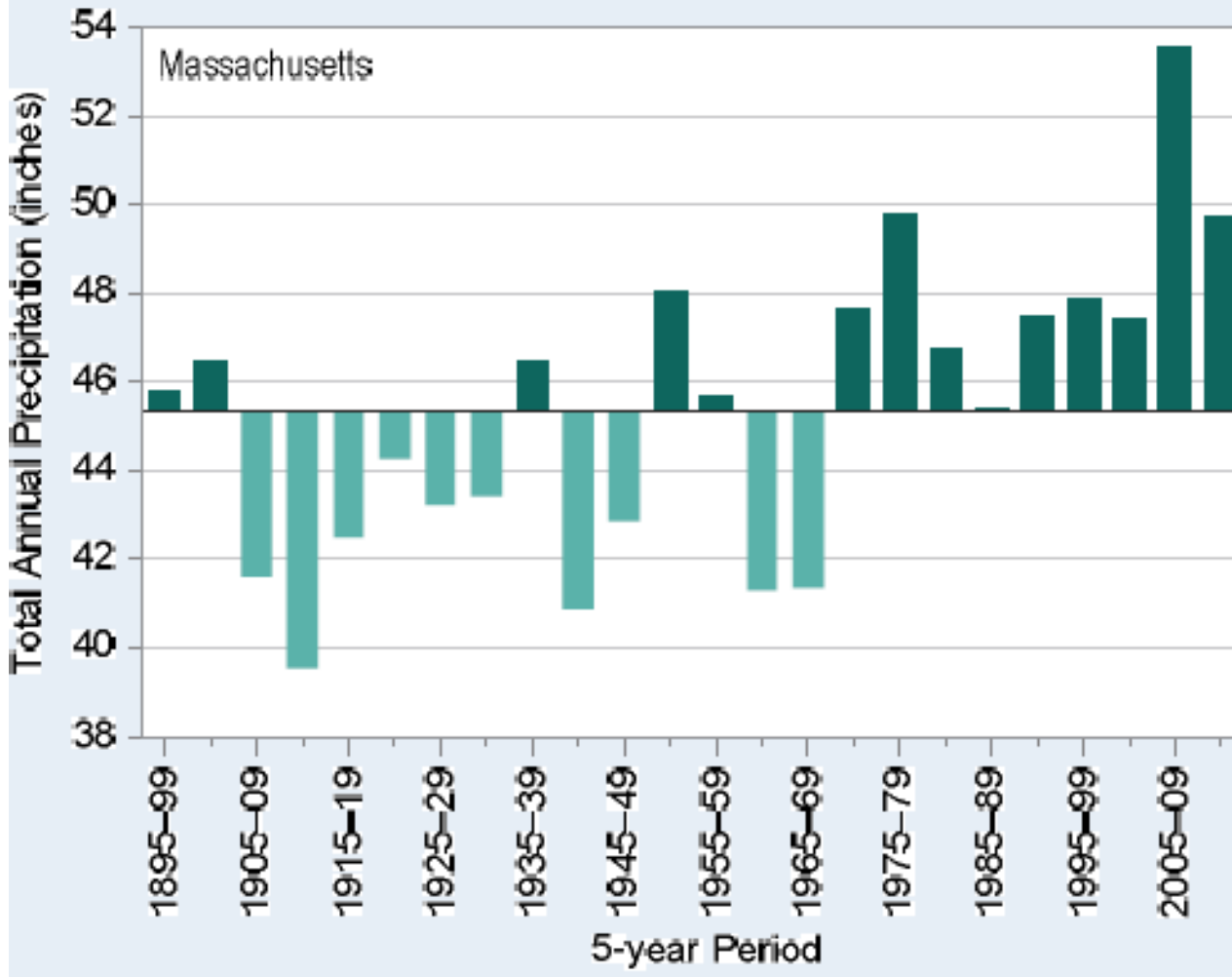
SLOSH Storm Surge
by Hurricane Category



By Aerial
Photography,
one of the
first areas to
be developed.

