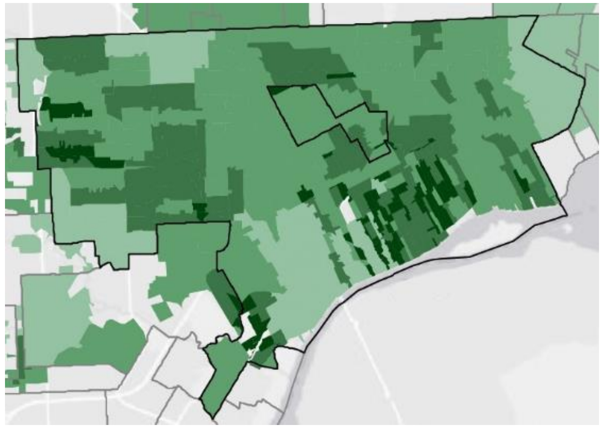
Water Quality and Potential for Green Infrastructure in Detroit

Colleen Long
University of Michigan Water Center
IMAGIN Conference, June 11, 2019

slides modified for web

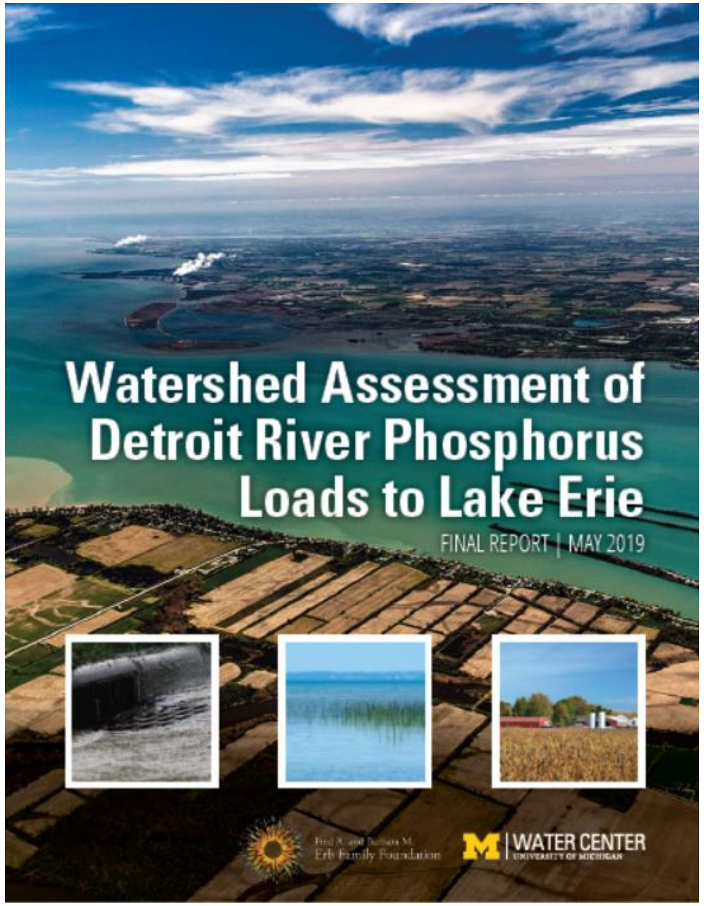
Source: TetraTech/DWSD GI consulting



WATER CENTER UNIVERSITY OF MICHIGAN

Fred A. and Barbara M. Erb Family Foundation

Project overview



TEAM: Don Scavia, Jen Read, Lynn Vaccaro, Awoke Dagnew, Becca Muenich, Branko Kerkez, Yao Hu, Serghei Bocaniov, Colleen Long, Yu-Chen Wang

FUNDING: Fred A. and Barbara M. Erb Family Foundation

ADVISORY GROUP: 30 people from US and Canadian public and private organizations at all levels

www.myumi.ch/detroit-river

Topics for today

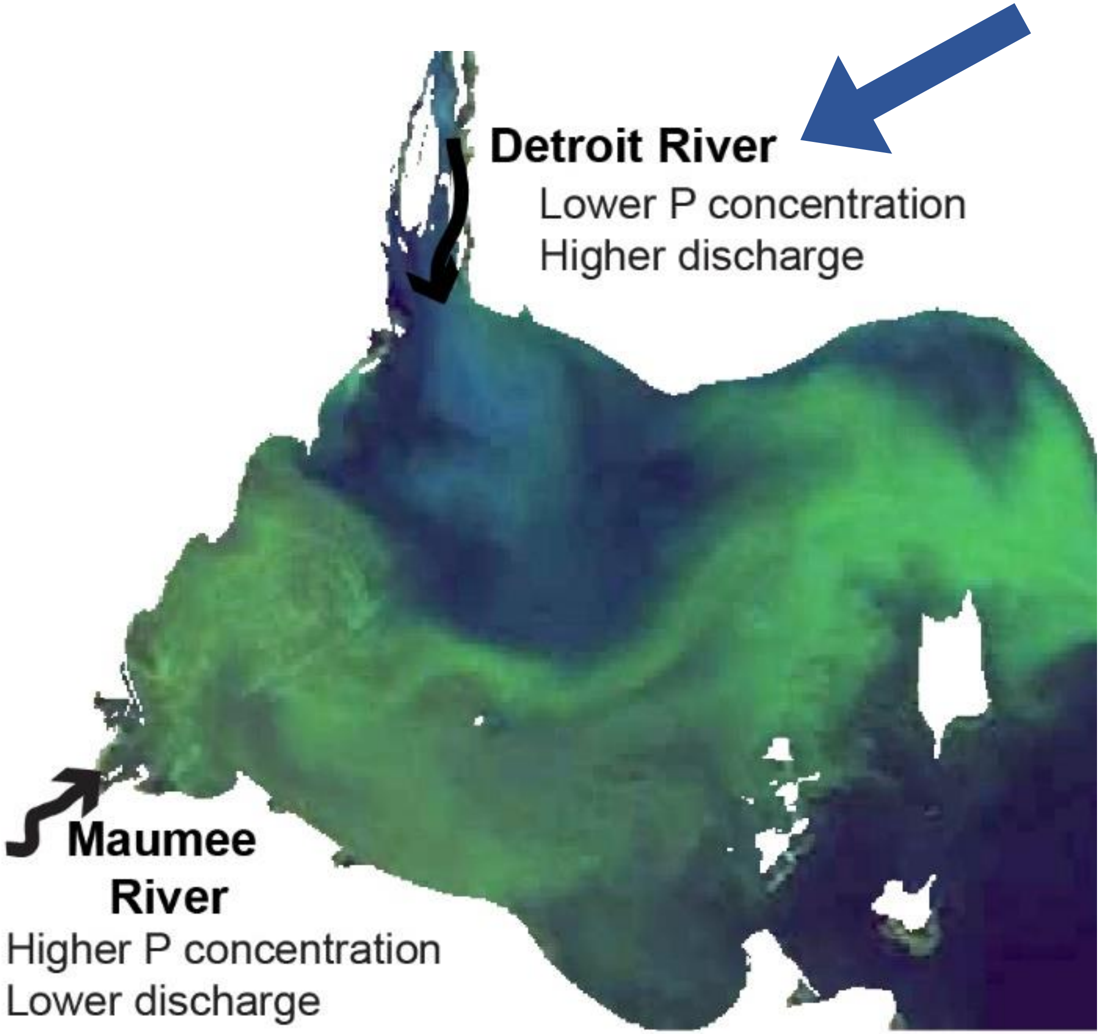
- Big picture: Detroit River phosphorus loads to Lake Erie
- Details of urban sources
- Combined sewer overflows (CSOs)
  - Overview (where, how much)
  - Strategies for improvements?
  - Where can we focus efforts?

- Geospatial highlights: ArcGIS, R, public data layers, original data layers

Phosphorus to Lake Erie

- Harmful Algal Blooms (HABs) and hypoxia (low oxygen) in Lake Erie are driven by phosphorus delivered by rivers to the lake.

