Green Stormwater Infrastructure Task Force

Katie Rousseau
Designing and Developing Stormwater Practices in Northwest Ohio
University of Toledo
April 14, 2016

American Rivers
Rivers Connect Us

American Rivers

- American Rivers protects wild rivers, restores damaged rivers, and conserves clean water for people and nature.
- Since 1973, American Rivers has protected and restored more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and an annual America's Most Endangered Rivers® campaign.
- Headquartered in Washington, DC, American Rivers has offices across the country and more than 200,000 members, supporters, and volunteers.

Innovate

Science

Collaborate

Advocate

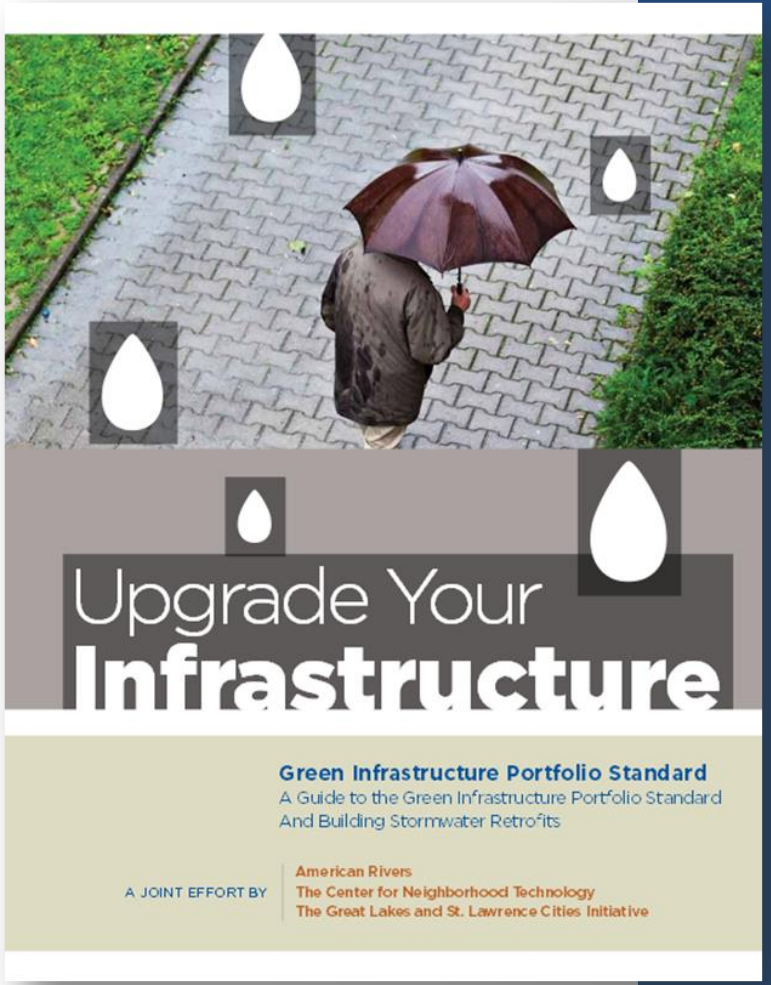
Background

- In October 2012, the Toledo – Lucas County Sustainability Commission hosted a GreenTown event on sustainability.
- Initiative to put together a sustainability plan for the Toledo – Lucas County region.
- After just over a year in development, *Greater Toledo: Going Beyond Green Regional Sustainability Plan* was finalized.
- www.lucascountygreen.com

Catalyst Project – Green Infrastructure Portfolio Standard

Gradually increase the retention of stormwater runoff on sites in a developed area using green infrastructure.

- Infiltration
- Evapotranspiration
- Harvesting for reuse



GIPS Process: Establish a Task Force

- Multidisciplinary team:
  - planning
  - engineering
  - streets
  - public works
  - forestry
  - stormwater management
  - economic development
  - community organizations
  - business organizations

- COT – Engineering, Environmental Services, Planning
- City of Oregon
- Lucas County Engineer, Lucas SWCD, Lucas County Land Bank
- OEPA, USDA - NRCS
- TMACOG
- Mannik & Smith Group, Hull & Associates, TTL Associates, DGL Consulting Engineers, Feller, Finch & Associates, Stantec, Blanchard Landscaping
- Metroparks of the Toledo Area
- American Rivers

Philadelphia in 2025

photo courtesy of Howard Neukrug, City of Philadelphia

Goal: Improve water quality through the implementation and maintenance of green stormwater infrastructure.

Actions

1. Create a Region-wide Green Stormwater Infrastructure Action & Implementation Strategy.

- Evaluate and compile existing best management practice installation information and corresponding metrics.
- Develop short-term and long-term implementation goals.
- Create metrics to evaluate and prioritize projects.
- Modify code, policy, and institutional barriers.

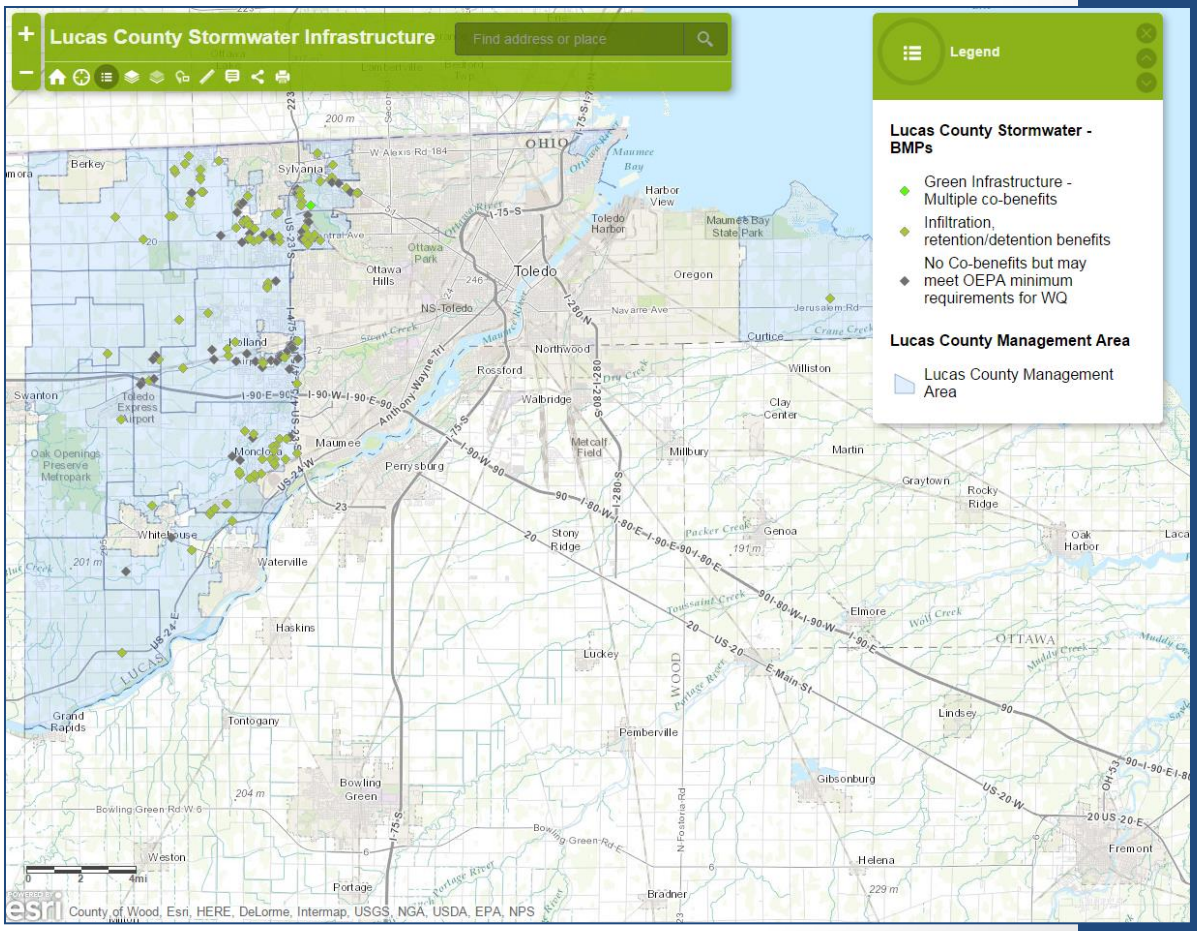
Goal: Improve water quality through the implementation and maintenance of green stormwater infrastructure.

2. Coordinate the development and distribution of green stormwater infrastructure information.

- Create two webpages – one with general information and one with technical resources.
- Provide trainings/workshops to educate municipal staff, the private sector and the public.

Developing the Baseline

- Data collection
- Created a standardized inventory and framework for future datasets
- Stormwater BMP categorization
- Mapping
- Online summaries



Stormwater BMP Benefits

GRAY Stormwater Infrastructure

- retention/detention

LIGHT GREEN Stormwater Infrastructure

- retention/detention

PLUS

- infiltration
- water quality improvement

GREEN Stormwater Infrastructure

- infiltration
- retention/detention
- water quality improvement

PLUS

- climate resiliency
- air quality improvement
- provide habitat
- aesthetic improvements
- education and engagement
- improve over time
- lower maintenance
- landscaping benefits
- rainwater re-use
- long-term cost savings/economic benefits
- multi-purpose

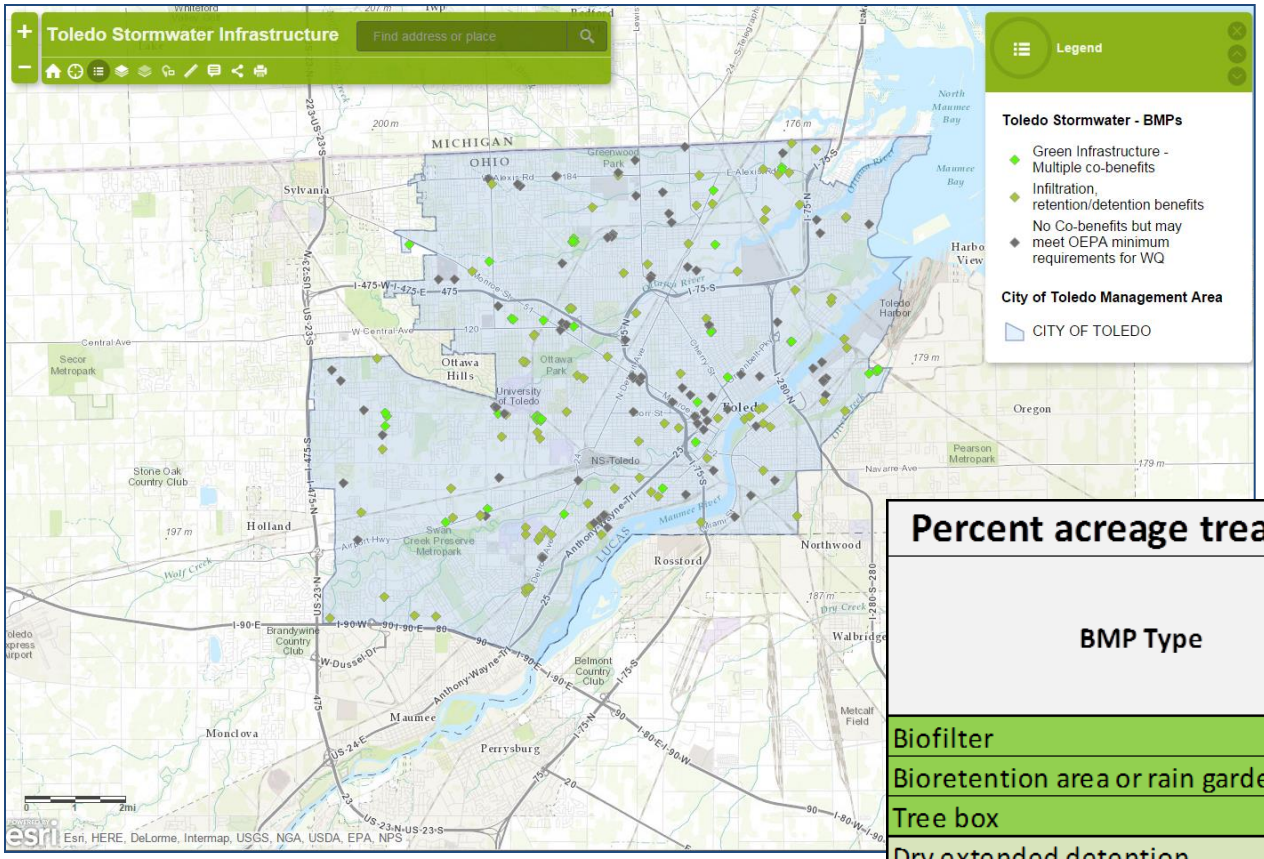
Classification of Stormwater BMPs

Standard Description	BMP Classification
Biofilter	Green Infrastructure - Multiple co-benefits
Bioretention area or rain garden	Green Infrastructure - Multiple co-benefits
Bioswale	Green Infrastructure - Multiple co-benefits
Constructed or pocket wetland	Green Infrastructure - Multiple co-benefits
Filter strip	Green Infrastructure - Multiple co-benefits
Permeable paving	Green Infrastructure - Multiple co-benefits
Rain barrel, cistern, or rain water harvesting	Green Infrastructure - Multiple co-benefits
Tree box or Silva Cell	Green Infrastructure - Multiple co-benefits
Vegetated paving	Green Infrastructure - Multiple co-benefits
Vegetated roof or wall	Green Infrastructure - Multiple co-benefits
Dry extended detention	Infiltration, retention/detention benefits
Dry well	Infiltration, retention/detention benefits
Grass swale	Infiltration, retention/detention benefits
Infiltration basin or trench	Infiltration, retention/detention benefits
Impervious surface reduction	Infiltration, retention/detention benefits
Sand & other media filtration	Infiltration, retention/detention benefits
Two-stage ditch	Infiltration, retention/detention benefits
Wet extended detention	Infiltration, retention/detention benefits
Proprietary infiltration device	Infiltration, retention/detention benefits
Proprietary water quality device	Infiltration, retention/detention benefits
Conduit	conveyance and/or retention/detention only
Detention - not extended	conveyance and/or retention/detention only
Ditch - drainage only	conveyance and/or retention/detention only
Parking lot ponding	conveyance and/or retention/detention only
Proprietary device - no infiltration or WQ	conveyance and/or retention/detention only

Measuring Green Stormwater Infrastructure Implementation

1. **The amount of land area that drains to and is treated by BMPs.** Each BMP has a watershed area that drains to it. Some BMPs treat the pollutants from the watershed while others only hold stormwater for a period of time before releasing it to waterways. Increasing the green stormwater infrastructure on our developed lands will reduce the impact of development on our waterways while providing many additional benefits.
2. **The amount of storm water runoff designed to be captured by BMPs in order to remove a majority of storm water pollutants.** The "water quality volume" (WQv) is a required design calculation for post construction BMPs and is also helpful in assessing the treatment potential during typical rain events. Increasing the green stormwater infrastructure water quality volume will provide additional benefits that cannot be achieved by gray and light green BMPs.

