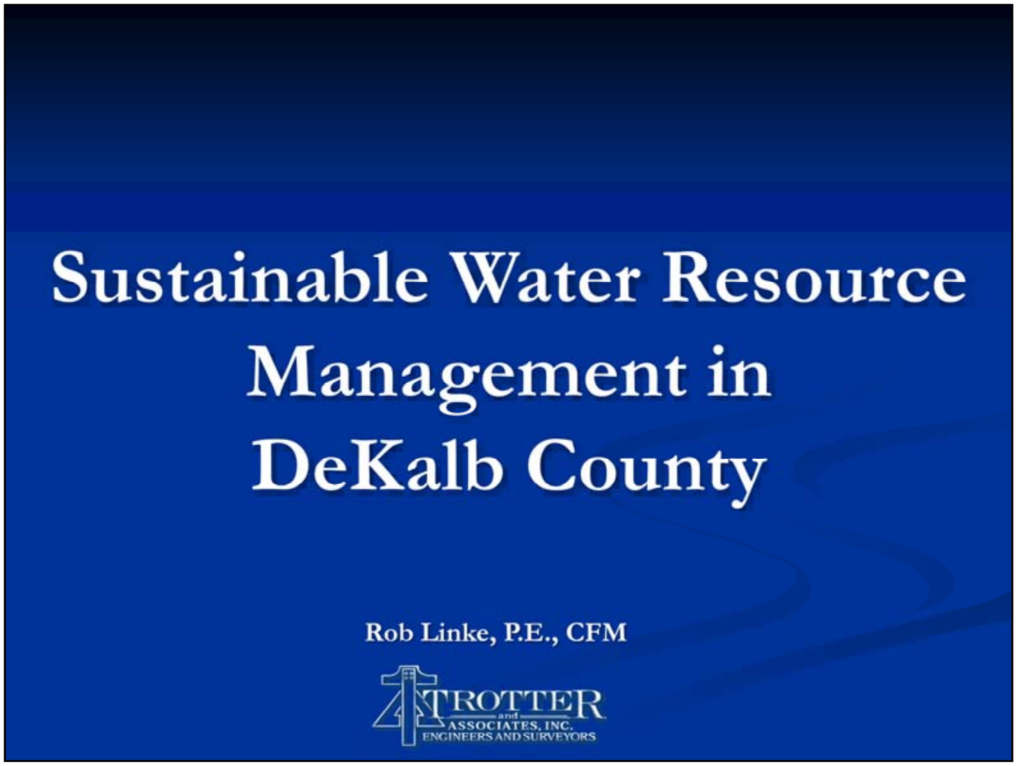

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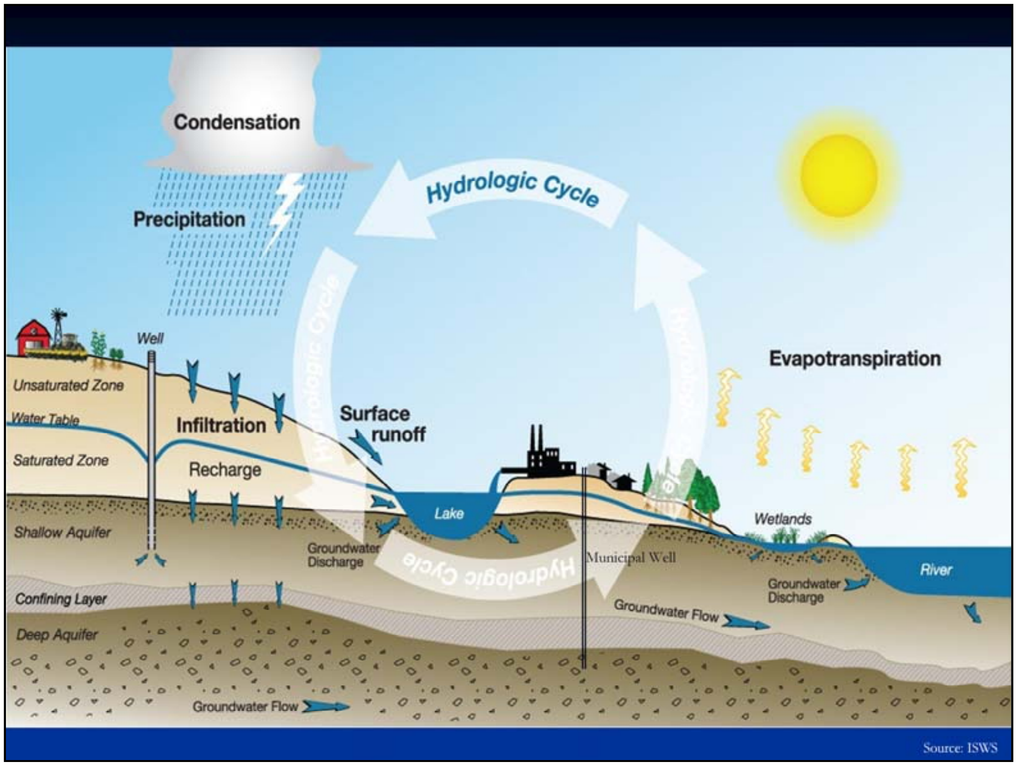
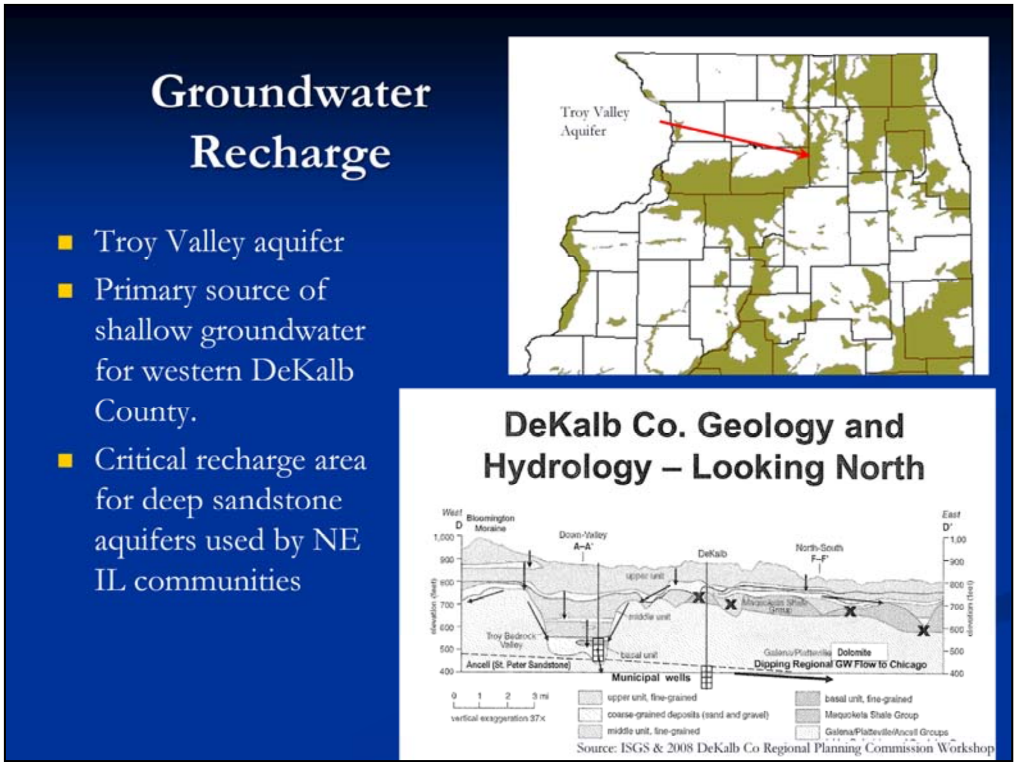
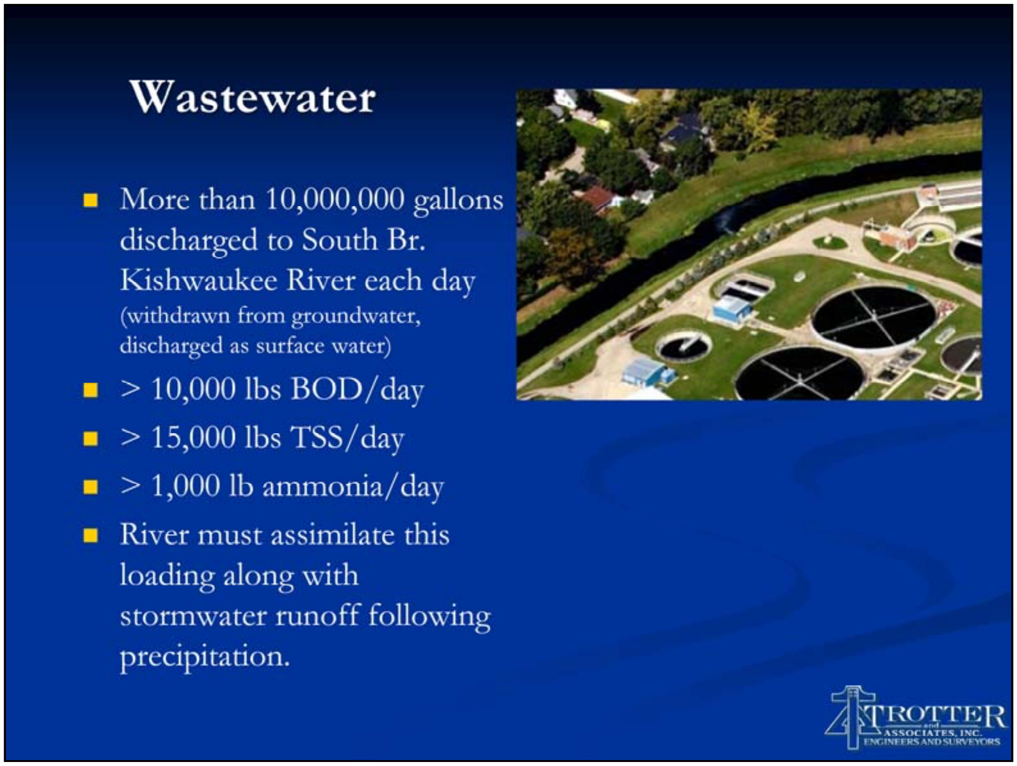
Water in DeKalb County must serve several functions – both natural and man-made.



