

Growing Smarter

In the 4 Lakes Watershed Area: A Simplified Model of Green Infrastructure Impacts on Water Quality in the Bangs & Slocum Lake Watershed



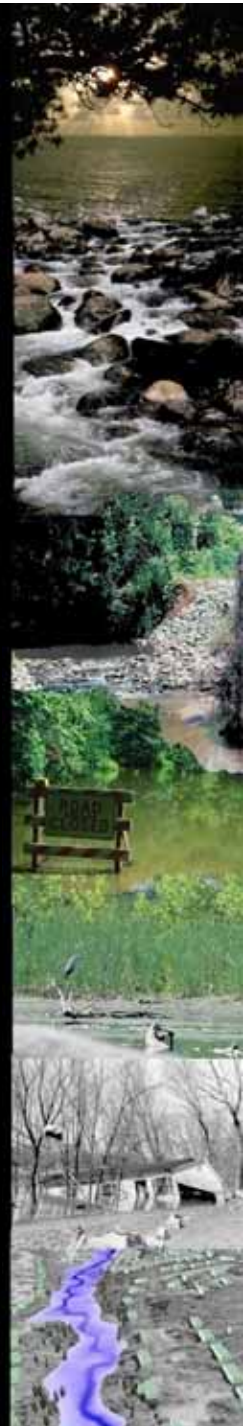
4 Lakes Watershed Initiative

Water Resources

- ❑ Impaired Waters per IEPA for phosphorus, fecal coliform and dissolved oxygen
- ❑ Bodies of water include:
 - ❑ Bangs Lake
 - ❑ Slocum Lake
 - ❑ Lake Napa Suwe
 - ❑ Griswold Lake
 - ❑ Port Barrington Channels
 - ❑ Tower Lake
 - ❑ Lake Barrington
 - ❑ Island Lake

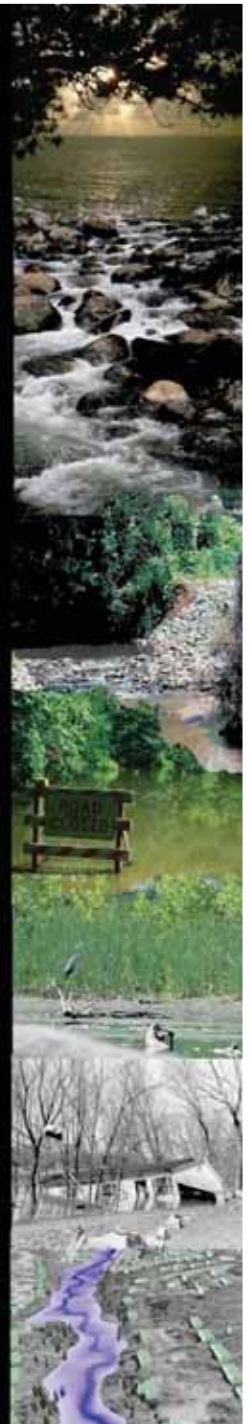
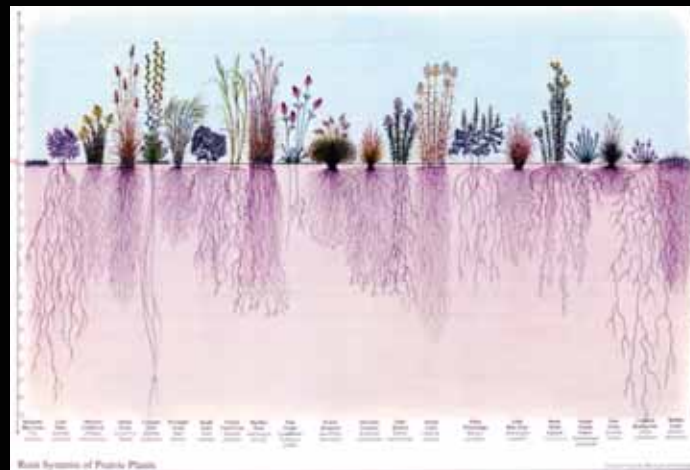


sites.google.com/site/4lakesinitiative/



Watershed Impact

- ❑ Bangs /Slocum Watershed was the subject of 2010 sedimentation study indicating a need for holistic watershed based plan to address pollutant loading
- ❑ Average annual loading determined:
 - ❑ Bangs Lake: 61.8 Tons
 - ❑ Slocum Lake: 47.6 Tons



Land Use and Impervious Cover

The Bangs/Slocum Lake watershed consists of 8 recognized land uses

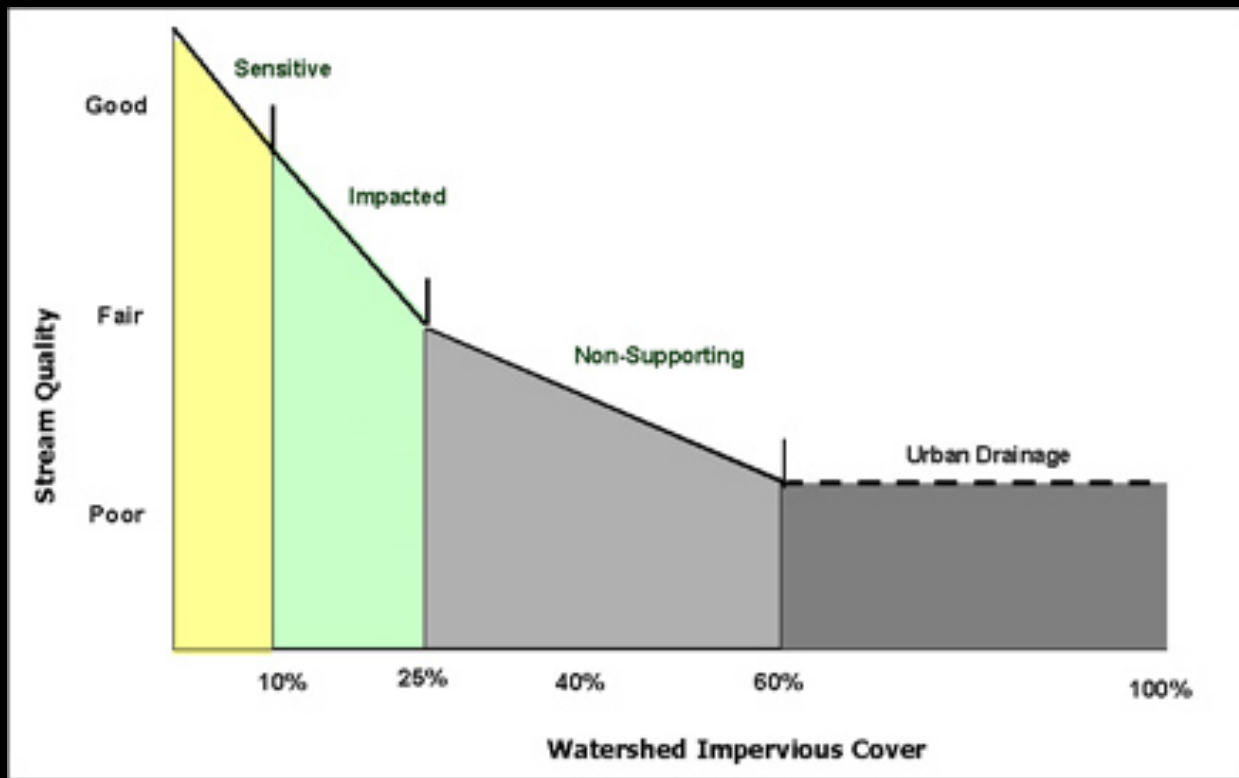
1. Water Wetlands
2. Commercial
3. Agricultural
4. High density residential (1/4 acre)
5. Low density residential (1/2 acre)
6. Grass/Prairie
7. Forest
8. Industrial