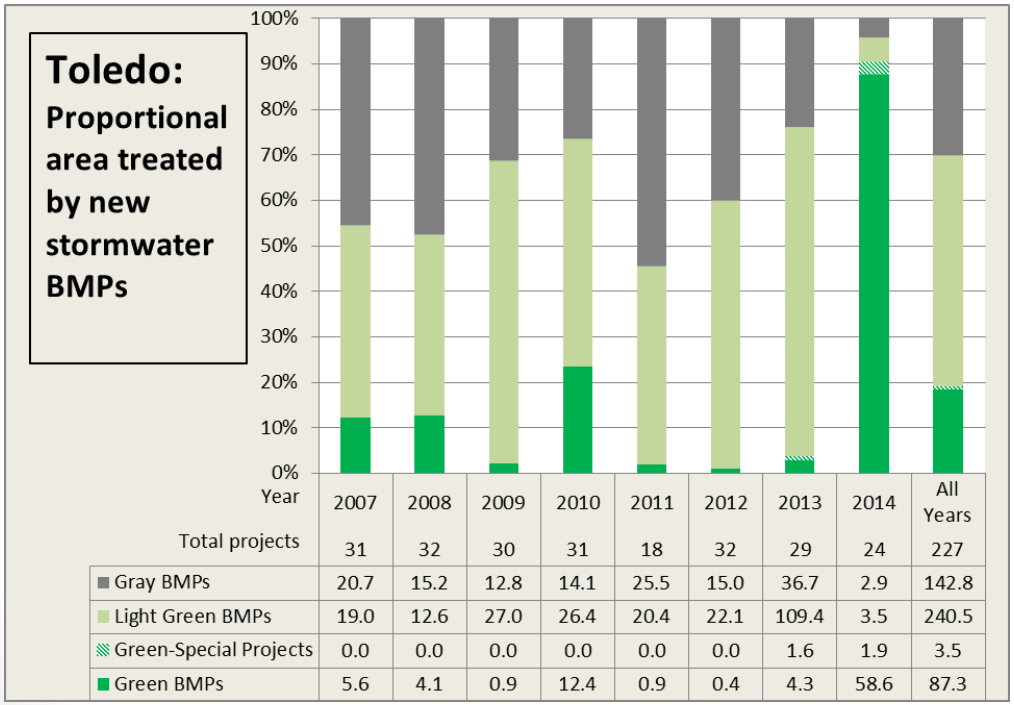
Toledo Green Infrastructure



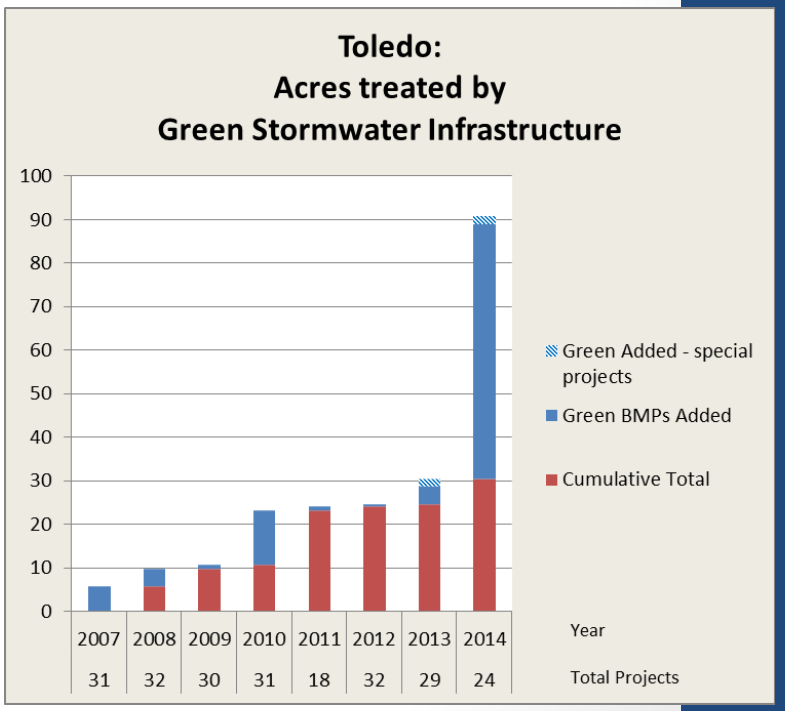
Percent acreage treated by BMP Type 2007-2014

BMP Type	Number of BMPs	Percent acreage treated by BMP Type
Biofilter	39	17.7%
Bioretention area or rain garden	10	1.2%
Tree box	1	0.2%
Dry extended detention	64	24.6%
Wet extended detention	3	1.5%
Grass swale	19	23.6%
Sand & other media filtration	3	1.1%
Detention - not extended	57	20.9%
Proprietary water quality device	14	1.9%
Parking lot ponding	17	7.3%
Other type - no benefits	3	0.0%

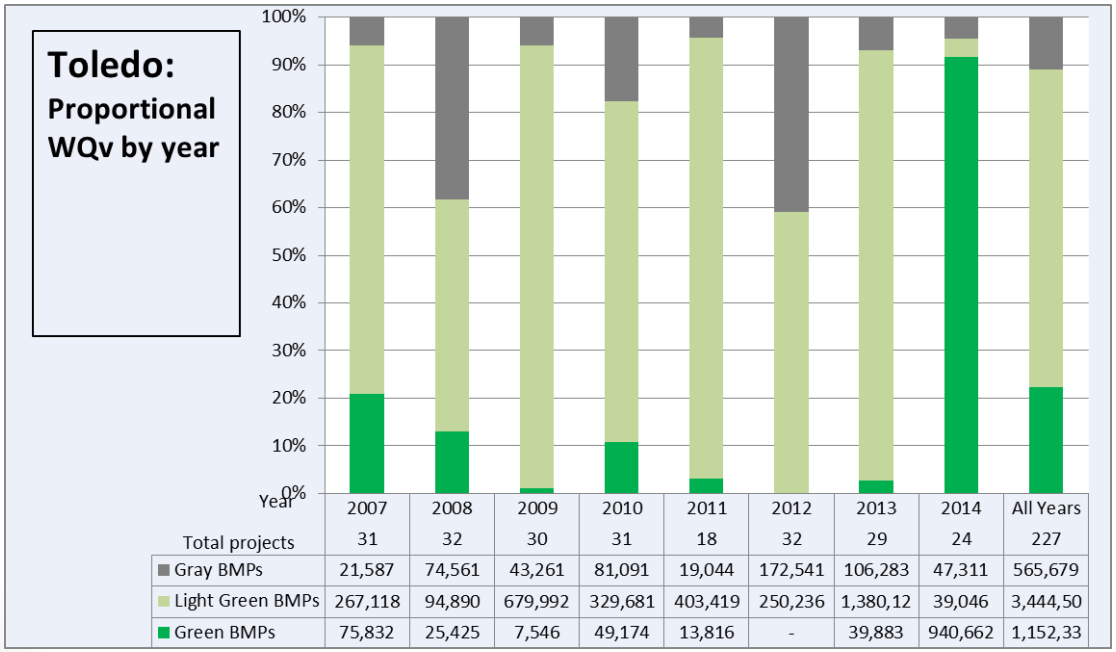
Toledo's Level of GSI Implementation – Acres Treated



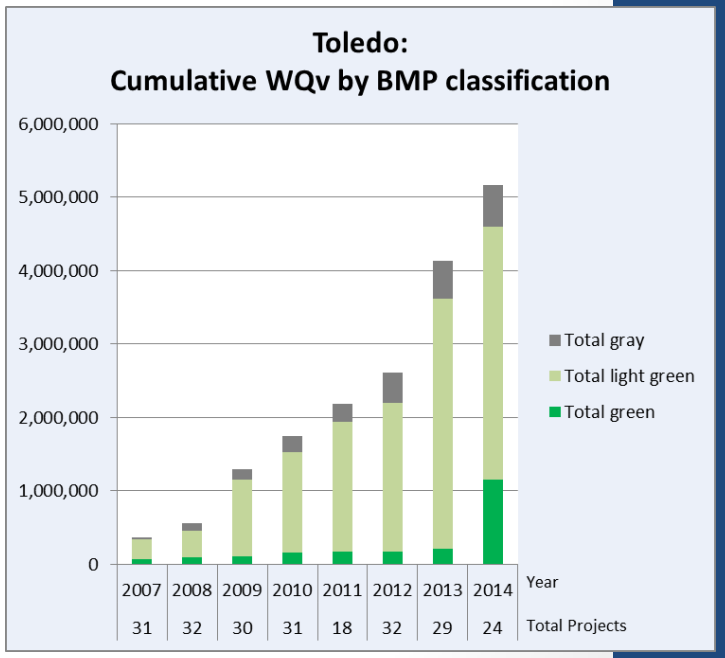
Year	2007	2008	2009	2010	2011	2012	2013	2014	All Years
Total projects	31	32	30	31	18	32	29	24	227
Gray BMPs	20.7	15.2	12.8	14.1	25.5	15.0	36.7	2.9	142.8
Light Green BMPs	19.0	12.6	27.0	26.4	20.4	22.1	109.4	3.5	240.5
Green-Special Projects	0.0	0.0	0.0	0.0	0.0	0.0	1.6	1.9	3.5
Green BMPs	5.6	4.1	0.9	12.4	0.9	0.4	4.3	58.6	87.3



Toledo's Level of GSI Implementation – Water Quality Volume



Year	2007	2008	2009	2010	2011	2012	2013	2014	All Years
Total projects	31	32	30	31	18	32	29	24	227
Gray BMPs	21,587	74,561	43,261	81,091	19,044	172,541	106,283	47,311	565,679
Light Green BMPs	267,118	94,890	679,992	329,681	403,419	250,236	1,380,12	39,046	3,444,50
Green BMPs	75,832	25,425	7,546	49,174	13,816	-	39,883	940,662	1,152,33



Toledo Metropolitan Area Council of Governments

Select Language

Google™ Custom Search Search

powered by Google™

Home | Environment | Stormwater Coalition | Green Infrastructure for Stormwater Management | Compare Local Efforts

Green Infrastructure Local Efforts

Compare Local Efforts

- Lucas County stormwater BMP portfolio and mapping
- Toledo stormwater BMP portfolio and mapping
- Oregon stormwater BMP potfolio
- Wood County Stormwater Mapping
- Bowling Green Stormwater Mapping

Stormwater BMP Portfolios

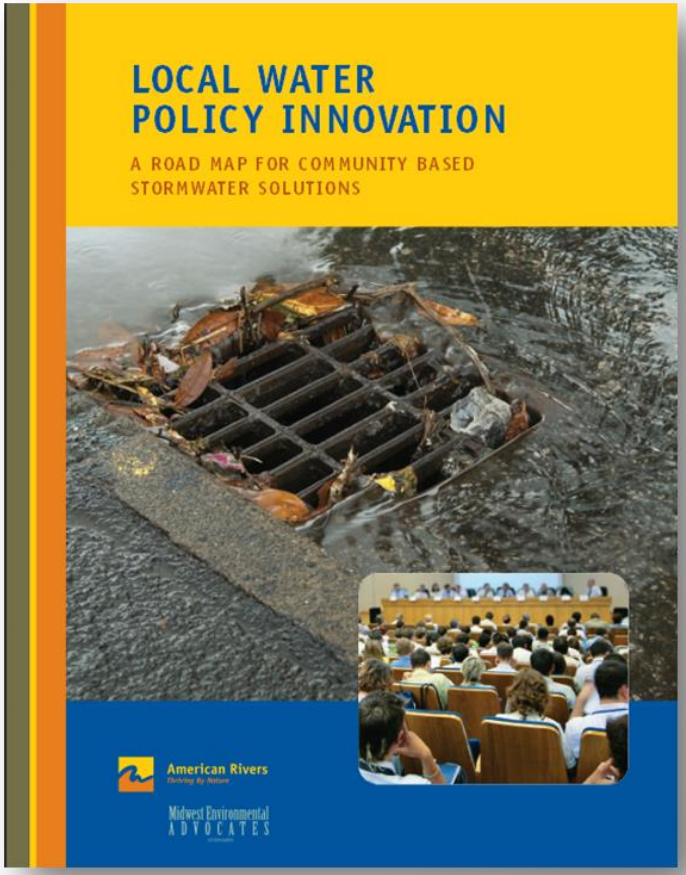
Local jurisdictions are responsible for building and maintaining infrastructure to manage stormwater, control flooding, and prevent pollution to our local waterways. This infrastructure was originally designed to convey rainwater as quickly as possible away from developed areas through systems of storm drains, pipes, and ditches. However, these highly modified drainage systems have been proven to contribute to water quality impairments and increased flooding in some areas.

Since 2003, Ohio EPA has required that development and redevelopment projects install post-construction best management practices (BMPs) for the long-term management of stormwater runoff. The primary purpose of these BMPs is to control stormwater volumes and pollutant loading from impervious surfaces that are typical of developed lands. These BMPs can be grouped into three main categories based upon their function and benefits. Green infrastructure offers a long list of economic, social, and environmental benefits that far exceed the minimum requirements of the OEPA construction general permit. Members of the Green Infrastructure Task Force recognize the importance of these co-benefits for environmental, economic, and community sustainability and are setting achievable goals to add more green stormwater infrastructure to their stormwater management portfolios.

Identifying code, policy, and institutional barriers

Tools Available

- American Rivers' Local Water Policy Innovation Guidebook
- EPA's Water Quality Scorecard
- Center for Watershed Protection's Code and Ordinance Worksheet
- Ohio Balanced Growth program's Checklist for Code Review: Best Local Land Use Practices



City of Toledo Municipal Code

- Streets, Utilities, and Public Services Code
  - Complete Streets Policy, Trees, Stormwater Discharge Control and Stormwater Management Program
- Planning & Zoning Code
  - Parking, Loading, and Access, Landscaping and Screening, Flood Control Regulation, and Site Plan Review
- Building Codes
  - Residential Code of Ohio, Ohio Plumbing Code, and Ohio Building Code
- Community Development

Other documents reviewed

- Subdivision Regulations
- Storm Water Credit Manual
- Infrastructure Design and Construction Requirements
- Zoning Maps
- University of Michigan Stormwater Solutions Final Report

Kirby's Comments

In general, provisions for BMPs and site design practices do not appear to encumber the development process significantly more than for standard development. Consider incentives where appropriate to encourage implementation of recommended practices. In particular, finding ways to streamline review processes can be very helpful in encouraging developers to implement the desired practices – even better if it can be easier to implement them than to take the standard route.

