



# Managing Stormwater in the City: A Case Study of New Haven

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Passing storms cause flash flooding in New Haven



#WTHWEATHER

**PASSING STORMS CAUSE FLASH FLOODING IN AREAS**  
NEW HAVEN

**8**

6:06  
71°  
WTNH.COM

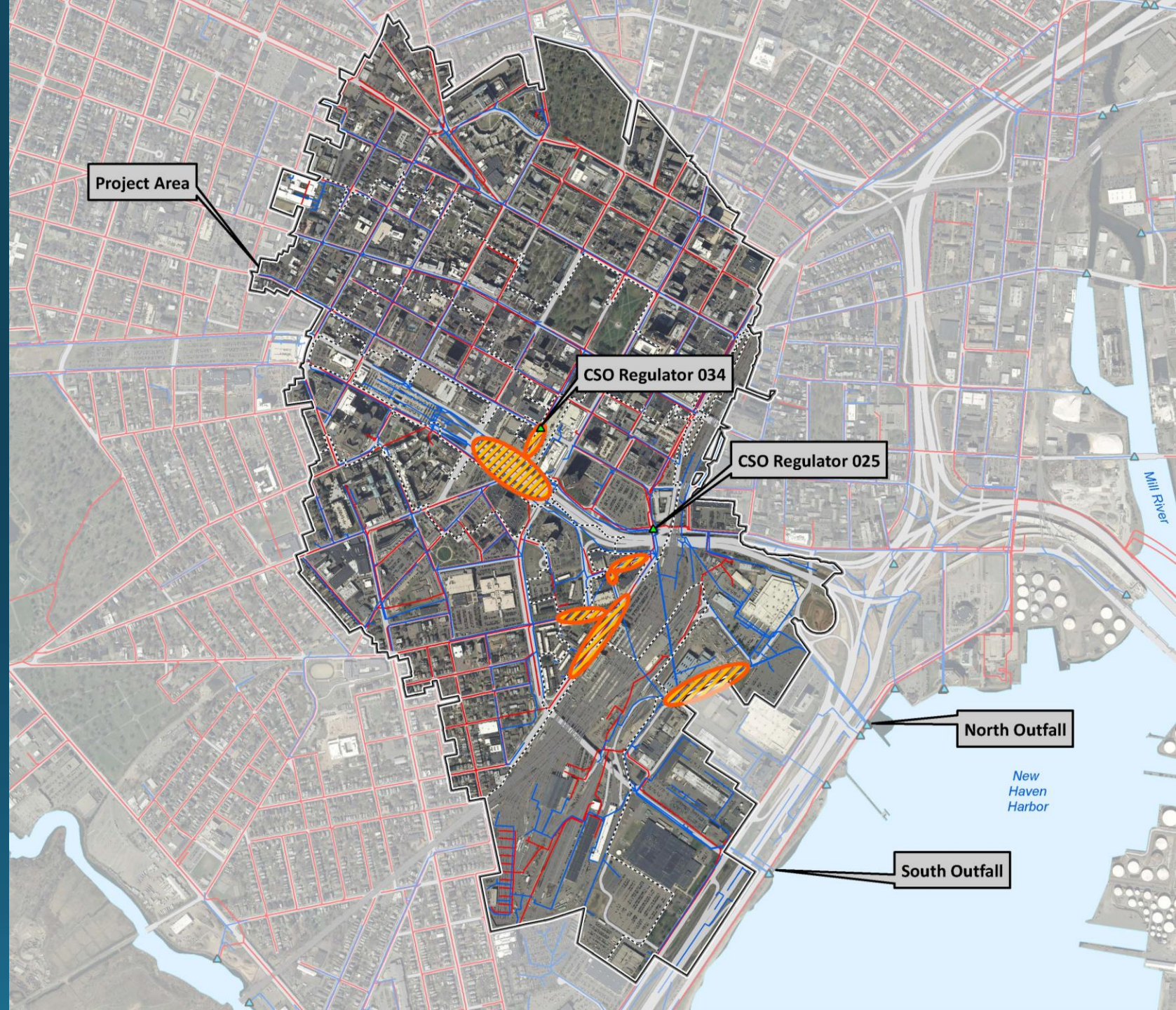
# Downtown Drainage System

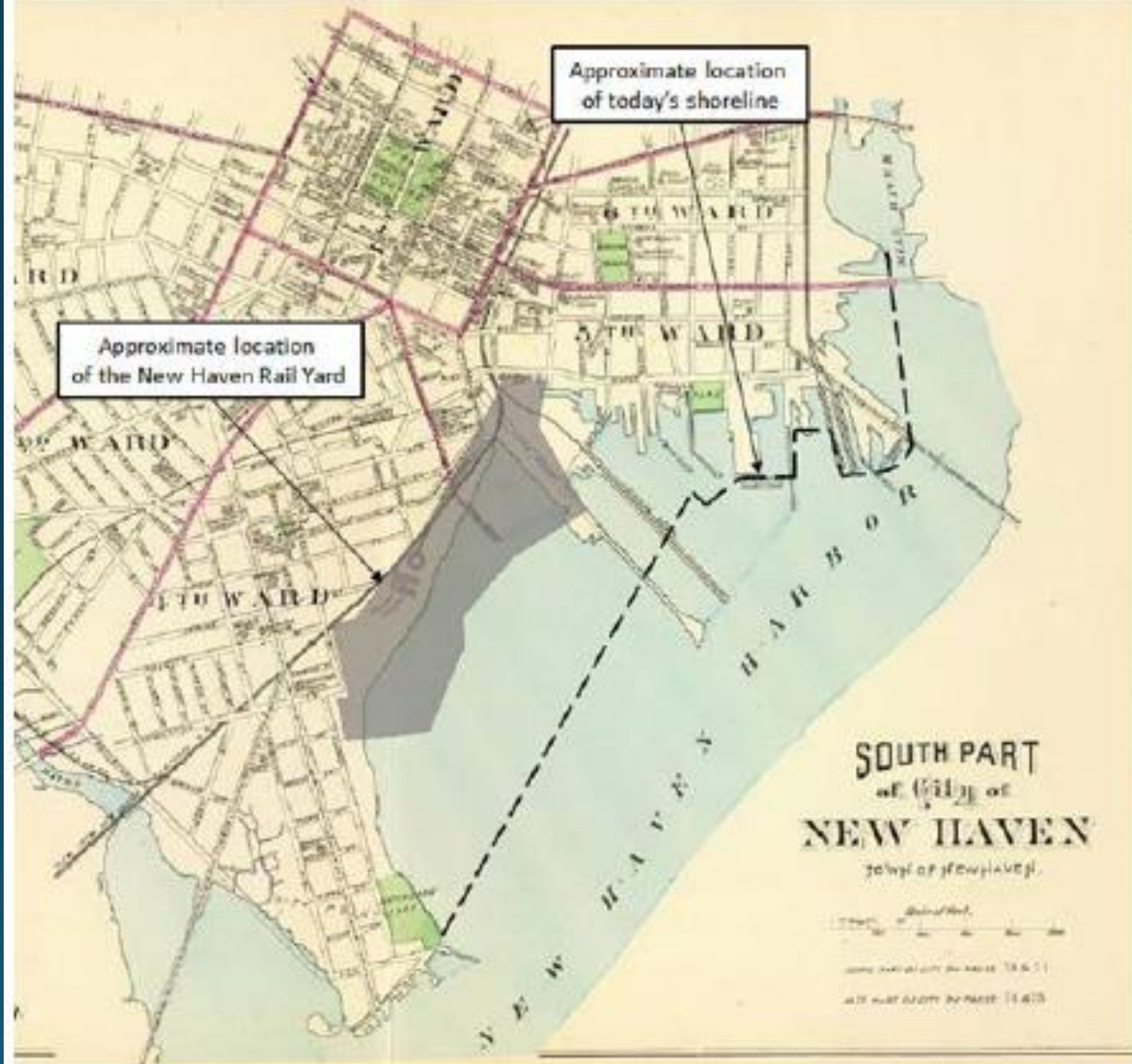
835 acres

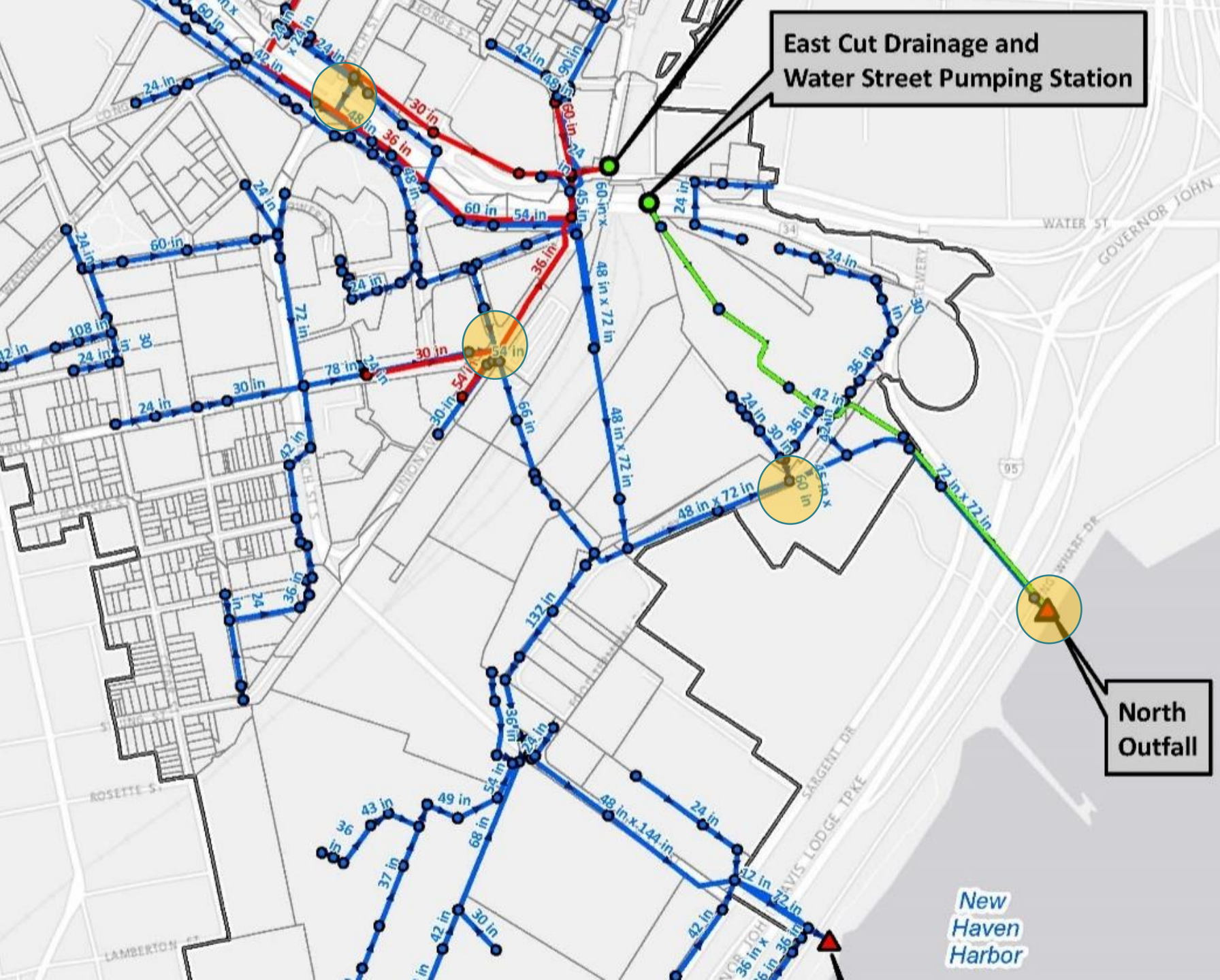
76% impervious

Combined and  
separately sewered  
areas

Two outfalls







East Cut Drainage and  
Water Street Pumping Station

Route 34 and Union Ave  
8.8-8.9 feet (NAVD88)