Each land use provides variable impervious cover



Impervious Area Impacts

How can we assess these impacts?



Center for Watershed Protection, 2000



Long Term Hydrologic Impact Assessment (L-THIA) Model

- ❑ Estimates impact over 30 years of average annual precipitation events
- ❑ Supported through Purdue University
- ❑ Looks at annual events, not extremes
- ❑ Useful tool for estimating trends in water resources impacts and methodology for reducing these impacts
- ❑ Not a design tool
- ❑ <https://engineering.purdue.edu/mapserve/LTHIA7/lthianew/Index.html>



Understanding the Impact

Long-Term Hydrologic Impact Assessment (L-THIA) - Mozilla Firefox




Local Government Environmental Assistance Network

HOT TOPICS | WHAT'S NEW? | REGULATORY INFORMATION | TOOLS & RESOURCES | CALENDAR

Land Use Impacts on Water Quality

As local land use decisions are made, municipal and county leaders regularly measure the benefits and costs of development proposals. In addition to factors such as the extension of existing infrastructure and the delivery of government services, local officials are beginning to consider the impact that land use changes will have on a community's water quality.

Land use changes can significantly impact groundwater recharge, stormwater drainage, and water pollution. The Long-Term Hydrologic Impact Assessment (L-THIA) model was developed as an accessible online tool to assess the water quality impacts of land use change. Based on community-specific climate data, L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. As a quick and easy-to-use approach, L-THIA's results can be used to generate community awareness of potential long-term problems and to support planning aimed at minimizing disturbance of critical areas. L-THIA is an ideal tool to assist in the evaluation of potential effects of land use change and to identify the best location of a particular land use so as to have minimum impact on a community's natural environment.

 **Basic L-THIA**
 **Impervious L-THIA**
 **GIS L-THIA**

Differences Between the Models:

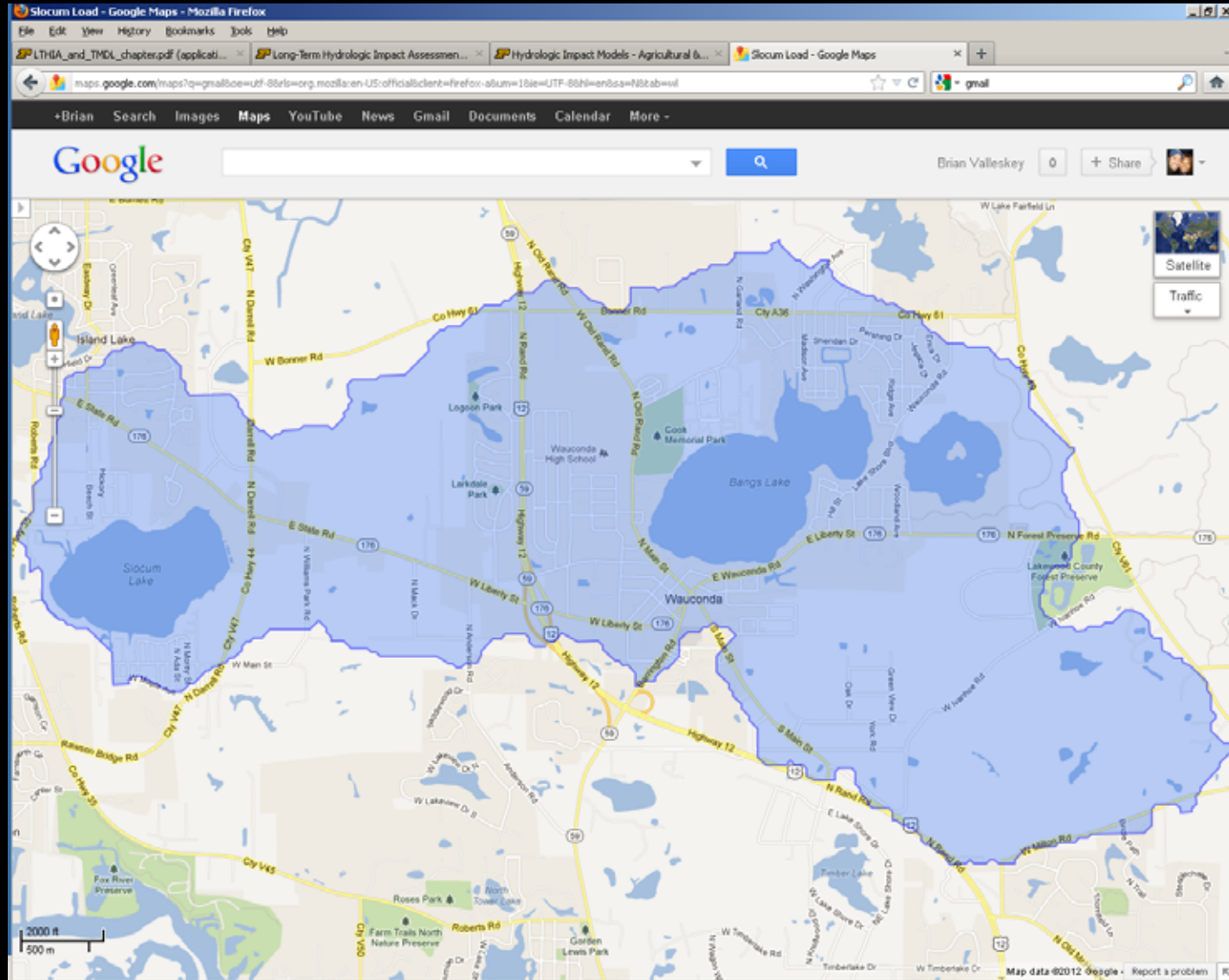
- Basic L-THIA**
Users only need to input their location, soil type, and the type of land use change taking place.
- Impervious L-THIA**
Allows users to input the percentage of impervious cover of different land uses.
- GIS L-THIA**
Enables users to download an ArcView GIS version of L-THIA for PCs.
- Detailed Input L-THIA**
Enables users to input detailed and customized land uses.
- Advanced Input L-THIA**
Enables users to input detailed and customized land uses and customized pollutant coefficients.
- L-THIA LID**
- Related Tools**
Other tools from the developers of L-THIA.

