Team Energy presents:

What's that smell?

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Introduction

- Sanitary sewer overflows (SSOs) occur when there is a blockage or break in the sanitary sewer line causing wastewater to flow out of the collection system
- SSOs can contaminate water sources, threatening public health and creating environmental issues
- The unpredictable and random nature of SSOs, in part, makes them very hard to monitor and study.
- SSOs in Baltimore are especially important because it will affect not only the city's surface water, but also the Chesapeake Bay watershed.

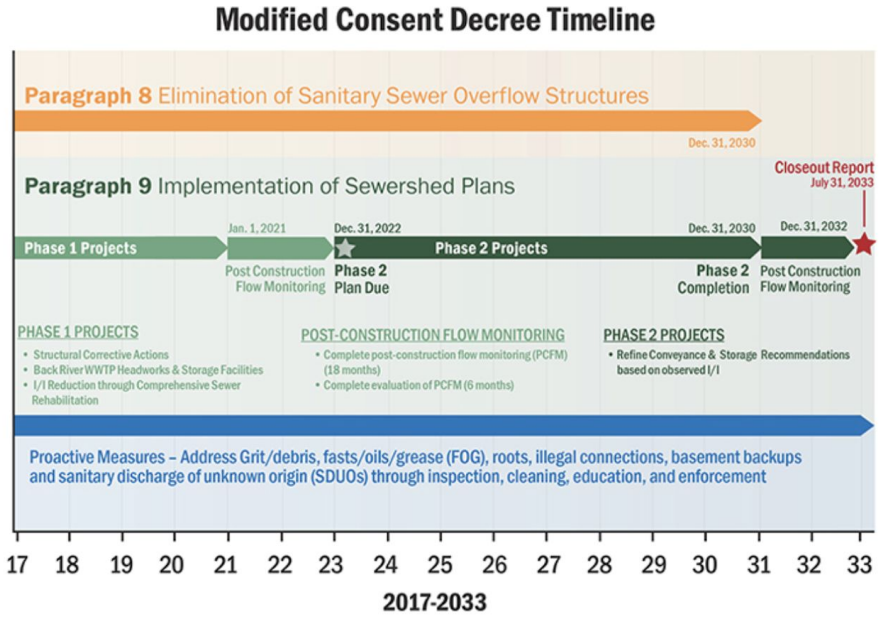
Introduction

- Sewage may include untreated human and animal wastes, household chemicals, industrial chemicals, pesticides, oxygen-demanding pollutants, suspended solids, nutrients, toxicants, floatable matter, radioactive materials and pathogens
  - Can lead to health issues
    - water-borne illnesses
  - Can lead to a number of environmental issues
    - Impede the ability of a habitat area to provide aquatic life support for desirable aquatic organisms
    - Prevent a source water from serving as a safe drinking water supply with conventional treatment
    - Interfere with a habitat's ability to support fish and shellfish that are free from contamination

Introduction

Baltimore Consent Decree:

- Agreement with EPA in 2005 to minimize SSOs
- Plan consists of Two Phases:
  - Phase 1: Renovate Existing Infrastructure (2021)
  - Phase 2: Capital Projects to reinforce network (2030)
- Attempt to eliminate 83% of SSO volume by 2021
- Consent Decree also considers basement backups and SDUOs