Current Work

- Site selection for potential projects using TMACOG vacant land prioritization outputs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	ASSESSOR_N	Define	Ownership2	bioret_sc	raing_sc	tree_sc	wetl_sc	acres	biore_rank	raing_rank	tree_rank	wetl_rank	PARCEL_1	OWNER_1	STREETNU_1	DIRECTIO_1	ADDRESS_1	CITY_1	STATE	ZIP_1
2	01544014	exempt Land Bank - Sheriff	PUBLIC	17.31	14.97	12.27	16.35	0.08	high	high	marginal	high	0103834	CITY OF TOLEDO	2838		LAWRENCE AVE	TOLEDO	OH	43610
3	01545003	exempt Land Bank - Auditor	PUBLIC	17.42	15.06	14.37	17.39	0.18	high	high	moderate	high	1021494	CITY OF TOLEDO AN OHIO MUNICIPAL CORPORATION	2821	N	DETROIT AVE	TOLEDO	OH	43610
4	01545004	exempt Land Bank - Gift	PUBLIC	17.42	15.05	14.37	17.38	0.16	high	high	moderate	high	1021501	CITY OF TOLEDO	2815	N	DETROIT AVE	TOLEDO	OH	43610
5	01545005	exempt Land Bank - Gift	PUBLIC	17.42	15.05	14.36	17.39	0.13	high	high	moderate	high	1021507	CITY OF TOLEDO	2811	N	DETROIT AVE	TOLEDO	OH	43610
6	01545009	exempt Land Bank - Sheriff	PUBLIC	17.30	14.86	13.20	17.31	0.08	high	moderate	moderate	high	0221137	TOLEDO CITY OF, AN OH MUNICIPAL CORPORATION	2765	N	DETROIT AVE	TOLEDO	OH	43610
7	01545015	exempt forfeit	PUBLIC	17.28	14.93	13.23	17.33	0.10	high	high	moderate	high	0221151	FORFEITED LAND	2722		LAWRENCE AVE	TOLEDO	OH	43610
8	01545020	exempt Land Bank - Auditor	PUBLIC	17.42	15.11	14.40	17.41	0.14	high	high	moderate	high	1021444	TOLEDO CITY OF AN OHIO MUNICIPAL CORPORATION	2804		LAWRENCE AVE	TOLEDO	OH	43610
9	01545024	exempt Land Bank - Sheriff	PUBLIC	17.42	15.11	13.40	17.41	0.14	high	high	moderate	high	1021457	TOLEDO CITY OF, AN OHIO MUNICIPAL CORPORATION	2828		LAWRENCE AVE	TOLEDO	OH	43610
10	01545028	exempt Land Bank - Auditor	PUBLIC	17.42	15.11	12.40	16.41	0.04	high	high	marginal	high	1021484	TOLEDO CITY OF, AN OHIO MUNICIPAL CORPORATION	839		COLLINS ST	TOLEDO	OH	43610
11	04003006	exempt Land Bank - Sheriff	PUBLIC	17.28	14.90	14.22	17.32	0.10	high	moderate	moderate	high	0330127	TOLEDO CITY OF, AN OHIO MUNICIPAL CORPORATION	2837		LAWRENCE AVE	TOLEDO	OH	43610
12	04005007	exempt Land Bank - Auditor	PUBLIC	17.31	14.70	12.11	16.25	0.10	high	moderate	marginal	high	1612834	CITY OF TOLEDO AN OHIO MUNICIPAL CORP	2701		LAWRENCE AVE	TOLEDO	OH	43610
13	04006007	exempt Land Bank - Sheriff	PUBLIC	17.31	14.84	13.19	17.30	0.13	high	moderate	moderate	high	1612994	TOLEDO CITY OF AN OHIO MUNICIPAL CORPORATION	2709	N	DETROIT AVE	TOLEDO	OH	43610
14	04038002	exempt Land Bank - Sheriff	PUBLIC	17.31	14.72	13.69	17.08	0.12	high	moderate	moderate	high	0964607	TOLEDO CITY OF, AN OHIO MUNICIPAL CORPORATION	2439	N	DETROIT AVE	TOLEDO	OH	43620
15	04038003	exempt Land Bank - Sheriff	PUBLIC	17.31	14.75	13.72	17.09	0.12	high	moderate	moderate	high	0964611	TOLEDO CITY OF	2435	N	DETROIT AVE	TOLEDO	OH	43620
16	04038004	exempt Land Bank - Auditor	PUBLIC	17.31	14.74	13.71	17.09	0.12	high	moderate	moderate	high	0964614	TOLEDO CITY OF AN OHIO MUNICIPAL CORPORATION	2433	N	DETROIT AVE	TOLEDO	OH	43620
17	04039001	exempt Land Bank - Auditor	PUBLIC	17.28	14.66	11.66	16.00	0.07	high	moderate	marginal	high	0964917	TOLEDO CITY OF, AN OH MUNICIPAL CORPORATION	2441		LAWTON AVE	TOLEDO	OH	43620
18	04040014	exempt Land Bank - Auditor	PUBLIC	17.36	14.81	12.77	17.11	0.12	high	moderate	moderate	high	0964597	TOLEDO CITY OF, AN OHIO MUNICIPAL CORP.	2451	N	DETROIT AVE	TOLEDO	OH	43620
19	04162008	exempt forfeit	PUBLIC	17.33	15.24	13.78	16.46	0.06	high	high	moderate	high	0502234	FORFEITED LAND	1677		OAKWOOD AVE	TOLEDO	OH	43607
20	04162009	exempt forfeit	PUBLIC	17.34	15.26	13.79	16.47	0.06	high	high	moderate	high	0502237	FORFEITED LAND	1675		OAKWOOD AVE	TOLEDO	OH	43607
21	04162010	exempt forfeit	PUBLIC	17.31	15.26	13.79	16.46	0.06	high	high	moderate	high	0502241	FORFEITED LAND	1671		OAKWOOD AVE	TOLEDO	OH	43607
22	05075008	exempt forfeit	PUBLIC	17.36	14.89	12.82	16.69	0.12	high	moderate	moderate	high	0958454	FORFEITED LAND	833		VANCE ST	TOLEDO	OH	43607
23	05076032	exempt Land Bank - Sheriff	PUBLIC	17.31	14.83	12.76	16.66	0.10	high	moderate	moderate	high	0958754	TOLEDO CITY OF	837		BLUM ST	TOLEDO	OH	43607
24	05076039	exempt forfeit	PUBLIC	17.29	14.75	12.71	16.63	0.10	high	moderate	moderate	high	0958731	FORFEITED LAND	813		BLUM ST	TOLEDO	OH	43607
25	09080002	exempt Land Bank - Sheriff	PUBLIC	17.63	14.24	13.25	16.54	0.09	high	moderate	moderate	high	1116597	TOLEDO CITY OF AN OH MUNICIPAL CORP	2841	N	ONTARIO ST	TOLEDO	OH	43611
26	09080003	exempt Land Bank - Sheriff	PUBLIC	17.63	14.28	13.27	16.55	0.10	high	moderate	moderate	high	1116604	TOLEDO CITY OF AN OH MUNICIPAL CORP	2837	N	ONTARIO ST	TOLEDO	OH	43611
27	09080004	exempt Land Bank - Sheriff	PUBLIC	17.61	14.25	13.24	16.54	0.09	high	moderate	moderate	high	1116607	TOLEDO CITY OF AN OH MUNICIPAL CORP	2833	N	ONTARIO ST	TOLEDO	OH	43611
28	09080005	exempt Land Bank - Sheriff	PUBLIC	17.47	14.21	13.20	16.48	0.10	high	moderate	moderate	high	1116611	TOLEDO CITY OF AN OH MUNICIPAL CORP	2829	N	ONTARIO ST	TOLEDO	OH	43611
29	02180001	commercial 4 - 19 apartments	LAND BANK-Demo	17.33	14.52	11.89	16.06	0.12	high	moderate	marginal	high	0200711	KEEL NATALIE M	605		CLARA AVE	TOLEDO	OH	43612
30	04041013	residential 2 family - platted	LAND BANK-Demo	17.31	16.37	11.69	16.07	0.08	high	high	marginal	high	0964907	DAVIS MICHAEL #	2453		LAWTON AVE	TOLEDO	OH	43620
31	09105011	residential 1 family - platted	LAND BANK-Demo	17.44	15.77	12.12	16.45	0.12	high	high	marginal	high	1117481	URBANSKI A P & J	2913	N	MICHIGAN ST	TOLEDO	OH	43611

Thank You!

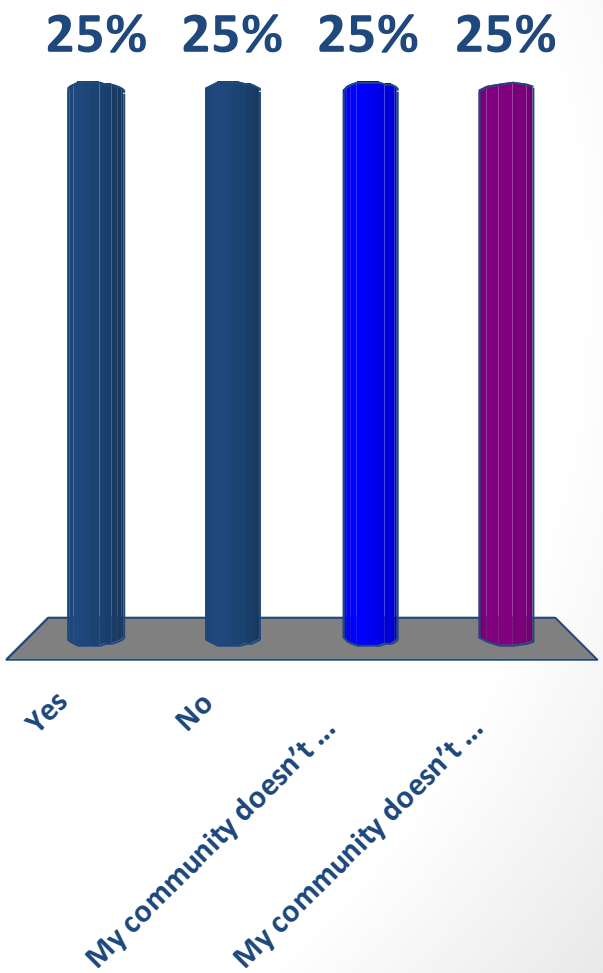
- Both American Rivers' guidebooks on the Green Infrastructure Portfolio Standard process and Local Water Policy Innovation are available on our website – www.americanrivers.org
- Information on the GSI Task Force can be found at www.lucascountygreen.com and www.tmacog.org

Katie Rousseau

krousseau@americanrivers.org or 419-936-3759

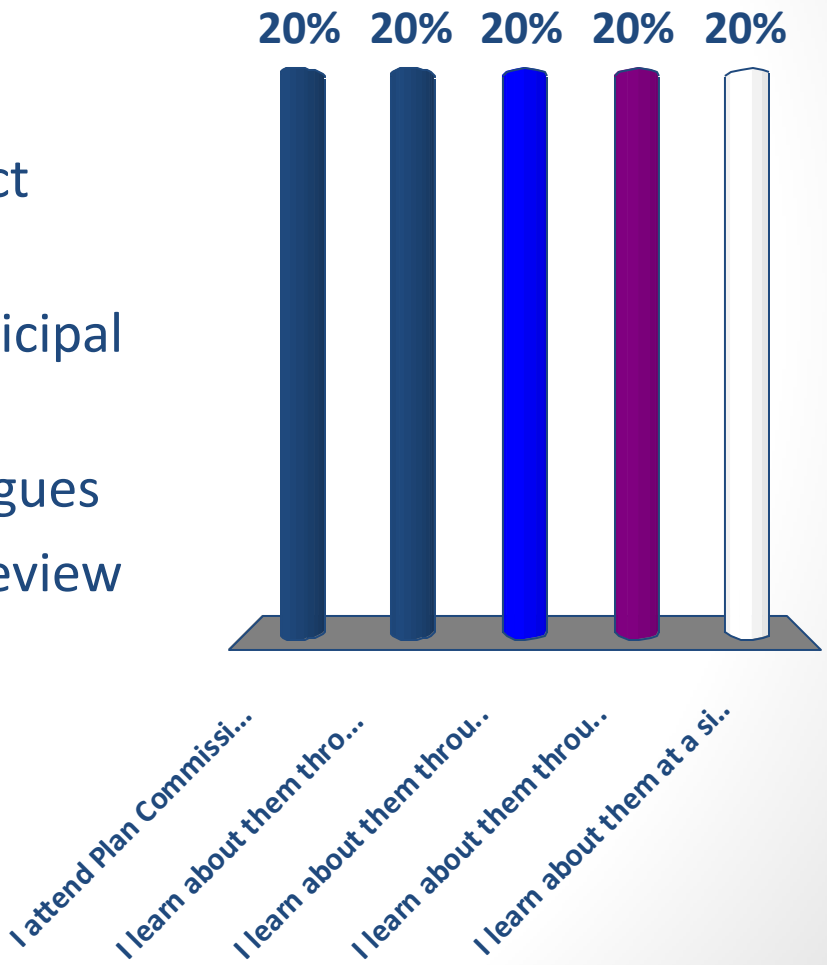
Are existing stormwater utility credits for green infrastructure in your community enough to encourage you or your developer to use these practices?

A. Yes
B. No
C. My community doesn't have a stormwater utility
D. My community doesn't have a stormwater utility with green infrastructure credits



How do you find out about code changes that relate to stormwater management and design?

A. I attend Plan Commission/Council meetings
B. I learn about them through a direct mailing from the municipality
C. I learn about them through a municipal website
D. I learn about them through colleagues
E. I learn about them at a site plan review meeting



QUESTIONS/BREAK

Urban Stormwater Research in Northwest Ohio

Dr. Cyndee Gruden, PE
Associate Professor
Civil Engineering
University of Toledo

Outline for Today:

1. GSI Performance and Cost Data
2. GSI Planning
3. Estimating Impact of Urban Stormwater on HAB Formation

THE UNIVERSITY OF TOLEDO

Performance Monitoring of GLRI SWIF Projects in Lucas County, OH

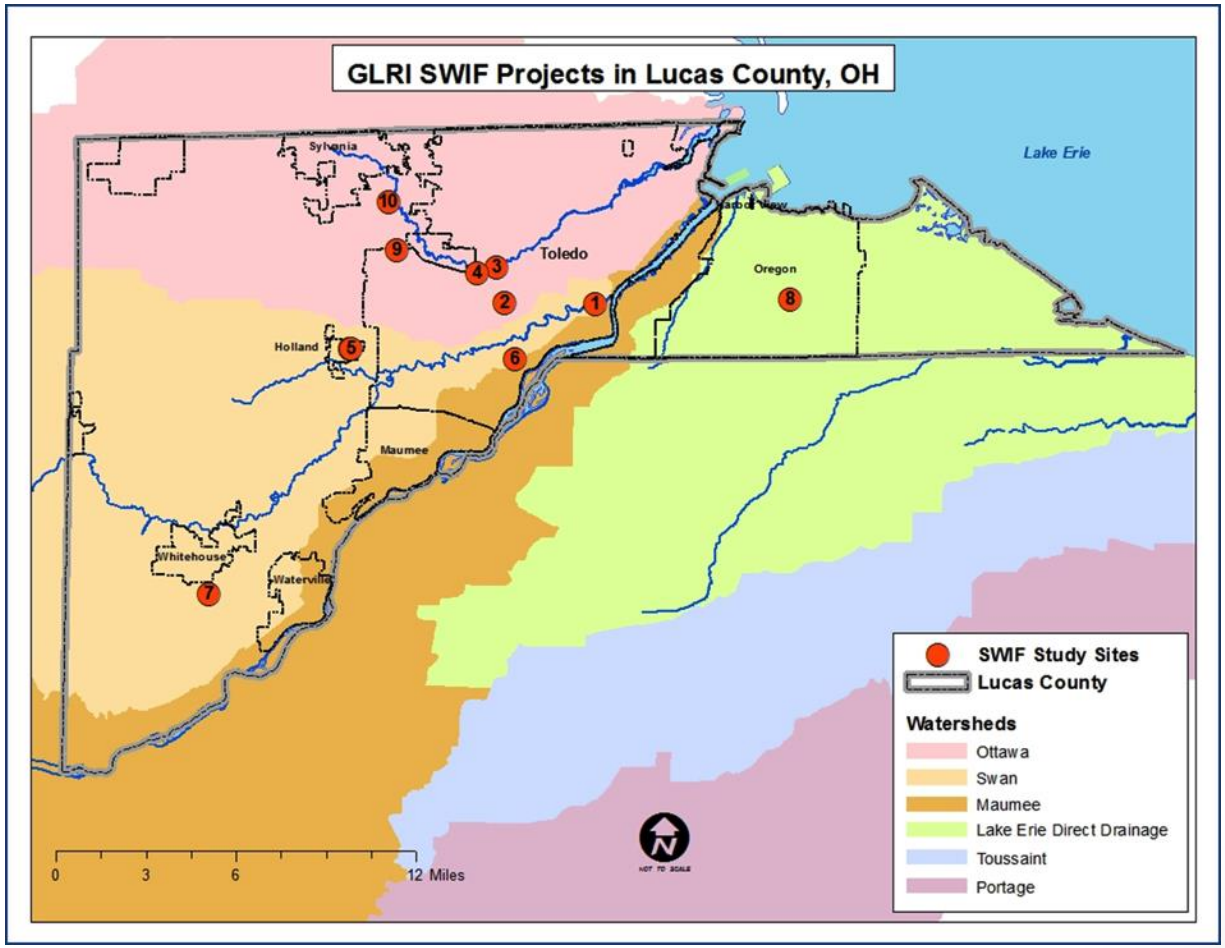
Cyndee Gruden, PE, PhD
Dept of Civil Engineering
University of Toledo