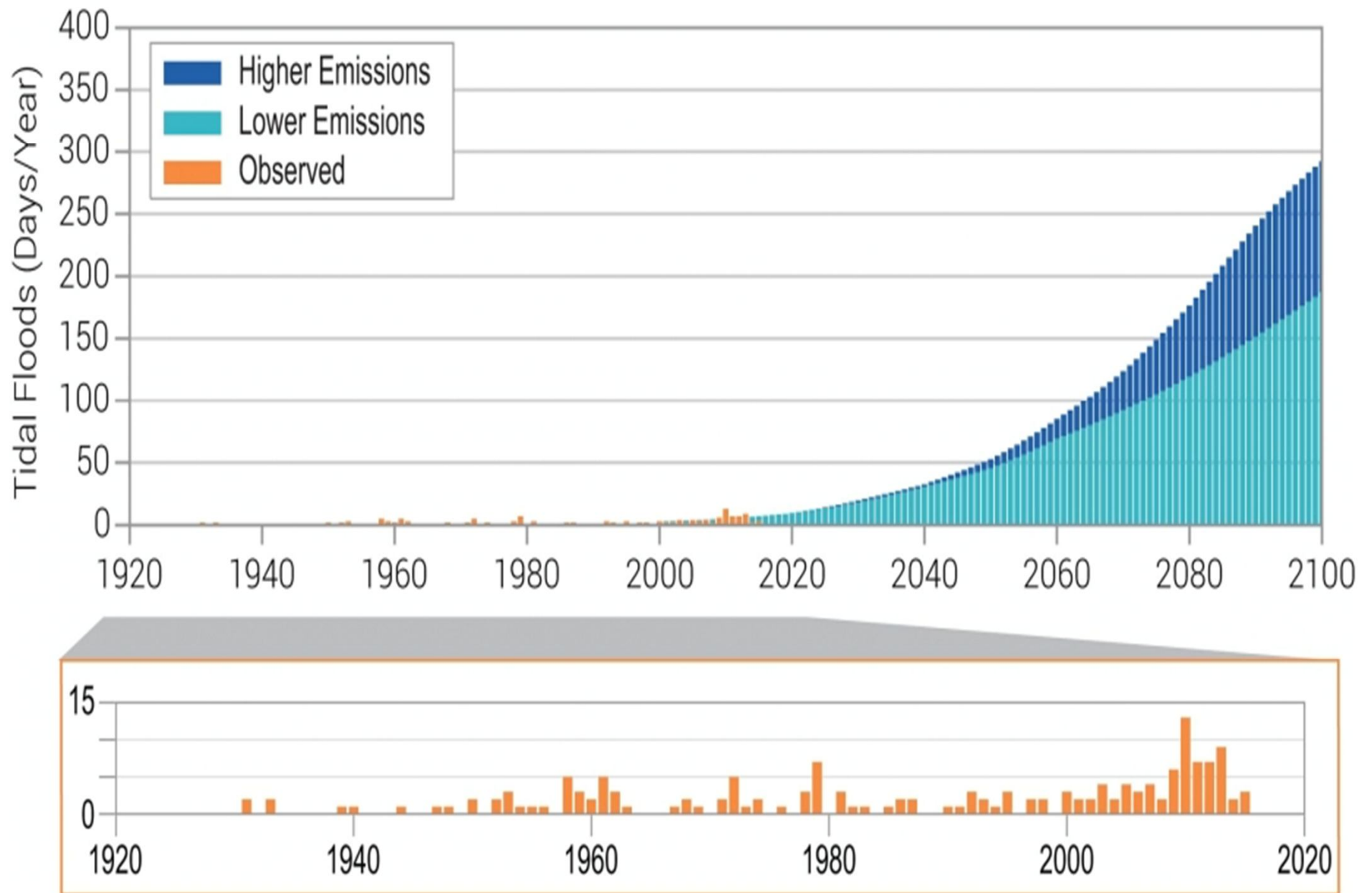


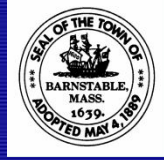
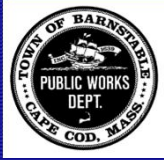
Observed Annual Precipitation