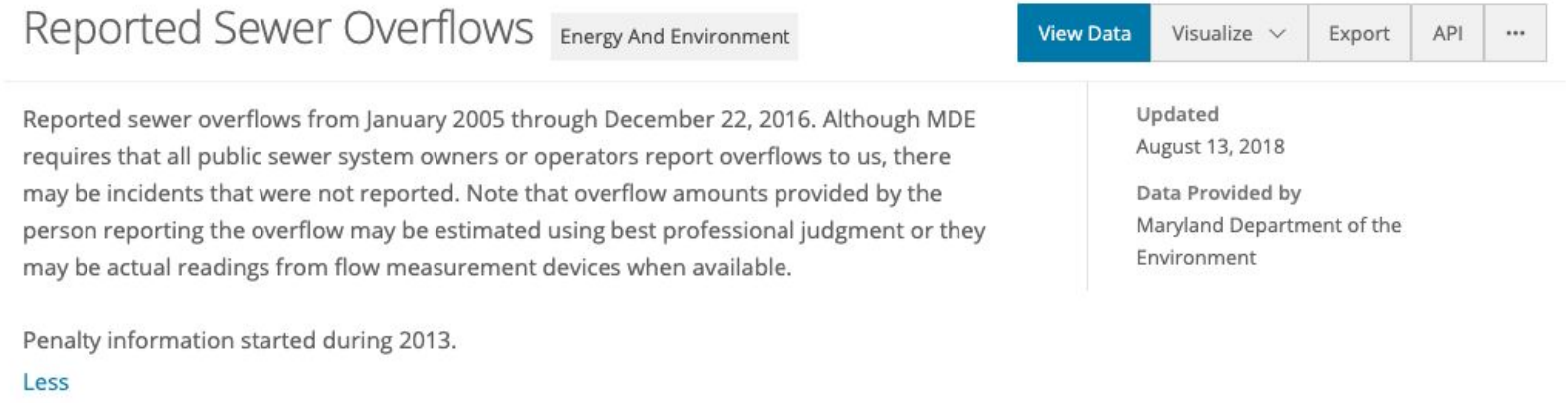


Introduction

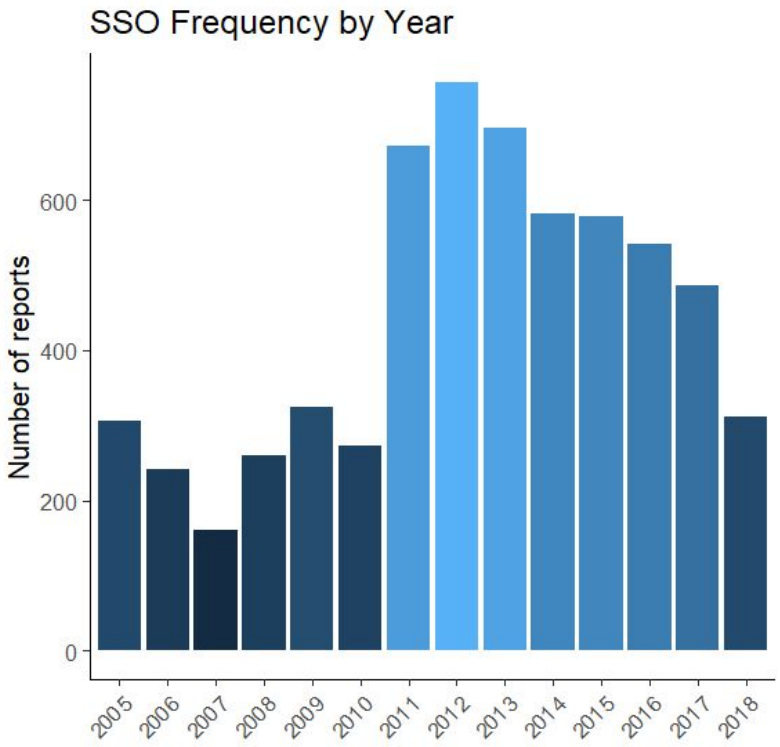
- Objectives:
  - Describe SSOs in Baltimore City
  - Quantify the effect of precipitation on SSOs
  - Determine areas and communities especially impacted by SSOs