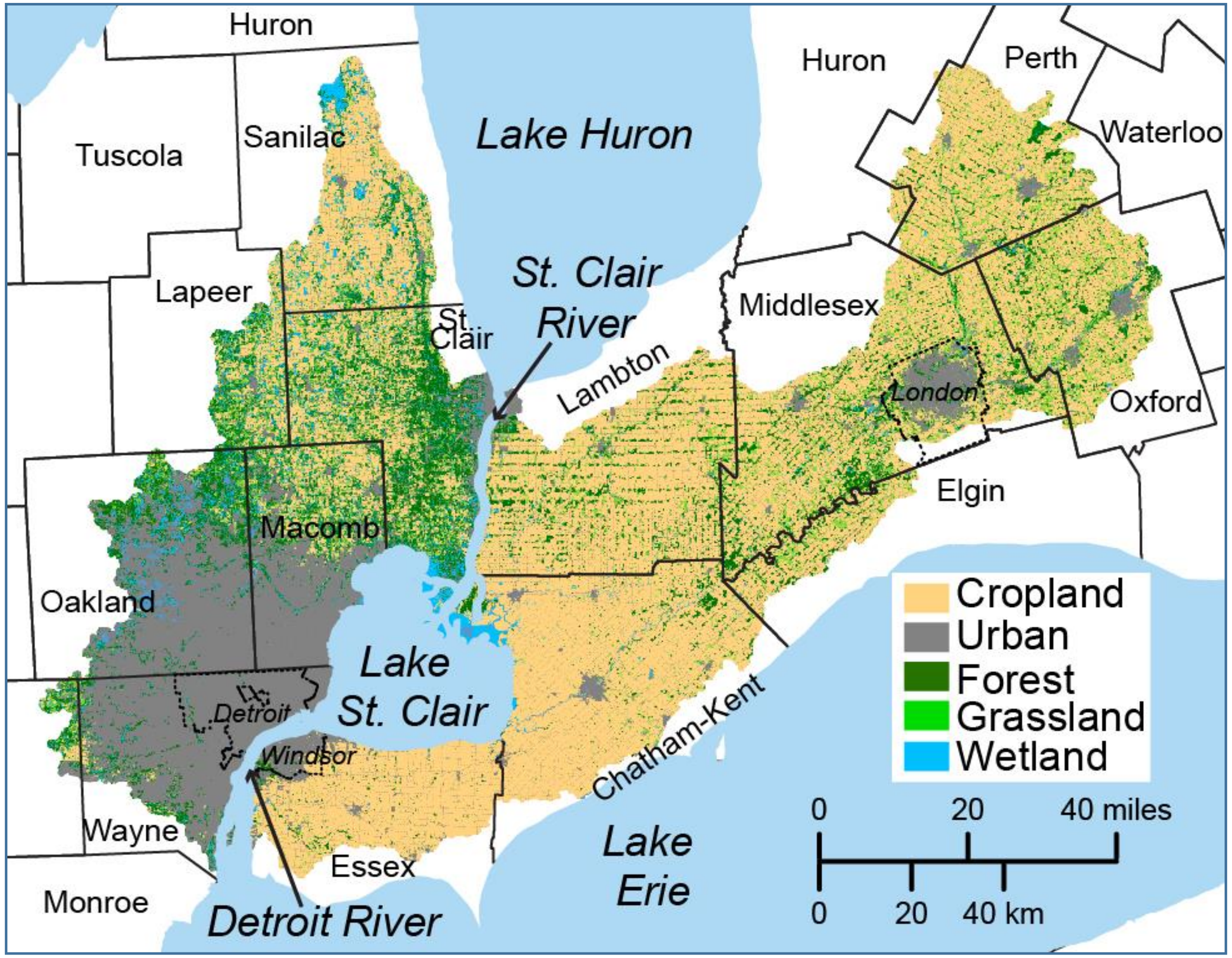
- US and Canada signed a revised *Great Lakes Water Quality Agreement* in 2012 which led to the adoption of new loading targets and the development of action plans to reach those targets.



Sources of Detroit River total phosphorus load

St. Clair-Detroit River System watershed

- Over 19,000 km^2
- Some of Canada's most productive cropland
- Major urban area in Michigan
- Lake St. Clair in middle



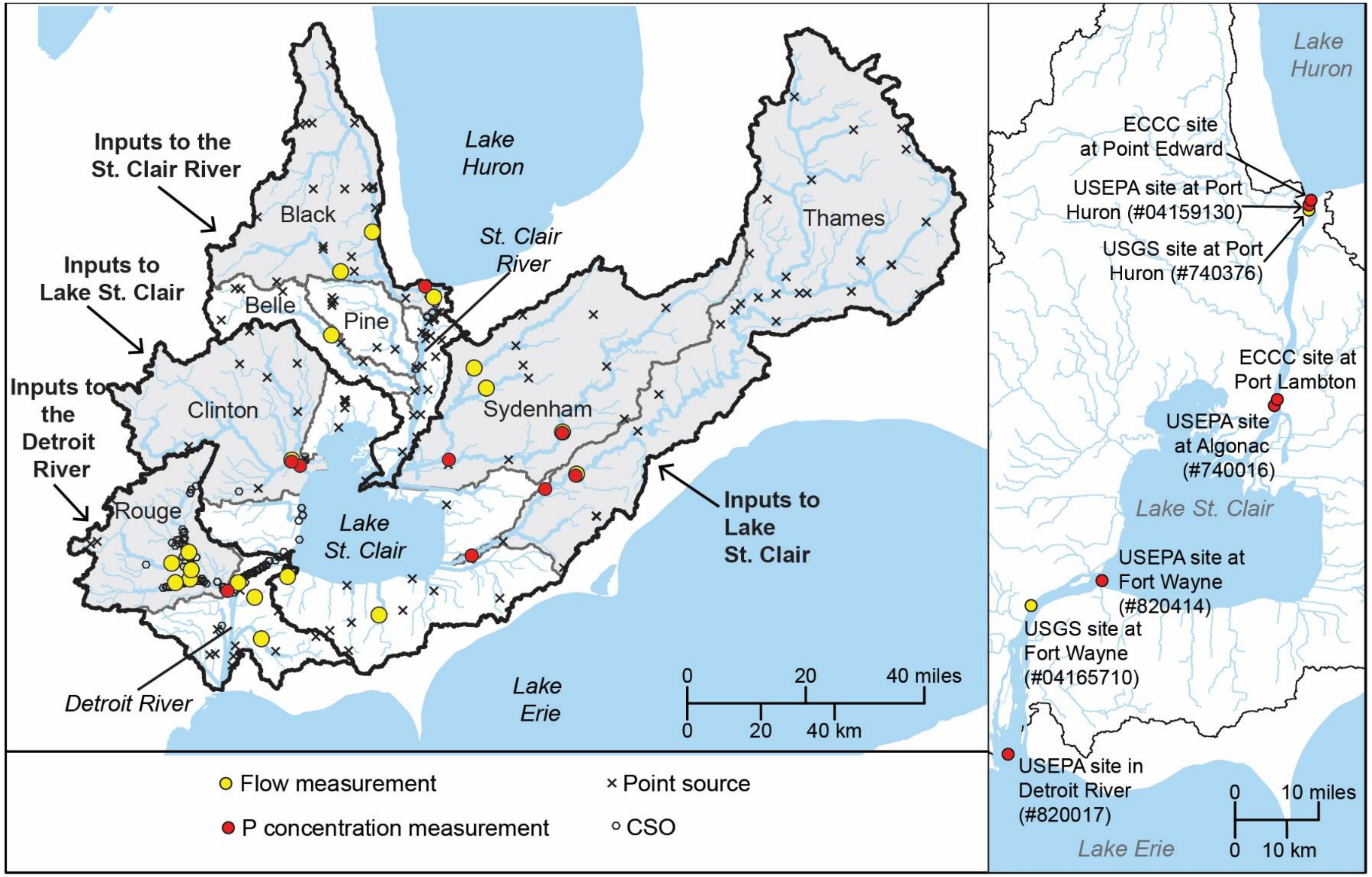
How to reach loading targets? First, need to identify, classify, and quantify sources of phosphorus.

- Point sources vs. non-point sources?
- Urban vs. agricultural land?
- Michigan vs. Ontario?

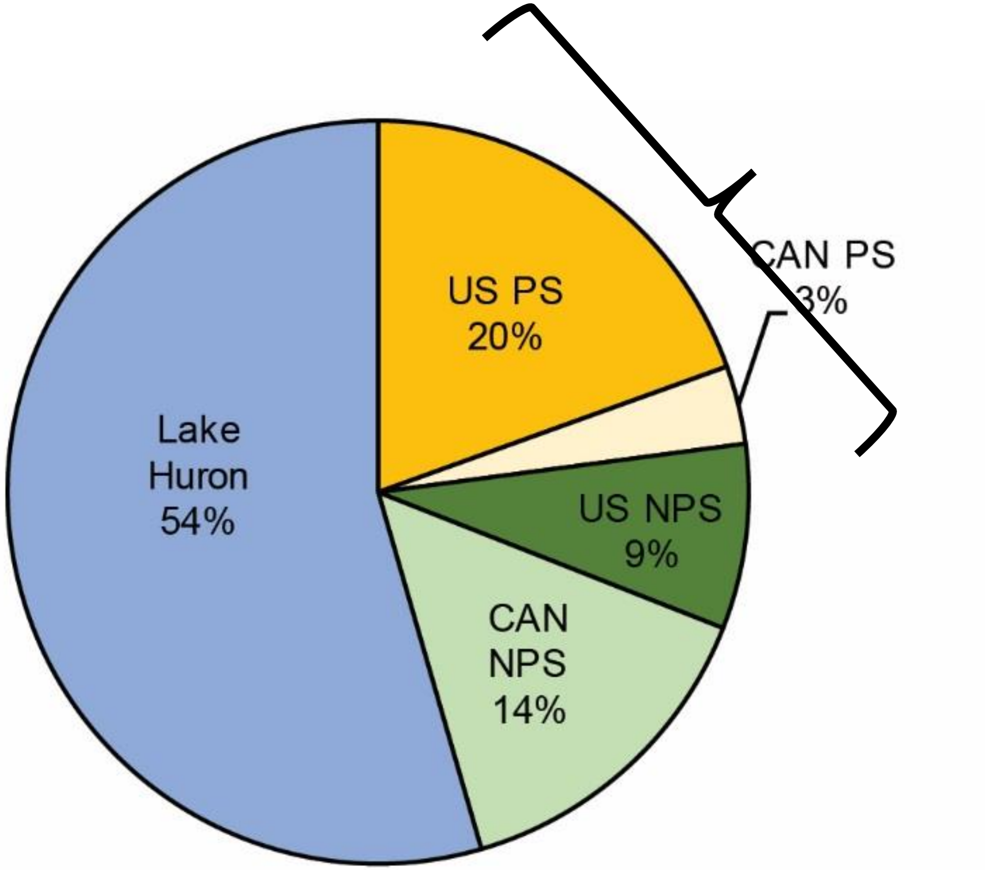
Sources of Detroit River total phosphorus load