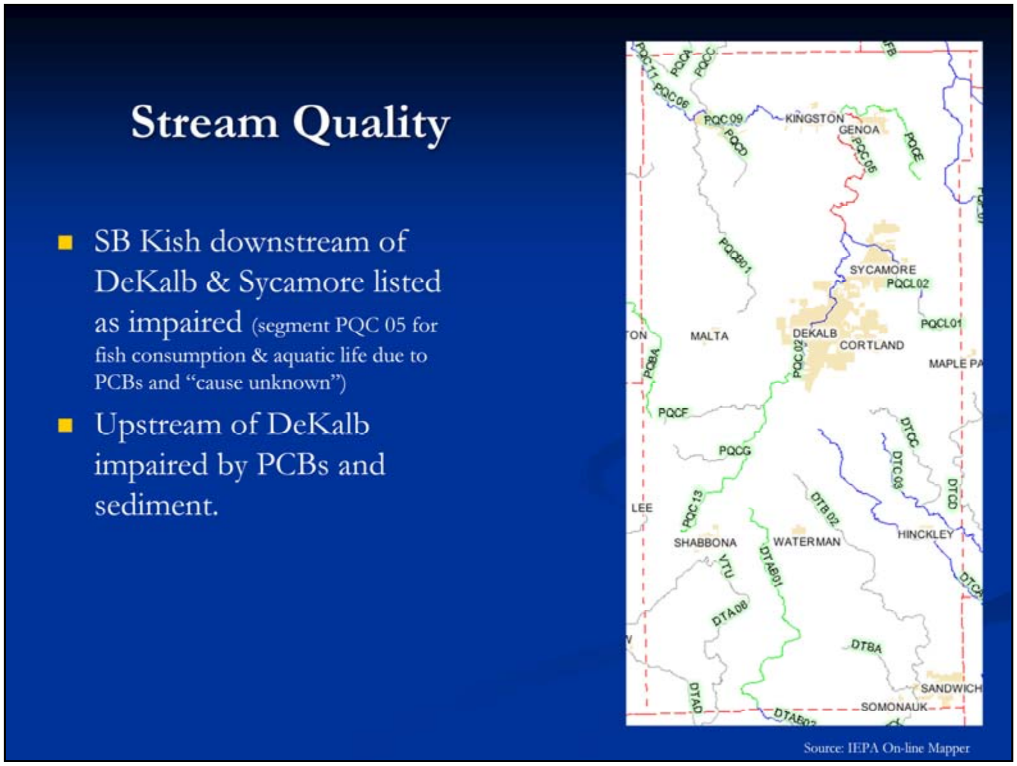
Basics of the hydrologic cycle. Evaporated water rises, moves over our landscape generally from west to east, condenses and falls on DeKalb County in the form of rain when its warm and snow when its cold. Water falling on the land, depending on the landcover and temperature, either infiltrates into the soil or runs overland to the nearest depression, swale, or stream. The part that infiltrates moves downward through the soil and collects in the sand and gravel deposits that are scattered throughout DeKalb County. The flow in generally west to east and is largely contained within the material resting on the bedrock as well as through sections of weathered bedrock that are fractured.



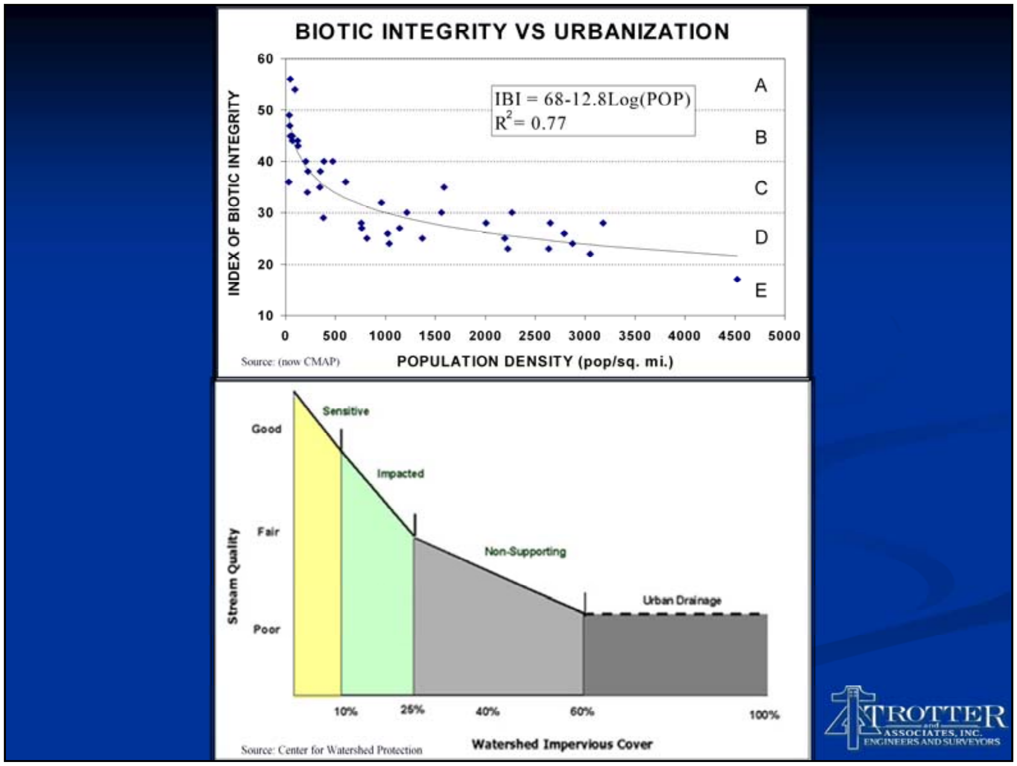
The glacial aquifers in the Troy Valley recharge the bedrock aquifers where the Troy Valley aquifers are in direct contact with the bedrock surface. Immediately under the Troy Valley is the shallowest bedrock aquifer in the area, referred to as the Galena/Platteville Dolomite aquifer. The bottom aquifer unit of the Troy Valley (left side of lower figure) lies directly above the bedrock surface. –Therefore, the Troy Valley is one of the primary sources for recharging the deep sandstone aquifers on which much of DeKalb County and many of the suburbs west of Chicago depend upon for clean drinking water.