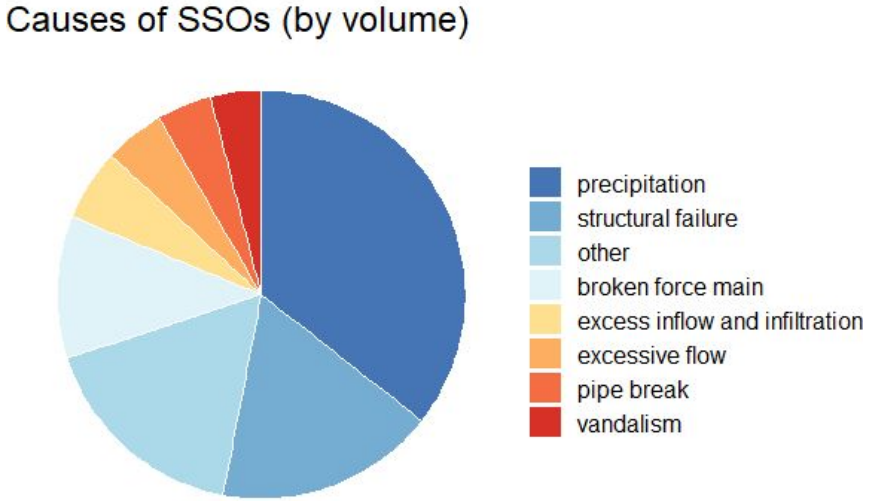
Methods

- Data used was taken from Maryland's open data portal
- Plotted using R Studio
- Mapped using ArcGIS Pro