1. **Non-point source loads** calculated using flow and phosphorus measurements from gauge stations for each subwatershed, direct drainage area, and Lake Huron

2. **Point source loads** (including CSOs) calculated using data from EPA and MOECC



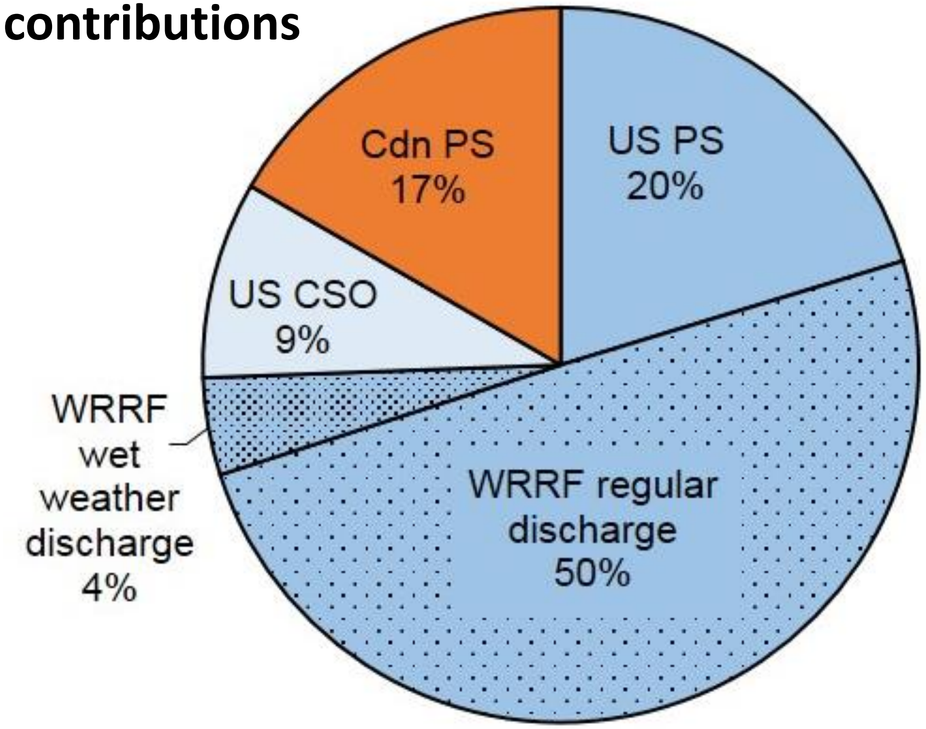
Sources of Detroit River total phosphorus load



- **54%** of Detroit River's load to Lake Erie is from Lake Huron
- Point sources and non-point sources contribute **roughly equal** amounts

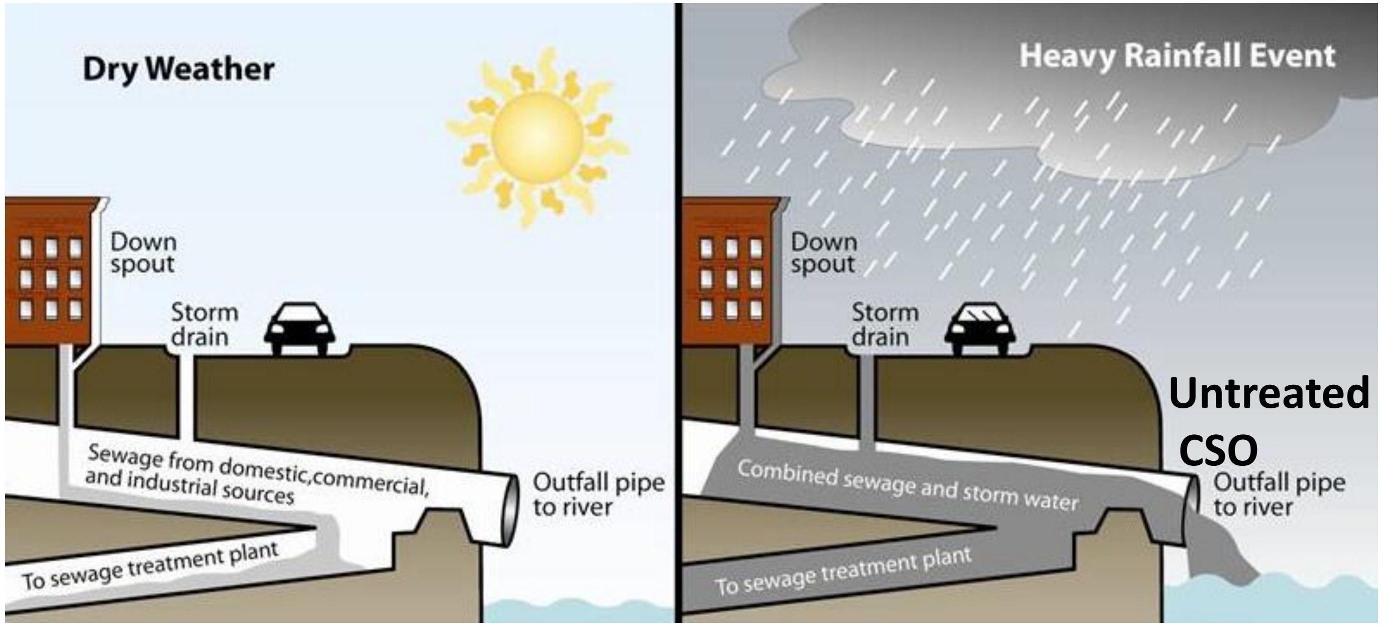
Sources of Detroit River total phosphorus load

Break down of point source contributions



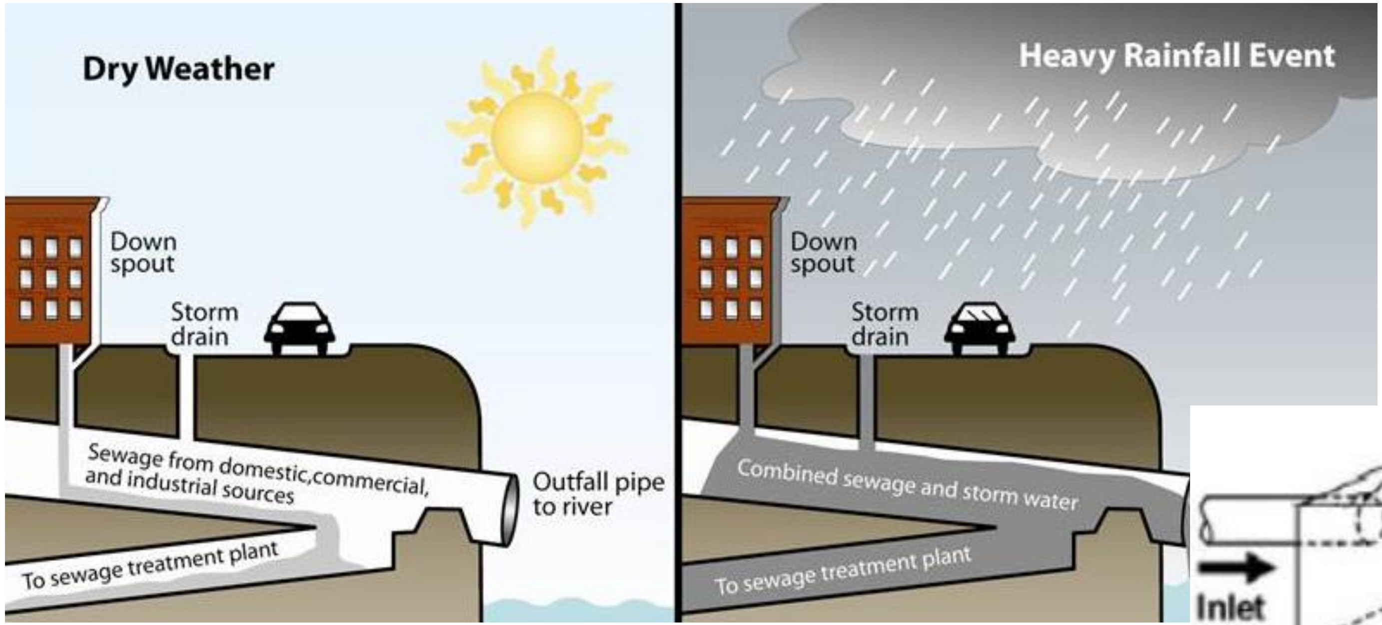
- **54%** of point source contribution is from the WRRF in Detroit
  - This is **13%** of the Detroit River's load to Lake Erie
- **9%** of point source contribution is from combined sewer overflows (CSOs)
  - This is **2.2%** of Detroit River's load to Lake Erie