[Background Information](#)
[FAQ](#)



Long Term Hydrologic Impact Assessment (L-THIA) Model

Water Resources



Basis of Analysis

- ❑ L-THIA was used to determine the current status of common water resources impacts (sediment, phosphorus, and stormwater volume) to establish a baseline.
- ❑ Each of the lakes was viewed independently for side to side comparison but combined for total watershed impact.
- ❑ Two proposed scenarios were implemented as alternatives to current land use and stormwater practice.
 - ❑ Reduced impervious area percentage (%)
 - ❑ Reduced impervious area percentage (%) and application of BMPs.
- ❑ To simplify and focus the results, residential served as the land use of choice to isolate the study impact(s).



Watershed Breakdowns

Bangs Lake (4.7 mi²)

- Water/Wetlands (471 ac)
- Commercial (94.3 ac)
- Agriculture (441.5 ac)
- HD Residential (221.8 ac)
- LD Residential (347.1 ac)
- Grass/Prairie (587.9 ac)
- Forest (806.1 ac)
- Industrial (21.1 ac)

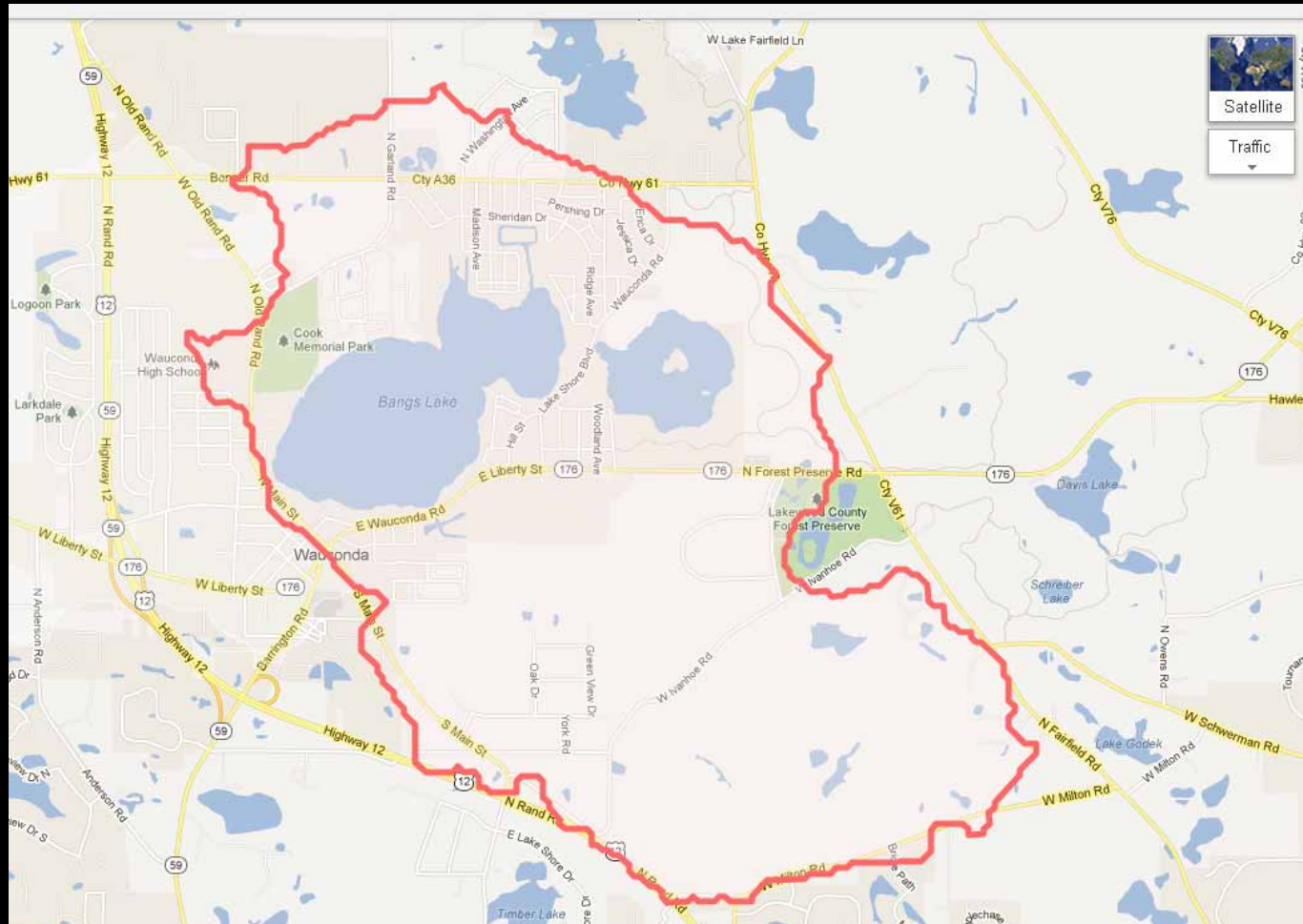
Slocum Lake (3.8 mi²)