Source: NOAA National Centers for Environmental Information | State Summaries 149-MA

Observed and Projected Annual Number of Tidal Floods for Boston, MA





Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

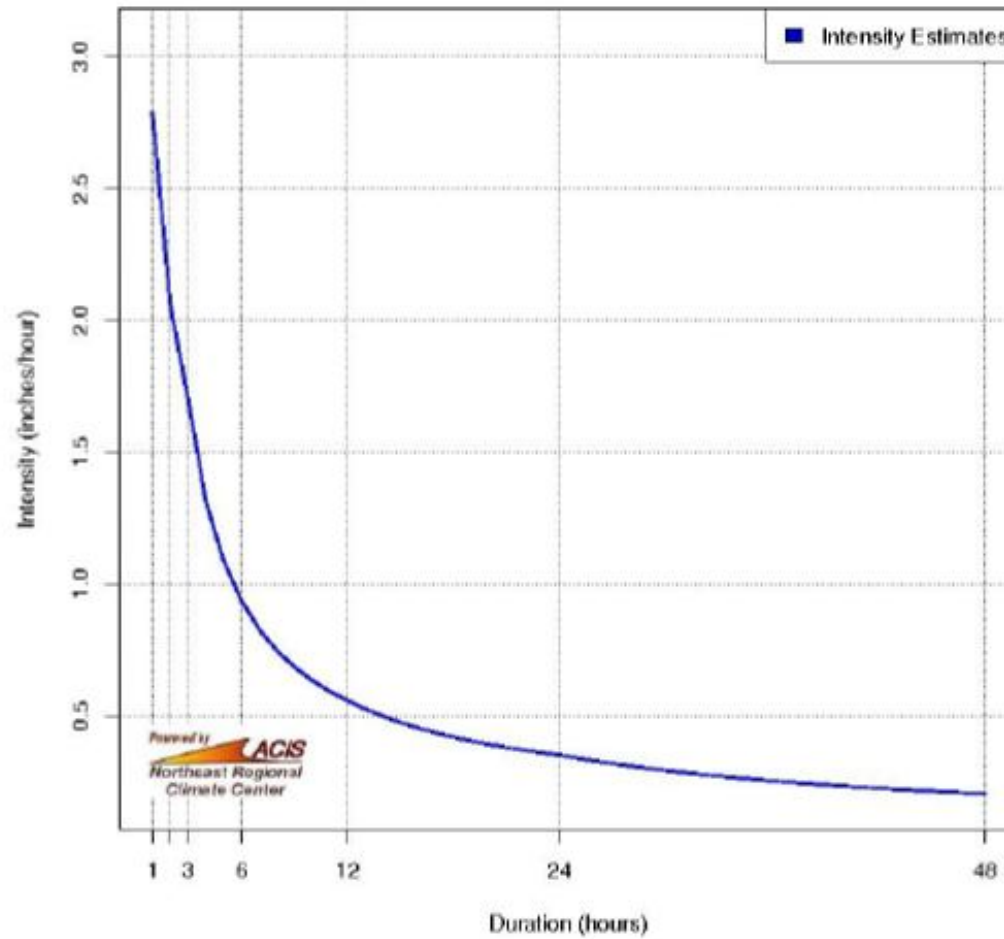
| | |
|-----------|---------------------------------|
| Smoothing | Yes |
| State | Massachusetts |
| Location | |
| Longitude | 70.321 degrees West |
| Latitude | 41.699 degrees North |
| Elevation | 0 feet |
| Date/Time | Tue, 11 Sep 2018 10:55:43 -0400 |