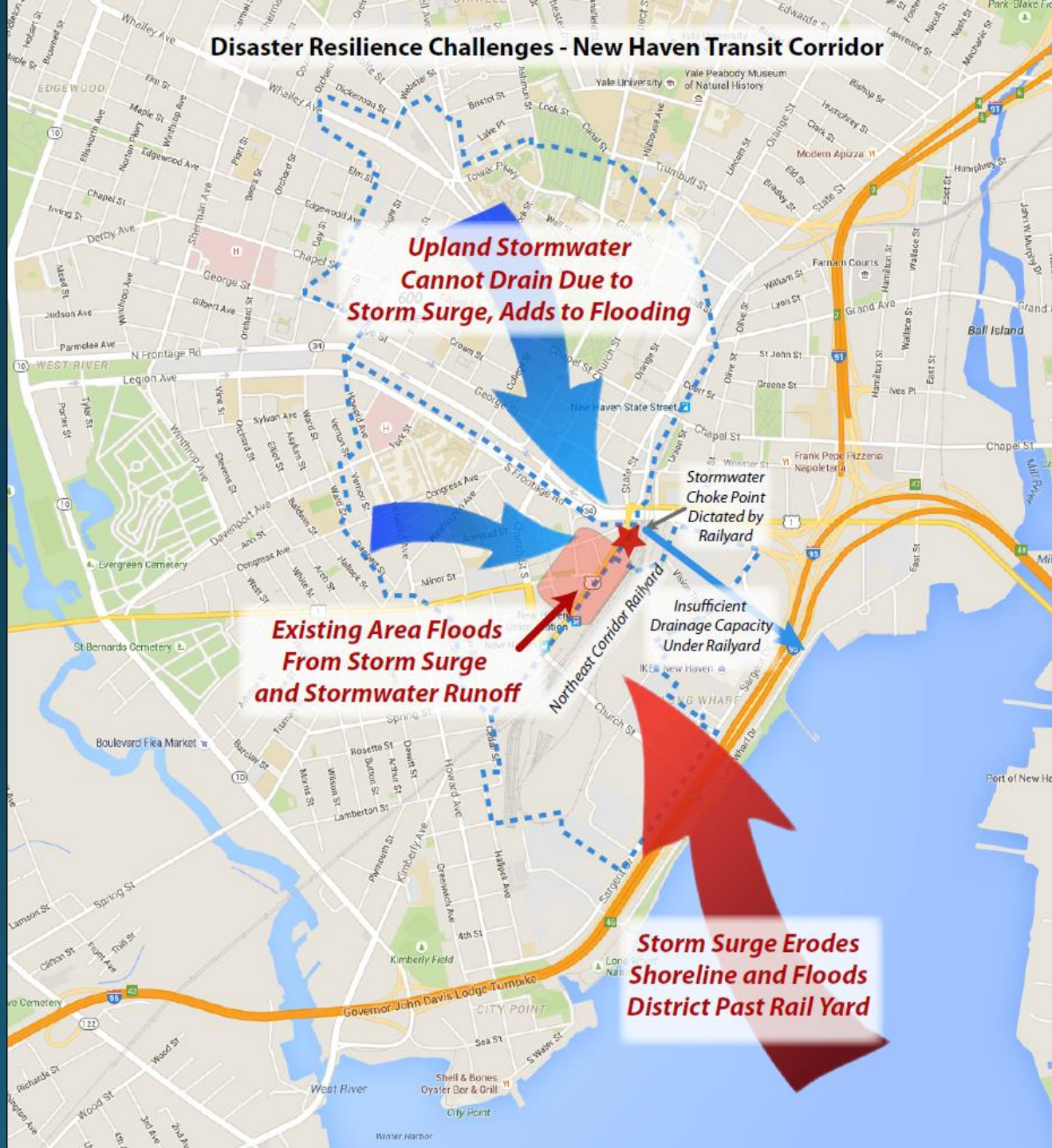
Brewery St Ext  
5.45 feet (NAVD88)

North  
Outfall

Higher High Tide  
about 4.4 feet (NAVD88)

New  
Haven  
Harbor

# Disaster Resilience Challenges - New Haven Transit Corridor



**Upland Stormwater  
Cannot Drain Due to  
Storm Surge, Adds to Flooding**

**Stormwater  
Choke Point  
Dictated by  
Railyard**

**Existing Area Floods  
From Storm Surge  
and Stormwater Runoff**

**Insufficient  
Drainage Capacity  
Under Railyard**

**Storm Surge Erodes  
Shoreline and Floods  
District Past Rail Yard**

# Rainfall- New Normal?

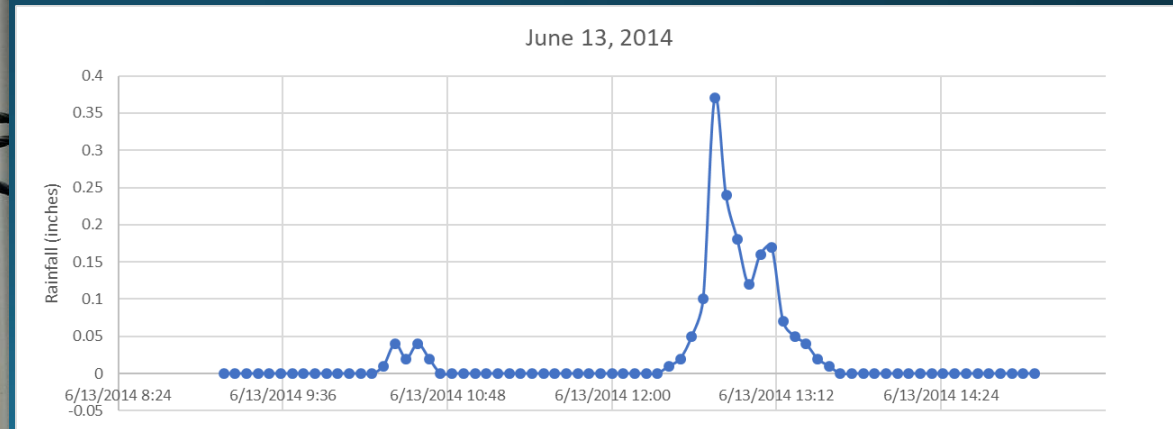
- High intensity, short duration rainfall events
- System-wide capacity issues + local bottlenecks
- Compounded by SLR

**Table 3-3**  
**Intense New Haven Rainfall 2010-2016**

Date	15-Min	1-Hr	3-Hr	6-Hr	24-Hr	Gauge
August 22, 2010	NA	1.0	1.2	1.7	2.6	Tweed
October 01, 2010	0.3	0.5	0.9	1.0	1.1	Tweed
May 18, 2011	0.6	1.4	1.8	1.8	2.3	Tweed
June 23, 2011	0.5	0.9	1.0	1.4	1.5	Tweed
August 01, 2011	0.7	0.9	0.9	0.9	0.9	Tweed
June 25, 2012	NA	0.9	1.0	1.0	1.1	Tweed
August 10, 2012	1.4	2.2	2.4	2.4	2.9	GNHWPCA
September 18, 2012	0.8	1.3	1.4	1.4	1.4	GNHWPCA
September 28, 2012	0.8	2.0	3.0	3.2	3.4	GNHWPCA
July 11, 2013	0.9	1.0	1.0	1.2	1.4	GNHWPCA
July 23, 2013	0.7	0.9	1.1	1.1	2.0	GNHWPCA
May 16, 2014	0.6	1.1	1.4	1.6	1.6	GNHWPCA
May 27, 2014	0.7	1.3	1.3	1.3	1.4	GNHWPCA
June 13, 2014	0.8	1.6	1.7	1.7	2.1	GNHWPCA
July 14, 2014	1.0	1.8	2.4	2.4	2.5	GNHWPCA
August 13, 2014	0.4	1.1	1.8	2.5	2.7	Tweed
September 21, 2014	0.4	0.9	1.1	1.4	1.4	Tweed
July 01, 2015	0.8	0.9	0.9	0.9	0.9	GNHWPCA
May 30, 2016	0.7	1.1	1.5	1.5	1.5	Tweed
<b>NOAA Atlas 14</b>						
1-Year	0.6	1.0	1.5	1.9	2.8	
2-Year	0.7	1.2	1.8	2.3	3.4	
5-Year	0.9	1.6	2.4	3.0	4.4	
10-Year	1.0	1.8	2.8	3.5	5.2	
25-Year	1.3	2.2	3.4	4.3	6.3	

# June 13, 2014

- 5-year, 1 hour storm (1.5 inches)