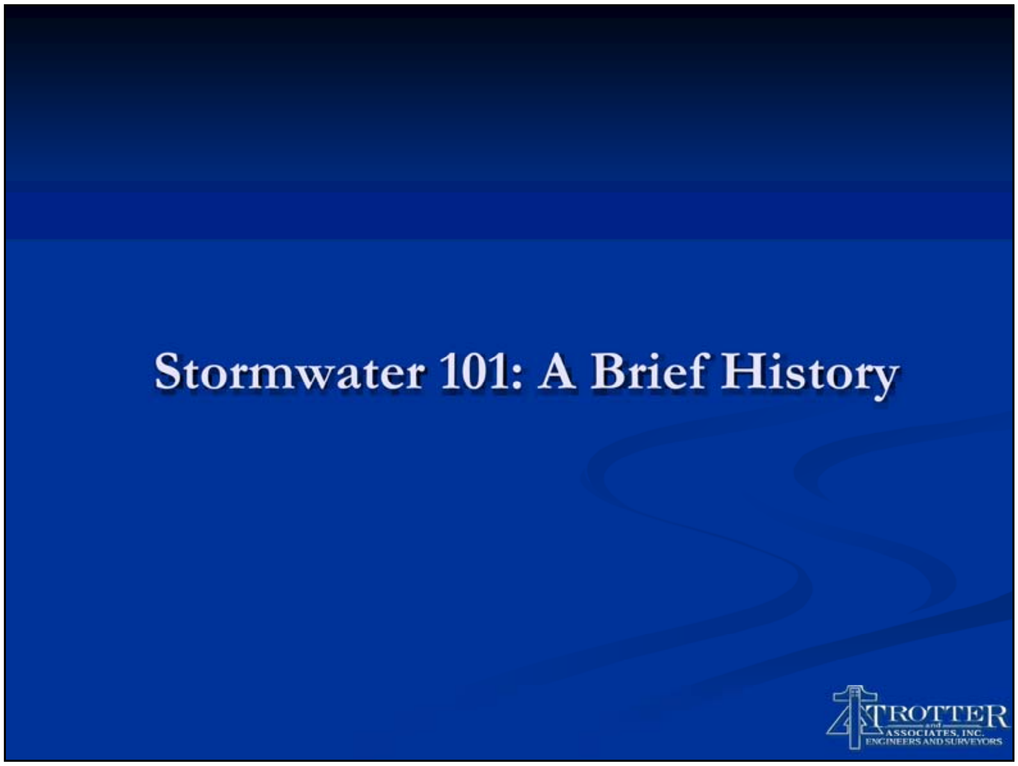
Waste water. As we withdraw the groundwater beneath us and use it, we generate wastewater that has to be dealt with. In urbanized areas the wastewater is collected and processed at a central treatment plant and ultimately released to a receiving water body – the South Branch Kishwaukee River for most communities in central and northern DeKalb County (or tributaries to the Fox River for communities in the southern 1/3 of DeKalb County). About 10 million gallons of treated wastewater a day is discharged into the Kishwaukee River in DeKalb. Treatment plants ultimately employ the same processes found in the river itself to remove the majority of pollutants from the wastewater stream (physical screening as occurs when the water flows through sand & gravels in the bottom of the river channel; biological processess similar to the bacteria & microrganisms which live in the river channel substrate and breakdown wastes and nutrients). The main difference is that at a WWTP it occurs in a highly controlled, organized environment. The wastewater discharged must be cleaned to the extent that it meets standards set by the EPA. With that said, the South Branch Kishwaukee River receives more than 10,000 pounds of organic material (BOD), 15,000 pounds of TSS, and 1,000 pounds of ammonia each day that must be assimilated along with any stormwater runoff entering the river. Can the river do this? The answer is we hope so, and we hope that it can take even more loading in the future as our communities expand and generate more wastewater and more stormwater runoff.



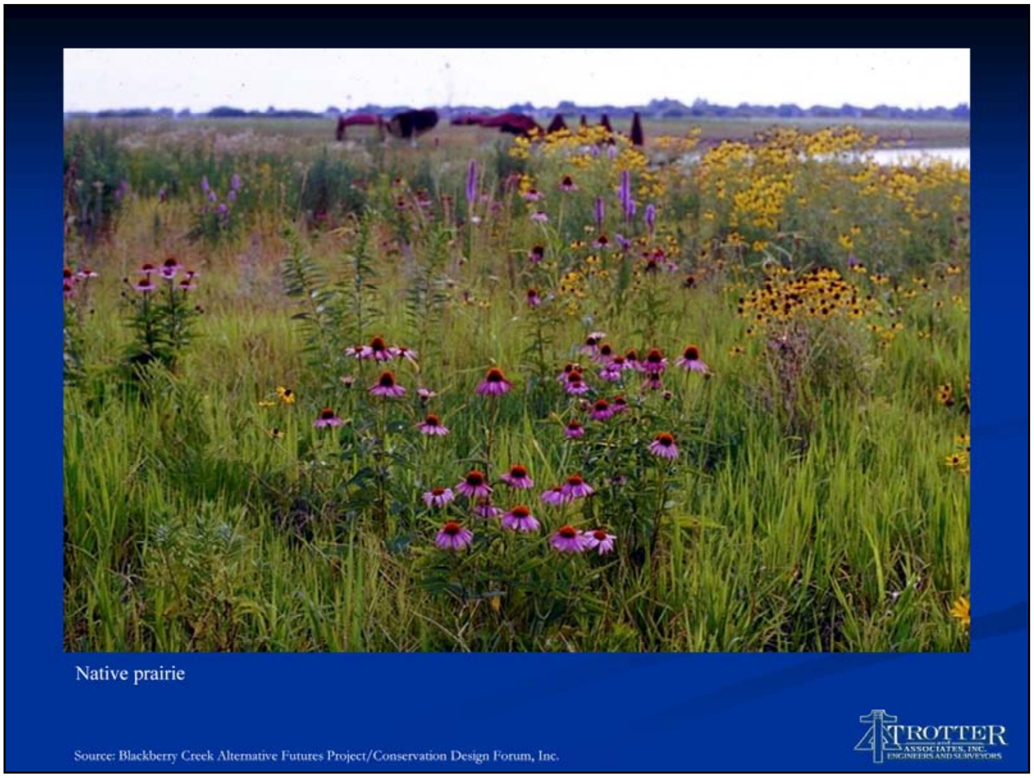
One way of answering the question is to look at the IEPA's water quality assessment report for DeKalb County, shown here on the right. Note that the reach downstream of the major urban center of DeKalb and Sycamore is shown as impaired. The impairments are based on biological sampling and chemical analysis of the water. North or downstream of the DeKalb Sycamore area, the river is classified as impaired because it doesn't meet the aquatic life standards set by the EPA. The cause is listed as UNKNOWN



Why is population & impervious cover important – their impacts are shown on these graphs.