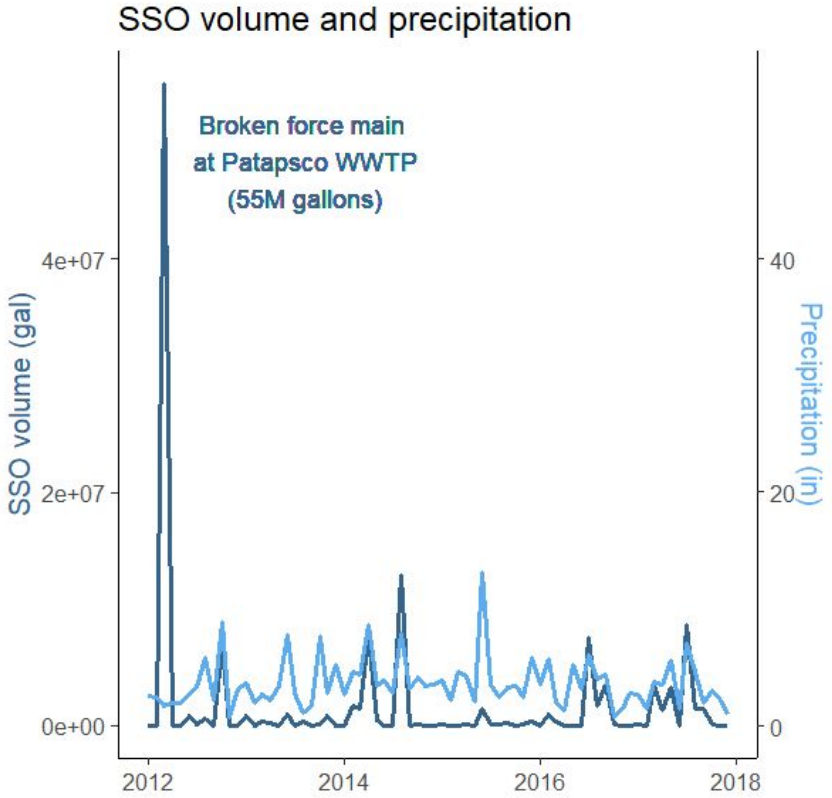


Results

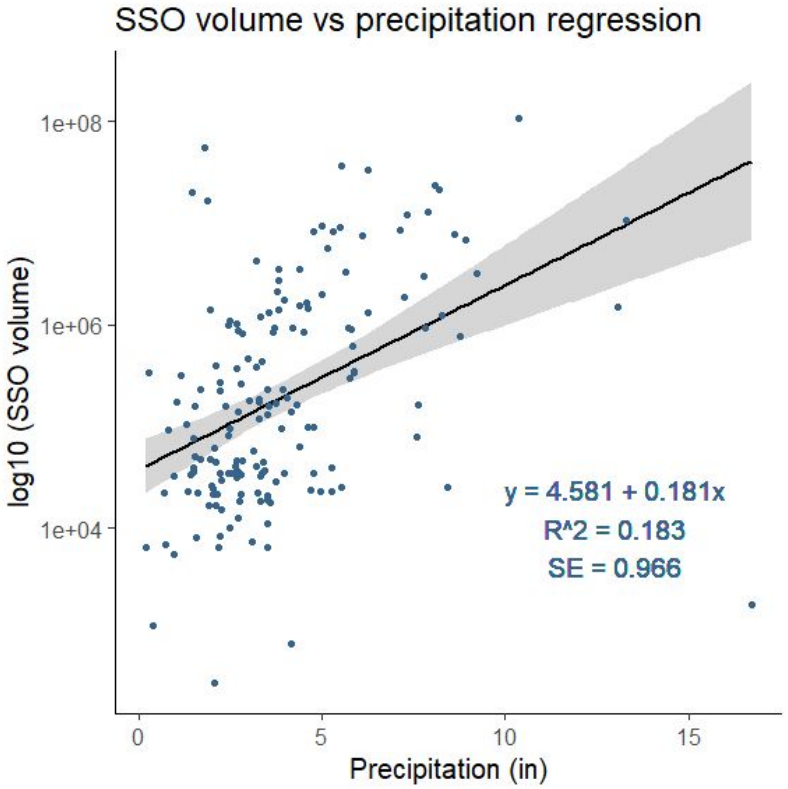

SSO Frequency by Year
Number of reports
0
200
400
600
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018


Causes of SSOs (by volume)
precipitation
structural failure
other
broken force main
excess inflow and infiltration
excessive flow
pipe break
vandalism

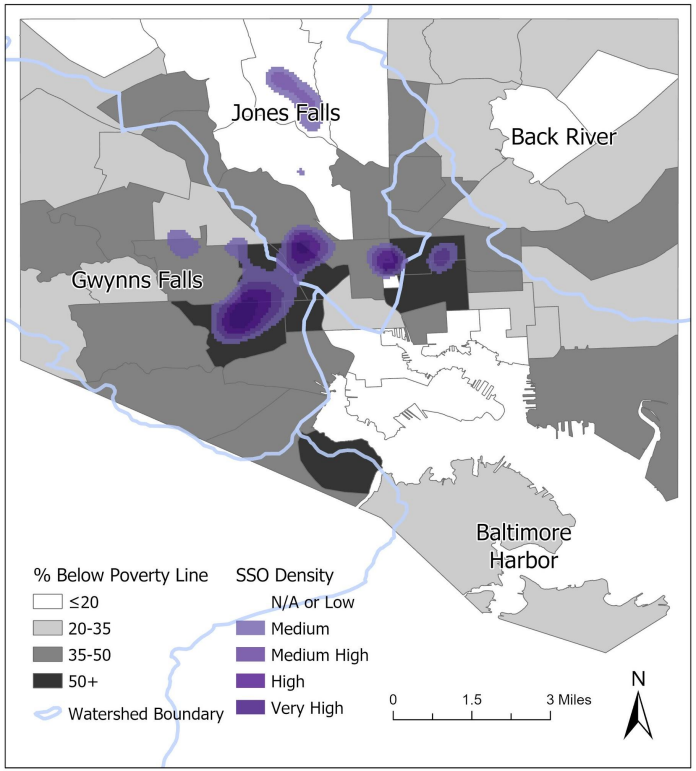
Results


SSO volume and precipitation
Broken force main
at Patapsco WWTP
(55M gallons)
SSO volume (gal)
4e+07
2e+07
0e+00
Precipitation (in)
40
20
0
2012
2014
2016
2018

Results


SSO volume vs precipitation regression
log10 (SSO volume)
1e+08
1e+06
1e+04
0
5
10
15
Precipitation (in)
y = 4.581 + 0.181x
R^2 = 0.183
SE = 0.966

SSO Density and Wealth Distribution in Baltimore City



Sources: Maryland Open Data Portal, Open Baltimore, Maryland.gov

Discussion

- Precipitation is the largest cause of SSOs in Baltimore
- Many months of high SSO volume also see high precipitation
  - Although some very significant spikes in SSO volumes are due to factors beyond precipitation
- Regression results show:
  - Statistical significance between precipitation and log SSO volume
  - From 0 to 1 inches of rain yields an increase of ~19,700 gallons of SSO
  - From 10 to 11 inches of rain yields an increase of ~1.2 million gallons of SSO
  - Low R^2 and outliers suggest other factors are at play
- Baltimore stormwater infrastructure needs to be expanded for larger volumes of precipitation