Combined sewer overflows (CSOs)

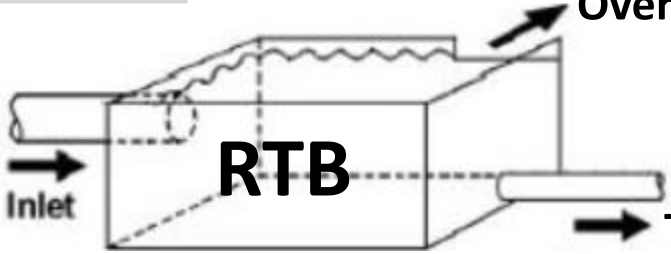


- Sanitary and storm sewers in one pipe system
- During rain events, the system can get overwhelmed, and CSOs can occur

Combined sewer overflows (CSOs)



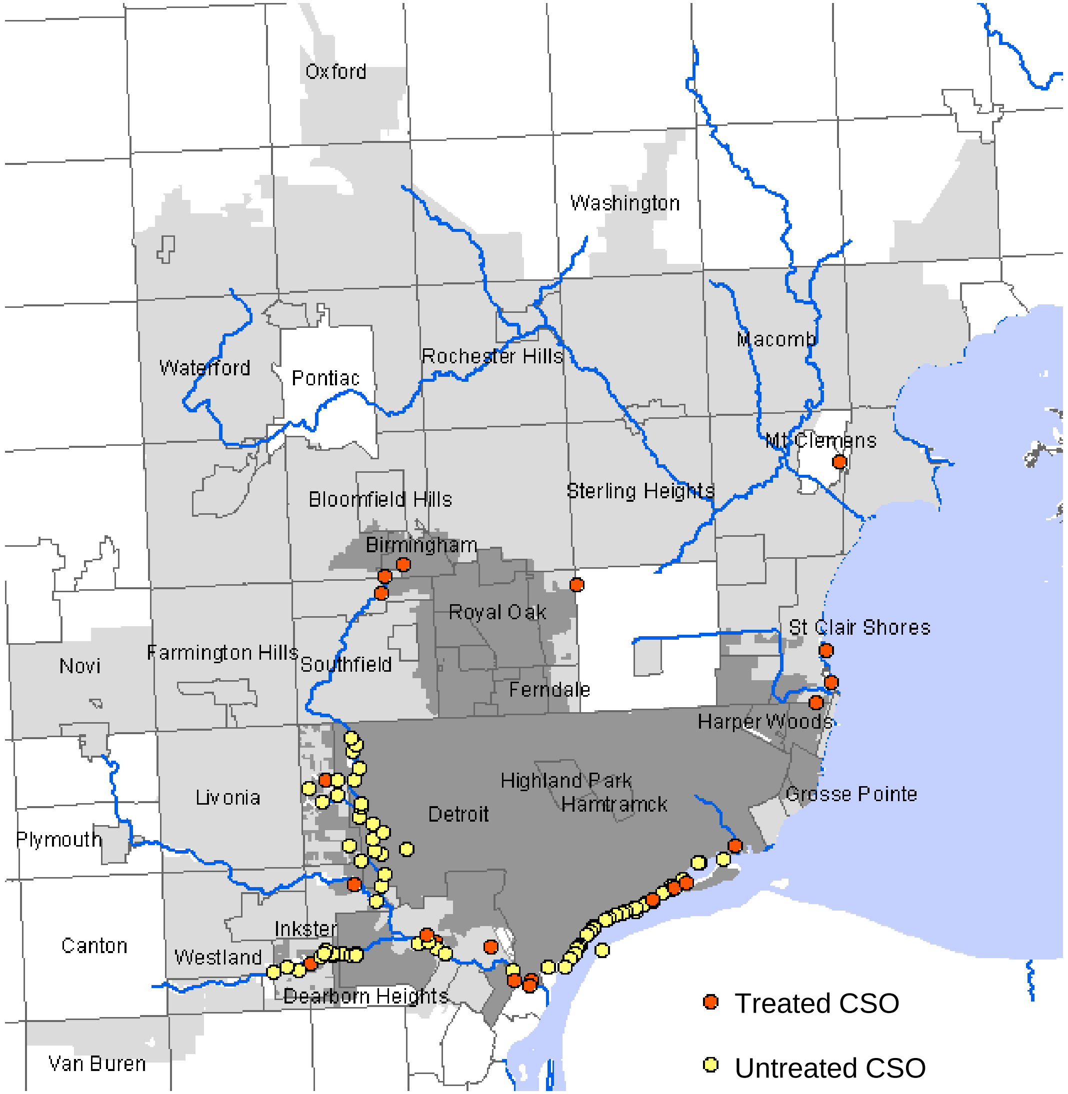
- Sanitary and storm sewers in one pipe system
- During rain events, the system can get overwhelmed, and CSOs can occur



CSOs are important local issue, even though they do not contribute a substantial amount of phosphorus to Lake Erie.

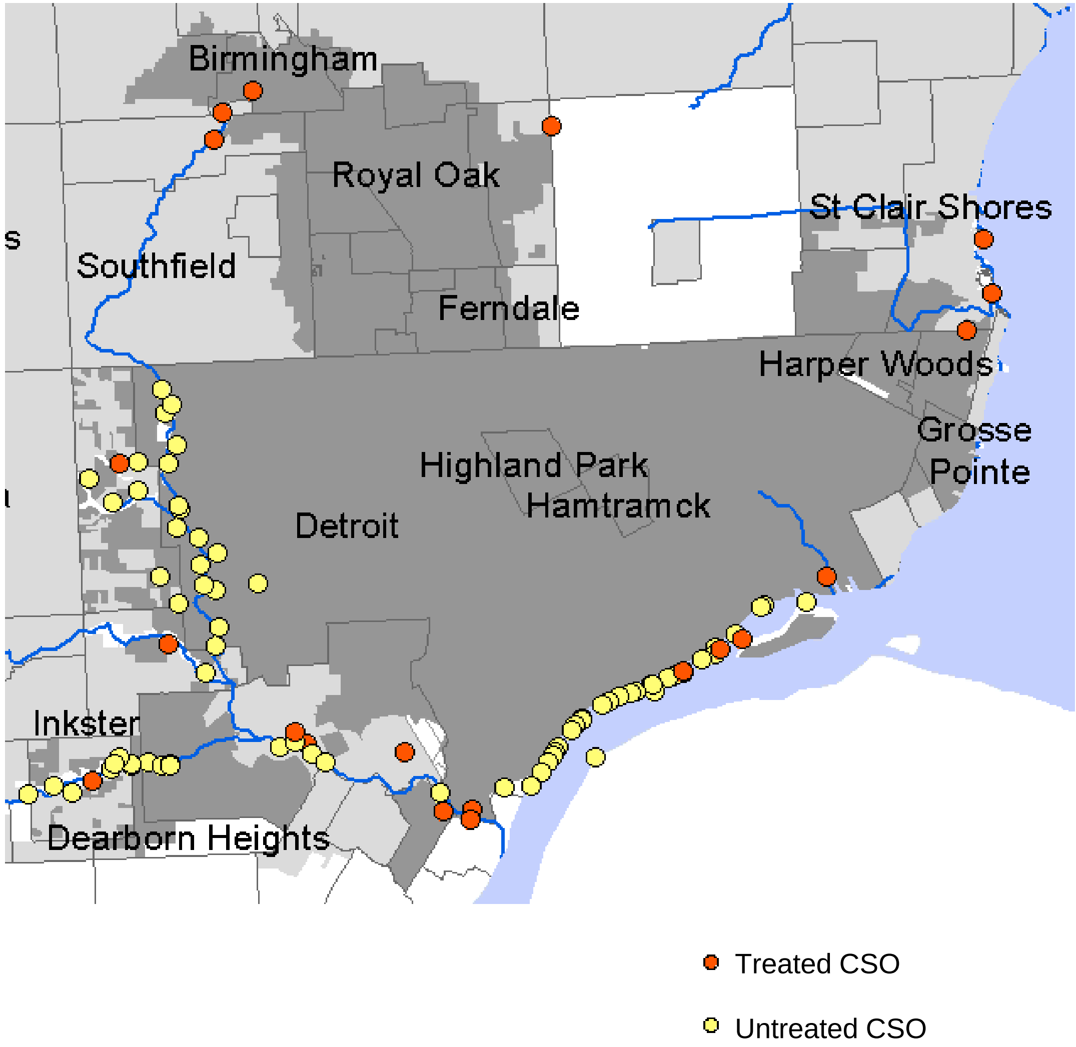
This led us to further study of CSOs and water quality in Detroit.