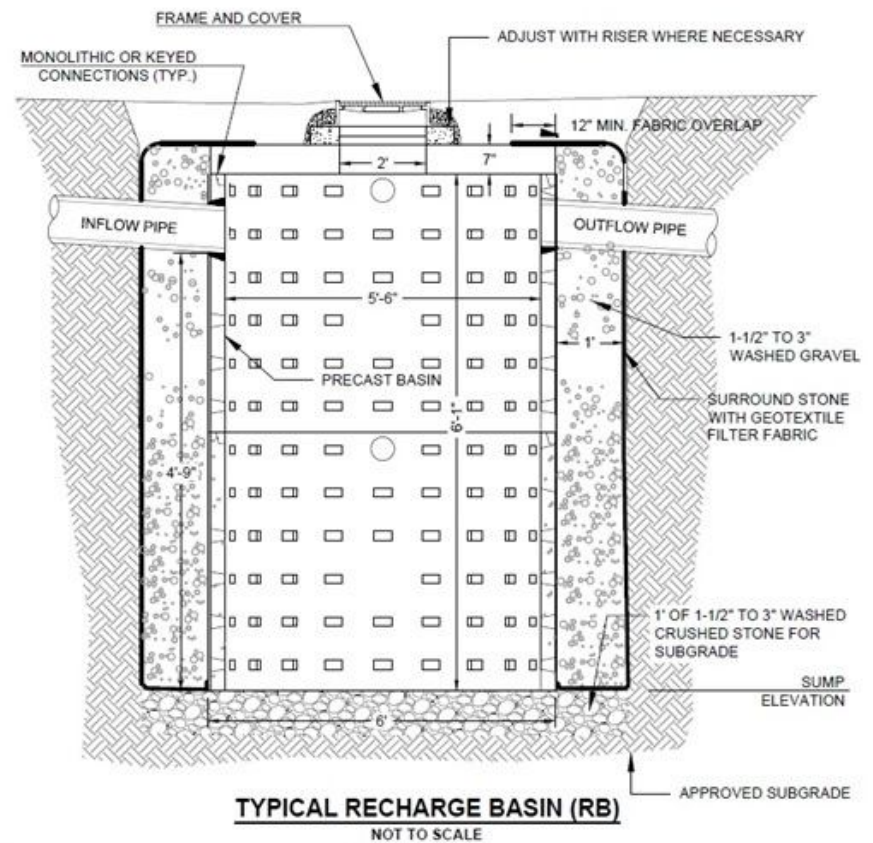
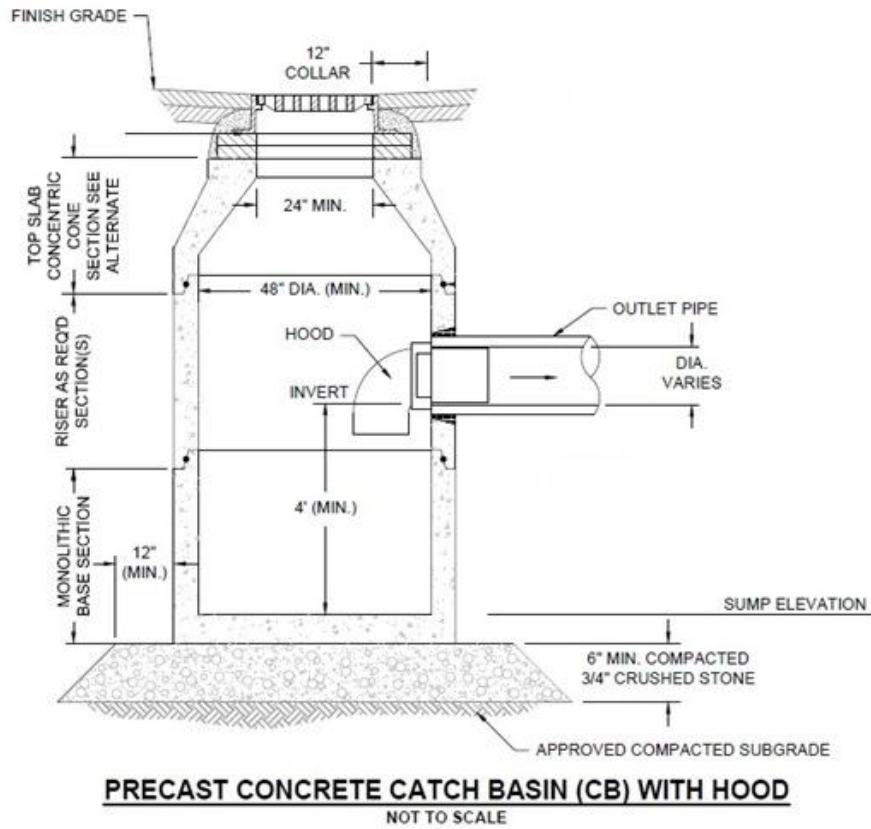
Extreme Precipitation Estimates