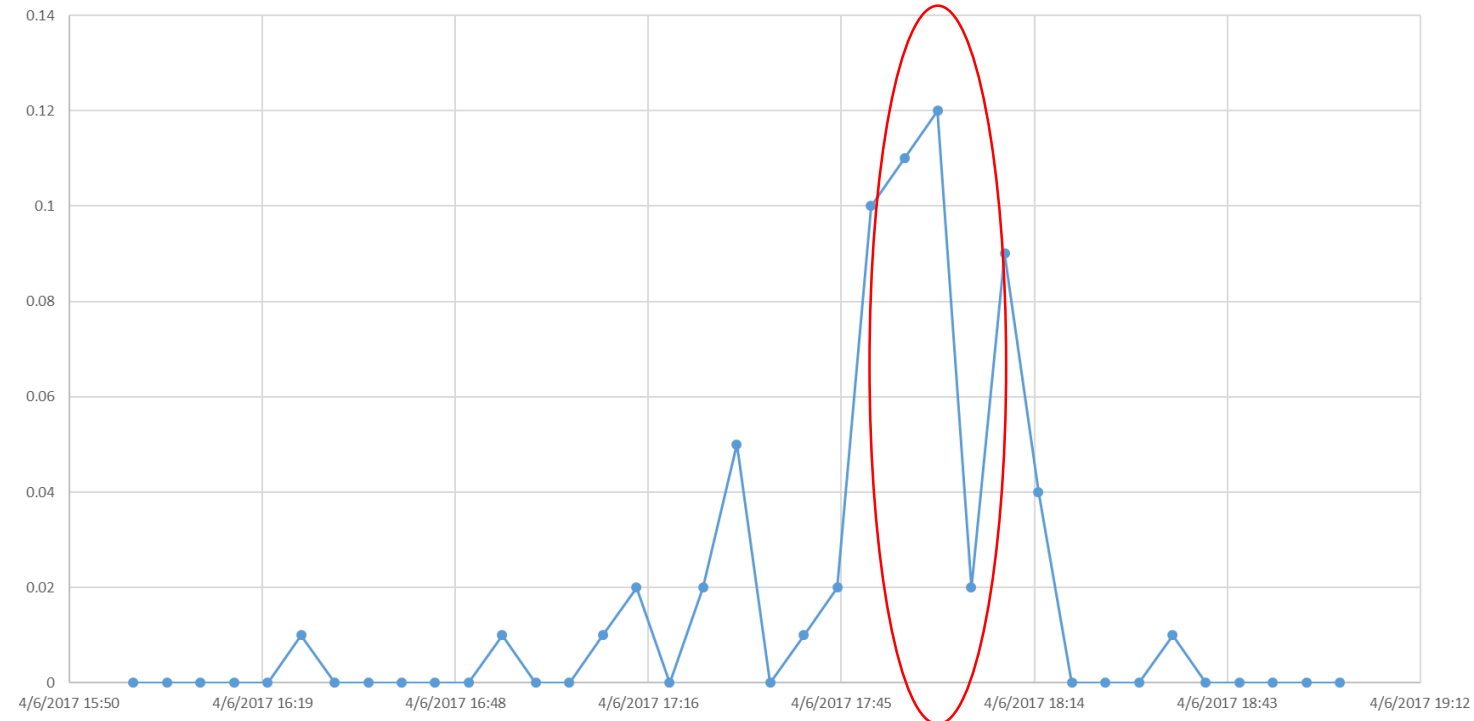




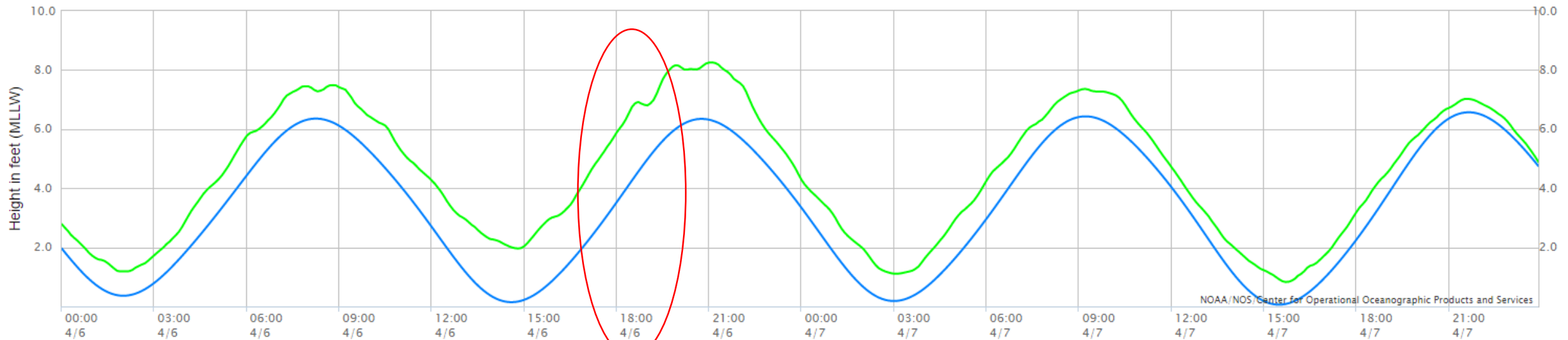
# April 6, 2017

Rainfall- April 6, 2017

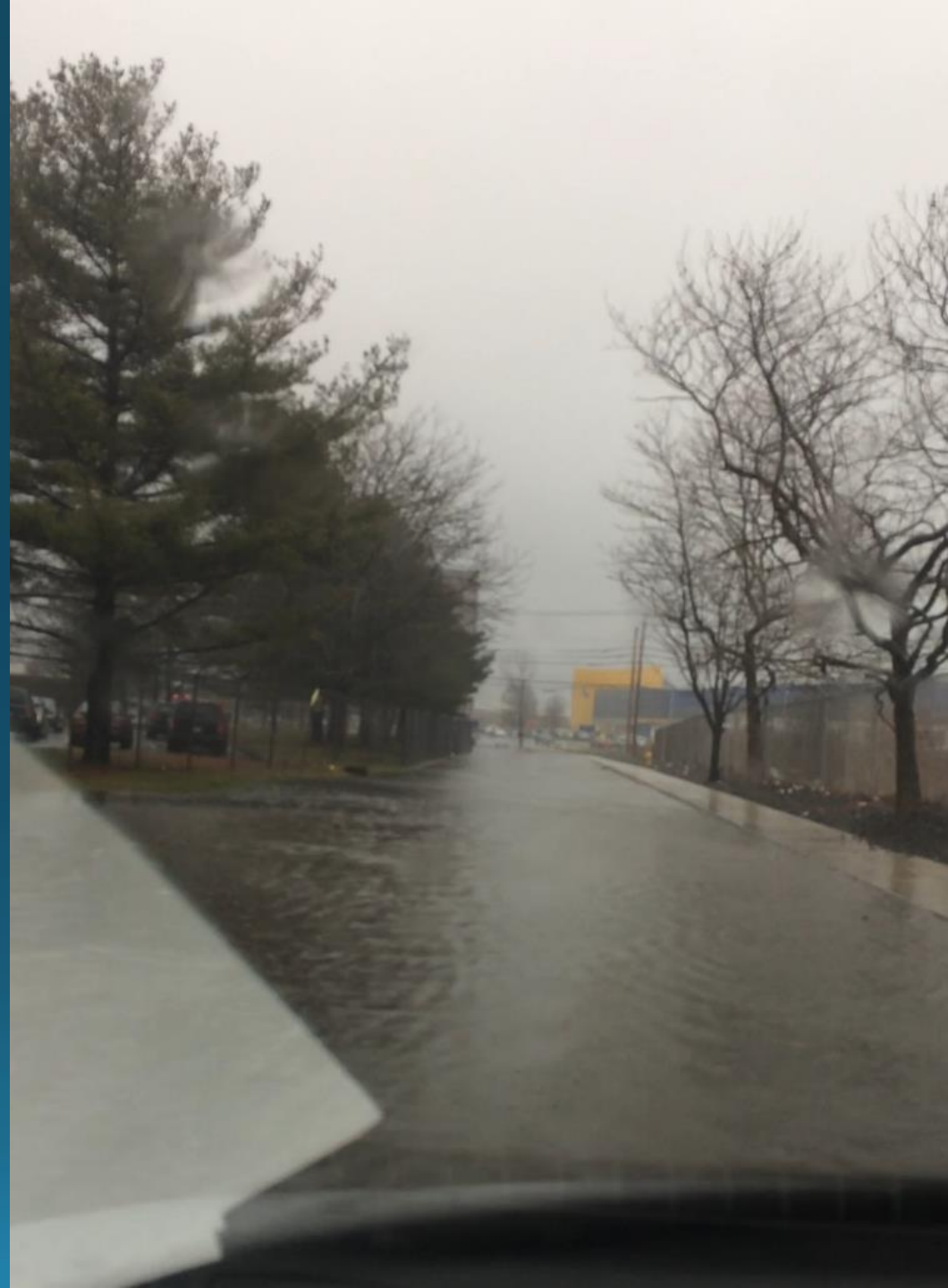
Date	Duration (hrs)	Max 5 min volume (in)	Max 30 min volume (in)	Total volume (in)
4/6/2017	2.25	0.12	0.48	0.64



NOAA/NOS/CO-OPS  
 Observed Water Levels at 8465705, New Haven CT  
 From 2017/04/06 00:00 LST/LDT to 2017/04/07 23:59 LST/LDT