Where are CSO outfalls throughout metro Detroit?



- Location data for CSO outfalls available from MiWaters (DEQ)
- Event-based volume and water quality data available from MDEQ CSO/SSO database (migrated to MiWaters since time of study)
- Compiled data for 2013-2016

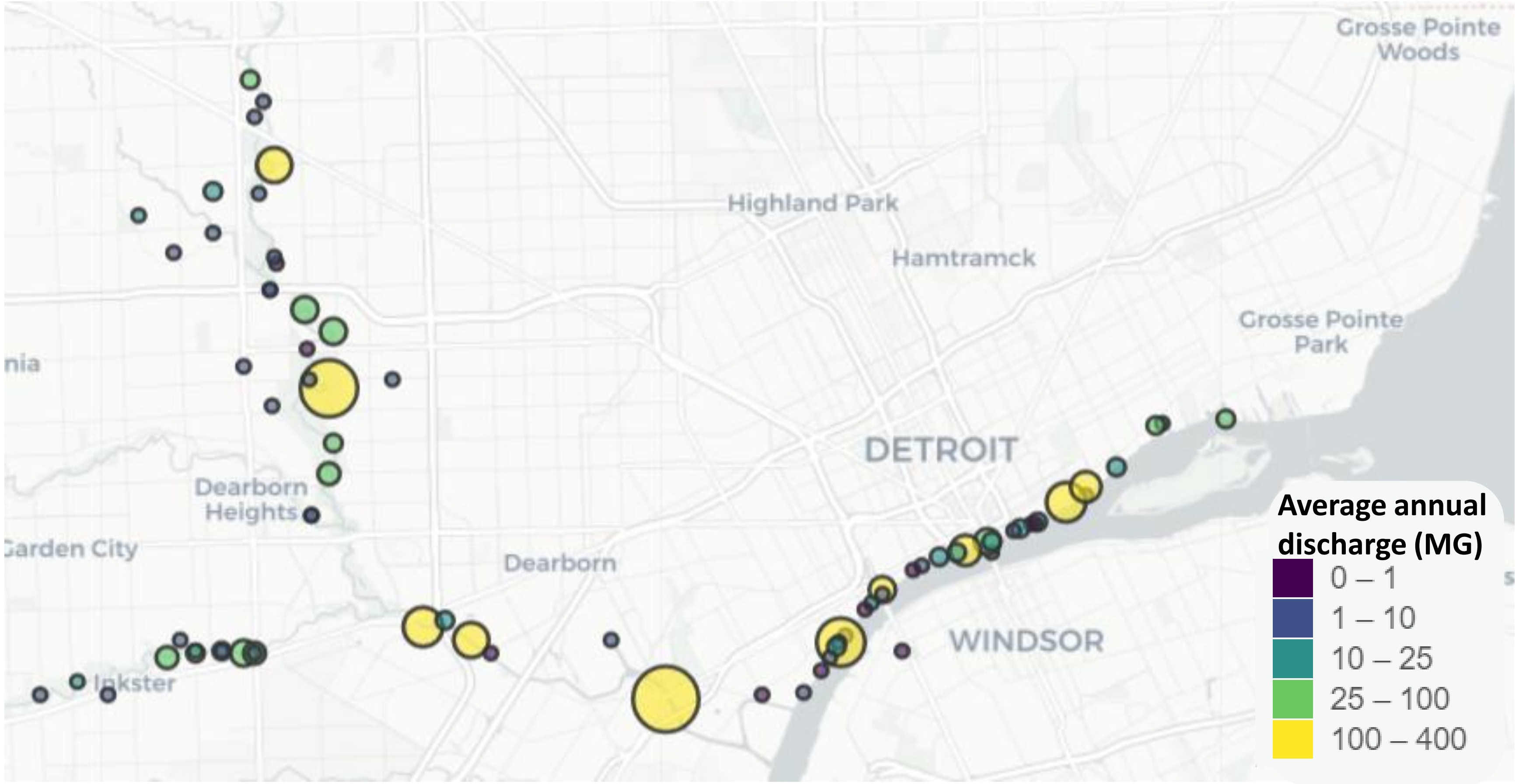
Where are CSO outfalls throughout metro Detroit?



- Location data for CSO outfalls available from MiWaters (DEQ)
- Event-based volume and water quality data available from MDEQ CSO/SSO database (migrated to MiWaters since time of study)
- Compiled data for 2013-2016

How much discharge comes from each CSO outfall?

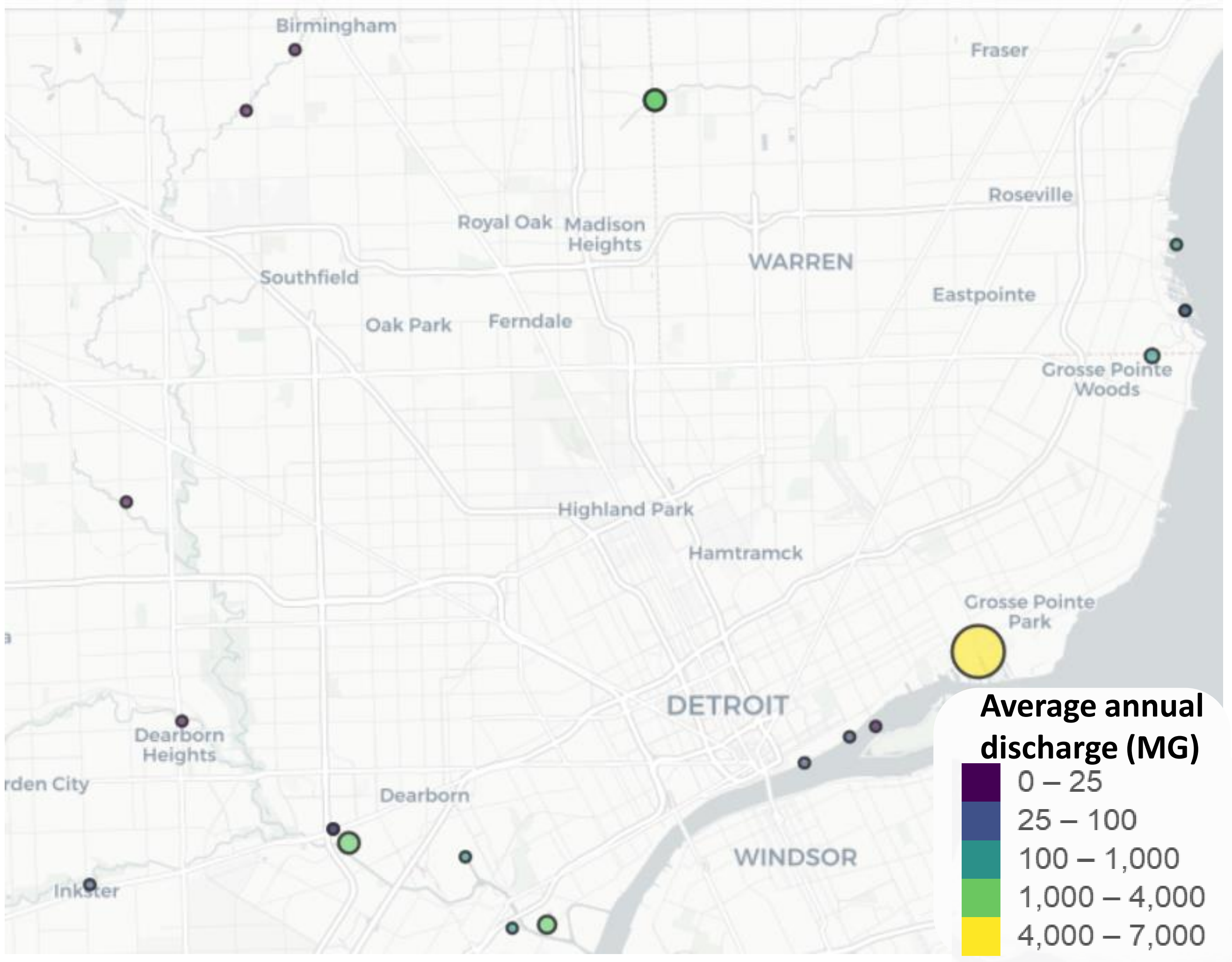
Untreated CSO outfalls



- 78 untreated CSO outfalls
- Biggest contribution is about 350 million gallons (MG) per year
- Average contribution is 41 MG per year
- Median contribution is 9 MG per year

How much discharge comes from each CSO outfall?