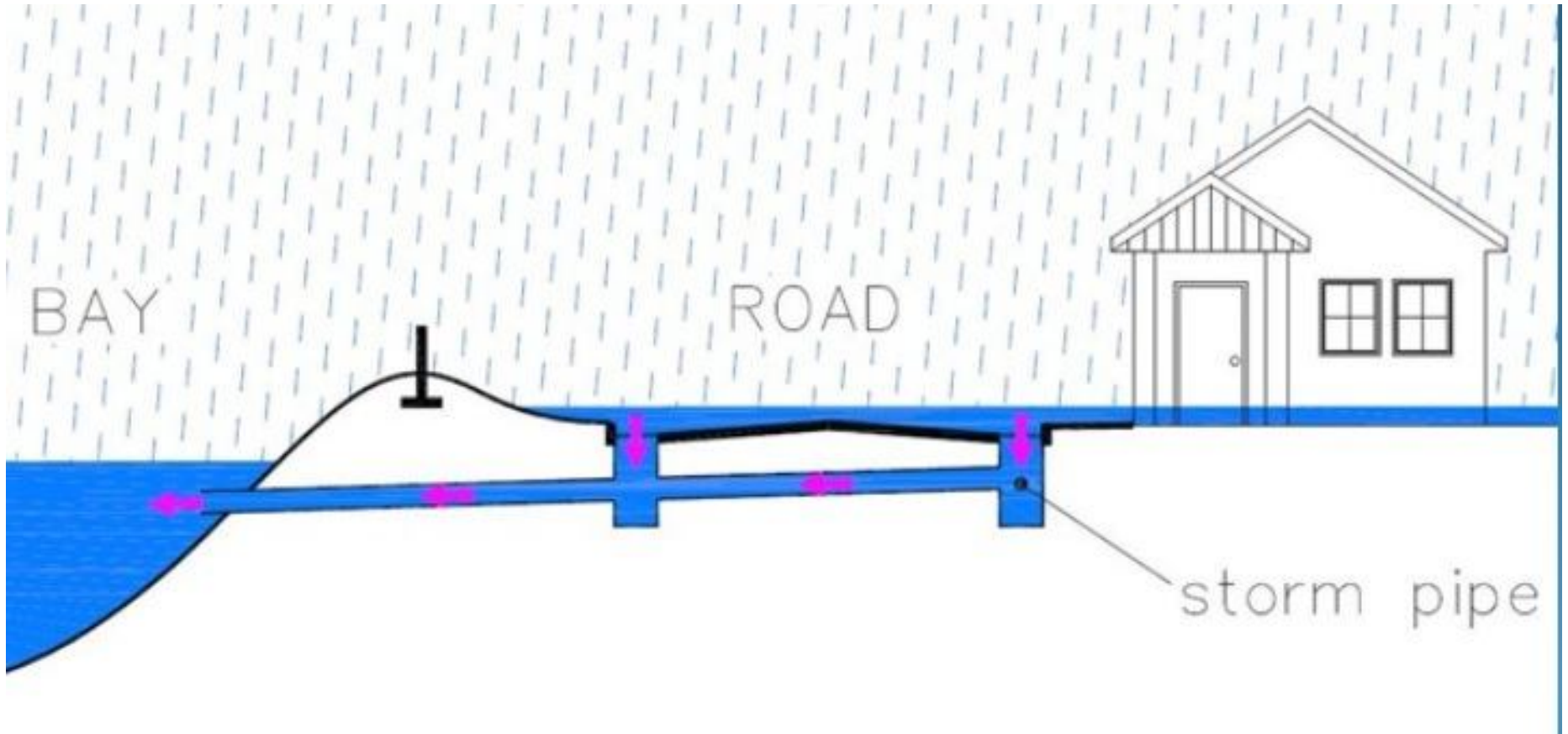
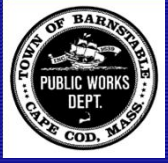
| | 5min | 10min | 15min | 30min | 60min | 120min | | 1hr | 2hr | 3hr | 6hr | 12hr | 24hr | 48hr | | 1day | 2day | 4day | 7day | 10day | |
|-------|------|-------|-------|-------|-------|--------|-------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1yr | 0.29 | 0.45 | 0.56 | 0.73 | 0.92 | 1.16 | 1yr | 0.79 | 1.16 | 1.34 | 1.70 | 2.17 | 2.78 | 3.15 | 1yr | 2.46 | 3.03 | 3.48 | 4.01 | 4.62 | 1yr |
| 2yr | 0.37 | 0.57 | 0.71 | 0.93 | 1.17 | 1.47 | 2yr | 1.01 | 1.39 | 1.70 | 2.12 | 2.64 | 3.28 | 3.67 | 2yr | 2.90 | 3.53 | 4.01 | 4.74 | 5.37 | 2yr |
| 5yr | 0.44 | 0.69 | 0.86 | 1.16 | 1.48 | 1.87 | 5yr | 1.28 | 1.79 | 2.16 | 2.69 | 3.32 | 4.08 | 4.60 | 5yr | 3.61 | 4.42 | 4.98 | 5.81 | 6.52 | 5yr |
| 10yr | 0.51 | 0.80 | 1.01 | 1.36 | 1.77 | 2.26 | 10yr | 1.53 | 2.17 | 2.61 | 3.23 | 3.95 | 4.81 | 5.46 | 10yr | 4.26 | 5.25 | 5.86 | 6.77 | 7.55 | 10yr |