Kari Gerwin
Stormwater Planner
TMACOG

What is the most significant barrier to GSI implementation?

a. Lack of Performance Data
b. Capital Cost
c. Long Term Maintenance

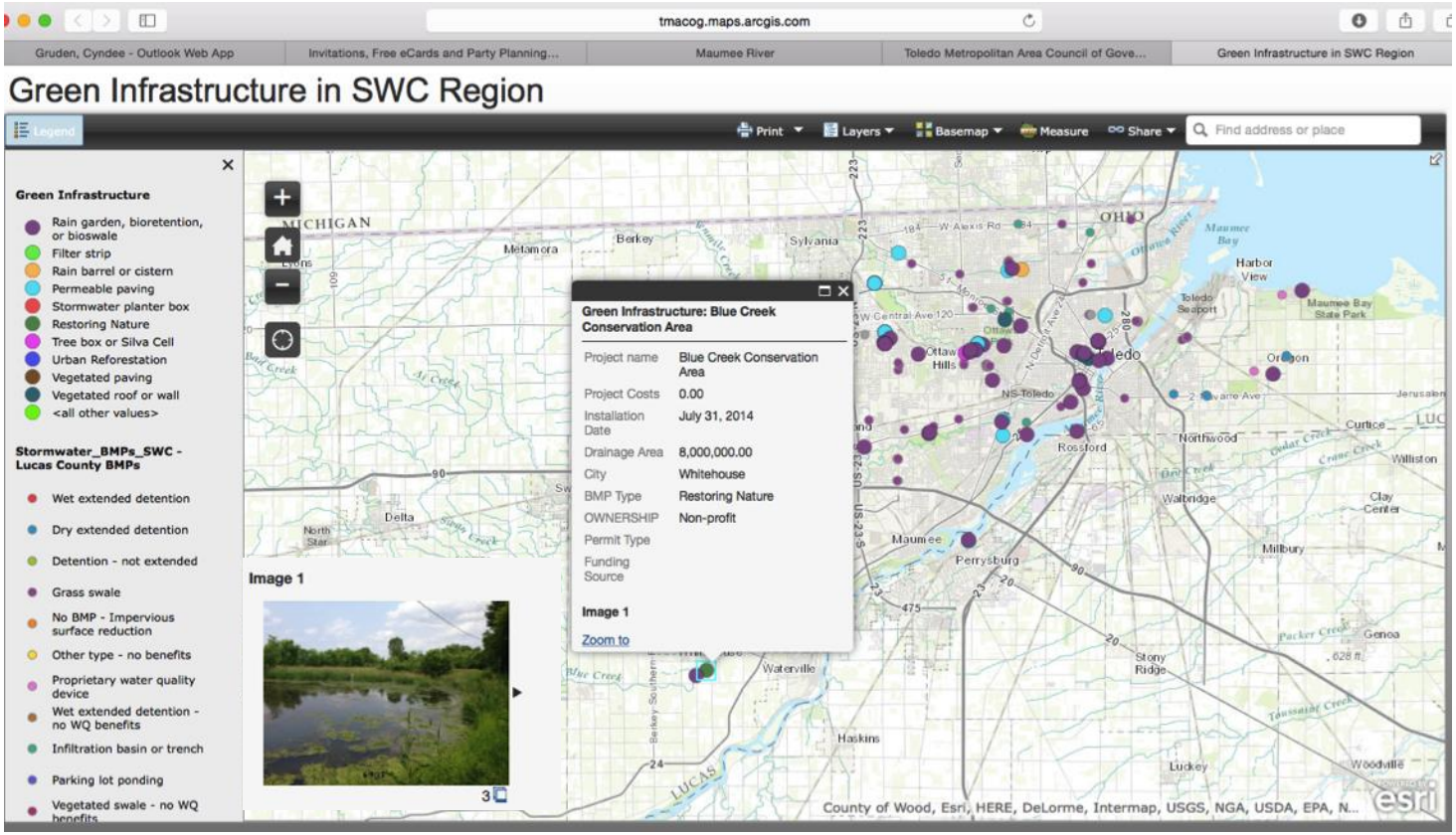
The main goal of this project was to work with Lucas County SWIF project managers to acquire, analyze, and share performance (quantity, water quality, O&M) and cost data. Data is needed by <u>local/regional stormwater stakeholders</u> to promote and plan future green stormwater infrastructure.



TMACOG Stormwater

TMACOG Stormwater – GSI Resources

http://www.tmacog.org/Environment/Green_Infrastructure/green_infrastructure.htm



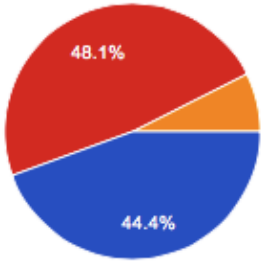
BMPs in Greater Toledo – Kari Gerwin, Stormwater Planner

THE UNIVERSITY OF TOLEDO

End User Driven Data Collection:

[Site Design Information](#)
[Site Cost and Installation Information](#)
[Performance Tracking](#)
[Maintenance Tracking](#)

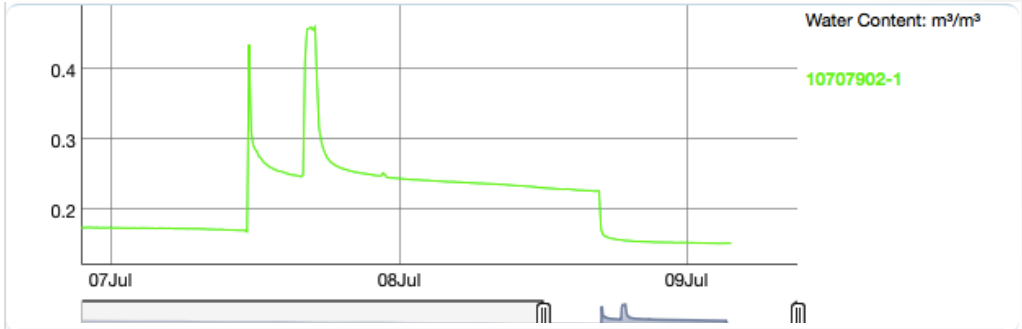
Overall BMP Condition

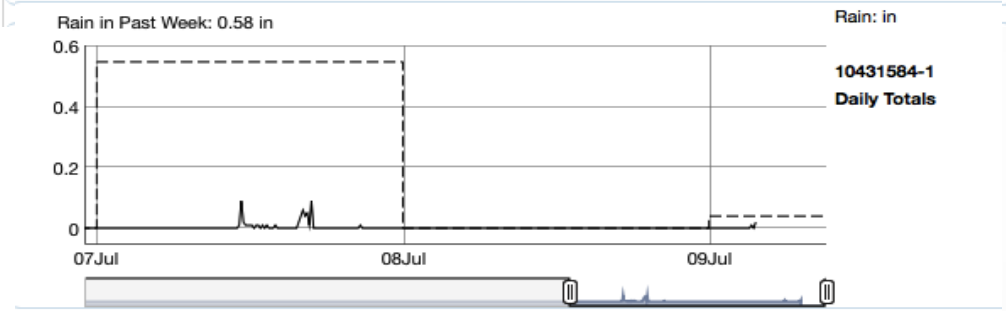


Good condition. Well maintained, no action required.	12	40%
Moderate condition. Adequately maintained, routine maintenance required	13	43.3%
Degraded condition. Poorly maintained, routine maintenance required	2	6.7%
Serious condition. Immediate need for repair or replacement.	0	0%

THE UNIVERSITY OF TOLEDO

Performance Monitoring

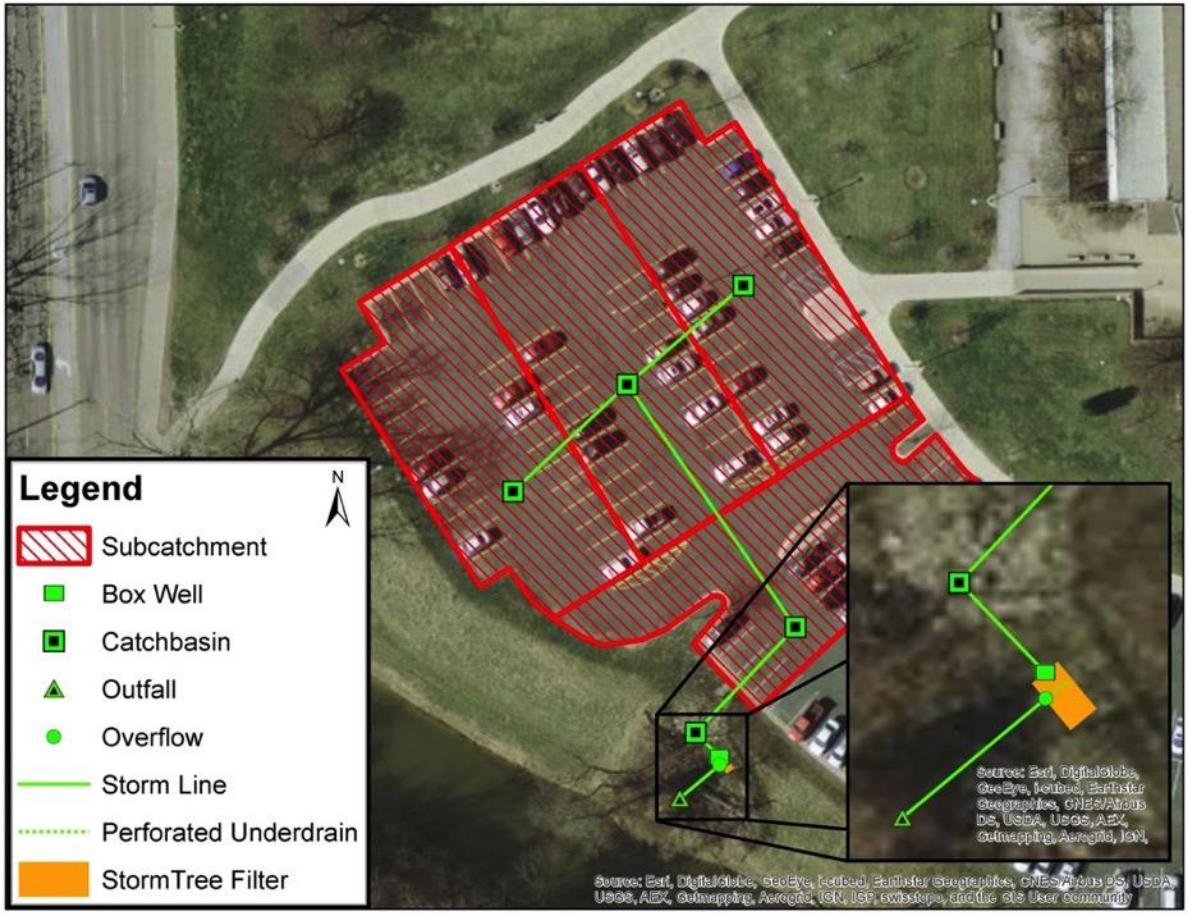


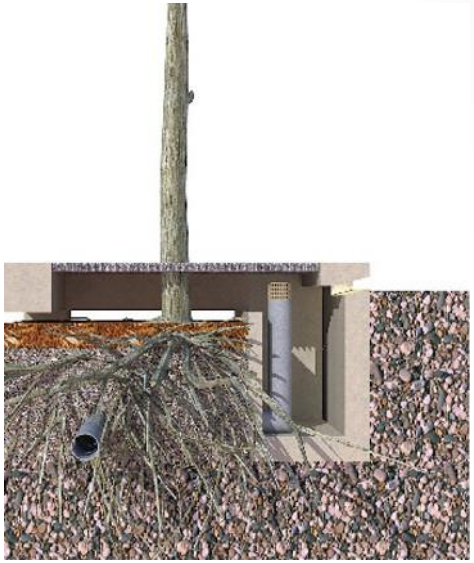


HOBO RX3000 Station - CELL-3G

[UT Weather Station: https://www.hobolink.com/p/aa90e60bbfbbb7ef63a9da89c178cc8e](https://www.hobolink.com/p/aa90e60bbfbbb7ef63a9da89c178cc8e)

UT Law School : Tree Filter Site





section view

contributing watershed is 0.8 acre
curbed parking lot with 4 catch basins

THE UNIVERSITY OF TOLEDO

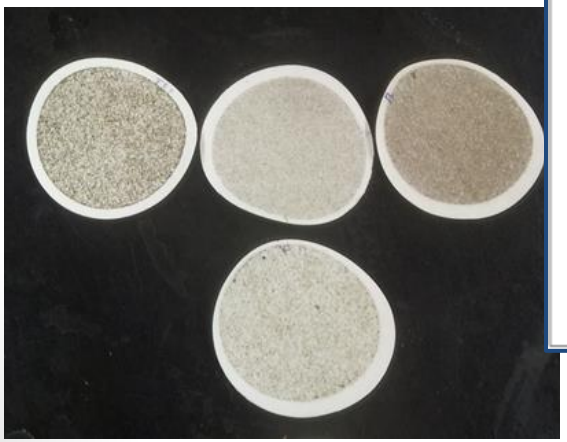
Performance Monitoring

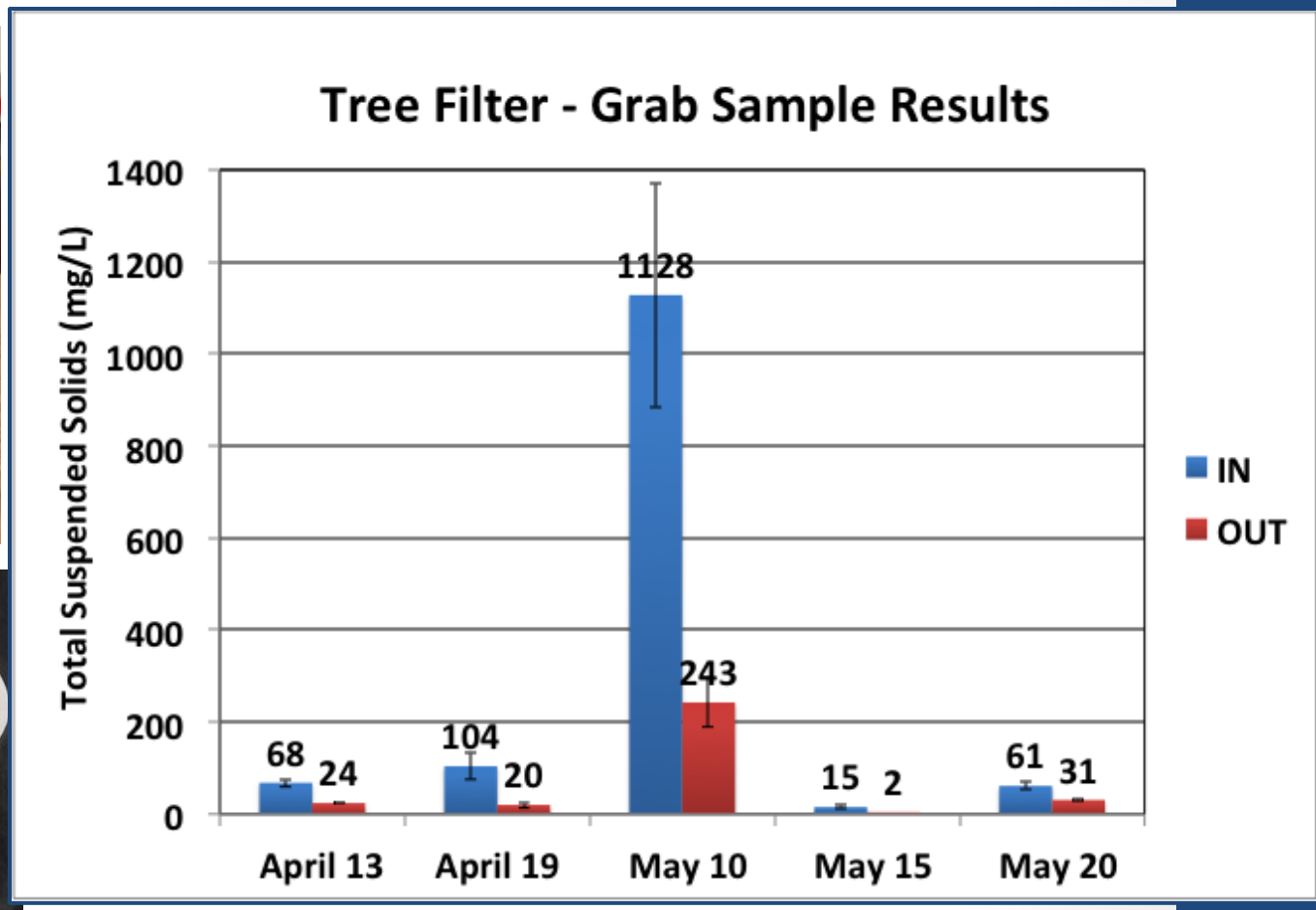
Spring 2015 Rain Events

DATE	RAIN (inches)	Time (min)	ADD (days)
Apr 13	0.07	45	2
Apr 19	0.60	360	5
May 10	0.34	240	4
May 15	0.23	240	3
May 20	0.02	15	2

Grab samples collected at most events. Composite samples were not possible for all events because of limited volumes.