Treated CSO outfalls



- 24 treated CSO outfalls
- Biggest contribution is 6,600 million (6.6 billion) gallons (MG) per year
- Average contribution is 670 MG per year

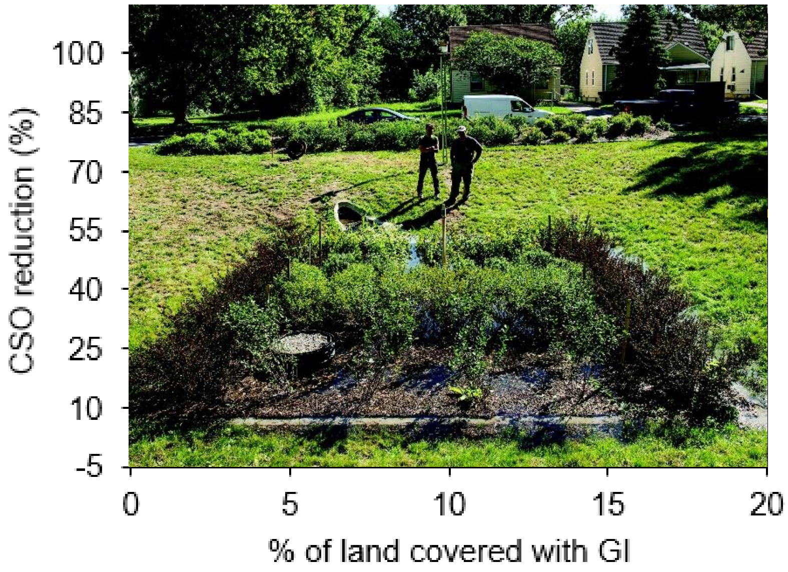
We know how much discharge comes from CSOs.

We know which outfalls contribute the most discharge.

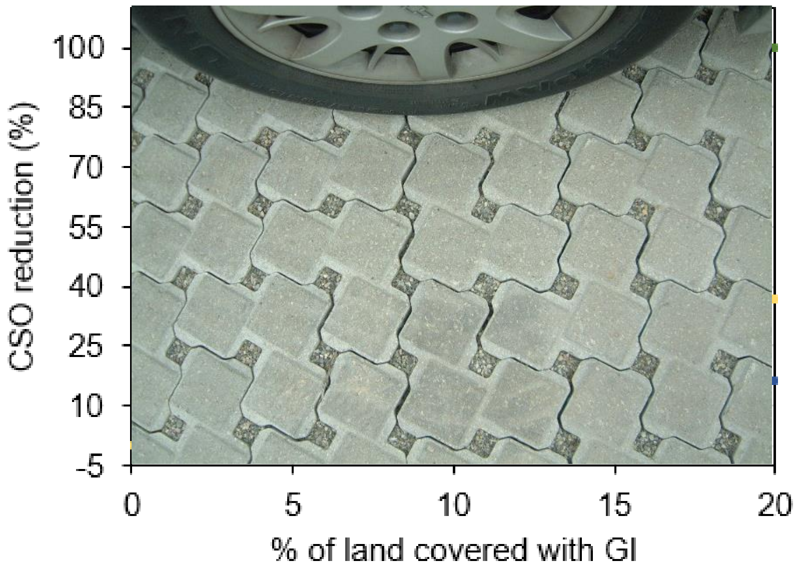
Next: Can we use green infrastructure to reduce overflows?

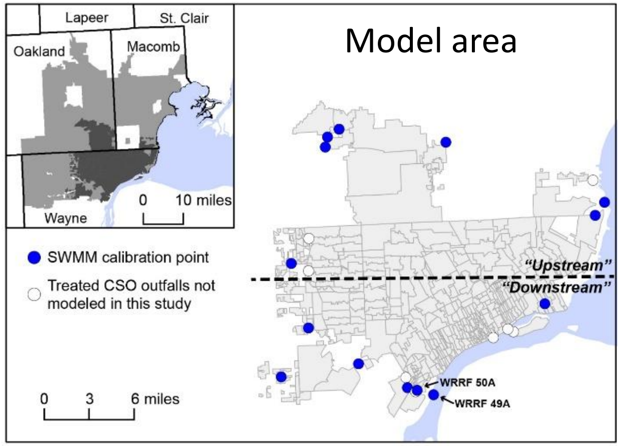
Can GI be used to reduce CSOs?

Bioretention cells

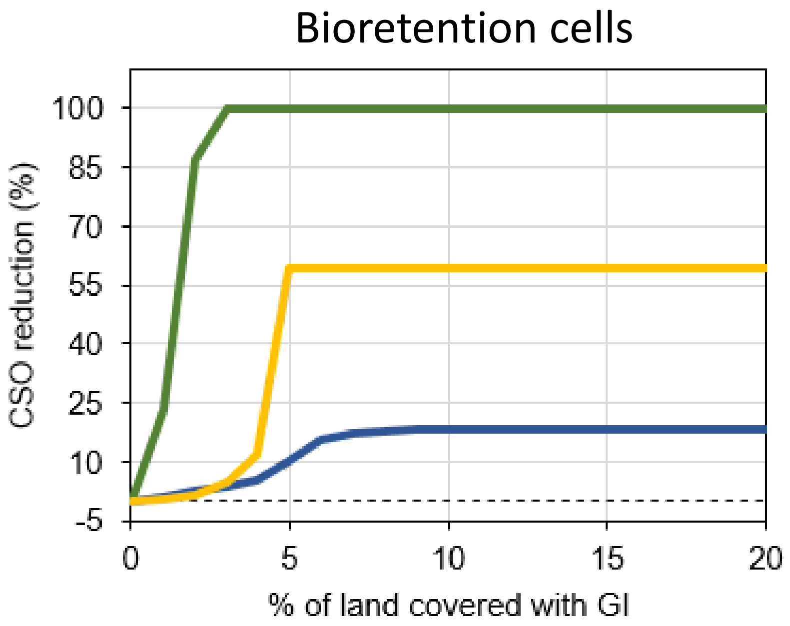


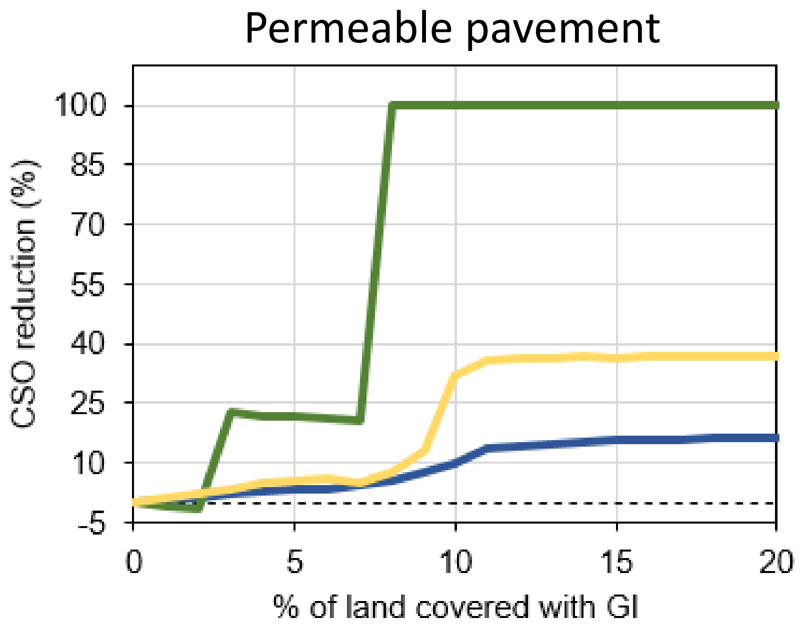
Permeable pavement

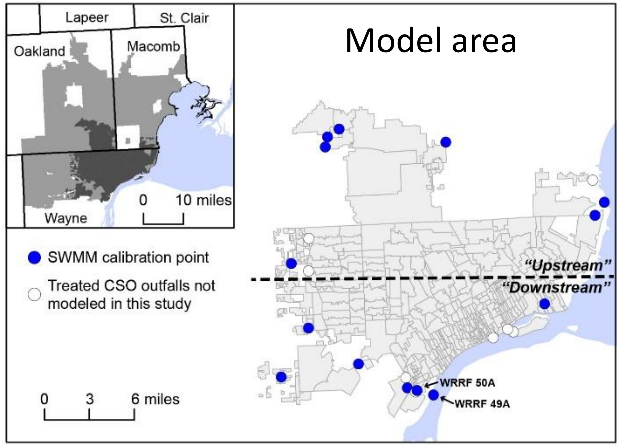




Can GI be used to reduce CSOs?