April 6,  
2017



April 16, 2018

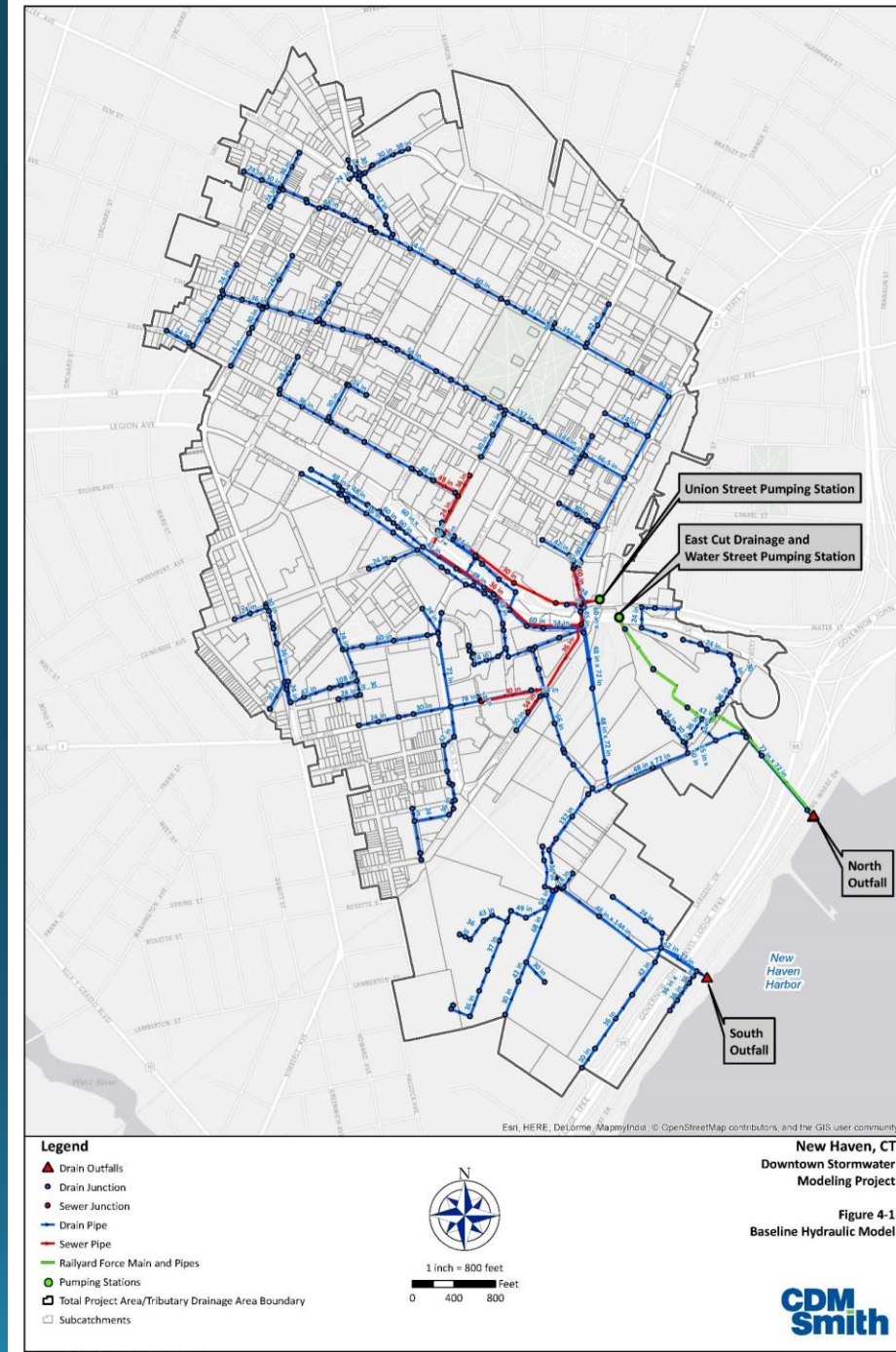
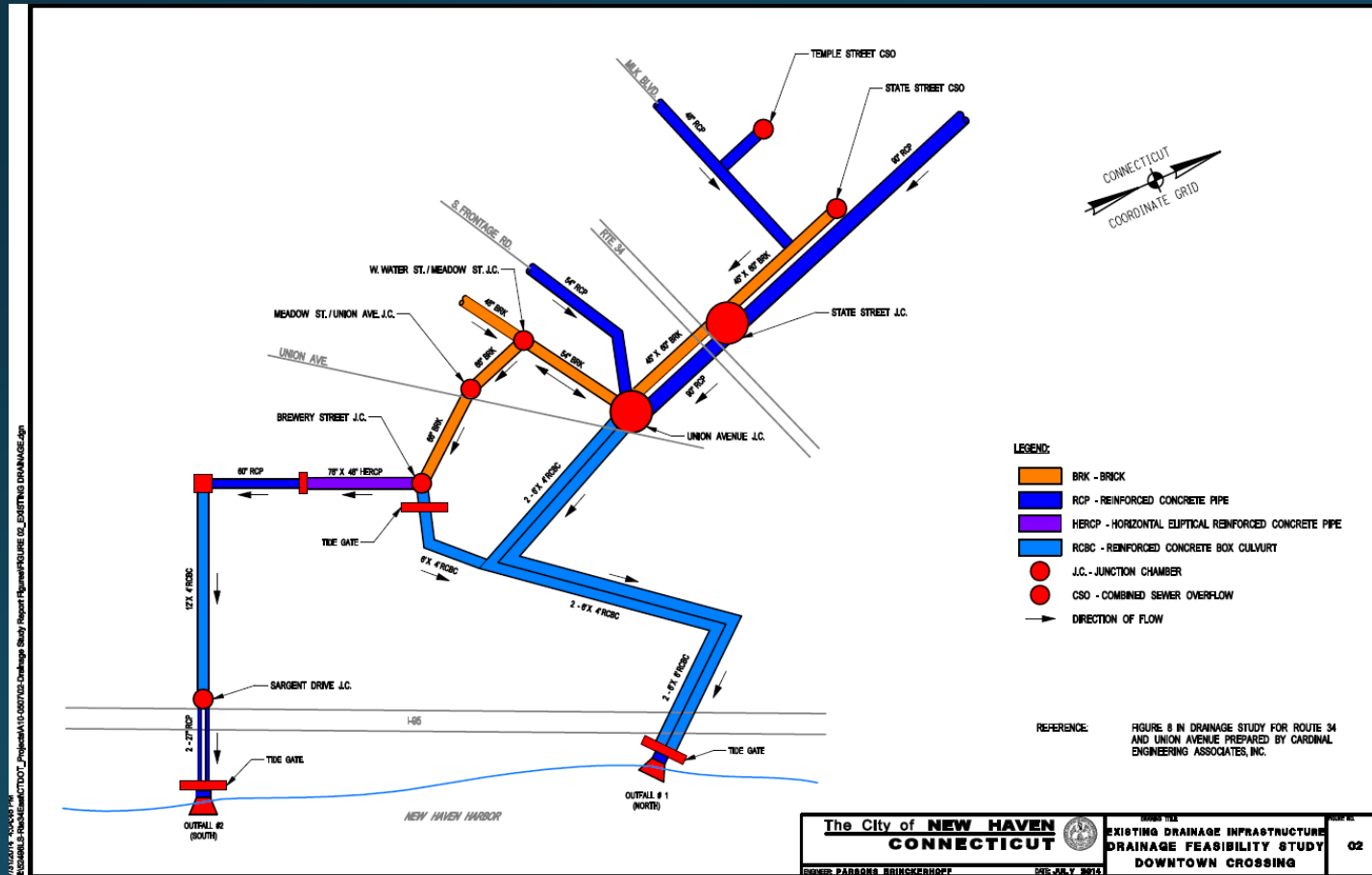