| 25yr | 0.60 | 0.96 | 1.22 | 1.69 | 2.25 | 2.88 | 25yr | 1.94 | 2.80 | 3.33 | 4.11 | 4.99 | 5.99 | 6.85 | 25yr | 5.30 | 6.58 | 7.27 | 8.30 | 9.18 | 25yr |
| 50yr | 0.70 | 1.12 | 1.43 | 2.01 | 2.70 | 3.47 | 50yr | 2.33 | 3.39 | 4.02 | 4.93 | 5.94 | 7.07 | 8.13 | 50yr | 6.26 | 7.82 | 8.56 | 9.69 | 10.64 | 50yr |
| 100yr | 0.80 | 1.30 | 1.68 | 2.37 | 3.23 | 4.17 | 100yr | 2.79 | 4.12 | 4.83 | 5.90 | 7.07 | 8.35 | 9.66 | 100yr | 7.39 | 9.29 | 10.09 | 11.32 | 12.35 | 100yr |
| 200yr | 0.93 | 1.51 | 1.96 | 2.81 | 3.88 | 5.02 | 200yr | 3.35 | 5.00 | 5.81 | 7.07 | 8.42 | 9.86 | 11.49 | 200yr | 8.73 | 11.05 | 11.90 | 13.23 | 14.33 | 200yr |
| 500yr | 1.13 | 1.86 | 2.42 | 3.52 | 4.93 | 6.41 | 500yr | 4.26 | 6.47 | 7.41 | 8.98 | 10.60 | 12.30 | 14.45 | 500yr | 10.89 | 13.89 | 14.80 | 16.29 | 17.46 | 500yr |