Overall (CSOs and WRRF wet weather)

Upstream CSOs

Downstream CSOs

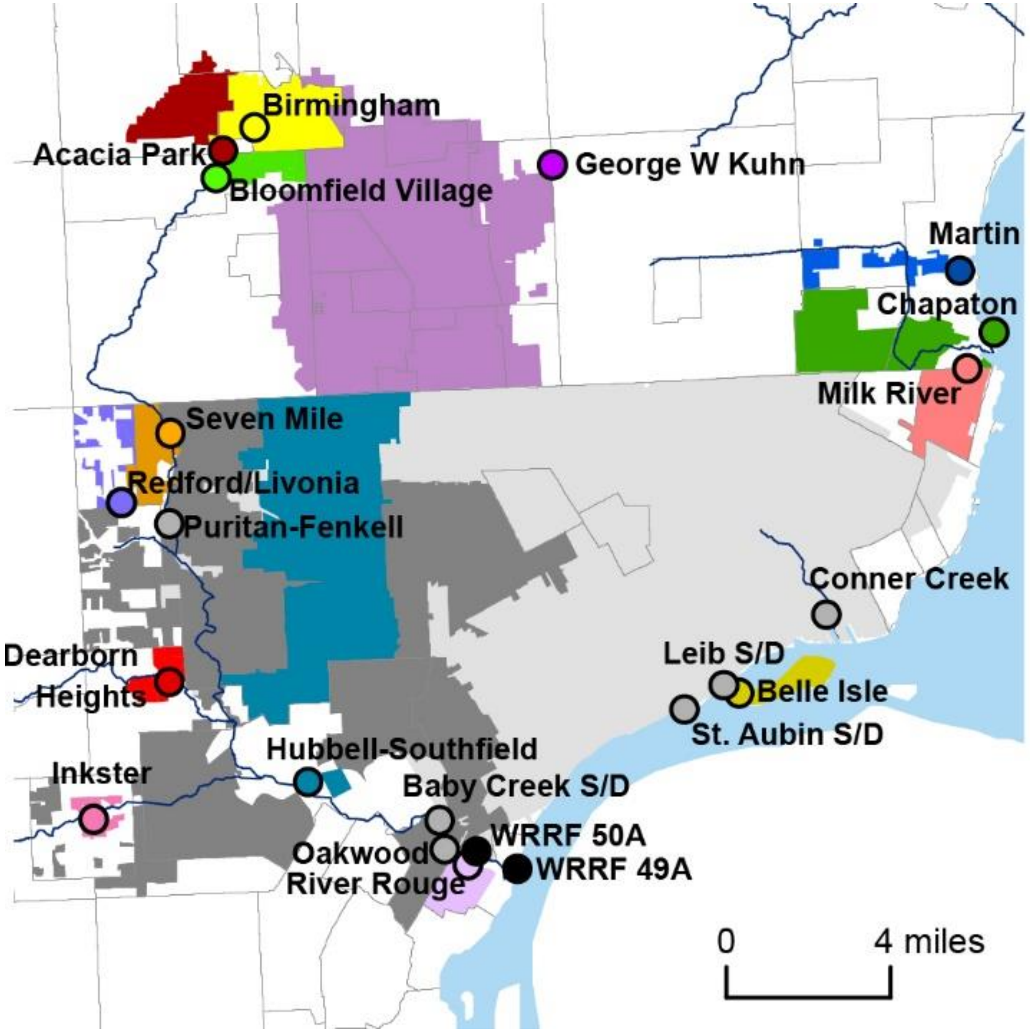
- The system as a whole showed reduction of 16-18% under normal rainfall.
- GI showed potential to entirely reduce upstream CSOs under normal rainfall.
- Downstream CSOs were less impacted, but still showed potential for reductions.
- **Next: Where should GI be placed?**

Mapping CSO contribution areas

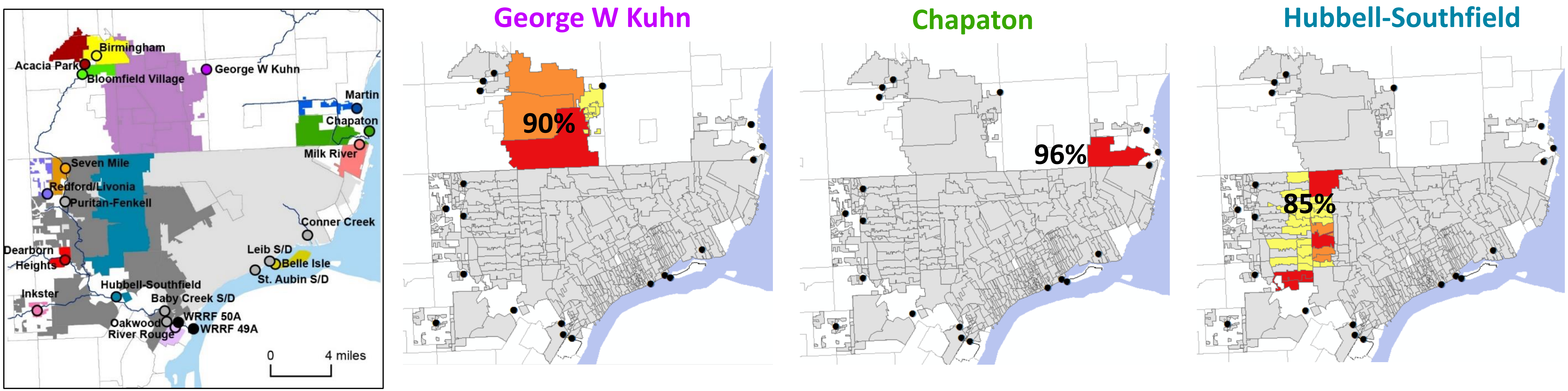
- Compiled maps from documents on MiWaters and from other reports to delineate *approximate* contribution areas for each RTB

- Contribution areas for some of the “downstream” RTBs could not be delineated, partially due to increasing complexity of the system in the lower reaches

- **Next: Can we use SWMM to gain more spatial information?**



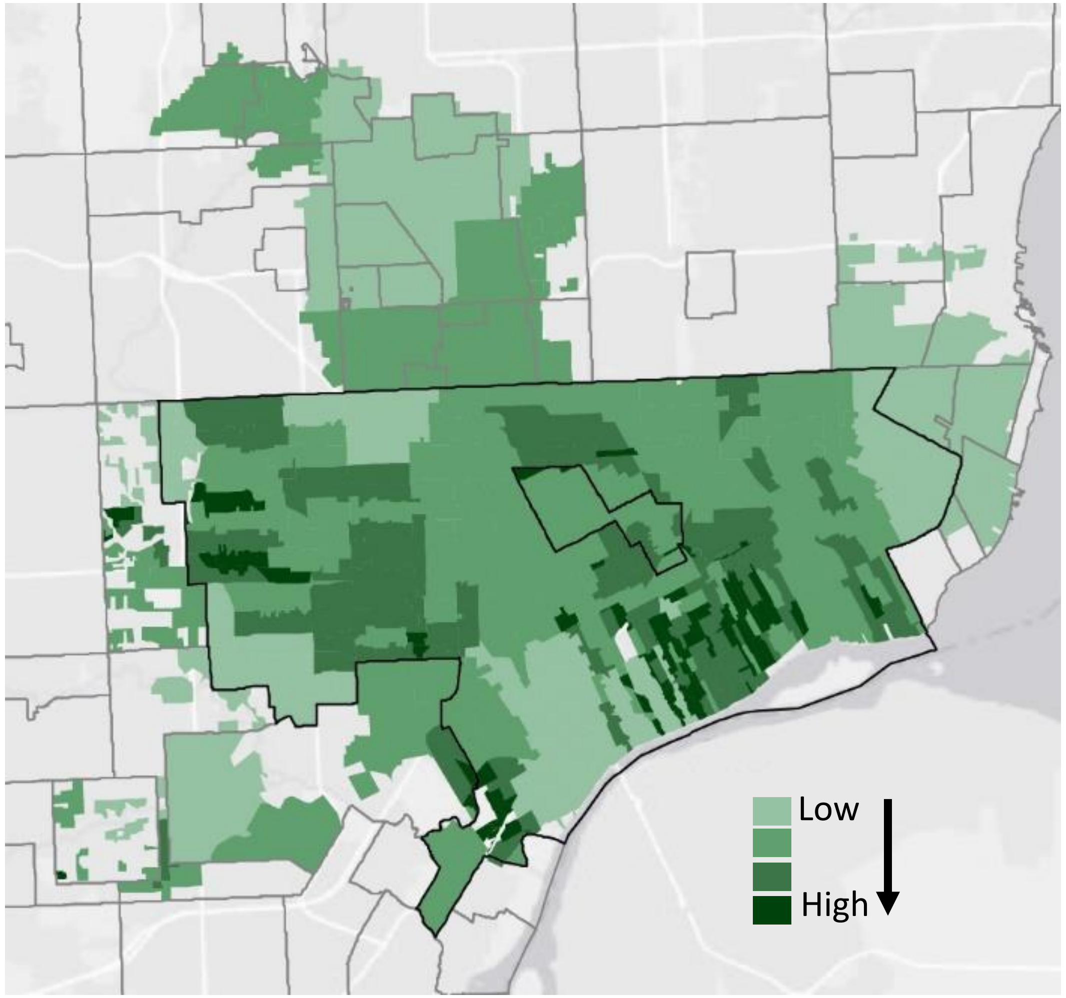
Mapping CSO contribution areas with SWMM



With confidence in model, we can now fill in the areas that could not be delineated with existing maps.