# Downtown Stormwater Studies

2010 – Cardinal

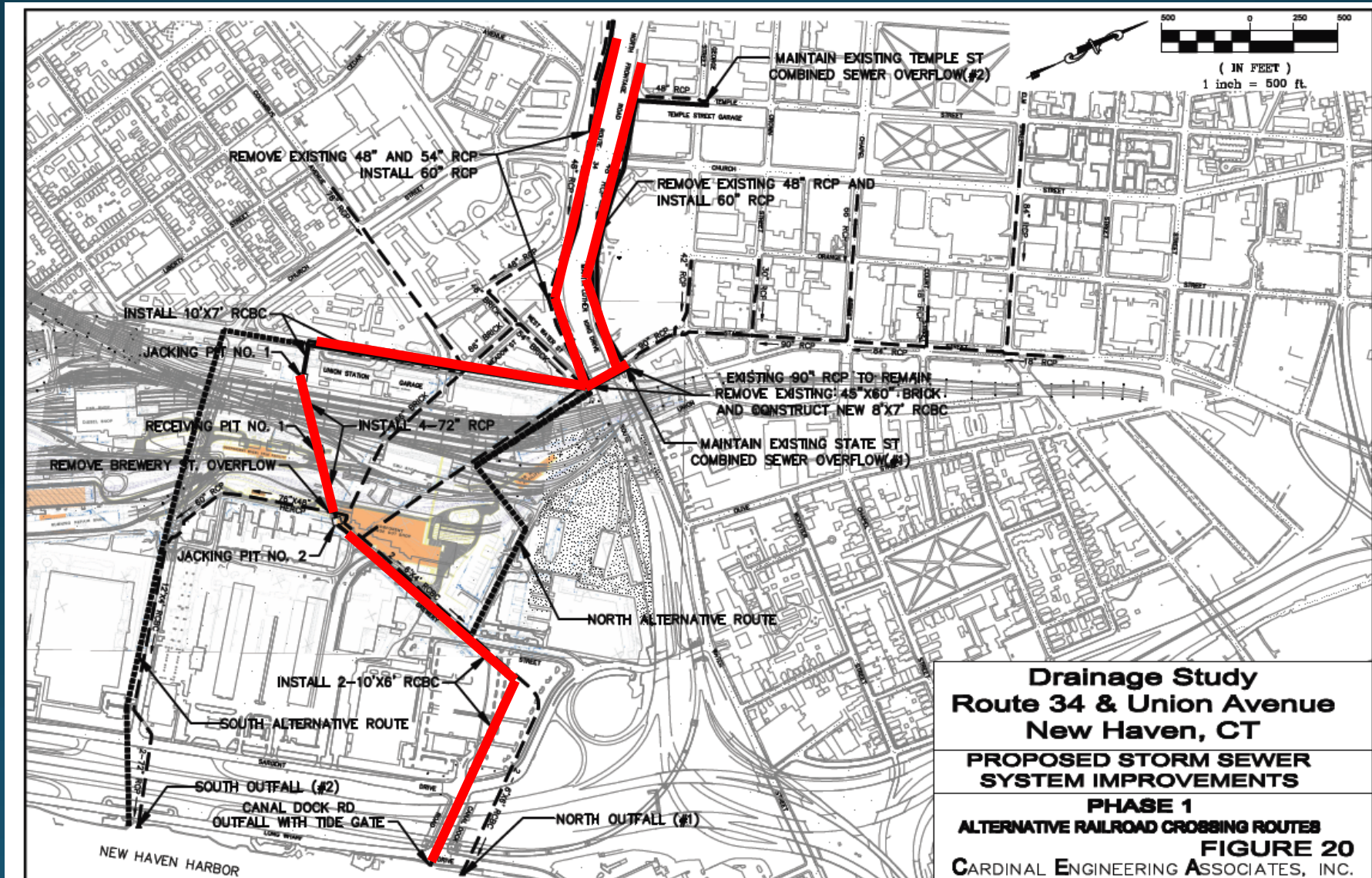
2014 – PB

2016 – CDM Smith



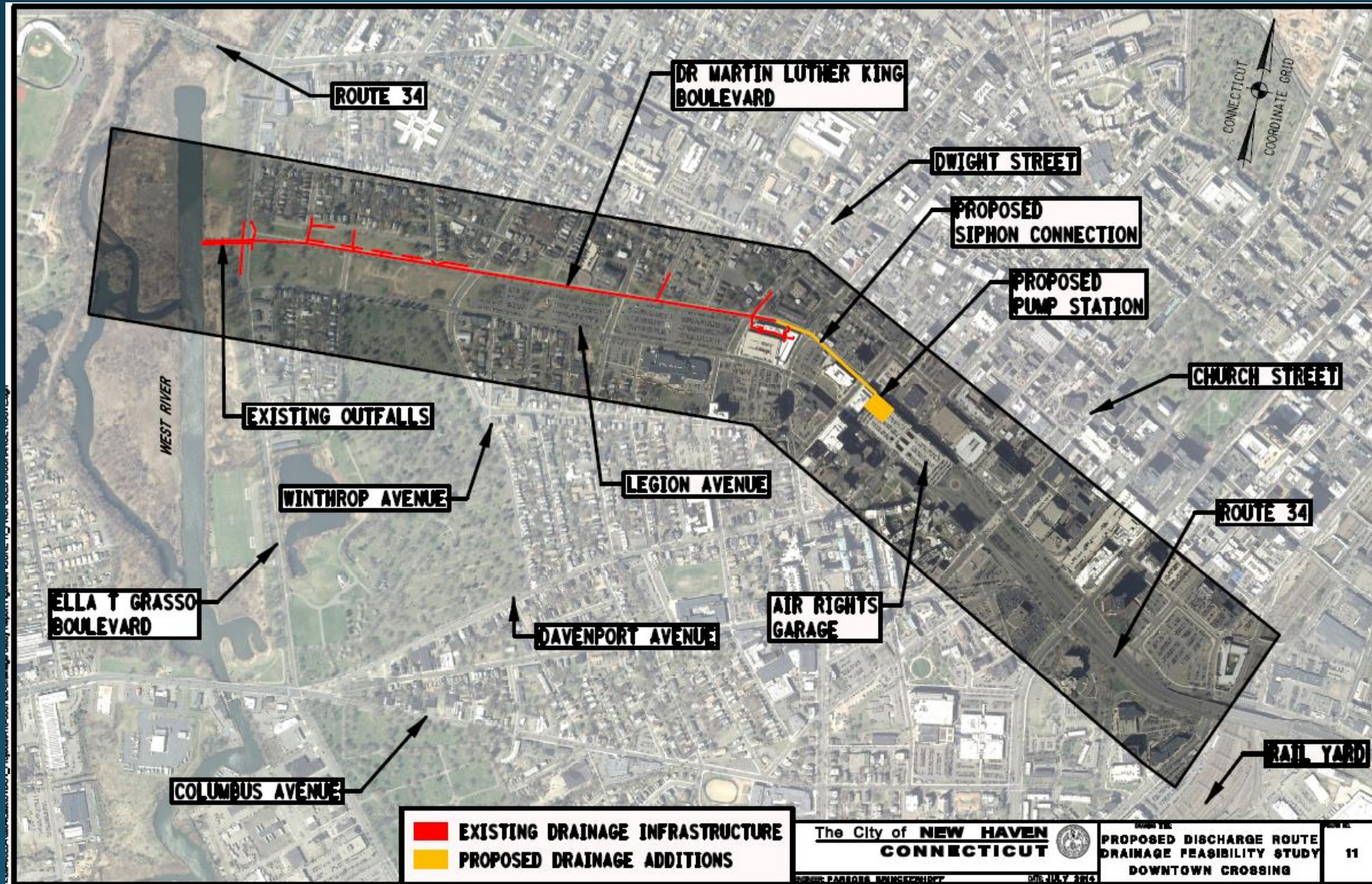
# Proposed Solutions

2010: Large Infrastructure Solution (\$54-59 M 2012 dollars including pump station)



# Proposed Solutions

2014: Diversion to West River (\$25 M 2013 dollars)



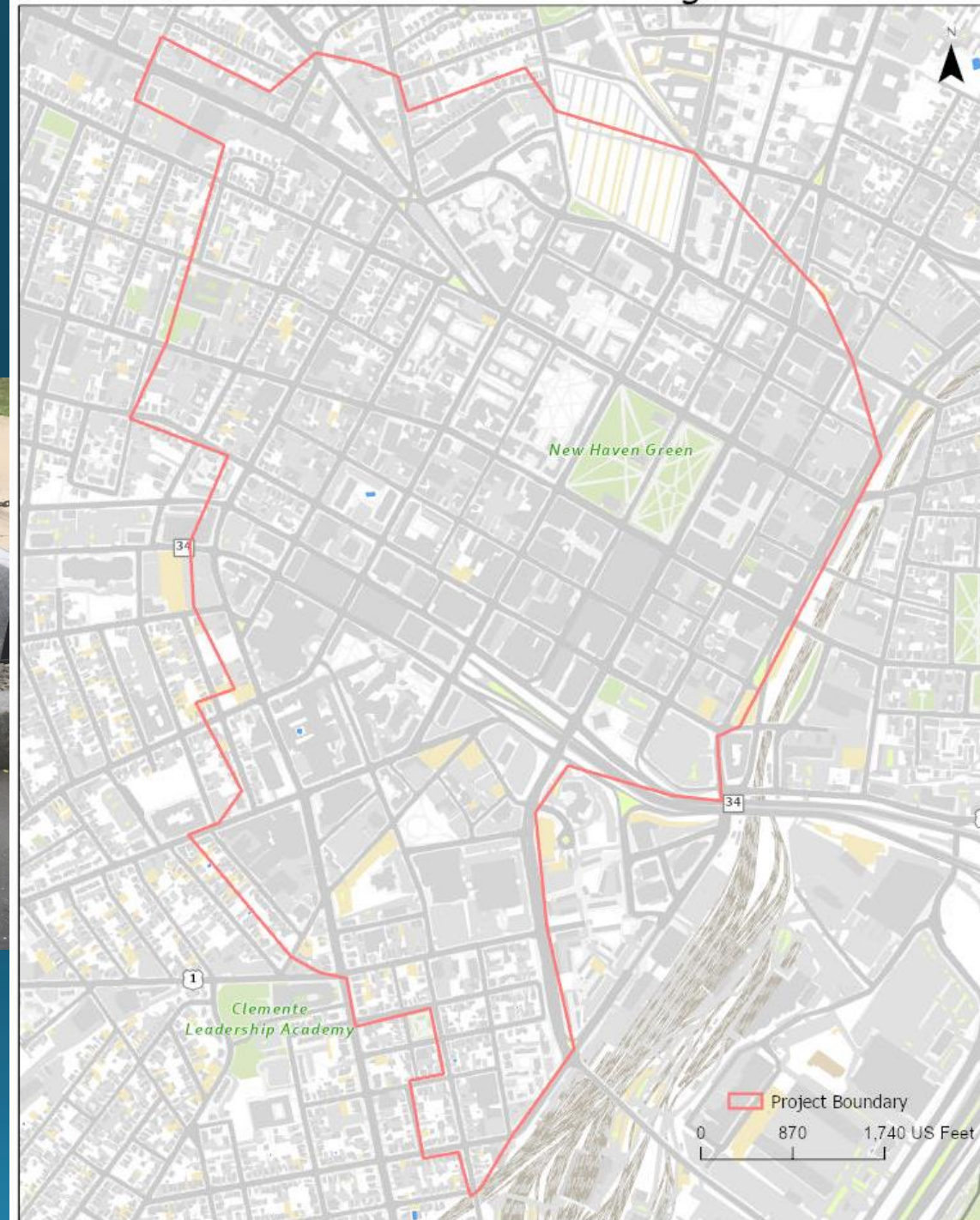
# Proposed Solutions

- Need a green + gray infrastructure approach



# Proposed Solutions

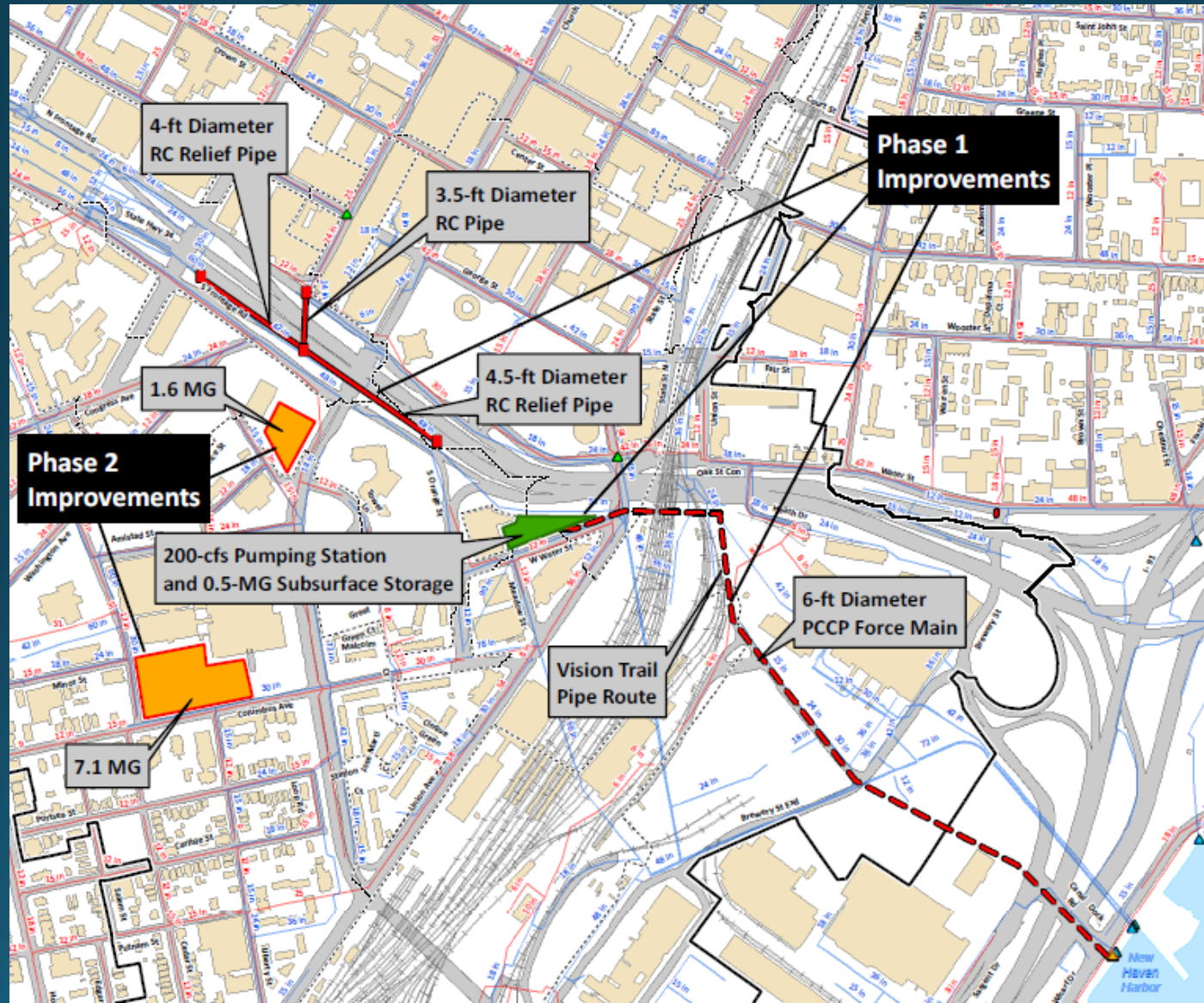
- 175 right-of-way bioswales throughout drainage area