Why do we have these impairments? Well, it has to do with the fundamental changes we've made to our landscape and how we manage the water that falls on it.



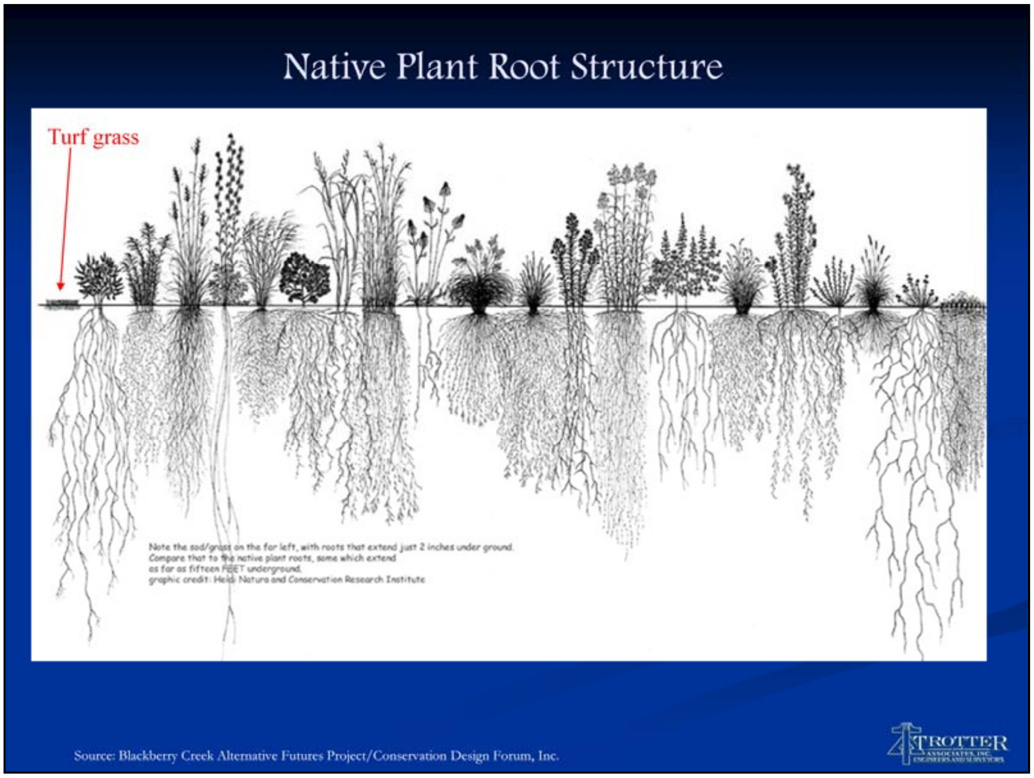
Native landscape characterized by rolling topography and wide diversity of vegetation.

Natural landscape very efficient at holding water and produced little or no surface runoff except perhaps during snowmelt and spring runoff:

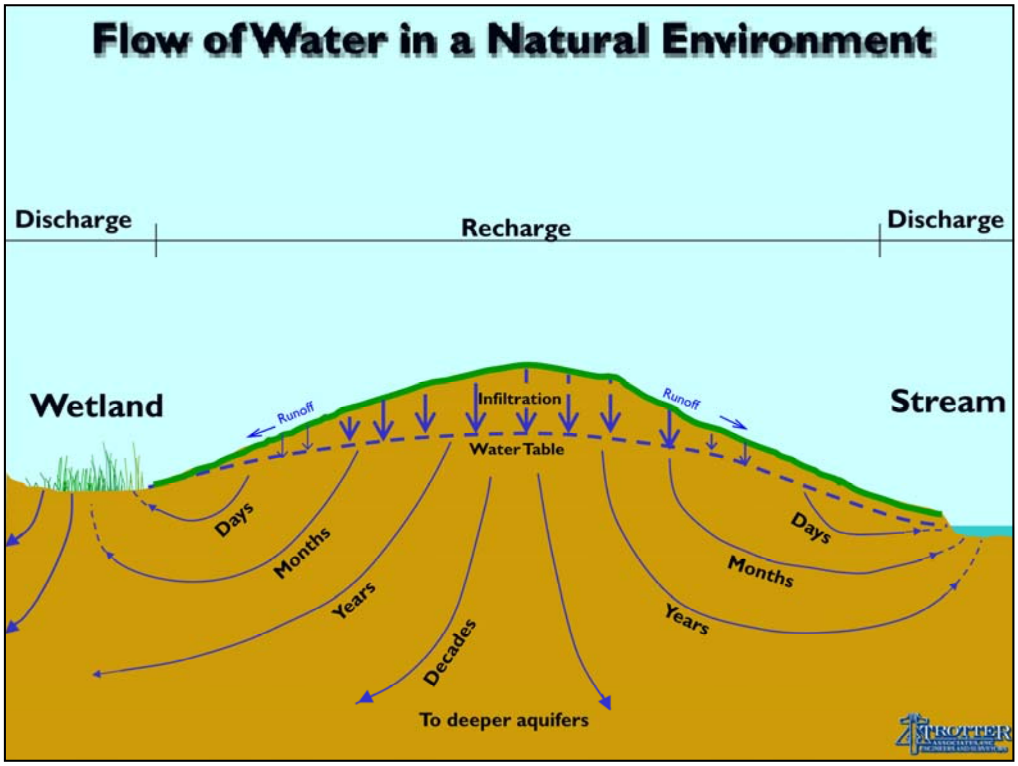
•Deep-rooted native vegetation improves permeability of soil

•High organic content of soil efficient at holding water

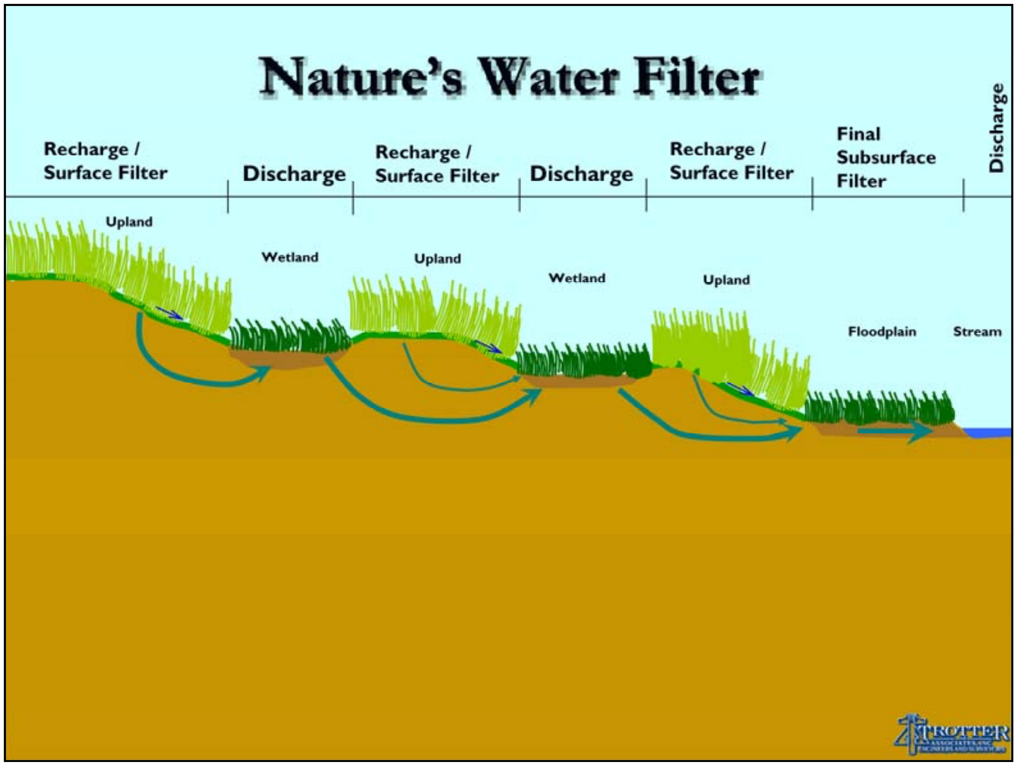
•Micro-topography can temporarily hold water until able to infiltrate



Our soils are a product of the native prairie landscape. The native vegetation sequesters carbon from the atmosphere and continues to build and improve the soils over time. That is why the Midwest has some of the most productive farmland in the world.