Mapping CSO contribution areas

Influence of each subcatchment on total wet weather discharge weighed by its impervious area



- Impact of any given single subcatchment is small – each contributes 1 or 2% to the total wet weather discharge.
- Downstream subcatchments and those not controlled by RTBs appear to be somewhat more influential.
- Map is not a guide of where to place GI; this requires a system-wide approach and consideration of other GI benefits.

Green infrastructure in Detroit

We are focusing on GI benefits related to managing stormwater and addressing water quality, though there are many other benefits:

- Reducing urban heat island
- Improving air quality
- Improving landscape connectivity
- Increasing access to green space
- Increasing property values

Green infrastructure in Detroit- ongoing work

<u>Some of the factors considered:</u>

- Soil
- Vacant land (area and aggregation)
- Slope
- Gray infrastructure (sewershed position, existing infrastructure)

<u>Example GI types:</u>

- Bioretention
- Permeable pavement

Different factors and different GI types would need to be considered to address a GI benefit other than water quality.

Green infrastructure in Detroit- ongoing work

Presentation slides with this ongoing, unpublished work removed for online version.

Topics for today

- Big picture: phosphorus loads to Lake Erie
- Details of urban sources
- Combined sewer overflows (CSOs)
  - Overview (where, how much)
  - Strategies for improvements
  - Where can we focus efforts?

Topics for today - Summary

- Big picture: phosphorus loads to Lake Erie → 54% of Detroit River's load to Lake Erie is from Lake Huron
20% is from US point sources
- Details of urban sources
- Combined sewer overflows (CSOs)
  - Overview (where, how much)
  - Strategies for improvements
  - Where can we focus efforts?

Topics for today - Summary

- Big picture: phosphorus loads to Lake Erie
- Details of urban sources →
    - WRRF in Detroit contributes 13% to the Detroit River's load to Lake Erie
    - CSOs contribute less than 3%
- Combined sewer overflows (CSOs)
    - Overview (where, how much)
    - Strategies for improvements
    - Where can we focus efforts?

Topics for today - Summary

- Big picture: phosphorus loads to Lake Erie
- Details of urban sources
- Combined sewer overflows (CSOs)
  - Overview (where, how much)
  - Strategies for improvements
  - Where can we focus efforts?

Not a big contributor to Lake Erie phosphorus loads, but still a very important issue

26 treated and 78 untreated outfalls (2013-2016)
Volume contribution is largely spread out over system

Topics for today - Summary

- Big picture: phosphorus loads to Lake Erie
- Details of urban sources
- Combined sewer overflows (CSOs)
  - Overview (where, how much)
  - Strategies for improvements
  - Where can we focus efforts?

Not a big contributor to Lake Erie phosphorus loads, but still a very important issue

26 treated and 78 untreated outfalls (2013-2016)
Volume contribution is largely spread out over system

Bioretention cells and permeable pavement both show potential to reduce CSOs across the entire system (and especially at upstream outfalls) under normal rainfall.

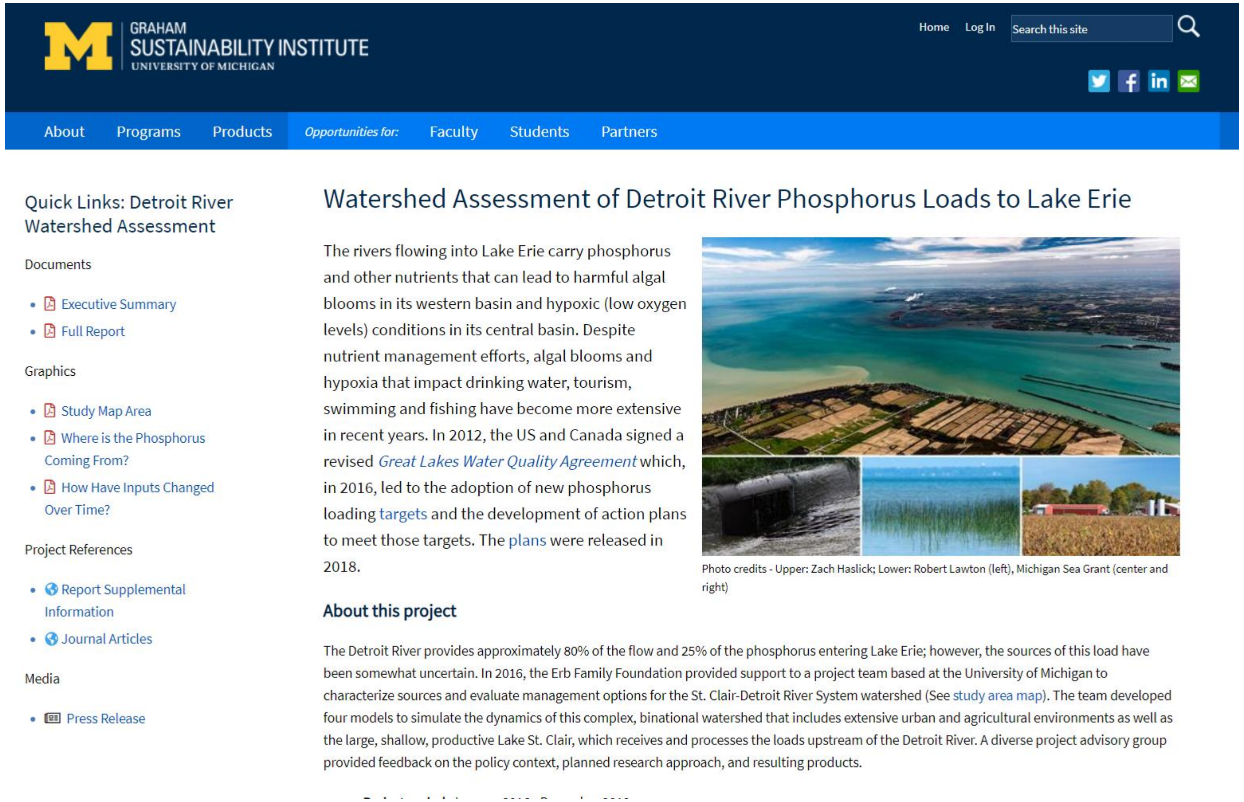
Model used to map areas that are most influential on CSOs.

Ongoing spatial analysis will help indicate which types of GI make the most sense in different locations.

Thank you!

Contact: Colleen Long - longcm@umich.edu

More details on this work at myumi.ch/detroit-river



GRAHAM SUSTAINABILITY INSTITUTE
UNIVERSITY OF MICHIGAN

Home Log In Search this site

About Programs Products *Opportunities for:* Faculty Students Partners

Quick Links: Detroit River Watershed Assessment

Documents

- Executive Summary
- Full Report

Graphics

- Study Map Area
- Where is the Phosphorus Coming From?
- How Have Inputs Changed Over Time?

Project References

- Report Supplemental Information
- Journal Articles

Media

- Press Release

Watershed Assessment of Detroit River Phosphorus Loads to Lake Erie

The rivers flowing into Lake Erie carry phosphorus and other nutrients that can lead to harmful algal blooms in its western basin and hypoxic (low oxygen levels) conditions in its central basin. Despite nutrient management efforts, algal blooms and hypoxia that impact drinking water, tourism, swimming and fishing have become more extensive in recent years. In 2012, the US and Canada signed a revised *Great Lakes Water Quality Agreement* which, in 2016, led to the adoption of new phosphorus loading targets and the development of action plans to meet those targets. The plans were released in 2018.

Photo credits - Upper: Zach Haslick; Lower: Robert Lawton (left), Michigan Sea Grant (center and right)

About this project

The Detroit River provides approximately 80% of the flow and 25% of the phosphorus entering Lake Erie; however, the sources of this load have been somewhat uncertain. In 2016, the Erb Family Foundation provided support to a project team based at the University of Michigan to characterize sources and evaluate management options for the St. Clair-Detroit River System watershed (See study area map). The team developed four models to simulate the dynamics of this complex, binational watershed that includes extensive urban and agricultural environments as well as the large, shallow, productive Lake St. Clair, which receives and processes the loads upstream of the Detroit River. A diverse project advisory group provided feedback on the policy context, planned research approach, and resulting products.