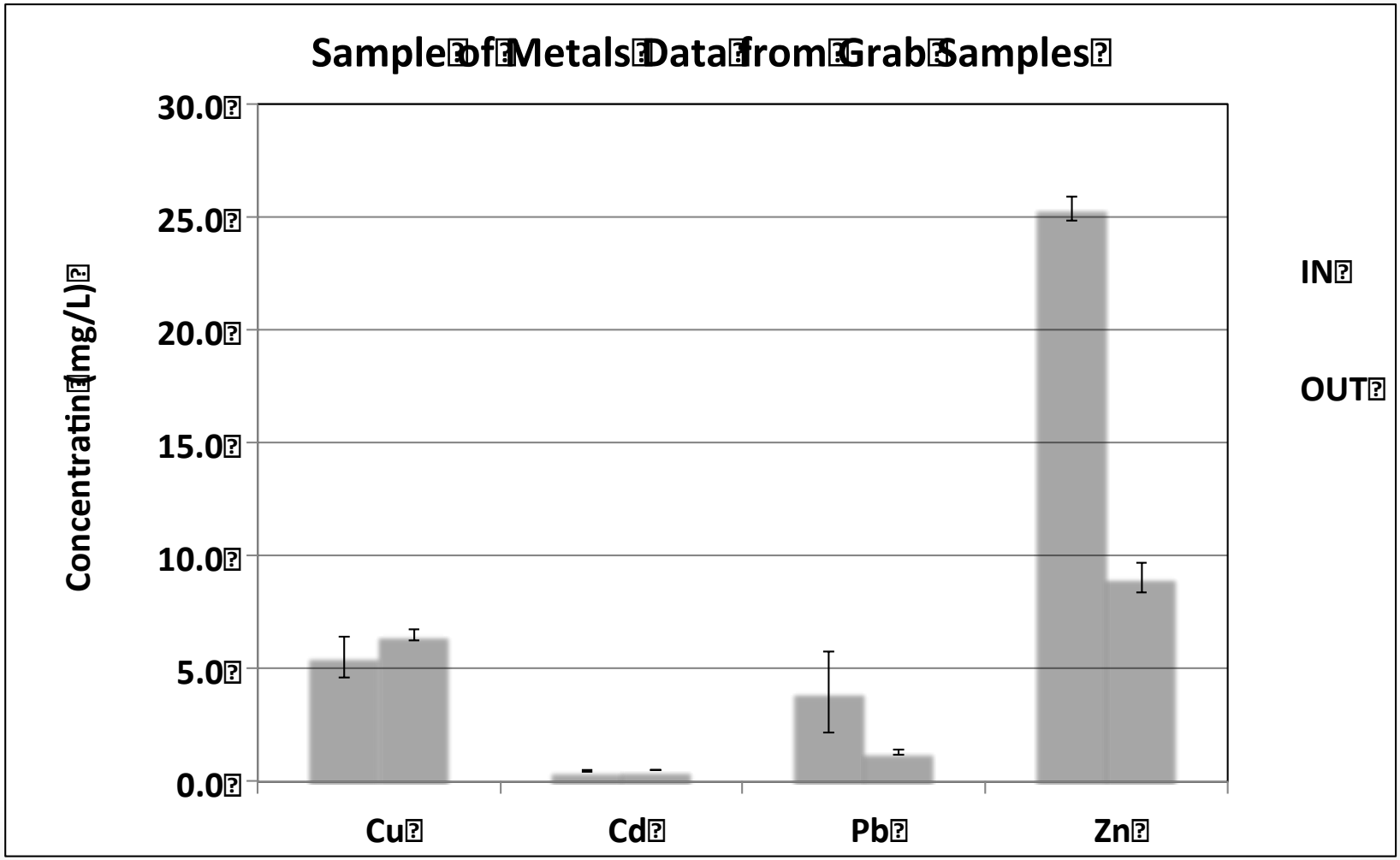
Water Quality Results: TSS





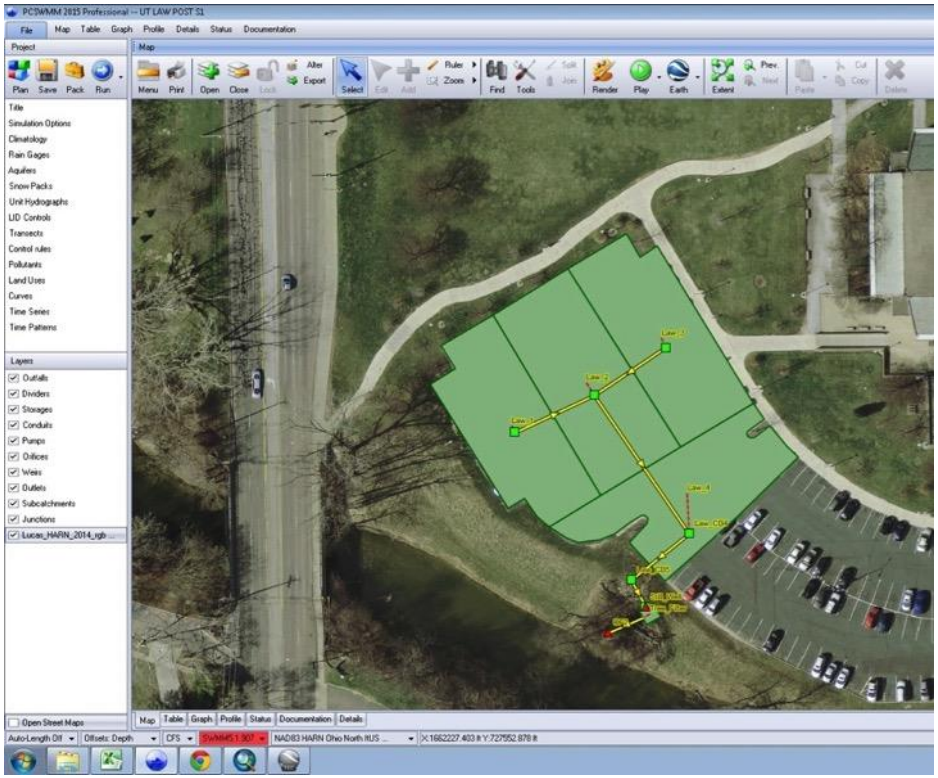
Statistically significant decrease in TSS for five separate events in Spring 2015.

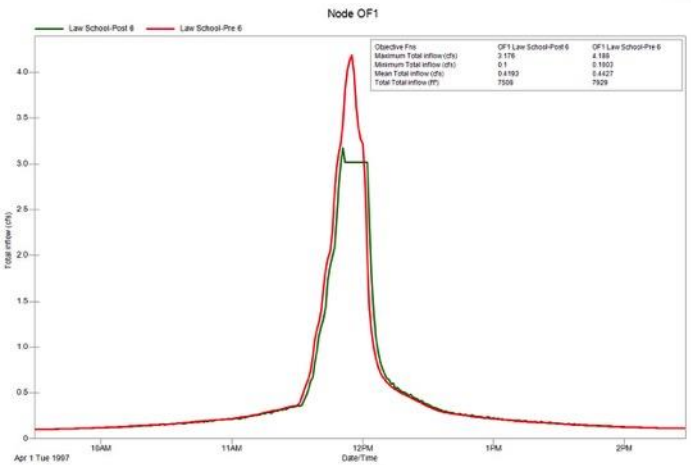
Water Quality Results: Metals



No statistically-significant differences in metals except zinc.
Zinc was significantly reduced in 3 of the 5 events.

SWMM Modeling





Simulation Event	Volume Reduction (gallons)	% Volume Reduction
5 Year Continuous	8000 gallons/year	1.30%
90 Percent Storm	1700 gallons	11.90%
10 year Storm	4825 gallons	5.90%

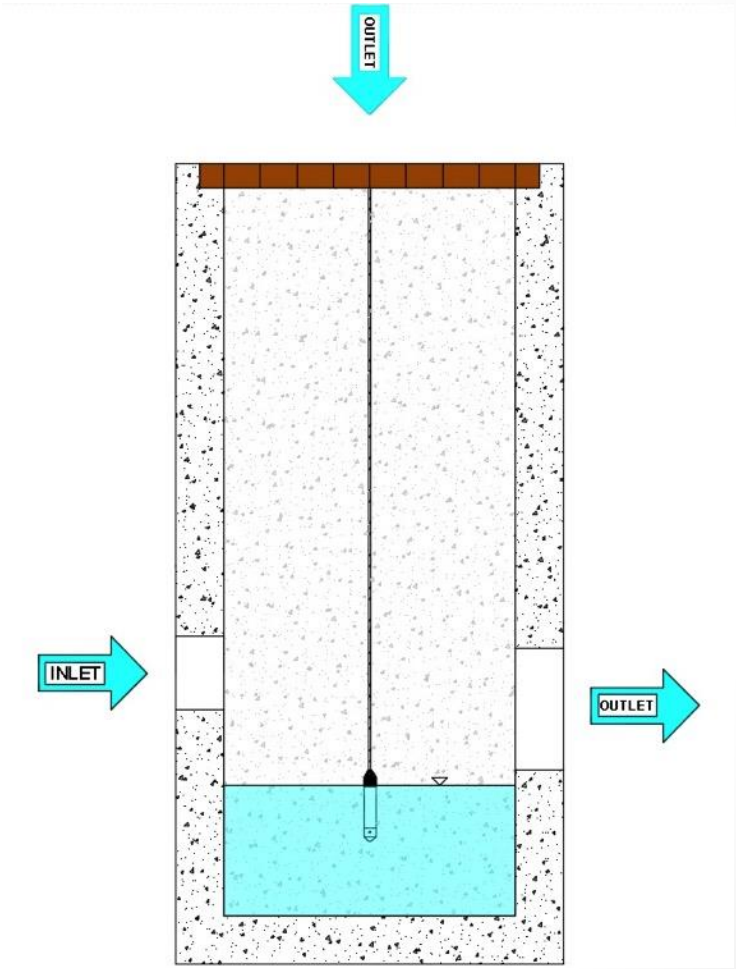
THE UNIVERSITY OF TOLEDO

Water Level Logger:

Surrogate Measure of Flow

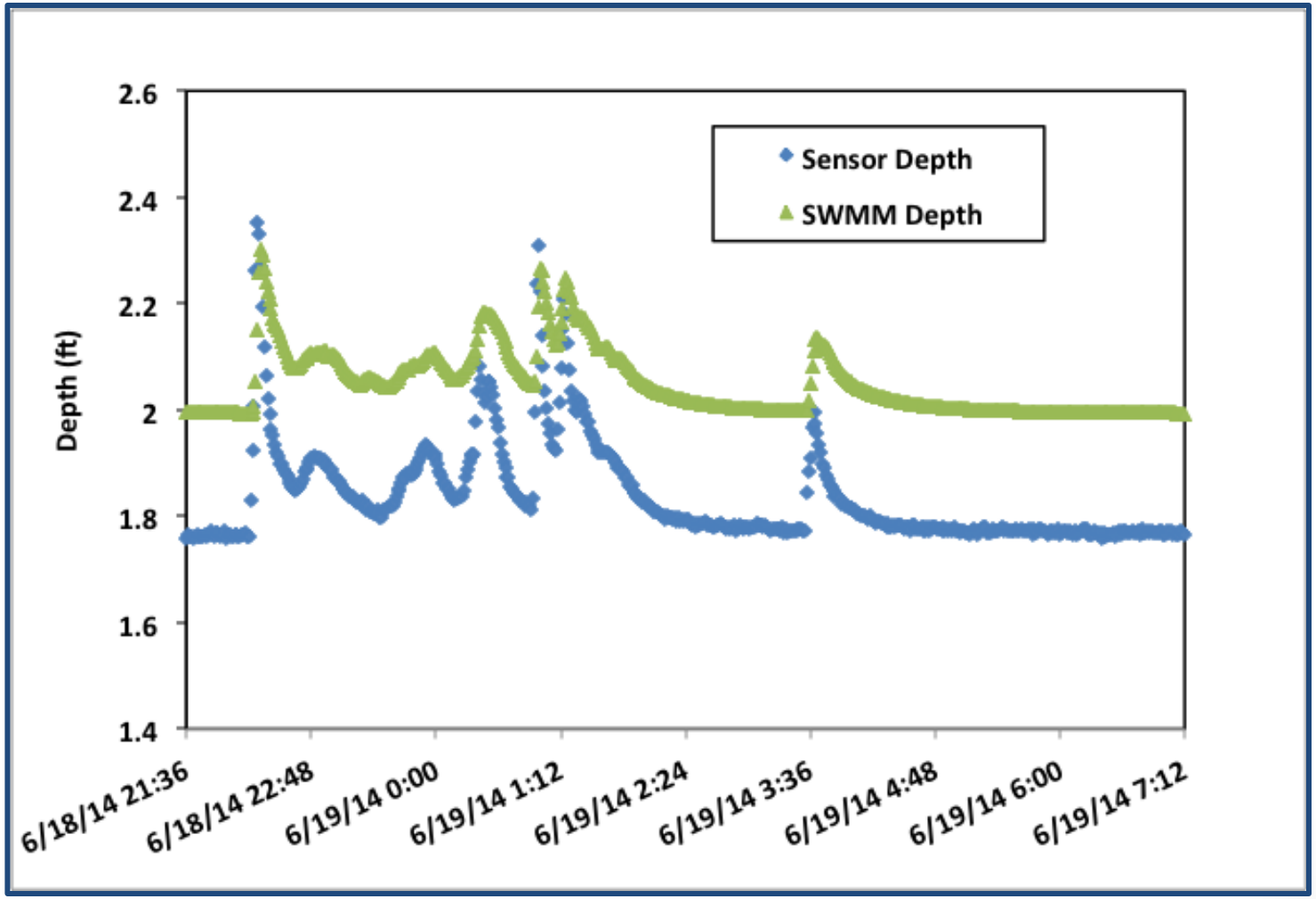
Onset HOBO U20 Water Level Logger

- **Water level fluctuations are recorded and used to estimate flow.**
- **Time series CB level data can be used to calibrate SWMM rainfall-runoff model**



SWMM Model Calibration:

Depth Sensor



Pressure-based depth sensor to calibrate SWMM models

THE UNIVERSITY OF TOLEDO

Project Outputs:

- SWIF site performance and cost data collected, shared, and analyzed for inclusion in the WERF's International Stormwater BMP database.
- Maintenance and data collection training.
- Data Collection and Dissemination: quarterly project meetings and monthly SWAG meetings hosted by TMACOG as well as OHSWA and EWRI conferences.
- Permanent web links and SWIF site databases.
- Remote sensing (soil moisture and/or water level loggers) to determine GSI performance and calibrate models.