- Water/Wetlands (241.2 ac)
- Commercial (126.4 ac)
- Agriculture (379.1 ac)
- HD Residential (208.3 ac)
- LD Residential (474.8 ac)
- Grass/Prairie (513.8 ac)
- Forest (423.8 ac)
- Industrial (88.5 ac)



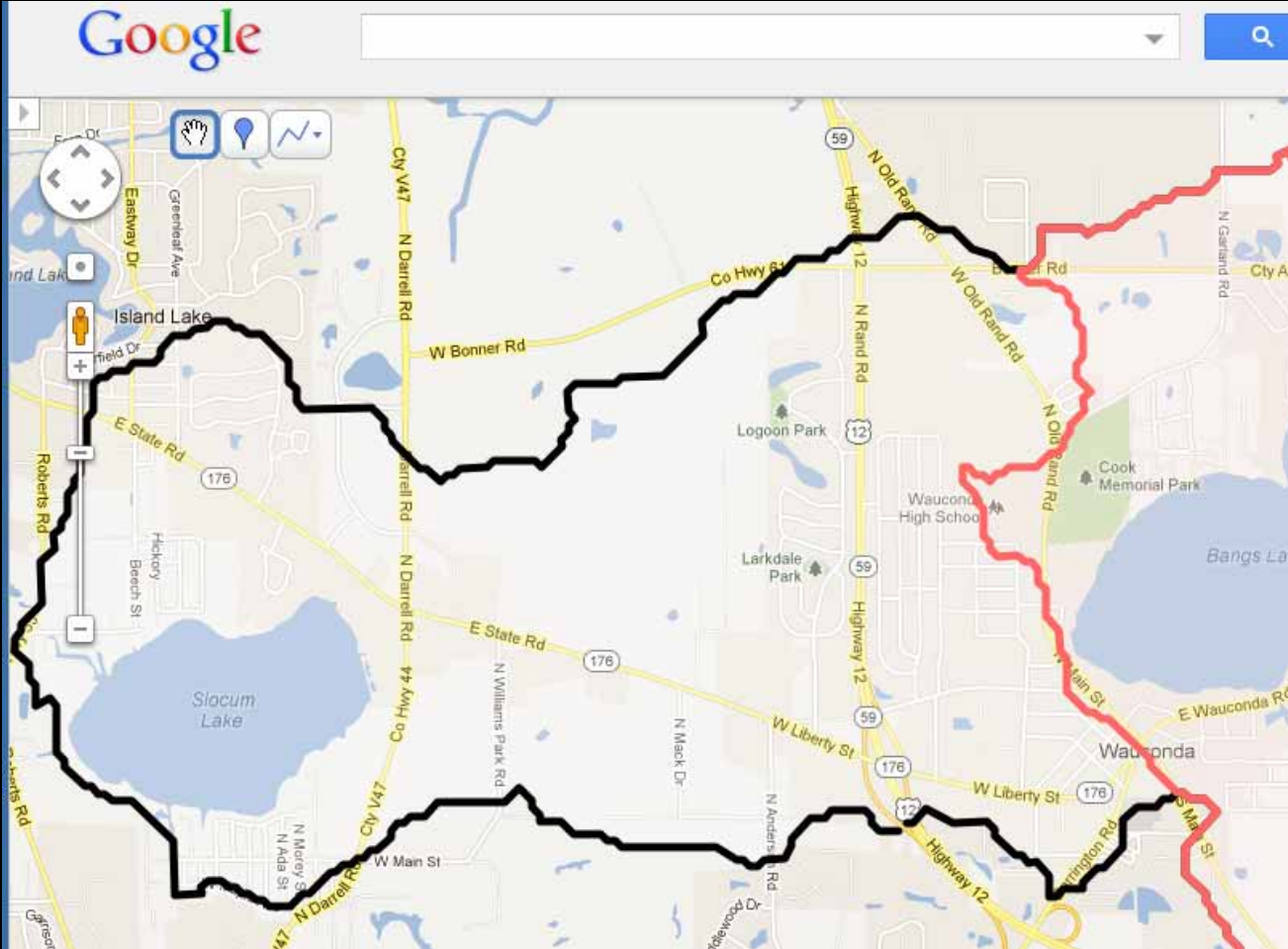
Bangs Lake Tributary

Water Resources



Slocum Lake Tributary

Water Resources



Existing Results (Residential Land Use Only)

Bangs Lake

HD Residential (221.8 ac)

- Phosphorus - 303 lbs
- Sediment – 10.9 TN
- Storm Volume - 193.6 ac-ft

LD Residential (347.1 ac)

- Phosphorus - 205.3 lbs
- Sediment – 7.4 TN
- Storm Volume – 131.3 ac-ft

Slocum Lake

HD Residential (208.3 ac)

- Phosphorus - 201 lbs
- Sediment – 7.3 TN
- Storm Volume – 127.7 ac-ft

LD Residential (474.8 ac)

- Phosphorus – 161.7 lbs
- Sediment – 5.8 TN
- Storm Volume – 102.9 ac-ft

Reference: 1 ac-ft of water = 325,851.4 gallons

Avg. annual household use = 127,400 gallons @350 gallons/day

Loss to avg. annual rainfall = 76,314,397.9 gallons



Alternate (Scenario 1)

- ❑ Propose to reasonably reduce the amount of impervious area dedicated to residential land use only
- ❑ Propose 10% reduction for HD residential (65% impervious) and 5% reduction of LD residential (25% impervious)
- ❑ HD residential now 55% impervious overall
- ❑ LD residential now 20% impervious overall
- ❑ No changes to any other land use practices in the Bangs/Slocum Lakes watershed(s)



L-THIA Lives!

Local Government Environmental Assistance Network

HOT TOPICS | WHAT'S NEW? | REGULATORY INFORMATION | TOOLS & RESOURCES | CALENDAR

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[Background Information](#)



Impervious L-THIA Input

L-THIA Impervious Model

Introduction | Location | **Land Use Change** | Results | Interpreting the Results

Step Three

[Introduction to Impervious L-THIA](#)

Land Use Change Scenarios

Users must identify the current land use for a specific area, and can describe up to two land use change scenarios. Users can select as many land use descriptions as necessary to describe the current land use or land use change scenarios.