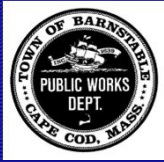


Intensity Frequency Duration - 100yr
(41.699N, -70.321W)









2018 Tidal Flooding Events at Barnstable Harbor

| Dates | Storm Name | Maximum High Tide (MLLW)* | Maximum High Tide (NAVD88)** | Estimated Storm Surge (feet)*** | Estimated Stillwater Elevation (NAVD88) | Estimated Stillwater Elevation (MLLW) | Recurrence (per table below) |
|------------------------|--------------------------|---------------------------|------------------------------|---------------------------------|-----------------------------------------|---------------------------------------|------------------------------|
| January 2-3, 2018 | Winter Storm Grayson | 12.3 | 6.6 | 3 | 9.6 | 15.3 | ~50-year |
| March 2-3, 2018 | Winter Storm Riley | 11.7 | 6.0 | 4 | 10.0 | 15.7 | ~100-year |
| March 7-8, 2018 | Winter Storm Quinn | 10.1 | 4.4 | 3 | 7.4 | 13.1 | <10-year |
| March 12-13, 2018 | Winter Storm Skylar | 9.2 | 3.5 | 3.5 | 7.0 | 12.7 | <10-year |
| March 21-22, 2018 | Winter Storm Toby | 10.7 | 5.0 | 2.2 | 7.2 | 12.9 | <10-year |
| Average High Tides**** | MLLW / NAVD88 | | | Recurrence**** | Flood Elevation (NAVD88) | Flood Elevation (MLLW) | |
| January 2018 | 8.5 to 10.4 / 2.8 to 4.7 | | | 10% chance (10-year) | 8.8 | 14.5 | |
| March 2018 | 8.5 to 10.6 / 2.8 to 4.9 | | | 2% chance (50-year) | 9.8 | 15.5 | |
| | | | | 1% chance (100-year) | 10.1 | 15.8 | |
| | | | | 0.2% chance (500-year) | 11.1 | 16.8 | |

*From U.S. Harbors at Barnstable Harbor <https://ma.us harbors.com/monthly-tides/Massachusetts-Cape%20Cod/Barnstable%20Harbor/> .

**NAVD88 plus 5.675 = MLLW at Barnstable Harbor per <http://buzzardsbay.org/technical-data/tidal-datums-ma/interactive-tidal-datum-viewer/> and validated at <https://tidesandcurrents.noaa.gov/datums.html?id=8443970> where NAVD88 plus 5.51 = MLLW at Boston Harbor.

***Grayson from <https://coastalengineeringcompany.com/news/winter-storm-grayson-2018-01-15/>; Riley from <https://www.capecodtoday.com/article/2018/03/02/237856-Winter-Storm-Riley-Batters-Barnstable-County>; Quinn from <http://www.ack.net/news/20180307/cape-storms-raise-climate-questions>; Skylar from Hazardous Weather Outlook, National Weather Service Taunton MA, 355 AM EDT Tue Mar 13 2018; Toby from Coastal Hazard Message, National Weather Service Taunton MA, 238 PM EDT Wed Mar 21 2018.

****From <https://www.townofbarnstable.us/conservation/FEMA/Maps716/Flood-Insurance-study.pdf> (July 16, 2014).

*****From <https://tides4fishing.com/us/massachusetts/barnstable-harbor-beach-point>.