THE UNIVERSITY OF TOLEDO

American Rivers
Thriving By Nature

Green Stormwater Infrastructure Planning in Lucas County, Ohio

Cyndee Gruden, Anthony Dietrich, Rahul Yarlagadda, Katie Rousseau, Margaux Empey, Melissa Greene

TOLEDO
LUCAS COUNTY
SUSTAINABILITY
COMMISSION

THE UNIVERSITY OF
TOLEDO

What should be the most important consideration for selecting a site for GSI?

a. Community Buy In
b. Potential to Improve Water Quality
c. Potential to Reduce Localized Flooding

THE UNIVERSITY OF TOLEDO

Project Objectives

Facilitate GSI planning in Lucas County

1. Select project sites – typical types in Lucas County
2. Select and design GSI
3. Estimate potential flow reductions from GSI implementation using modeling
4. Scale up and determine potential run-off reductions in Lucas County

Community-Based Planning

GSI Task Force Meetings

- Monthly Task Force
- Monthly Subcommittee
- Site visits
- Workshops
- Monthly Stormwater Action Group (SWAG) meetings
- Weekly SWMM Meetings at UT

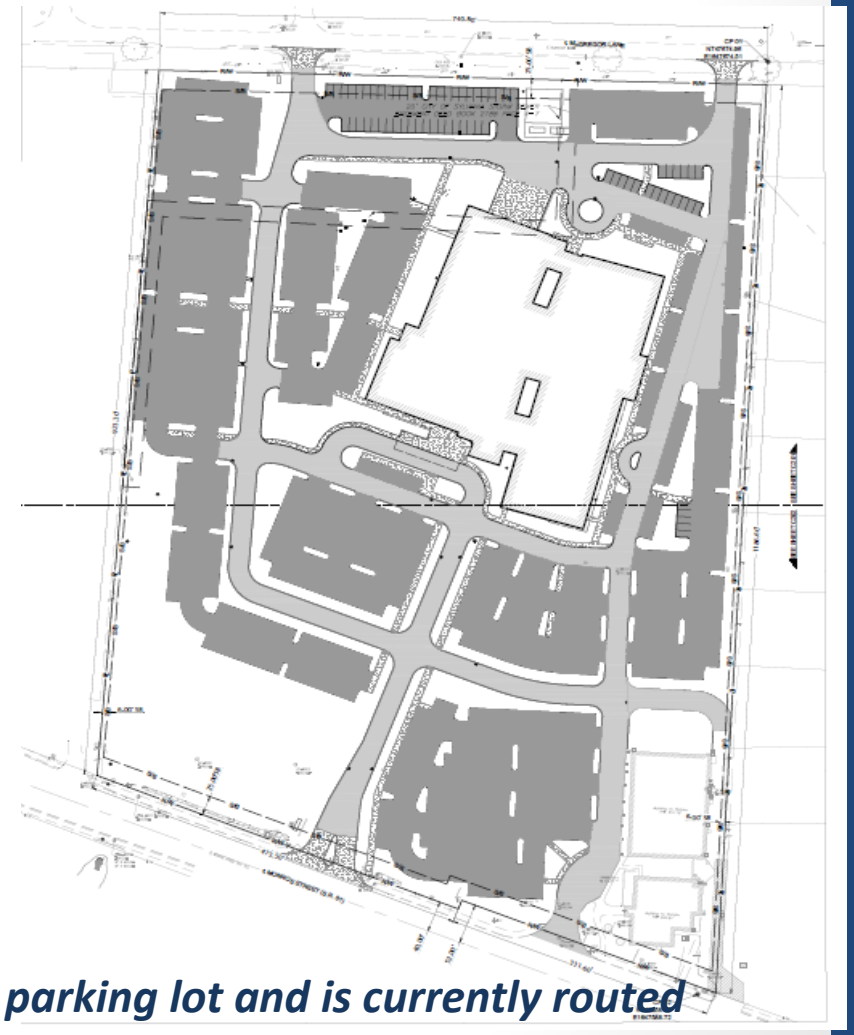
Vacant Residential Property

The stormwater is produced on roof tops, sidewalks, streets, and grassy surfaces. It travels over land to catch basins in the street.

Multifamily Housing

The stormwater is generated on the roof tops and roof drains are routed to the grass and runoff travels to the catch basin.

Commercial Site: Medical Office



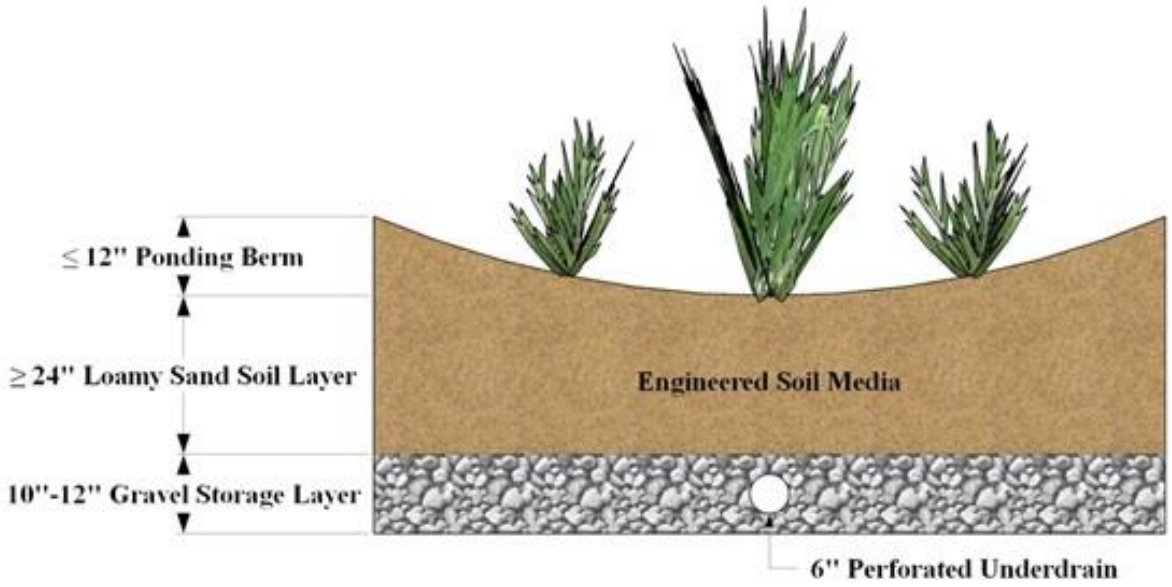
The stormwater is generated on the parking lot and is currently routed directly to the storm sewer.

Site Characteristics

SITE	Location	Site Area (acres)	Soil Type	Infiltration (in/hr)	% Impervious
Vacant	Belmont/Forest	2.45	Sandy-clay	0.05	40
Multifamily	Vistula	0.11	Loam	0.52	100*
Commercial	Starlite Plaza	14.2	Sand	9.27	100**

Runoff from building roof tops only.
****Parking lot runoff only.***

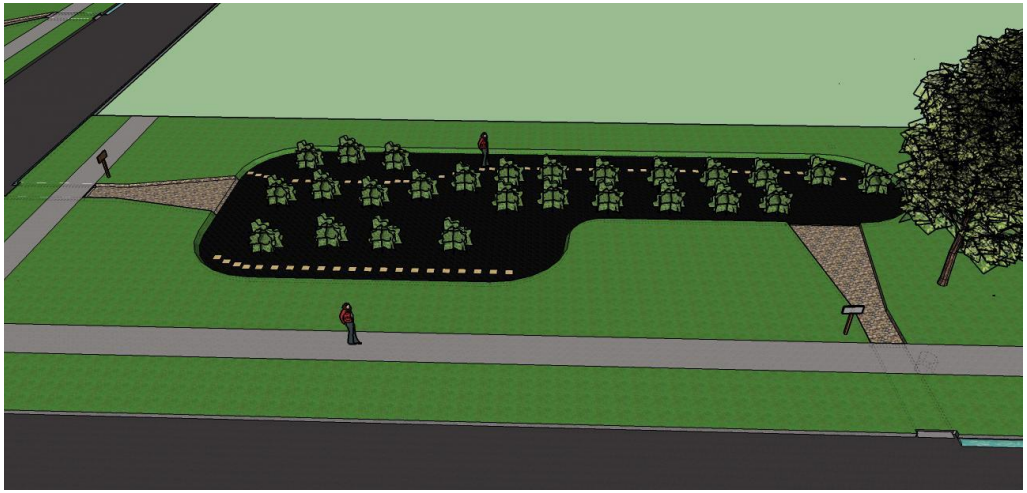
Bioretention



If infiltration rate is less than 0.5 in/hr, a gravel underdrain is required.

loamy sand = ≥80% sand, ≤10% clay, 8-20% organic matter

Bioretention Design

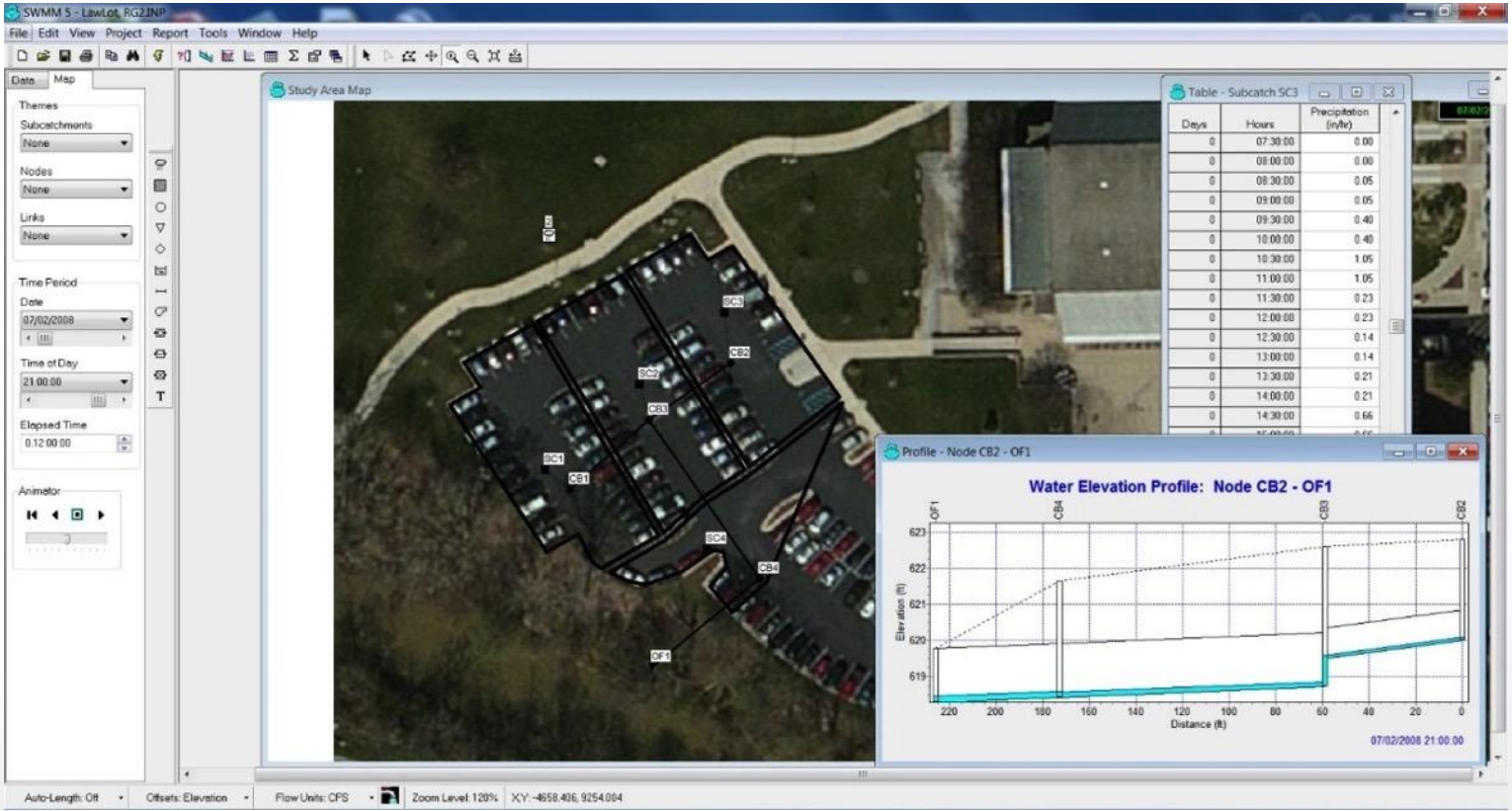


Vacant Site Bioretention Cell Rendering

- **Water Quality Volume is calculated as ¾ of an inch of rain multiplied by conversion factor(s).**
- **If impervious > 25%, use min of 5% of impervious area.**

SWMM Modeling

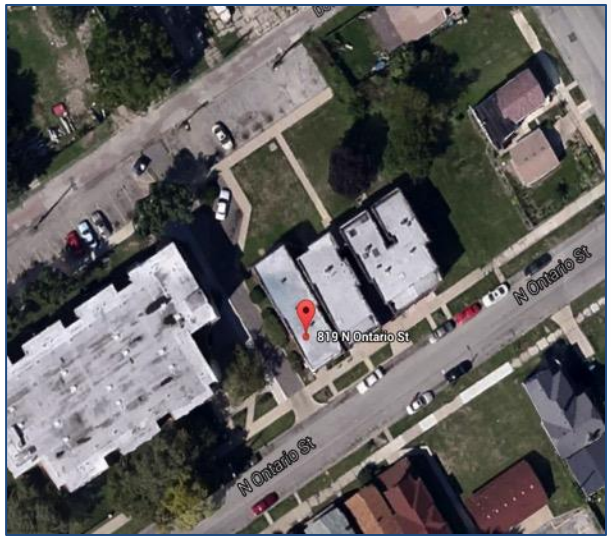
EPA's Stormwater Management Model is a dynamic hydrology-hydraulic simulation model used for single event or long-term continuous simulation of runoff quantity and quality from primarily urban areas.