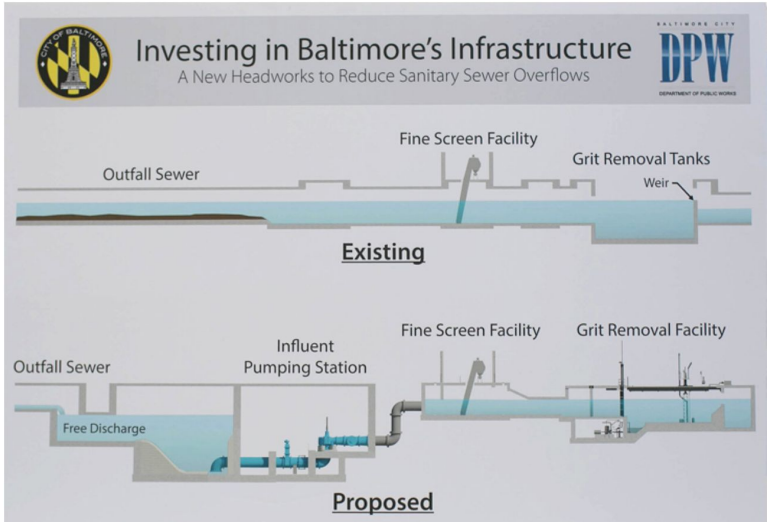
Discussion

- SSO hotspots in East & West Baltimore correspond with areas of highest poverty
  - Age of pipes + underfunding
  - Illustrates the disparities in Baltimore City
  - Inner city is built up with more infrastructure; harder to dig underground and repair
- SSO hotspot in Roland Park -- oldest suburban community in North America (built between 1890-1920)
- Hotspots near bottom of Jones Falls and Gwynns Falls watersheds → flow into harbor

Discussion

- Capital Projects required to account for rainfall events
- Risk and Asset Management Strategies are necessary to proactively protect against SSOs
- Baltimore not accountable for water quality improvements
    - BWM argue city noncompliant with Clean Water Act
    - $1 Billion spent on project since 2002; Customer water rates have skyrocketed

Proposed Headworks Project



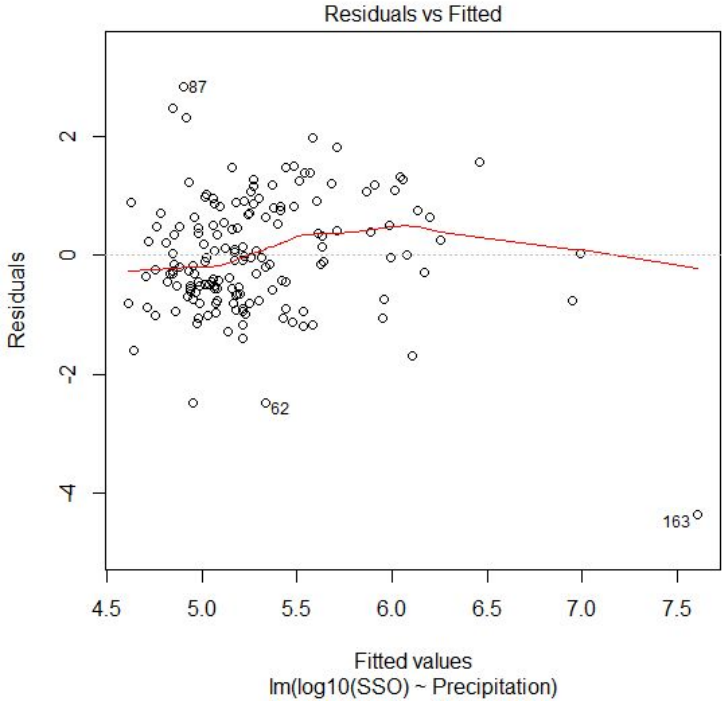
Source: Baltimore DPW

Conclusion

- SSOs are:
  - The primary reason for poor surface water quality in Baltimore
  - Positively correlated with precipitation
  - Visibly correlated with socioeconomic status
- All SSOs from Baltimore City eventually end up in the Chesapeake Bay
  - Ecological implications for the greater region
- Further action is required to elevate surrounding water quality to an acceptable level

Questions?

Appendix


Residuals vs Fitted
87
62
163
Residuals
2
0
-2
-4
4.5
5.0
5.5
6.0
6.5
7.0
7.5
Fitted values
lm(log10(SSO) ~ Precipitation)