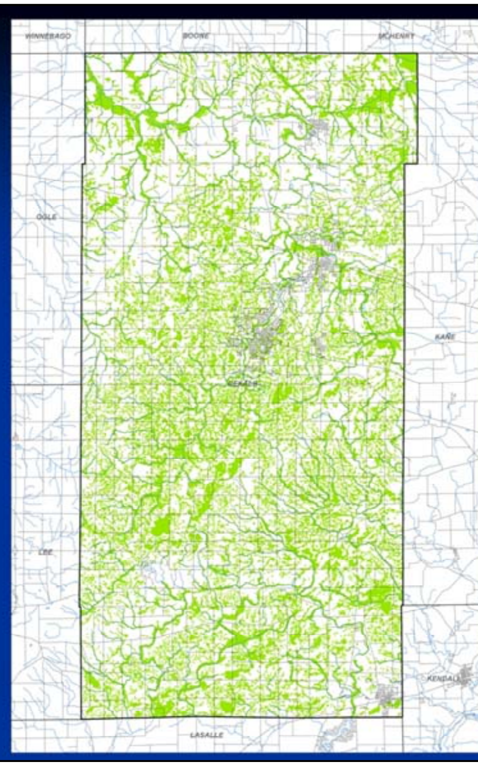
This is a schematic of how water moves through the landscape in a natural ecosystem



These wetland areas – these act as nature's sponges, filtering the water as it moves downgradient to the stream. We've lost more than 96% of our wetlands over the last 150 years. The remnants of these wetlands can be observed today by looking at the soils. How many people here know what a hydric soil is?