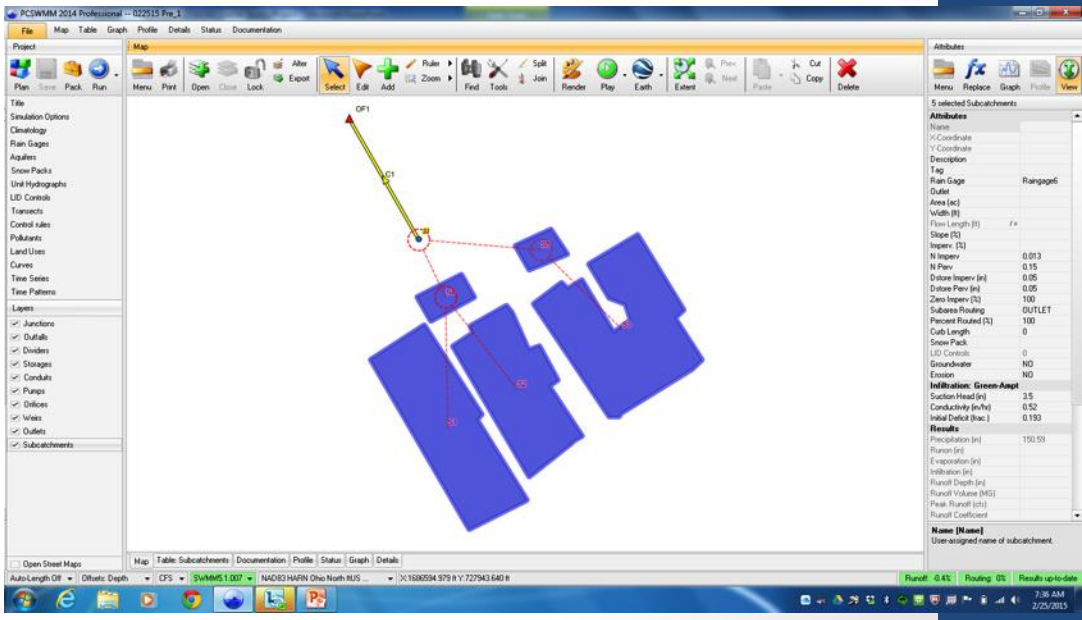


Modeling

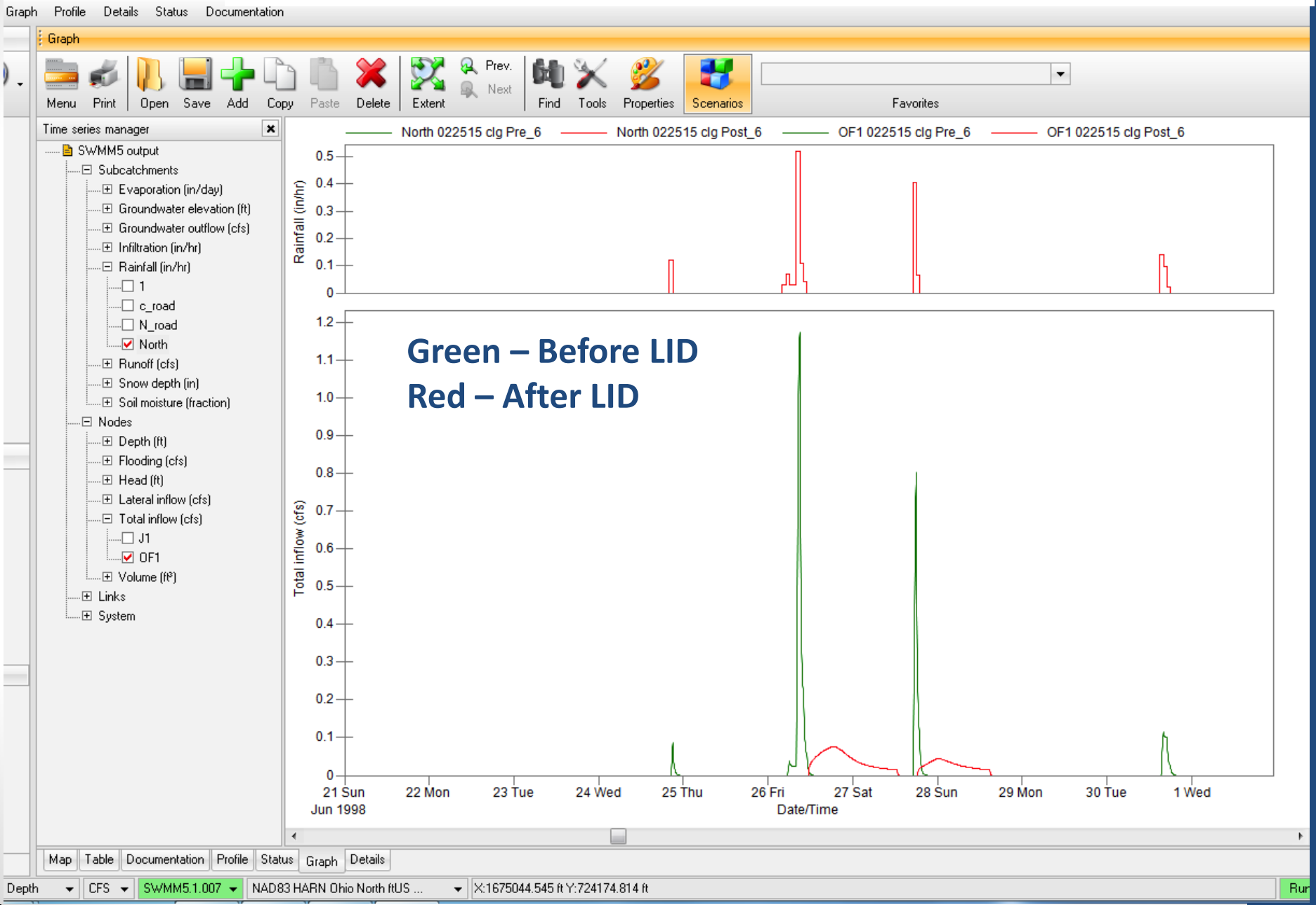
EPA SWMM Used:

1. Site Hydrology
   - Watershed area
   - Soils – infiltration rate
   - Impervious surface
2. Simulation
   - 5 yrs of rain data
3. Volume Reduction
   - % of volume
   - Est. gallons/yr





Sample SWMM Data



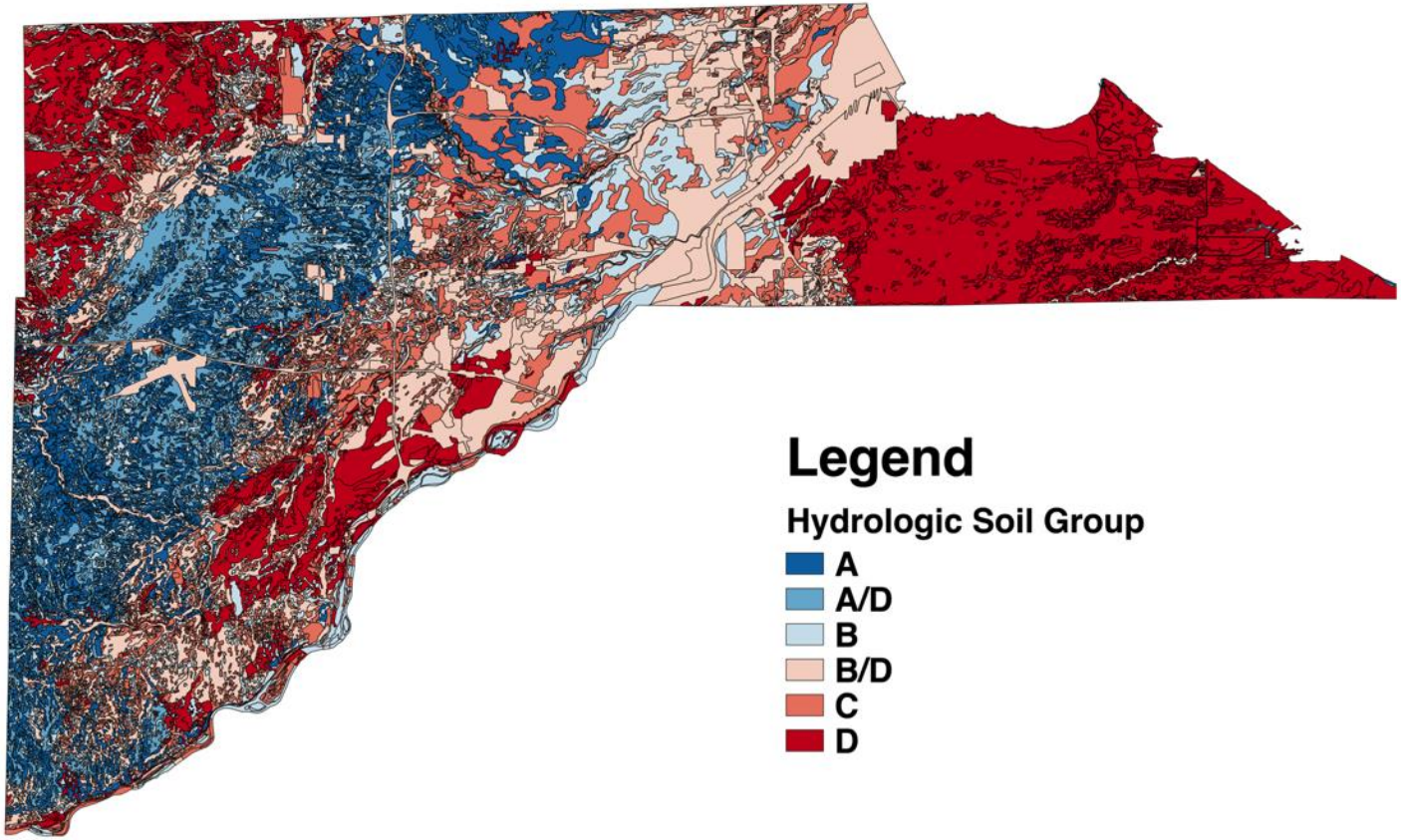
LID Performance:
% Volume Reduction

	Soil Texture Class	Hydrologic Soil Group	Vacant	Multi-Family	Commercial
1	Sand	A	100	0	80
2	Loamy Sand	B	100	34	80
3	Sandy Loam	C	100	84	79
4	Loam	C	99	85	75
5	Silt Loam	C	88	70	66
6	Sandy Clay loam	D	59	45	51
7	Clay Loam	D	42	36	41
8	Silty Clay Loam	D	42	36	41
9	Sandy Clay	D	29	31	30
10	Silty Clay	D	23	28	26
11	Clay	D	14	23	18

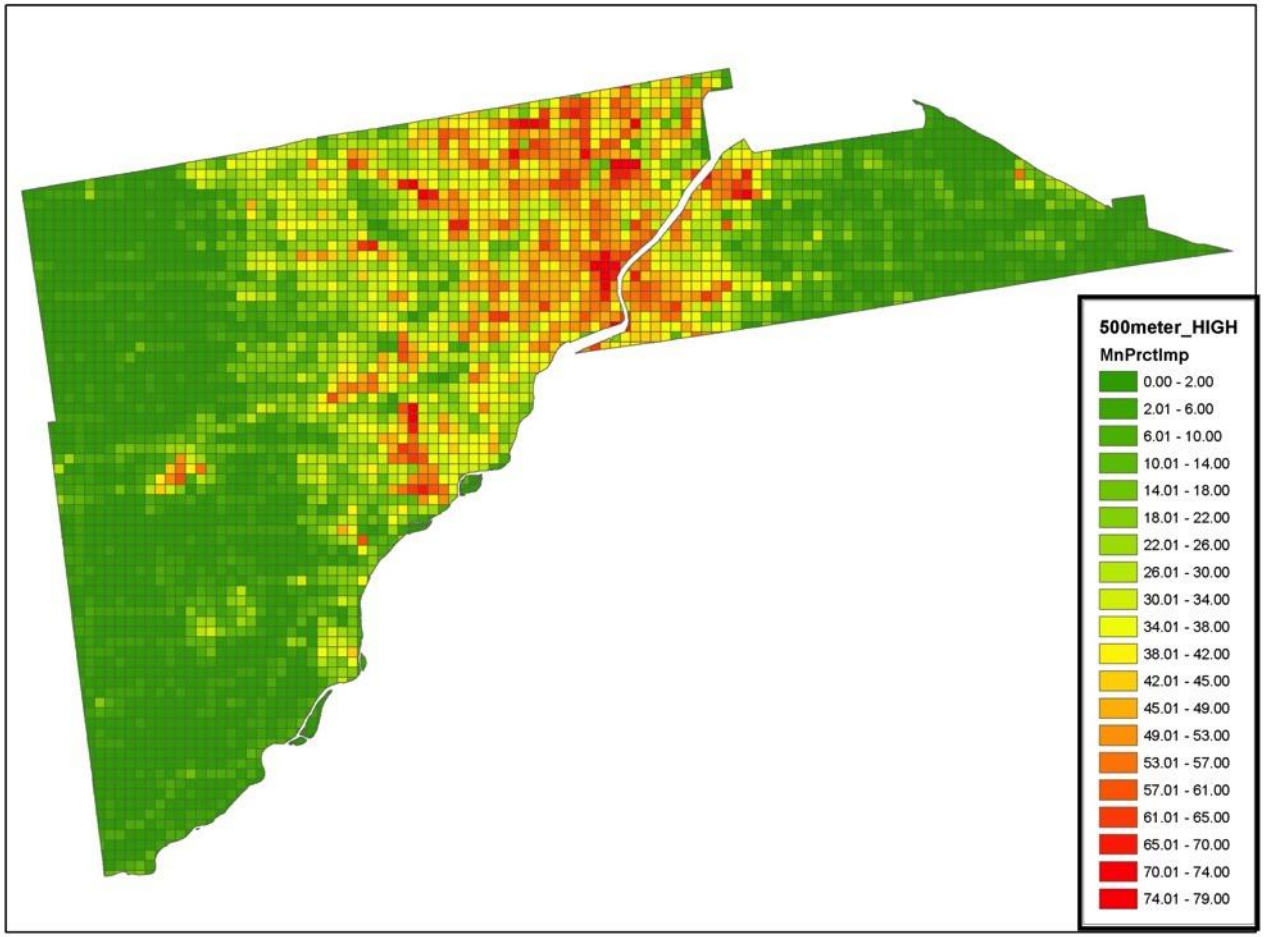
Scale Up

- Identify potential sites in Lucas County.
  - AREIS online/Auditor's Data
  - Land Bank and OHFA Demolition Data
- Determine soil type at each site.
- Determine % impervious at each site.
- Estimate performance based on site characteristics.
- Calculate overall potential impact of bioretention (flow reduction) by site type.