Users must also describe the percentage impervious for each land use and the land use description/size and soil type. Size can be entered in either acres, square miles, hectares, or square kilometers. If unknown, soil types can be determined using the link below to GIS maps of your region. **(Important: All Scenarios must have the same total area. The proportions of the total area of the current land use and each of the land use change scenarios vary but the total area must remain equal for L-THIA to run).**

Area will be entered in: [View Completed Sample](#)

Land Use Description	% Impervious	Soil Type	Area	Scenario 1	Scenario 2	Select Similar Land Use for NPS Calculation
(Use as many as necessary)		Check Map	Current			
HousesA	65	A	16.7			High Density Residential
HousesB	65	B	205.5			High Density Residential
HousesC	65	C	207.9			High Density Residential
HousesA	55	A		16.7		High Density Residential
HousesB	55	B		205.5		High Density Residential
HousesC	55	C		207.9		High Density Residential
		A				SELECT LANDUSE
		A				SELECT LANDUSE
		A				SELECT LANDUSE
Total Area:			430.1	430.1	0	

[L-THIA Home](#) [Previous](#) [Next](#)



Impervious L-THIA Output

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NOT TOPICS WHAT'S NEW? REGULATORY INFORMATION TOOLS & RESOURCES CALENDAR

L-THIA Impervious Model

Introduction Location Land Use Change **Results** Interpreting the Results

Step Four

SUMMARY OF SCENARIOS View as: Select

State: Illinois
County: Lake

Land Use	Hydrologic Soil Group	Current	Area	Scenario 1	Scenario 2
HouseA	A	16.7	0	0	0
HouseB	B	265.5	0	0	0
HouseC	C	207.9	0	0	0
HouseA	A	0	16.7	0	0
HouseB	B	0	265.5	0	0
HouseC	C	0	207.9	0	0

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft) View as: Select

Land Use	Current	Scenario 1	Scenario 2
HouseA	7.30	0	0
HouseB	158.96	0	0
HouseC	205.17	0	0
HouseA	0	4.97	0
HouseB	0	122.12	0
HouseC	0	171.86	0
Total Annual Volume (acre-ft)	371.44	299.96	0

Also view [Annual Variation](#) and [Probability of Exceedence](#)

Avg. Annual Runoff Depth (in) View as: Select

Current	Scenario 1	Scenario 2
10.36	0.34	0

Avg. Runoff Depth by Landuse View as: Select

Land Use	Hydrologic Soil Group	Curve Number	Runoff Depth (in)
HouseA	A	81	5.27
HouseB	B	88	9.32
HouseC	C	94	11.89



Scenario 1 – Combined Results

Bangs & Slocum Combined

Sediment

- Showed total reduction of 19%

Phosphorus

- Showed total reduction of 20%

Stormwater Volume

- Showed total reduction of 14%
- Equates to 77.7 ac-ft or 25,318,654 gallons or
- Annual use for nearly 200 households

Reference: 1 ac-ft of water = 325,851.4 gallons

Avg. annual household use = 127,400 gallons @350 gallons/day

Loss to avg. annual rainfall = 76,314,397.9 gallons



Alternate (Scenario 2) BMP Check

- ❑ Propose to reasonably reduce the amount of impervious area dedicated to residential land use only
- ❑ Propose 10% reduction for HD residential (65% impervious) and 5% reduction of LD residential (25% impervious)
- ❑ Add reasonable on-lot BMP practices in addition to 10% impervious reduction for HD residential
- ❑ Add reasonable on-lot BMP practices in addition to 5% impervious reduction for LD residential
- ❑ What is the additional benefit?



Data Input for Lot Level LID Screening

Water Resources

Low Impact Development L-THGA Spreadsheet - Mozilla Firefox

File Edit View History Bookmarks Tools Help

LTTHGA_and_THGA_spreadsheet.pdf Application Long Term Hydrologic Impact Assessment Low Impact Development L-THGA Spread...

pankaj.saha | https://engineering.purdue.edu/~pankaj/THGA/THGAweb/Spreadsheet/Spread/LotLevel

WILMINGTON, IL

Impervious surface calculator

Root River Customized Model

LOW IMPACT Development (CIG) spreadsheet

Saran Creek (Ohio) Management System

L-THGA for Barnes Ditch - Trail Creek (OH)

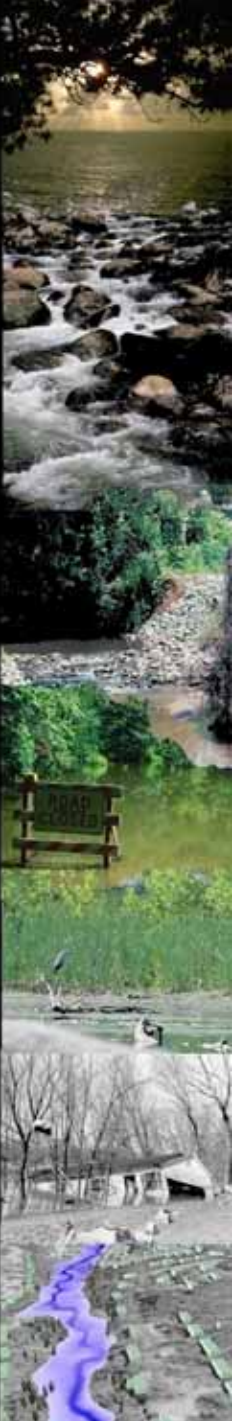
Maxwell Watershed Customized Model

STEP 2: Enter the pre-developed land use and area

Land Use	Lot Size	Soil Type	Pre Developed Area
(Use as many as necessary) (in acres)			
High Density Residential	1/8	A	18.7
High Density Residential	1/8	B	205.5
High Density Residential	1/8	C	207.9
Low Density Residential	1/2	A	38
Low Density Residential	1/2	B	438.4
Low Density Residential	1/2	C	347.5
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
SELECT LAND USE			
Total Area:			1782