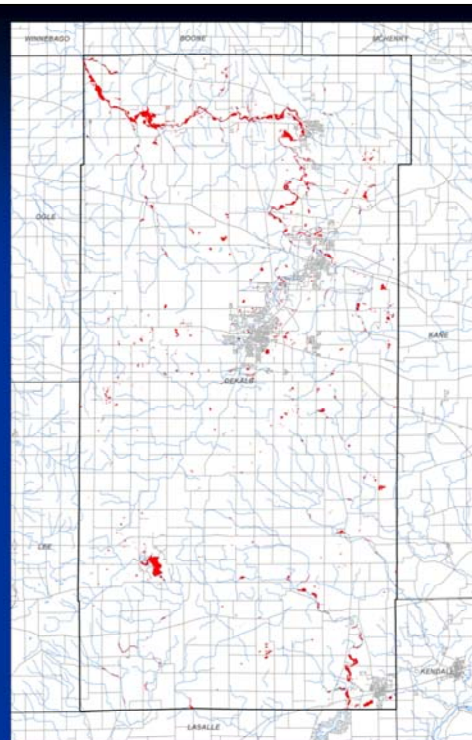
Hydric Soils in DeKalb County

- Historic Wetlands (in green)
- 131,700 acres
- 32% of the ENTIRE County

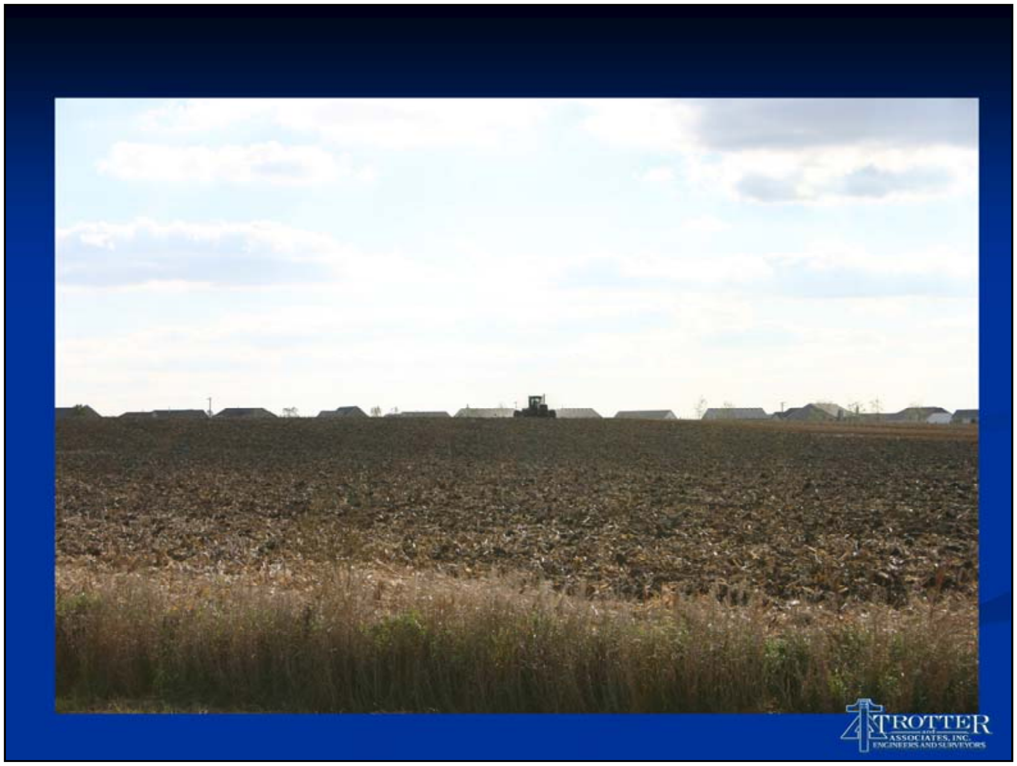


Mapped Wetlands in DeKalb County Today

- National Wetlands Inventory
- About 3% of the County

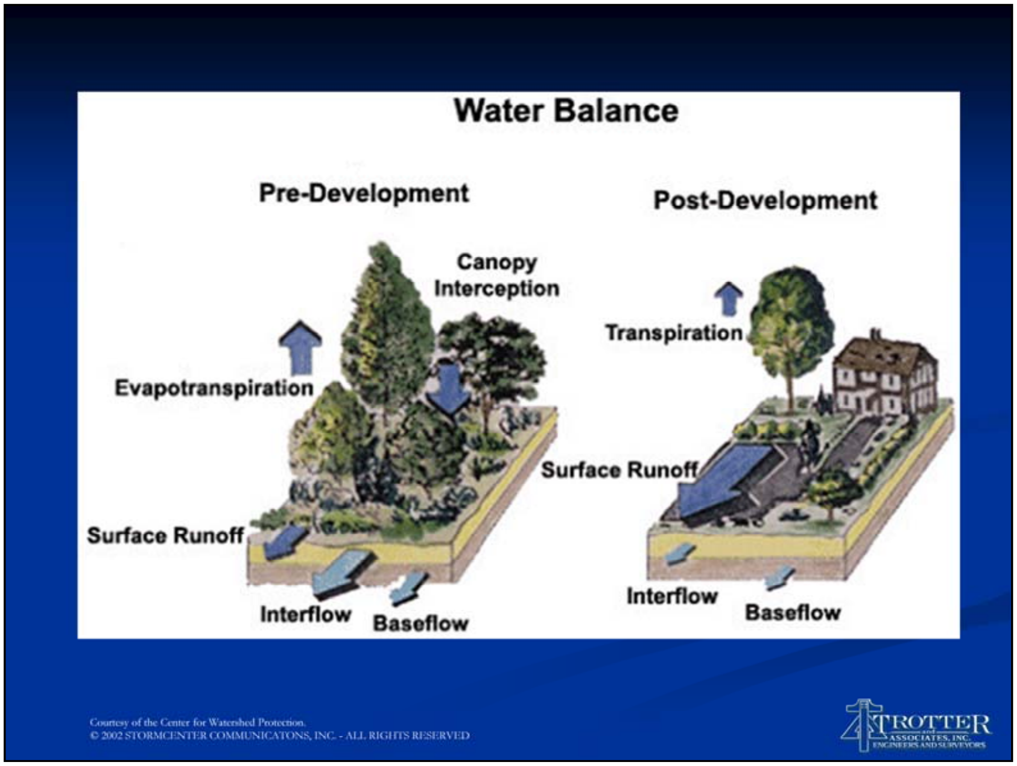


The first changes to the landscape were for agriculture. While the basic topography was often altered very little, the act of farming depleted the soils of their organic carbon and we began to drain the landscape.



Now we're changing from agricultural landscape to suburban development. Note the developer planting his new development as last years SFR crop is just beginning to sprout in the background. But you can see as we go from this -

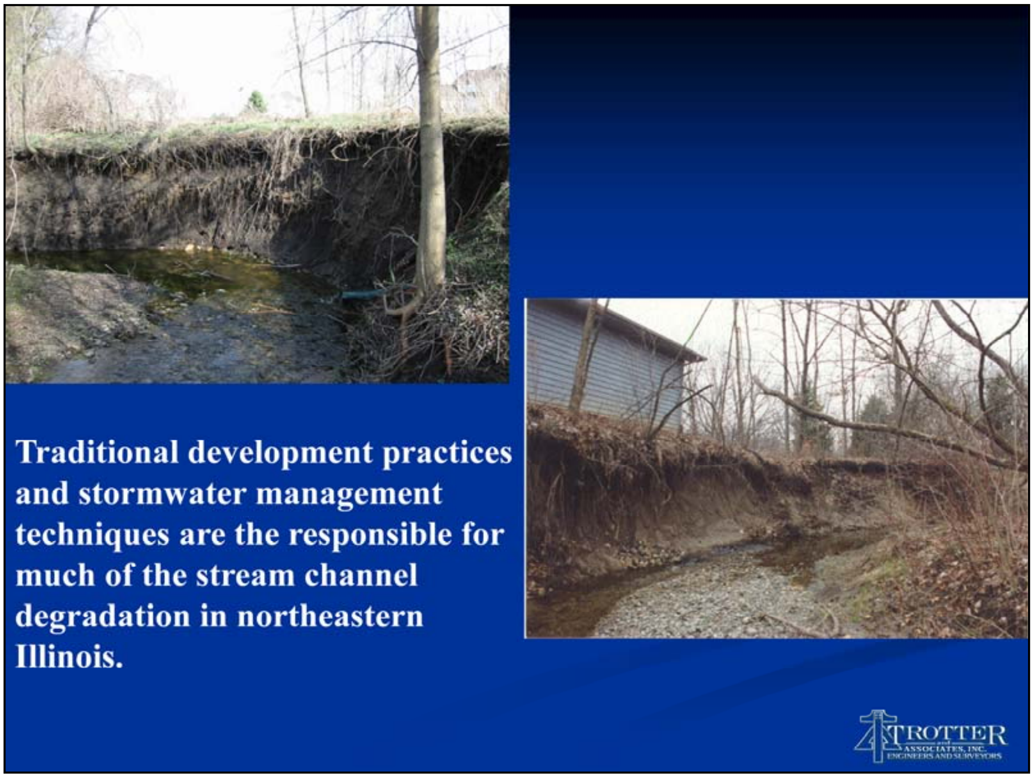
- To this, the final and irreversible step in the landuse process, you can see that we have converted our landscape from one that was once very efficient at holding water to one that is designed & constructed to be very efficient at shedding its water. Even the pervious areas are designed to drain to the impervious surfaces. The current development approach to stormwater is to get it off the landscape and into the detention pond.



Shown graphically here, you can see the changes to the Hydrologic Cycle resulting from urbanization. Note that prior to development, around 90% of the rainfall either evaporates or is soaked into the ground. Contrast that to highly urbanized areas where runoff increases 3-5 times the existing and infiltration is reduced by as much as 30% - 70%.

Development historically addressed stormwater using a conveyance approach which provided direct connections between developed impervious surfaces and the receiving stream by a system of enclosed sewers and paved channels. This method of stormwater management worked great in upland areas, but the further one went downstream, the more severe the flooding became during heavy storms.

The next revolution in stormwater management become the detention method, currently used in most urban areas today. In this method, stormwater runoff is temporarily detained in a basin and gradually released over a 24-48 hour period.



While traditional stormwater management with detention mitigates flooding problems immediately downstream, the benefits become less and less the further downstream you go from the detention basin. This is because detention only reduces the peak flow leaving a site, and not the total volume of stormwater runoff. The result is often a net increase in stream flow for all storms, and this is especially true for small storm events, in the 3 mo. – 2 year return interval.

Flooding in DeKalb, August 2007

Finally, traditional stormwater management, due to its inability to reduce and/or retain runoff, often cannot prevent flooding problems downstream from heavily urbanized areas.

How do we prevent all these bad things from happening?

By changing our approach to development of our landscape

A. Respect the natural drainage features of the landscape
- ✓ Preserve wetlands, floodplains, hydric soils

B. Manage stormwater on-site
- ✓ Minimize discharge to streams
- ✓ Filter runoff
- ✓ Maintain pre-development flow characteristics