# Proposed Solutions

2016: Pump Station to Harbor (\$37 M 2019 dollars- Phase 1)



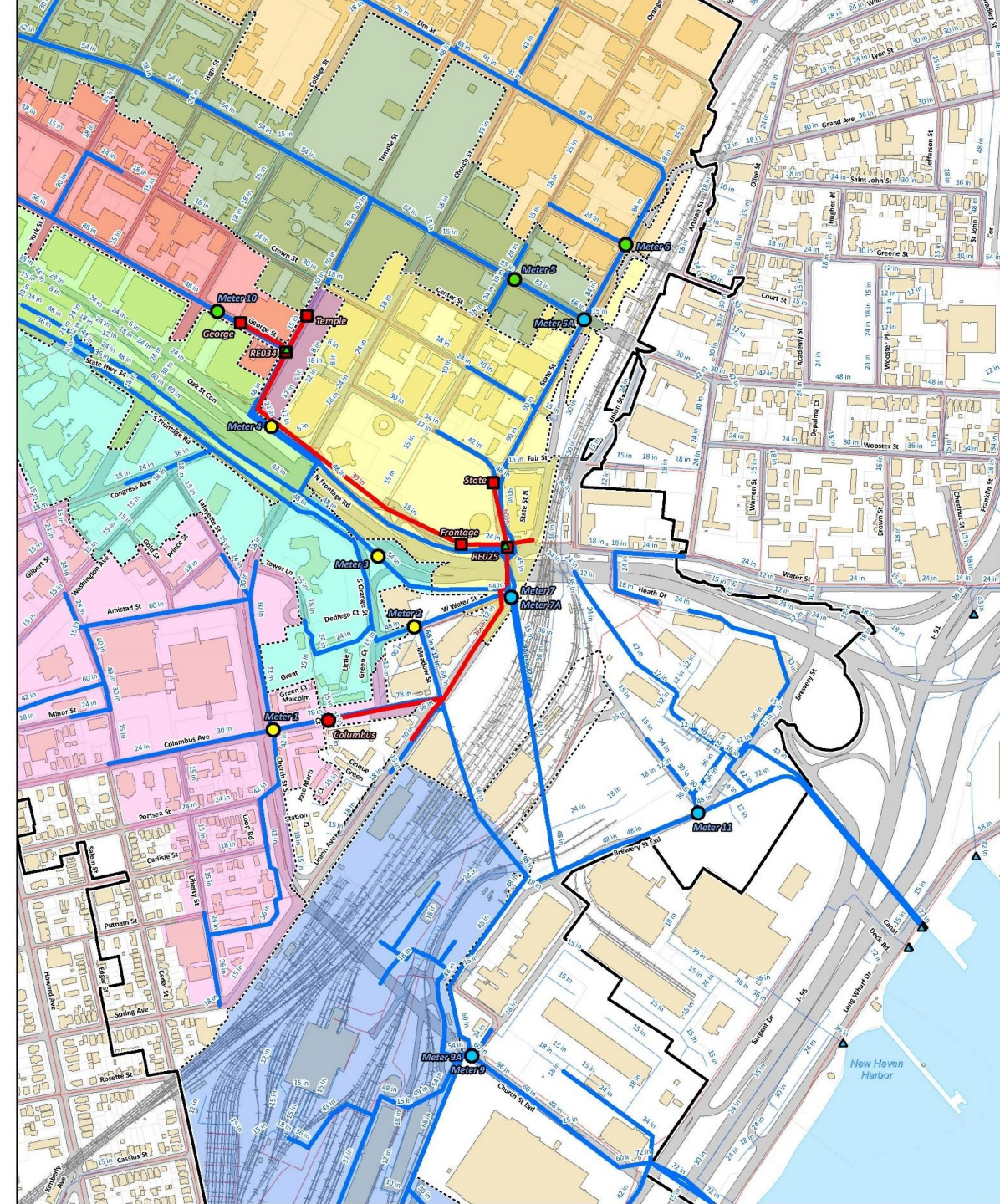
# Proposed Solutions

- All rainfall used to calibrate SWMM model is less than a 1 year storm frequency

Calibration Events

Event	Duration (days)	Storms	Rain (inches)		
			1-Hr	24-Hr	Total <sup>1</sup>
Fall 1	0.9	November 19, 2015 18:45	0.31	1.12	1.78
Fall 2	3.3	December 14, 2015 19:30	0.39	0.80	
		December 17, 2015 5:00	0.32	0.98	
Fall 3	2.0	December 22, 2015 10:00	0.18	0.43	1.98
		December 23, 2015 15:30	0.45	1.55	
<b>Fall Total</b>					<b>4.88</b>
Spring 1	6.3	March 28, 2016 5:00	0.20	0.82	2.69
		April 1, 2016 0:30	0.35	1.68	
Spring 2	3.8	April 22, 2016 20:00	0.24	0.51	1.05
		April 26, 2016 4:00	0.36	0.54	
Spring 3	4.5	May 3, 2016 2:45	0.11	0.66	2.14
		May 6, 2016 4:30	0.56	0.76	
<b>Spring Total</b>					<b>5.75</b>

<sup>1</sup> - Total rainfall spans event duration

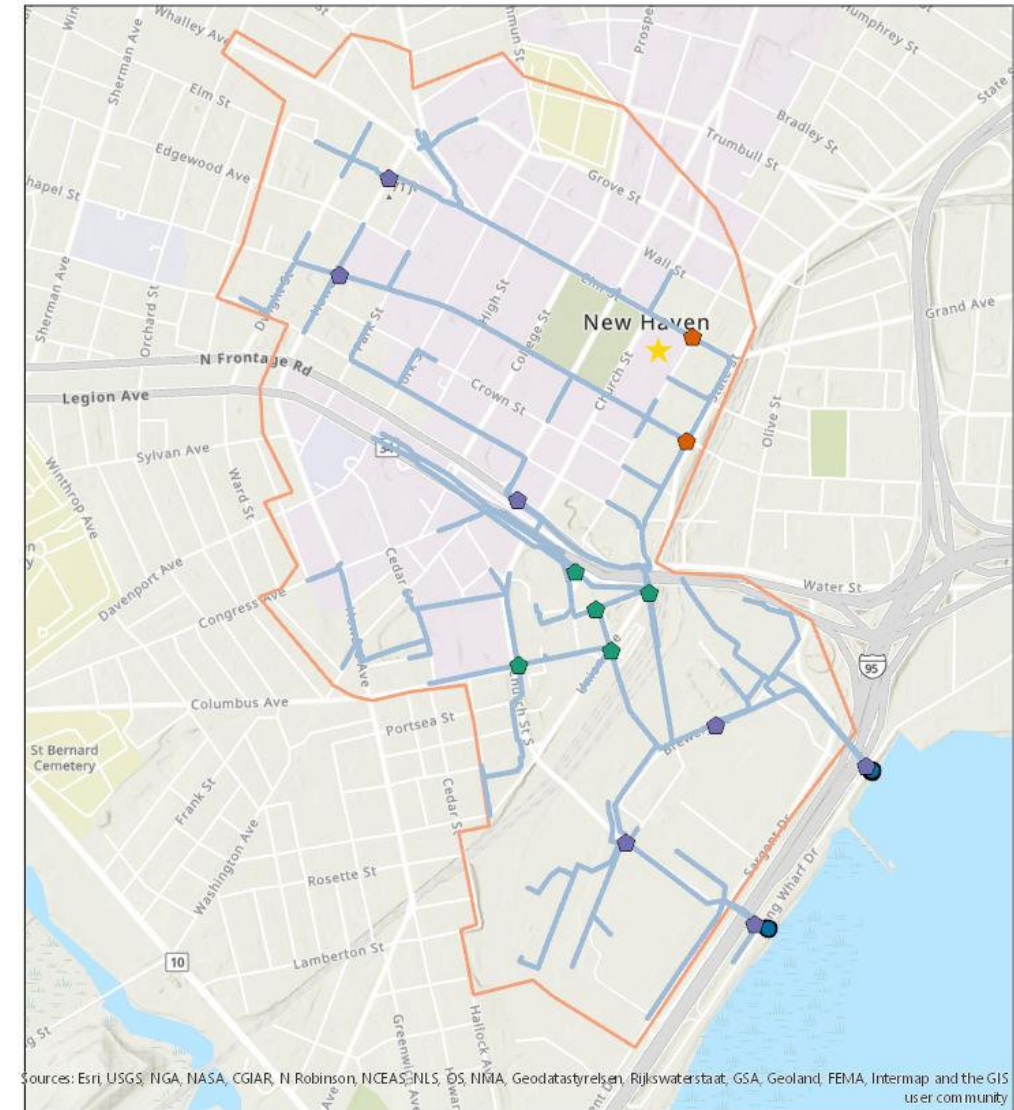


# Long Term Monitoring

- Funded through CIRCA grant
- Strategically install series of depth and flow sensors throughout drainage area to collect long term data on storm sewer system performance



City of New Haven Downtown Monitoring Locations



Sources: Esri, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatasysteisen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community