STEP 3: Enter the post-developed land use and area

Land Use	Lot Size	Soil Type	Post Developed Area	With LID Area
(Use as many as necessary) (in acres)				
1. High Density Residential	1/8	A	18.7	16.7
2. High Density Residential	1/8	B	205.5	205.5
3. High Density Residential	1/8	C	207.9	207.9
4. Low Density Residential	1/2	A	38	38
5. Low Density Residential	1/2	B	438.4	438.4
6. Low Density Residential	1/2	C	347.5	347.5
7. SELECT LAND USE				
8. SELECT LAND USE				
9. SELECT LAND USE				
10. SELECT LAND USE				
11. SELECT LAND USE				
12. SELECT LAND USE				
13. SELECT LAND USE				
14. SELECT LAND USE				
Total Area:			1782	1782



On-Lot Low Impact Model - LD

Water Resources

Hydrologic Impact Models - Agricultural & Biological Engr, Purdue University - Mozilla Firefox

http://www.georgiastormwater.com/ Main Page L-TH5A Long-Term Hydrologic Impact Assessmen... Hydrologic Impact Models - Agricultural & ...

purdue.edu https://engineering.purdue.edu/mapserv/ld/TH5A7/th5a/cg-bin/ld.use.cg

Introduction Location Land Use Change **Low Level LID** Results

Low Density Residential High Density Residential

+ LANDUSE 4 - 1/2 acre lot [L-TH5A Home](#)

Soil Group: A Total Area: 38 with [Previous](#)

%Impervious 25 %Openspace 75 %W [Next](#)

Curve Number: 51

Disconnection of Impervious Surfaces

+ STREETS/ROADS %Impervious

10 (10)

Width 26 ft (26)

Conventional/curb & gutters/connected

Curb and gutter & porous pavement/connected

Swales/disconnection

Swales & porous pavement/disconnection

Disconnection

+ BUILDINGS/ROOFS %Impervious

7 (9)

+ SIDEWALKS %Impervious

2 (2)

+ PARKING/DRIVEWAY %Impervious

5 (4)

Driveway/Parking area 705 Sq. ft. (871)

Conventional

Parking w/ Porous Pavement (Low)

Parking w/ Porous Pavement (Medium)

Parking w/ Porous Pavement (High)

Disconnection

+ OPEN SPACE/LAWN

+ NATURAL RESOURCE CONSERVATION

+ LANDUSE 5 - 1/2 acre lot

+ LANDUSE 6 - 1/2 acre lot



On-Lot Low Impact Model - LD

W a t e r R e s o u r c e s

Hydrologic Impact Models - Agricultural & Biological Eng., Purdue University - Monica Fenton

1784_wd_THD_chapter.pdf (Applied) | Long Term Hydrologic Impact Assessment... | Hydrologic Impact Models - Agricultural & ...

https://engineering.purdue.edu/hydro/wd/THD/THDapp.php/US.com.jsp

WILMINGTON, IL

+ LANDUSE 4 - 1/2 acre lot

Soil Group: A Total Area: 33 833

%Impervious: 0 %OpenSpace: 0 %W

Curve Number: 49

Disconnection of Impervious Surfaces

+ STREETS/ROADS %Impervious

(10)

Width: 24 ft (24)

Conventional/Curb & gutters/connected

Curb and gutter & porous pavement/connected

Swales/Disconnection

Swales & porous pavement/disconnection

Disconnection

+ BUILDINGS/ROOFS %Impervious

(9)

Building area: 1800 Sq. Ft. (1800)

Conventional

Rain Barrels

Cisterns

Green Roofs

Downspout/Disconnection

+ SIDEWALKS %Impervious

(7)

Width: 4 ft (4)

Conventional

Sidewalk w/ Porous Pavement

Disconnection

+ PARKING/DRIVEWAY %Impervious

(4)

Driveway/Parking area: 250 Sq. Ft. (250)

Conventional

Parking w/ Porous Pavement (Low)

Parking w/ Porous Pavement (Medium)

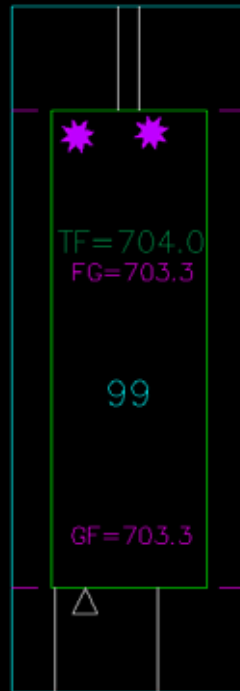
Parking w/ Porous Pavement (High)

Disconnection

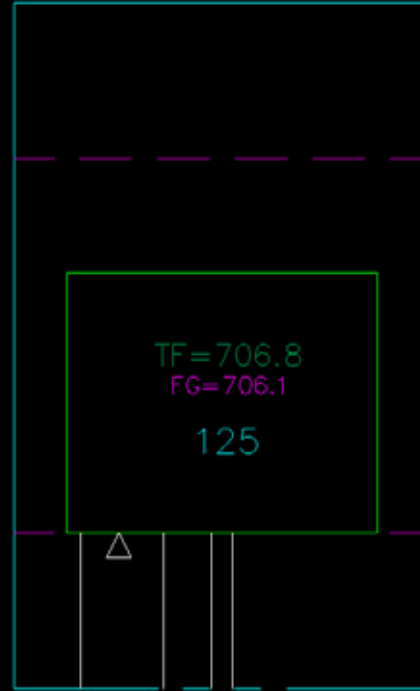


Example of Alternative lot configuration

W a t e r R e s o u r c e s



LID



Conventional

Reduced 10%
Impervious
footprint



On-Lot Low Impact Model - HD

W a t e r R e s o u r c e s

The screenshot displays the 'Hydrologic Impact Model' software interface. It features a browser window at the top with the URL 'http://engineering.purdue.edu/~hmad/hydrologic/HD.html'. The main interface is divided into two sections for land use assessment:

- LANDUSE 1 - 1/8 acre lot**
 - Soil Group: A, Total Area: 16.7, With LID: 16.7
 - %Impervious: 0, %Openpace: 100, %W: 0
 - Curve Number: 68
 - Disconnection of Impervious Surfaces:
 - STREETS/ROADS %Impervious (22)**
 - Width: 24 ft
 - Conventional/curb & gutters/connected:
 - Curb and gutter & porous pavement/connected:
 - Swales/disconnection:
 - Swales & porous pavement/disconnection:
 - Disconnection:
 - BUILDINGS/ROOFS %Impervious (18)**
 - SIDEWALKS %Impervious (9)**
 - PARKING/DRIVEWAY %Impervious (16)**
 - Driveway/Parking area: 450 sq. ft
 - Conventional:
 - Parking w/ Porous Pavement (Low):
 - Parking w/ Porous Pavement (Medium):
 - Parking w/ Porous Pavement (High):
 - Disconnection:
 - OPEN SPACE/LAWN**
 - NATURAL RESOURCE CONSERVATION**
- LANDUSE 2 - 1/8 acre lot**
 - Soil Group: B, Total Area: 205.5, With LID: 205.5
 - %Impervious: 0, %Openpace: 100, %Woods: 0
 - Curve Number: 79
 - Disconnection of Impervious Surfaces:
 - STREETS/ROADS %Impervious (22)**
 - Width: 24 ft
 - Conventional/curb & gutters/connected:
 - Curb and gutter & porous pavement/connected:
 - Swales/disconnection:
 - Swales & porous pavement/disconnection:
 - Disconnection:



On-Lot Low Impact Model - Results

W a t e r R e s o u r c e s

Hydrologic Impact Models - Agricultural & Biological Engr, Purdue University - Penelope Fischer

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Hydrologic Impact Models - Agricultural & Biological Engr, Purdue University - Penelope Fischer

Residential 10 acs 0 00 00 75

RUNOFF RESULTS

Avg. Annual Runoff Volume (acre-ft) View as: [Select]

Land Use	Current	Peak Development With LID	Peak Development With LID As Proposed
Residential 10 acs	0.46	0.46	2.46
Residential 10 acs	122.12	122.12	77.84
Residential 10 acs	144.21	144.21	126.43
Residential 10 acs	2.21	2.21	7.84
Residential 10 acs	81.44	81.44	75.84
Residential 10 acs	144.21	144.21	111.21
Total Annual Volume (acre-ft)	395.27	395.27	425.19

Also view [Watershed Location](#) and [Parameters of Assessment](#)

Avg. Annual Runoff Depth (in) View as: [Select]

Current	Peak Development With LID	Peak Development With LID As Proposed
4.27	6.27	4.07

Avg. Runoff Depth by Landuse View as: [Select]

Land Use	Hydrologic soil group	Current	Peak Development With LID	Peak Development With LID As Proposed
Residential 10 acs	A	0.84	0.84	3.16
Residential 10 acs	B	1.36	1.36	4.33
Residential 10 acs	C	11.07	11.07	7.81
Residential 10 acs	D	0.7	0.7	0.46
Residential 10 acs	E	2.27	2.27	1.19
Residential 10 acs	F	0	0	4.33
Average Annual Runoff Depth (in)		10.11		

NONPOINT SOURCE POLLUTANT RESULTS

Nitrogen (lbs) View as: [Select]

Land Use	Pre Developed	Peak Development With LID	Peak Development With LID As Proposed
----------	---------------	---------------------------	---------------------------------------



Scenario 2 Results

Bangs & Slocum Combined

Sediment

- Showed additional reduction of 4%, total 23%

Phosphorus

- Showed additional reduction of 3%, total 23%

Stormwater Volume

- Showed total reduction of 9%, total 23%
- Equates to 127.6 ac-ft or 41,578,638 gallons or
- Annual use for nearly 327 households

Reference: 1 ac-ft of water = 325,851.4 gallons

Avg. annual household use = 127,400 gallons @350 gallons/day

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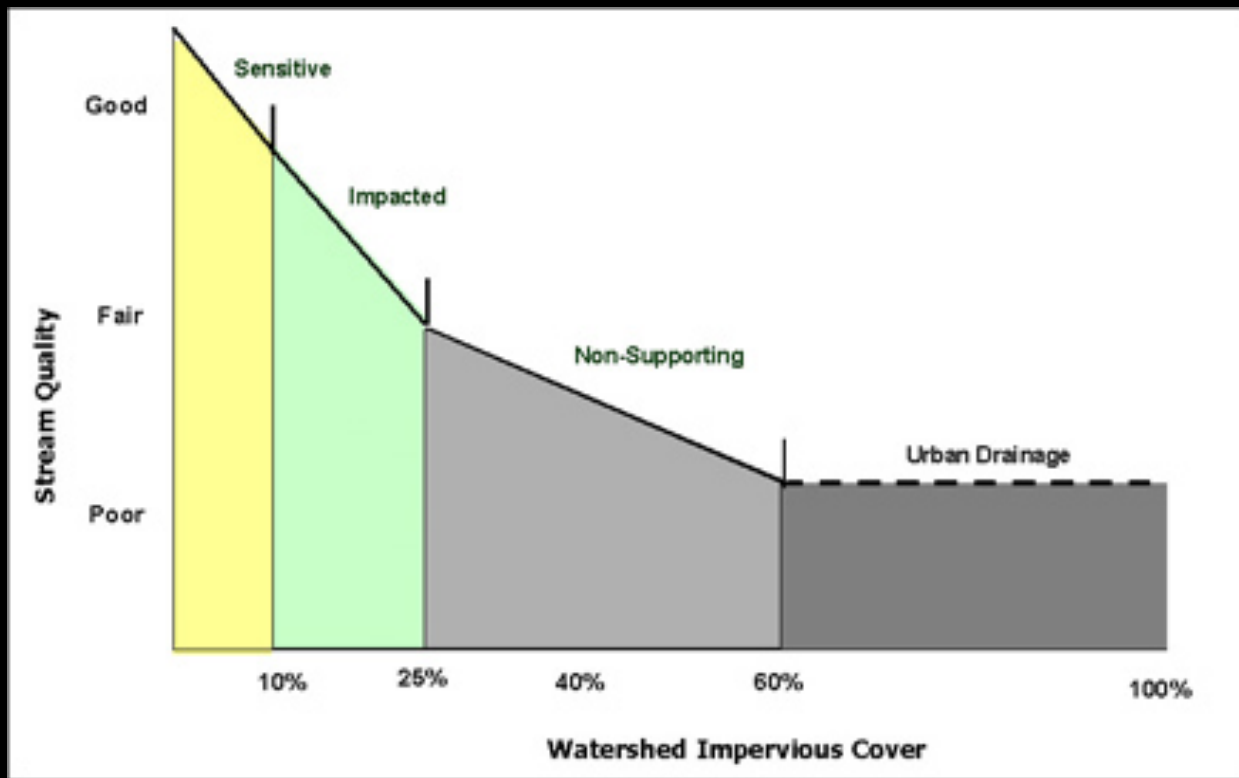
Why is this important?