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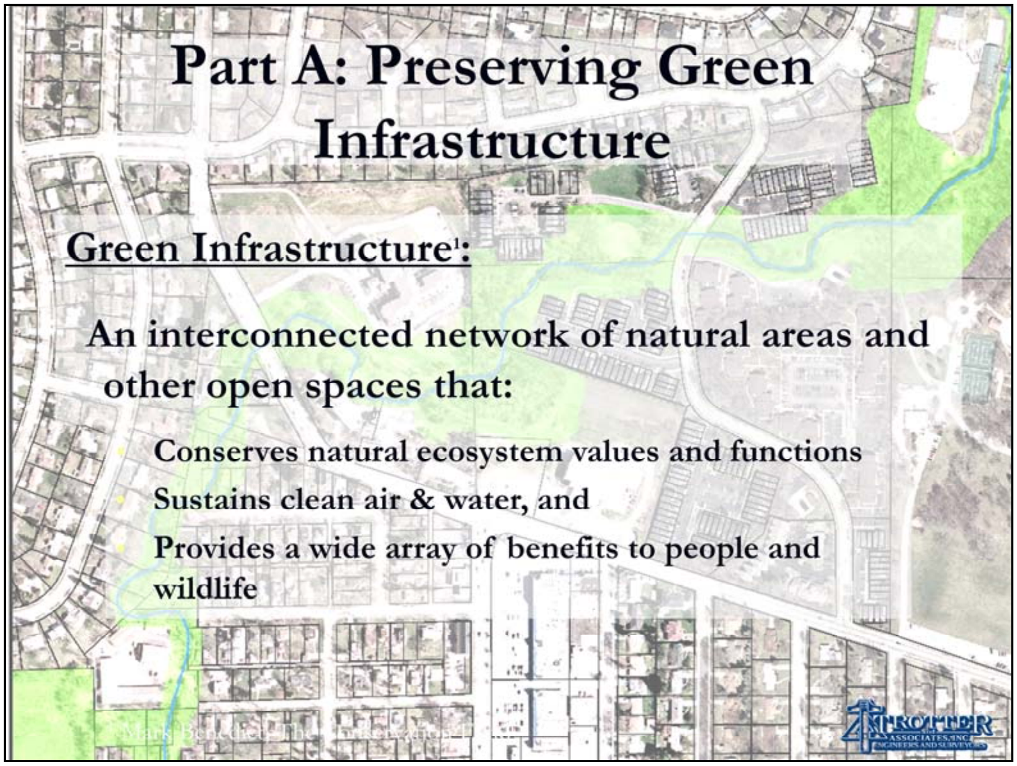
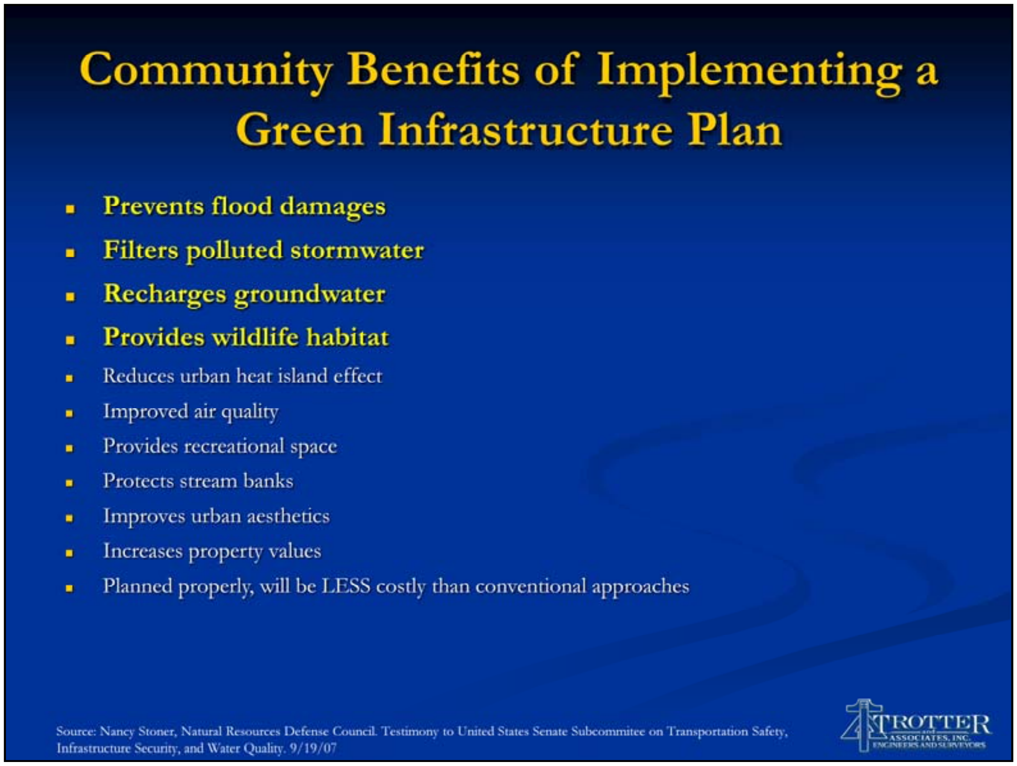


Two part approach Green Infrastructure & retain stormwater where it falls.


Community Benefits of Implementing a Green Infrastructure Plan
Prevents flood damages
Filters polluted stormwater
Recharges groundwater
Provides wildlife habitat
Reduces urban heat island effect
Improved air quality
Provides recreational space
Protects stream banks
Improves urban aesthetics
Increases property values
Planned properly, will be LESS costly than conventional approaches
Source: Nancy Stoner, Natural Resources Defense Council. Testimony to United States Senate Subcommitee on Transportation Safety, Infrastructure Security, and Water Quality. 9/19/07
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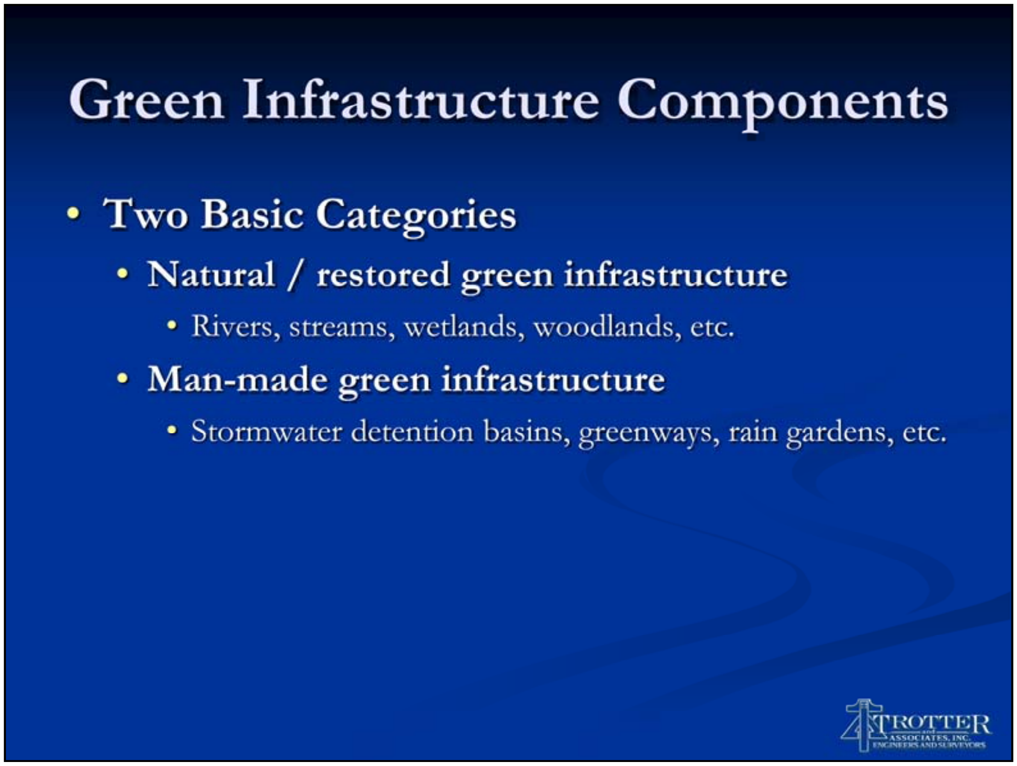
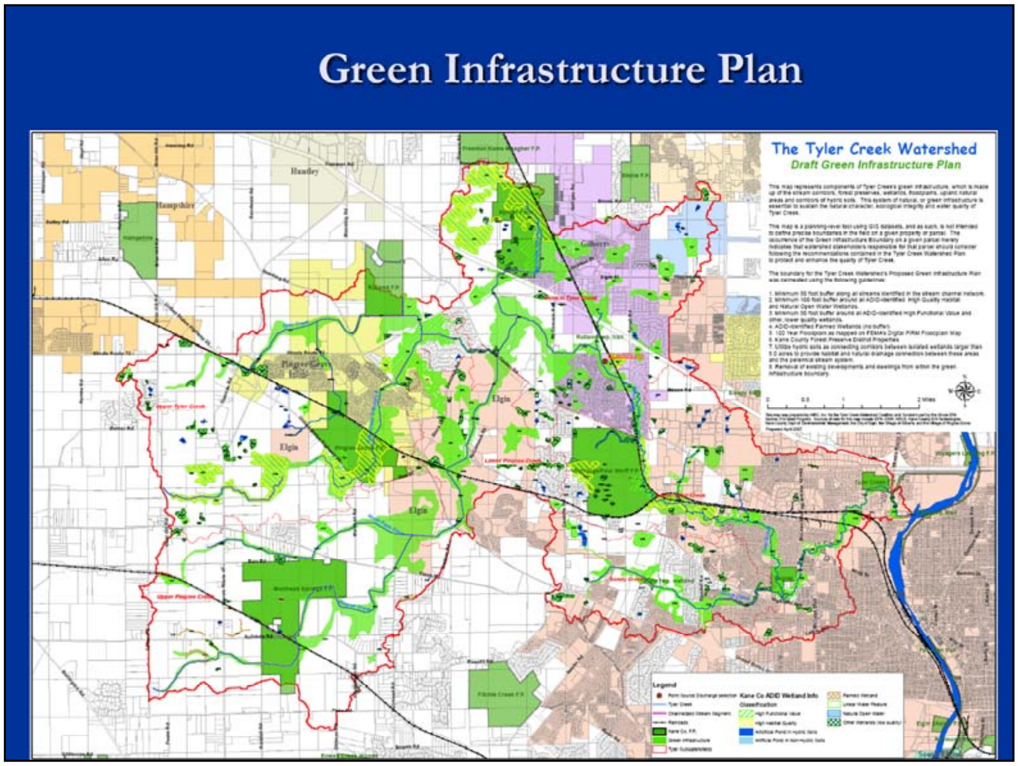