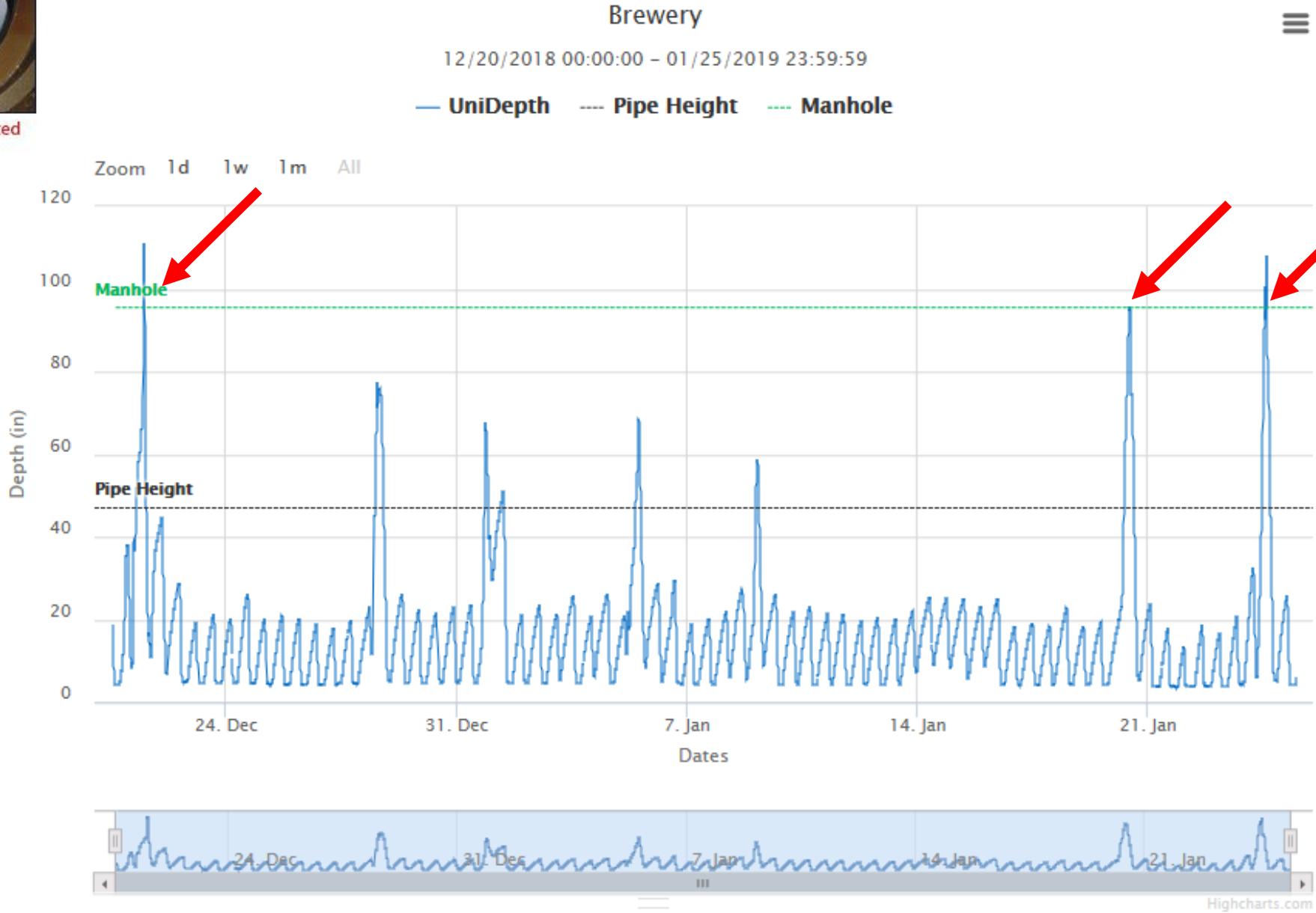
Sensor Type

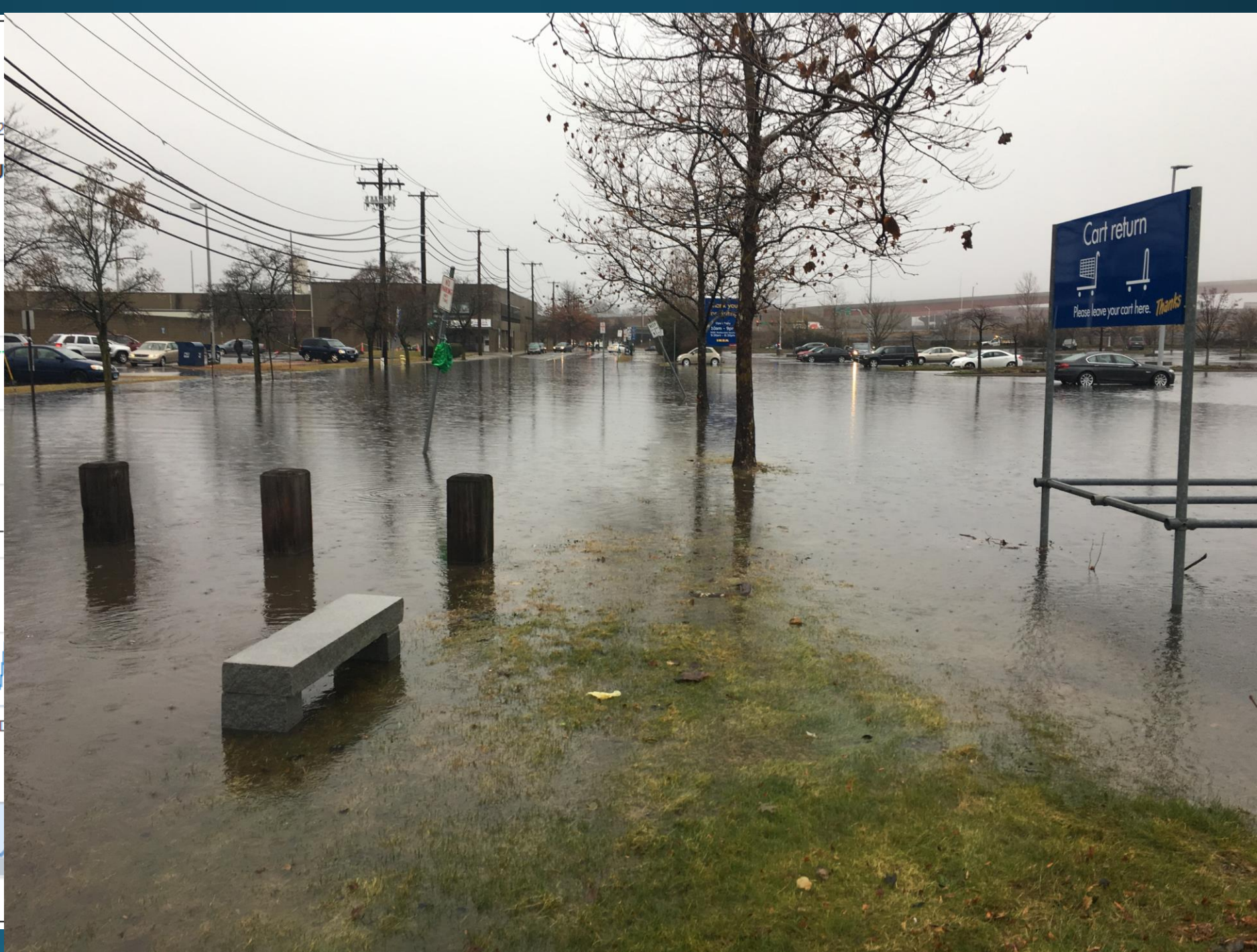
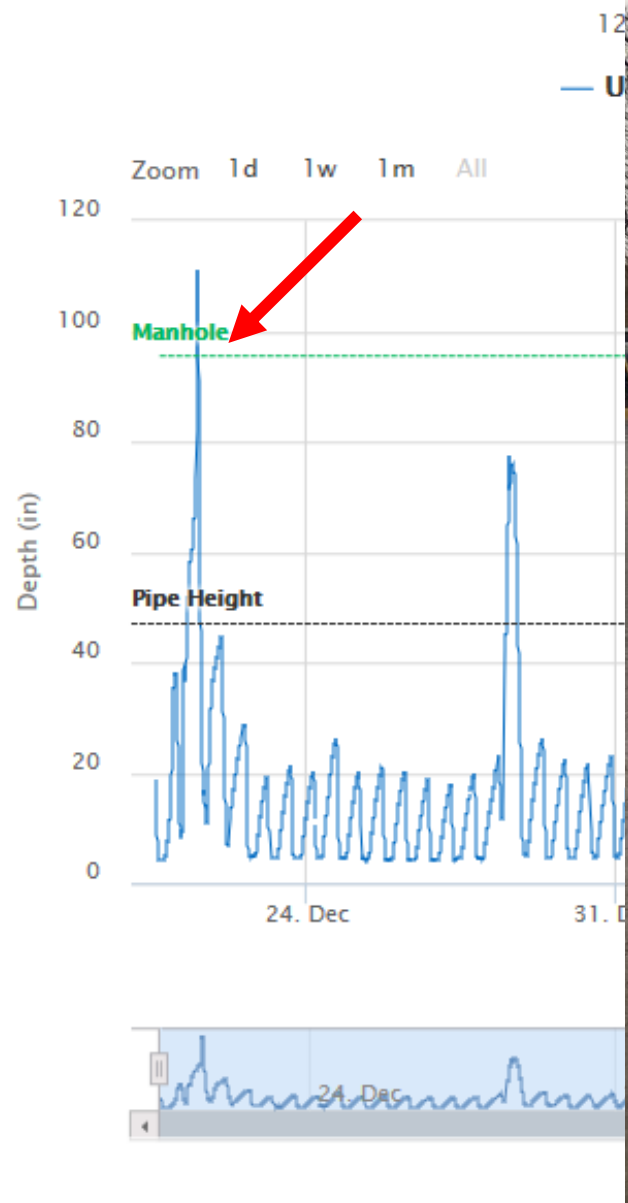
- Doppler Flow
- Doppler Flow (in line)
- Ultrasonic Level
- Rain Gauge
- Downtown Drainage Area
- Storm Sewer Pipes (30" and over)
- Outfall