- ❑ The impact of sediment and phosphorus to most is obvious – nuisance sediment and phosphorus is associated with the eutrophication of lakes, Slocum is listed as hyper-eutrophic
- ❑ Water Supply – Stormwater mismanagement and hydrologic alteration are partially to blame for water resources shortages
- ❑ Flat average of the cost of Wauconda to re-route Lake Michigan water due to depletion of the shallow groundwater well range from \$25.5 – \$46 M
- ❑ Keeping stormwater volume where it falls is important.



Impervious Area Impacts

How are we doing?



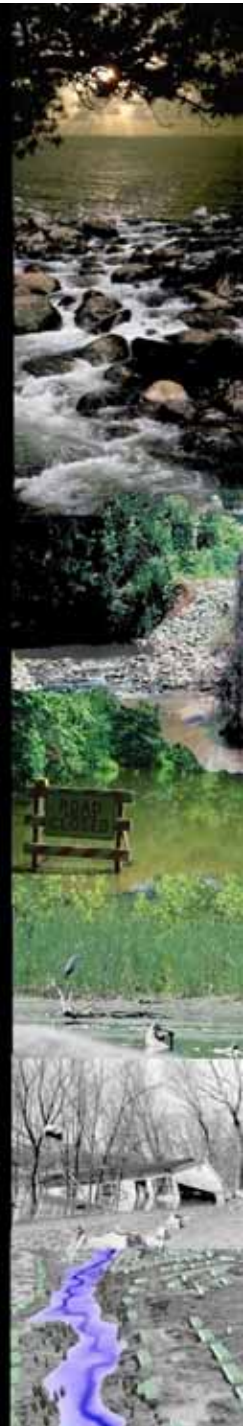
W a t e r R e s o u r c e s



Impervious Area Impacts

- Basinwide average puts the Bangs/Slocum Lake watershed in the range of 10% - 25% (impacted)
- Various portions of the watershed impact stream segments more adversely than others, exceeding 25% and nearing 90%

W a t e r R e s o u r c e s



The Future Looks Dark?

- ❑ No the future looks **GREEN !**
- ❑ While the scenarios presented today are unlikely to occur in unison, they present insight into stormwater being a solution rather than a nuisance
- ❑ Research done in other parts of the country and the world have implicated green infrastructure and Low Impact Design (LID) as a key component surface and groundwater protection and replenishment
- ❑ The following are simple examples:



Rethinking Our Values

W a t e r R e s o u r c e s

traditional



Proposed option



traditional

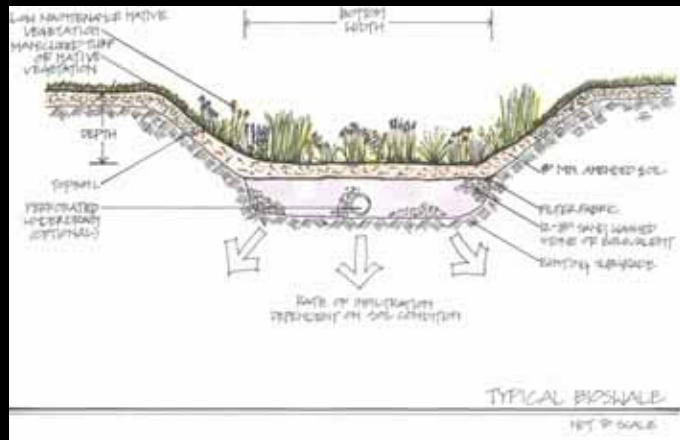


Proposed option



Physical BMPs - Bioswale

- ❑ A swale or vegetated swale IS NOT a bio-swale
- ❑ May serve as conveyance much like storm sewer
- ❑ Differ in that Bioswales typically have an amended soil or porous media added

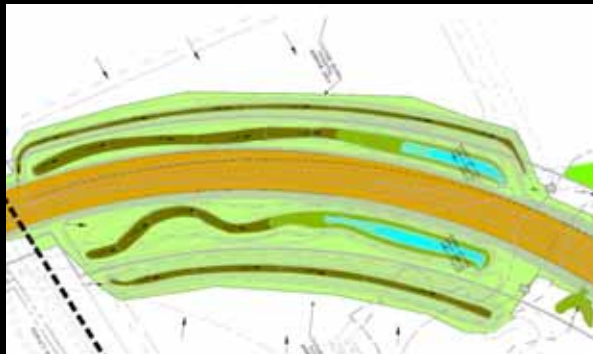


BIOSWALES



Physical BMPs - Swale

- ❑ A swale relies heavily on vegetative cover and Stoke's Law to remove pollutants and reduce stormwater volume
- ❑ Swale conveyance is cheaper than storm sewer by as much as 80%



CenterPoint Intermodal, Joliet

TYPICAL SWALES



Physical BMPs – Depressed Median

- ❑ Relies on the same concepts as a swale; however provides a better landscape space than traditional “mounding”
- ❑ Landscape debris no longer washes away
- ❑ Provides landscaping more readily available water source
- ❑ Often used in combination with Curb Cuts



Depressed Median



Physical BMPs – Bioretention/Rain Garden

- ❑ Key components focus on trapping water, infiltration and evapotranspiration
- ❑ Can work well in conjunction with an underdrain
- ❑ Relies on a matrix of soil and plants to serve as a filter for pollutants.



Bio-retention



Physical BMPs – Filter Strip

- ❑ Prairie can withstand the 100yr, 24hr storm producing no stormwater runoff
- ❑ Plants attract wildlife, promote infiltration, anchor soil
- ❑ Reduces the cost of detention basin maintenance, requires no fertilizer once established and is cheaper to maintain than turf grasses.



Questions? –THANK YOU!

Is it not in our best interests to adhere to better stormwater practices to protect water resources for future generations?

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