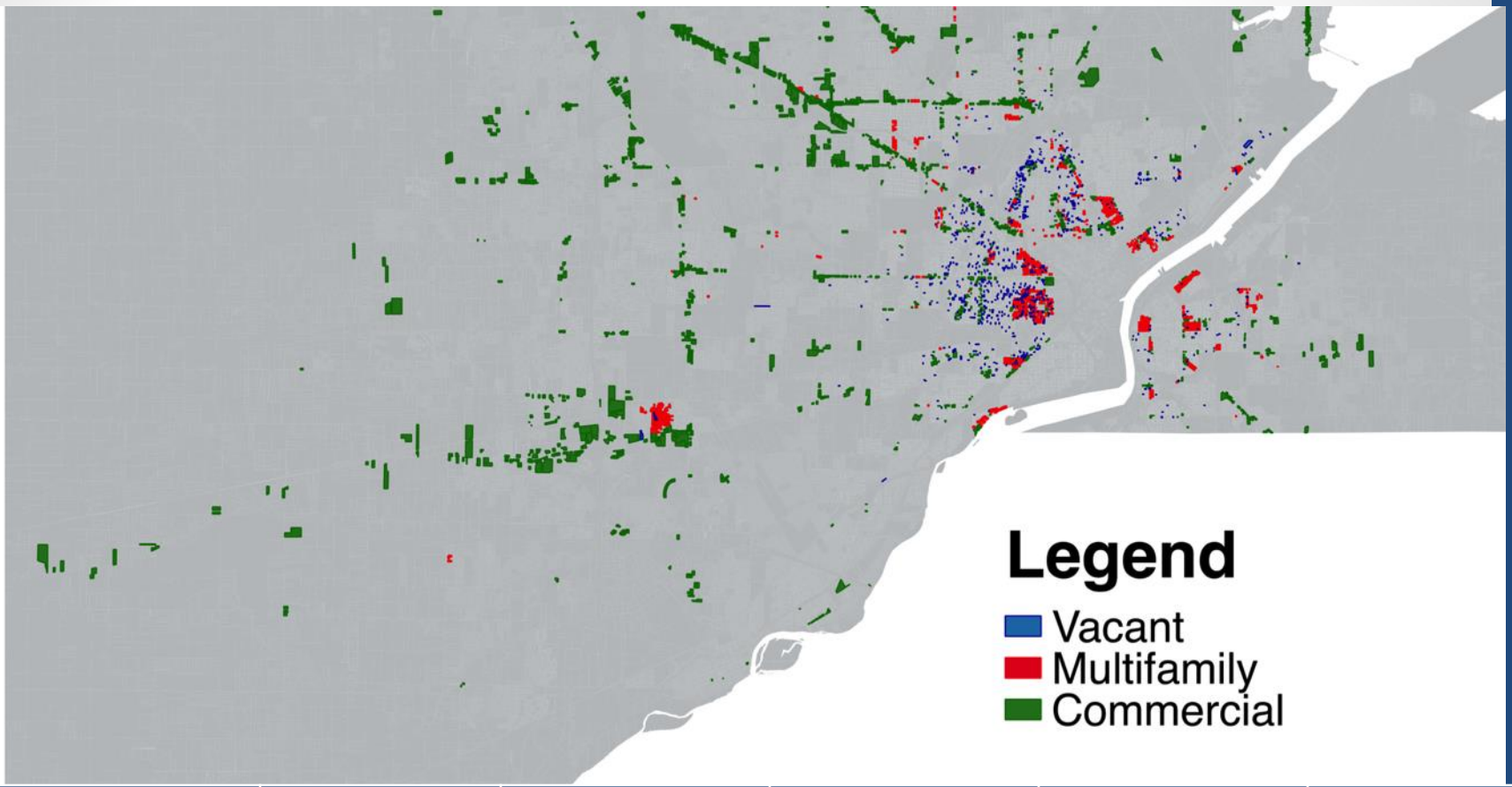
Site Hydrology: Soils



% Impervious



The Impervious Surface Analysis Tool (ISAT) was used to calculate the percentage of impervious surface area within user-selected geographic areas (500 m^2)



Site Type	# Parcels	LID Area (acres)	Treatment Area (acres)	Runoff Reduction(MG/yr)	MG/acre/y LID
Vacant	932	54	1800	445	8.3
Multifamily	2798	5.3	75	75	14
Commercial	3429	67	952	562	8.4

Summary:

- GSI was designed for 3 unique sites. These are analogous to other sites in Lucas County, Ohio.
- GSI performance and benefits rely on local soils. B and C type soils are most effective. Some D can also work. Soil data matters.
- Over 1 billion gallons of stormwater could be eliminated with the addition of GSI on all sites.
- Prioritization will need to include a variety of considerations including funding availability, water quality, and local/regional policies.

Determining the Role of Urban Runoff in Harmful Algal Bloom Formation in the Western Lake Erie Basin

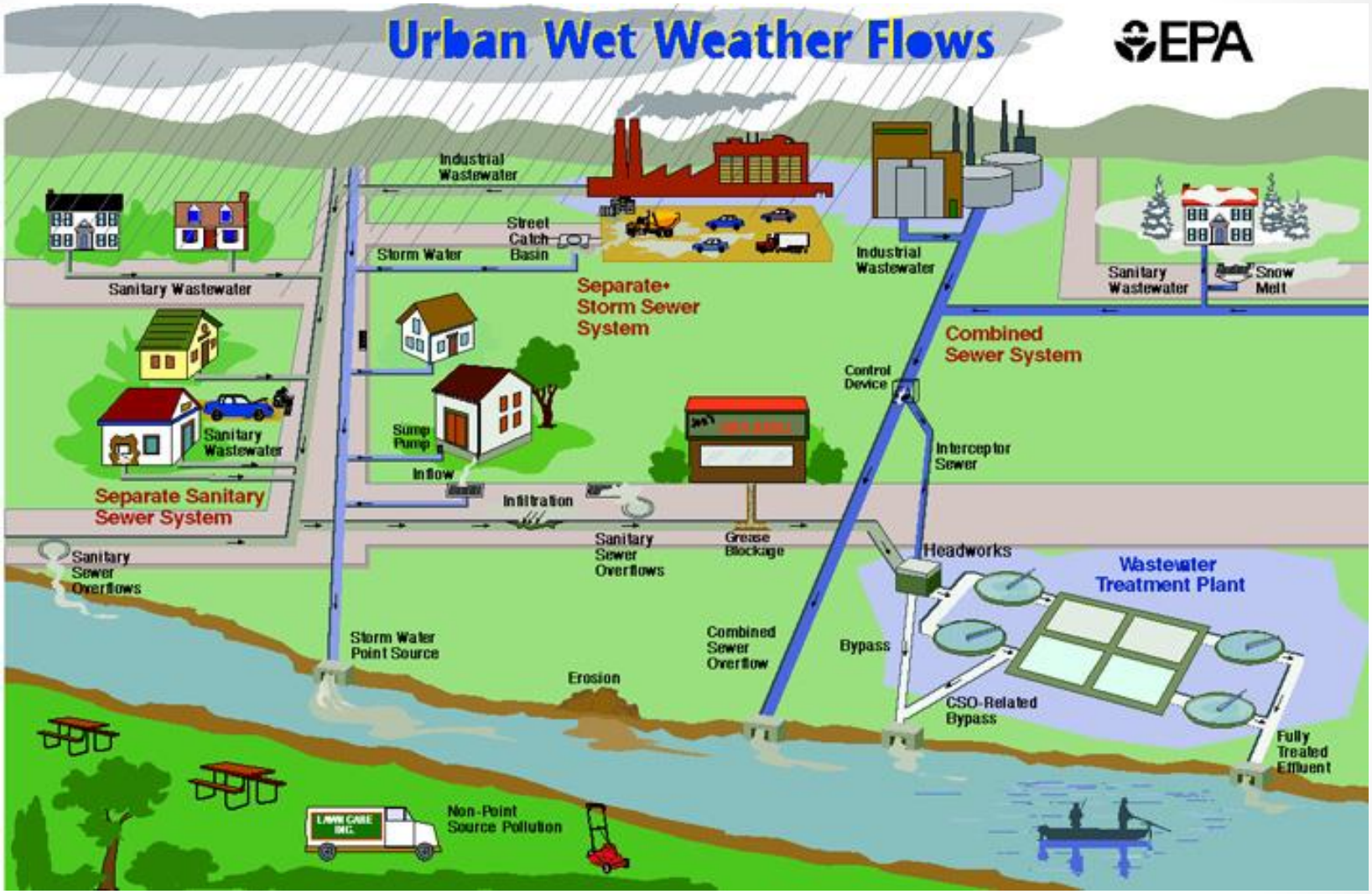
Cyndee Gruden, Bernard Bahaya, Muthana Al Quiraishi, and Katie Rousseau

American Rivers
Thriving By Nature

THE UNIVERSITY OF TOLEDO

How much impact does stormwater (MS4 and CSO) have on HAB formation?

a. No Impact
b. Significant Impact
c. Minor Impact


Urban Wet Weather Flows
EPA
Industrial Wastewater
Street Catch Basin
Storm Water
Sanitary Wastewater
Separate+ Storm Sewer System
Industrial Wastewater
Sanitary Wastewater
Snow Melt
Combined Sewer System
Control Device
Sump Pump
Sanitary Wastewater
Inflow
Interceptor Sewer
Separate Sanitary Sewer System
Infiltration
Sanitary Sewer Overflows
Grease Blockage
Headworks
Wastewater Treatment Plant
Sanitary Sewer Overflows
Storm Water Point Source
Combined Sewer Overflow
Bypass
Erosion
CSO-Related Bypass
Fully Treated Effluent
Non-Point Source Pollution

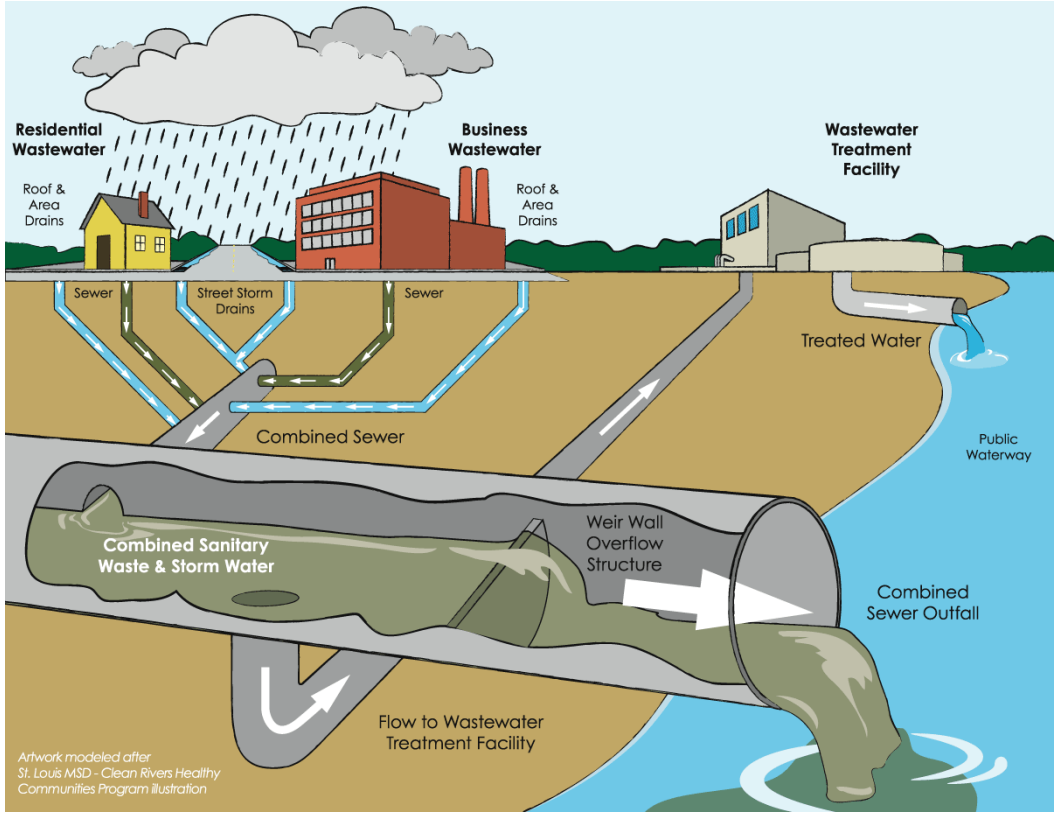
Stormwater Quality:
Nutrients and Solids

Constituent	EMC Range	References
TSS (mg/L)	180 - 548	USEPA 1983; Huber et al., 1982
TP (mg/L)	0.42 - 3.29	USEPA, 1983; Liu et al., 2013
TN (mg/L)	2.2 – 8.8	USEPA 1983

These vary widely based on land use patterns and on precipitation quantity and intensity.

THE UNIVERSITY OF TOLEDO

Combined Sewer Overflows



Wastewater and stormwater travel in the same collection system. During large precipitation events, the flow can be released without treatment to surface waters.

CSO Contributions

- COT signed a revised long-term control plan (LTCP) in May 2010 with a completion date of August 2020 to reduce CSOs.
- Discharges Occur: In 2011, the City of Toledo (COT) discharged 1.7 B gals of CSO and MS4 into Lake Erie.
- CSO contribution appears to be much less significant than agricultural inputs and wastewater treatment plant effluents (Ohio EPA, 2010).
- A recent International Joint Commission (IJC) report estimated that urban phosphorous inputs could constitute as much as 20% of total basin input (Watson and Carpenter, 2013).

THE UNIVERSITY OF TOLEDO

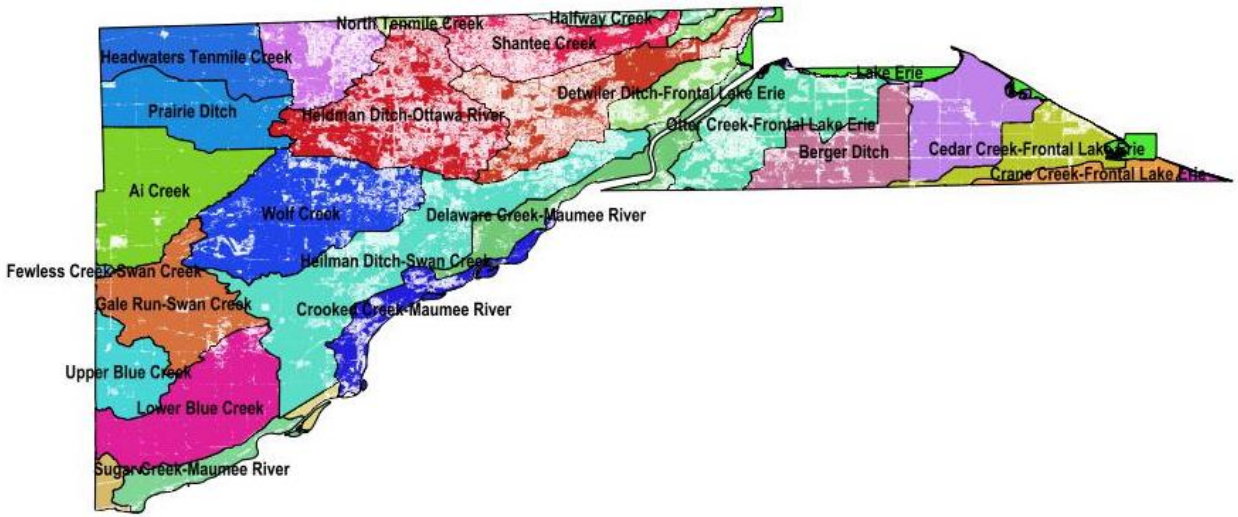
Raw Wastewater Quality:
Nutrients and Solids

Constituent	Weak	Medium	Strong
TSS	120 mg/L	210 mg/L	400 mg/L
Total N	20 mg/L	40 mg/L	80 mg/L
Total P	5 mg/L	10 mg/L	20 mg/L

Effluent wastewater requirements are specific to the individual permit. Permits are renewed every 5 years. TSS is always < 30mg/L. Total N and Total P vary. For Toledo, TSS < 25 mg/L; Total P is 1 mg/L, and Total N is 4 mg/L (95th percentile data).

THE UNIVERSITY OF TOLEDO

SWMM: Water Quality Modeling



Primary Data Needed:

- Hydrology -Imperviousness, Soils, Precipitation
- Contaminants – Land Use, Build Up, Washoff
- Validation Data

THE UNIVERSITY OF TOLEDO

Acknowledgements:

Funding and Collaborators:

- NOAA Coastal Storms (Ohio Sea Grant)
- UM Water Center
- Jon Kiely – Vistula Management
- Mike Melnyk and Brian Miller – Lucas County
- Patekka Bannister, Regina Collins, Lorie Haslinger, and Andy Stepnick – City of Toledo
- UT students – esp. Tony Dietrich

Sea Grant
Ohio Sea Grant College Program

WATER CENTER
UNIVERSITY OF MICHIGAN

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NOAA
U.S. DEPARTMENT OF COMMERCE