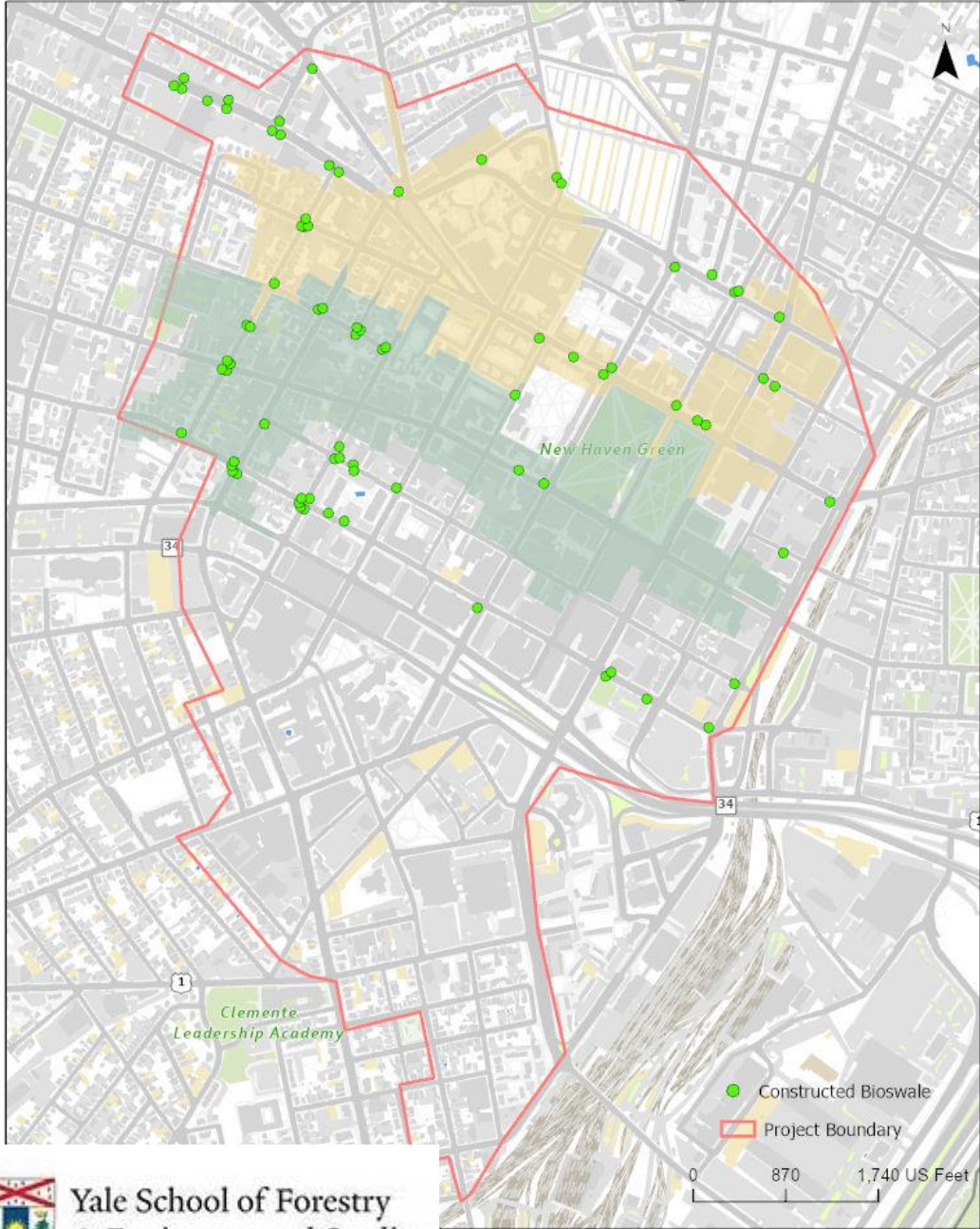


ECHO with installation bar mounted on manhole frame

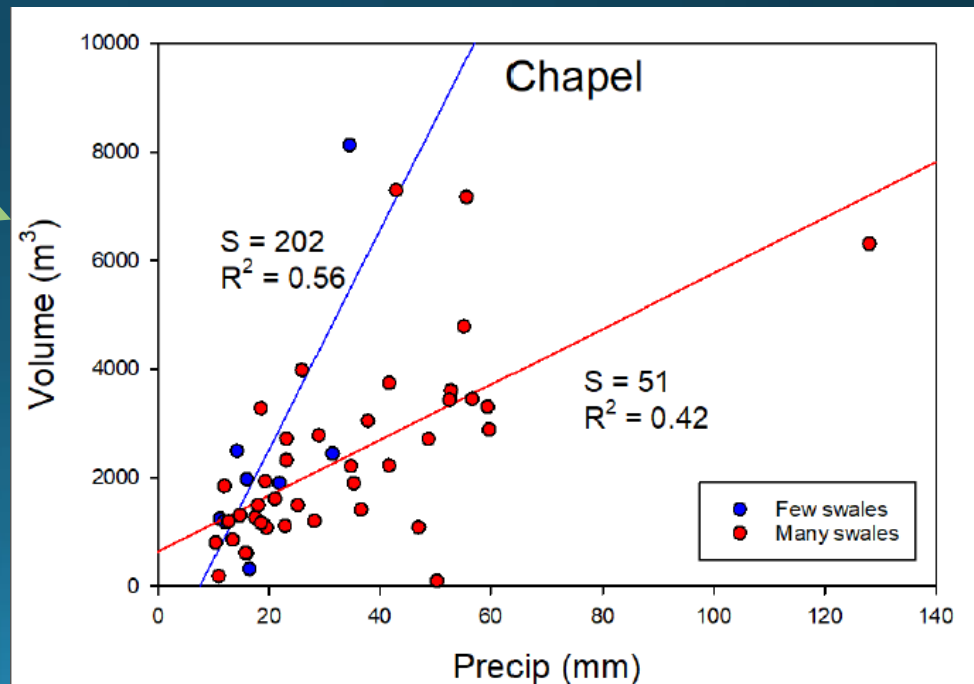
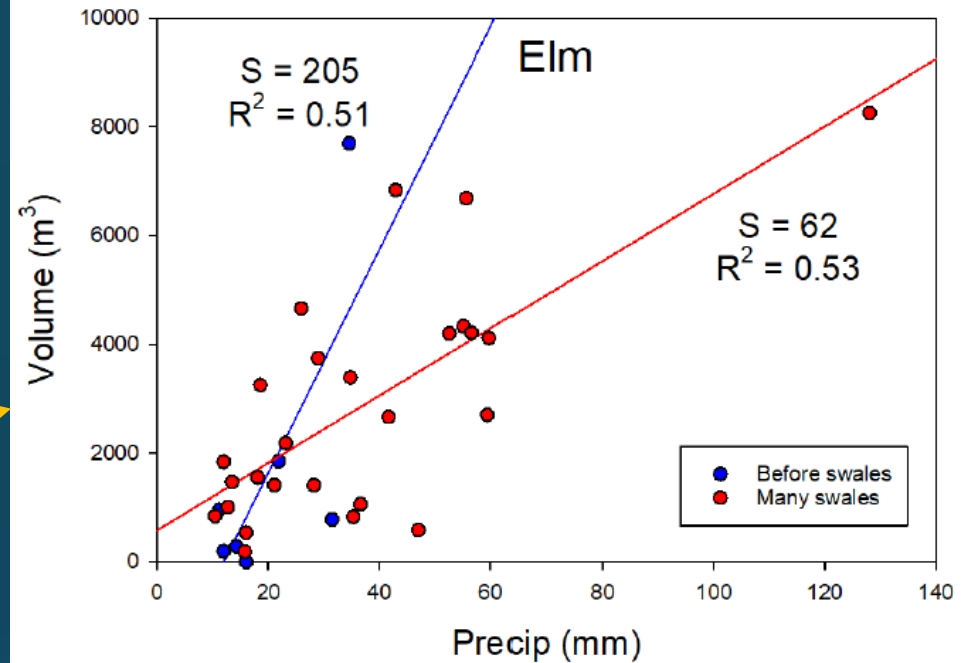
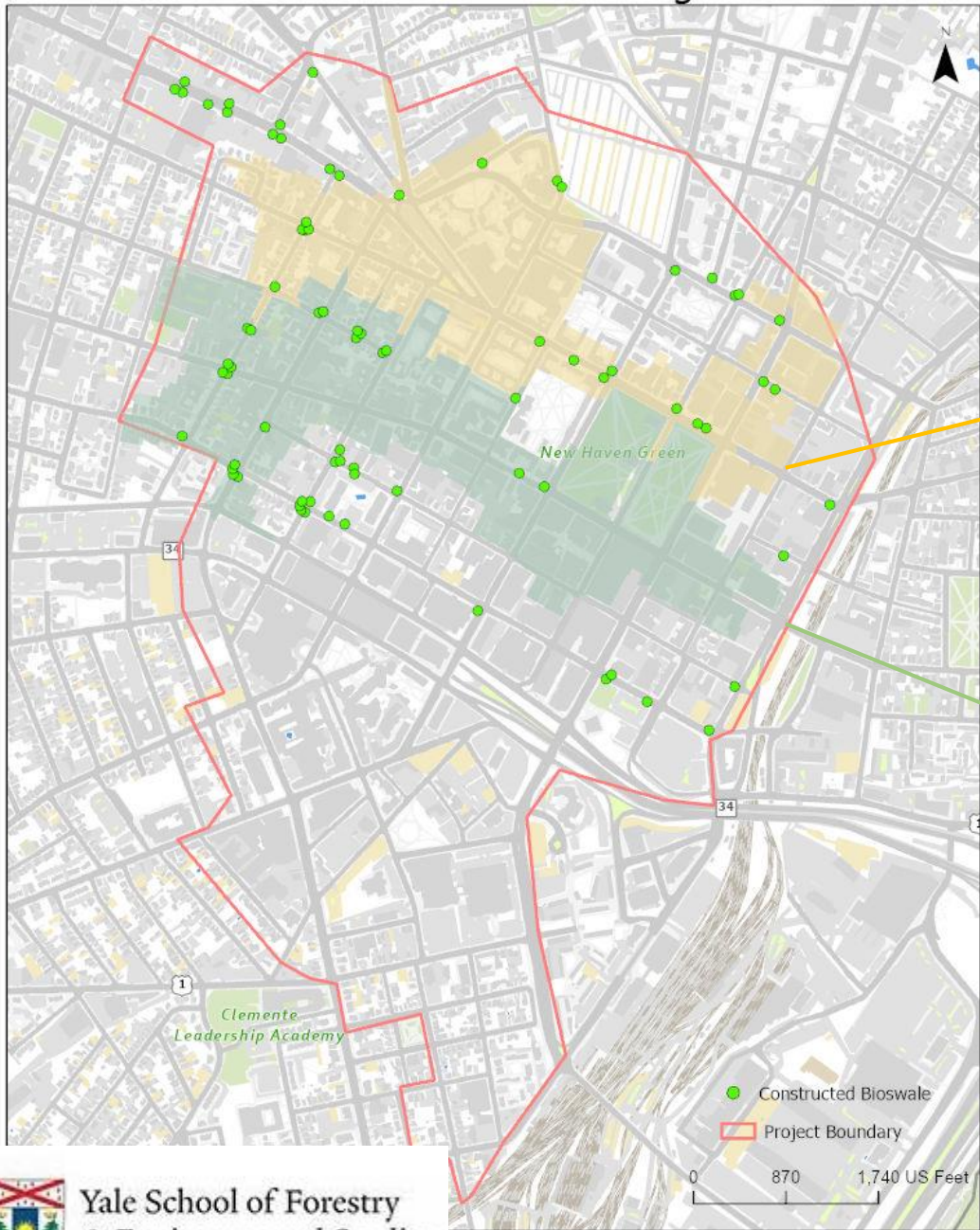




# Downtown Bioswale Drainage Area



# Downtown Bioswale Drainage Area



Preliminary results of research by Gaboury Benoit, Yale F&ES

## Project Websites:

New Haven:

[circa.uconn.edu/new-haven-stormwater/](https://circa.uconn.edu/new-haven-stormwater/)

PSCAR Report:

[circa.uconn.edu/ct-climate-science/](https://circa.uconn.edu/ct-climate-science/)

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