As mentioned previously, for planning purposes, it is helpful to divide our green infrastructure into two categories. The first and perhaps most important part of our green infrastructure is the natural system of rivers, streams, wetlands, woodlands, and prairies.

The second is well known, but not always thought of as being a key element in our community's green infrastructure – these are the manmade features such as parks, greenways, trails, and stormwater management areas.



GIP Basics:

Utilize existing protected parcels (Kane County F.P.; municipally owned properties) and floodplain
Combine with ADID Wetlands & stream channels
Link isolated natural areas larger than 5 acres using hydric soil corridors

For Areas Already Developed:

Highlights restoration/buffer opportunities for landowners to protect Tyler Creek

For Areas Planned for Development:

Indicates critical land features to be retained and preserved as resources wildlife, recreational, and water quality benefits

Above is an example of a typical pre-development scenario in the Fox River Watershed; a small stream extensively ditched and channelized in an agricultural field. Note that while the green infrastructure along this stream is very narrow in this picture (30-50ft), the historic green infrastructure was likely MUCH wider. Note the dark colors of the soils along the channel – they indicate that the hydric soils (indicators of historic wetlands prior to draining by agriculture) and floodplain were much more extensive prior to modifications made to the landscape for agriculture. The PRE-AGRICULTURAL green infrastructure area should be included in the future development layout – NOT the narrow and degraded existing stream corridor!

Unfortunately, this is all too often what happens. If existing wetland and floodplain regulations are all that is followed, the green infrastructure that is essential for the long-term sustainability of our watersheds is almost entirely lost due to encroachment by land development and it's required Grey Infrastructure. Note how the historic wetland resources (the dark colored soils in the previous slide) were completely filled in. The stream channel, degraded from years of agricultural activity, was left in it's artificial and degraded state. Even the man-made green infrastructure (the stormwater basins) appear to have been designed as turf-grass lined open water basins with none of the physical or biological features of the wetlands that once dominated this landscape. If this is done for all the remaining undeveloped segments of our watershed's streams, what will be the impact on our natural resources, wildlife and overall quality of life?

Green Infrastructure Recommendations

- Incorporate a Green Infrastructure Boundary into your community's Comprehensive Plan
- Require Green Infrastructure to be included/delineated/restored in new developments
- Restrict encroachment and disturbances in the green infrastructure boundary (GIB) by new development. Allow disturbances only if they are absolutely necessary - "put it back to a condition better than you found it".
- If new development infrastructure, such as stormwater facilities, must be constructed within the green infrastructure area, then such facilities must be designed to maximize habitat and replicate the geometries of natural wetlands (i,e, shallow side slopes, native wetland vegetation, etc.)

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Part B
We've done our best to protect our Green Infrastructure.
It's time to start building again.
Now what?

Solution:

Manage stormwater on-site as close to where the rain falls!

Developments should now include Stormwater Best Management Practices (BMPs) as part of their drainage infrastructure.

- Permeable Pavement
- Rain Gardens / Bioswales / Bioretention basins
- Infiltration Trenches
- Level Spreaders & Filter Strips
- Naturalized Stormwater Basins

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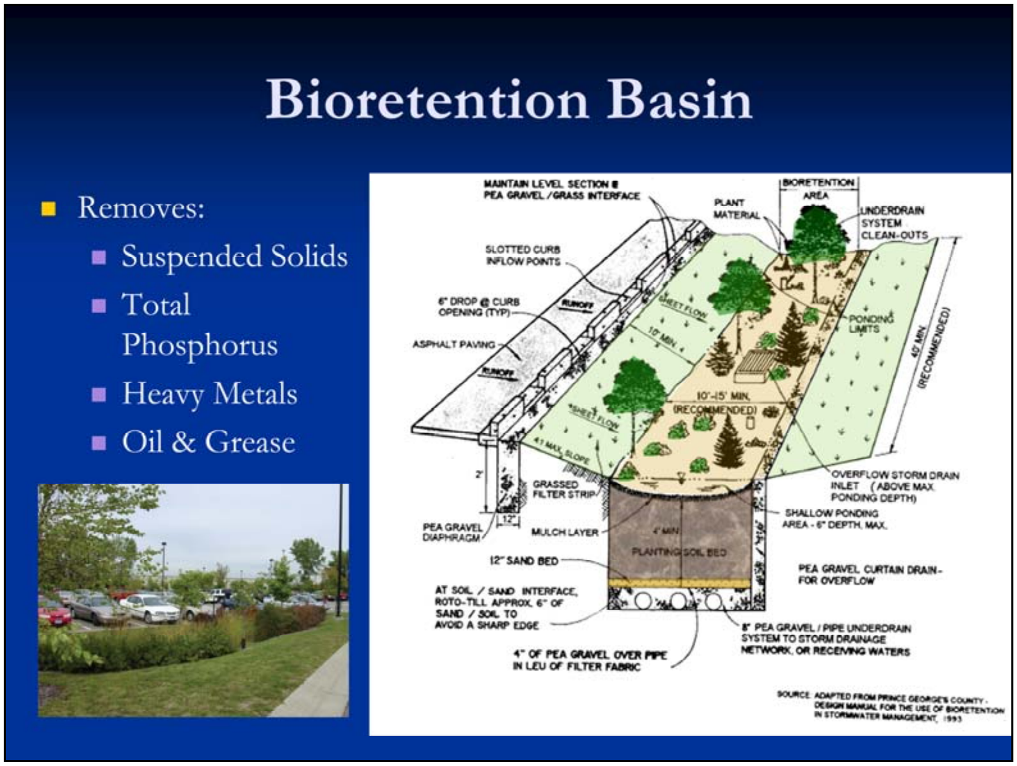
Permeable pavement is an excellent BMP that can be readily applied here in northern IL. Impervious surfaces are the #1 source of increased runoff and urban pollutants. Interlocking concrete pavers are most applicable in this area (porous concrete & asphalt appear to have more problematic maintenance issues in this climate). Visit the Interlocking Concrete Pavement Institute for more information (www.icpi.org).

Asphalt cost = $1.00 per square foot; ICP cost = $7.00 - $10 per SF; however, the true cost of asphalt, including storm sewers, inlets, etc. is around $5 per SF. Interlocking pavers don't need storm sewer system under them.

Cost $10 - $25 per square foot. Strongly recommend revising local ordinances to require depressed landscape islands for commercial/retail developments as a simple way to reduce total runoff and cleanse runoff before it is discharged to the downstream detention basin.

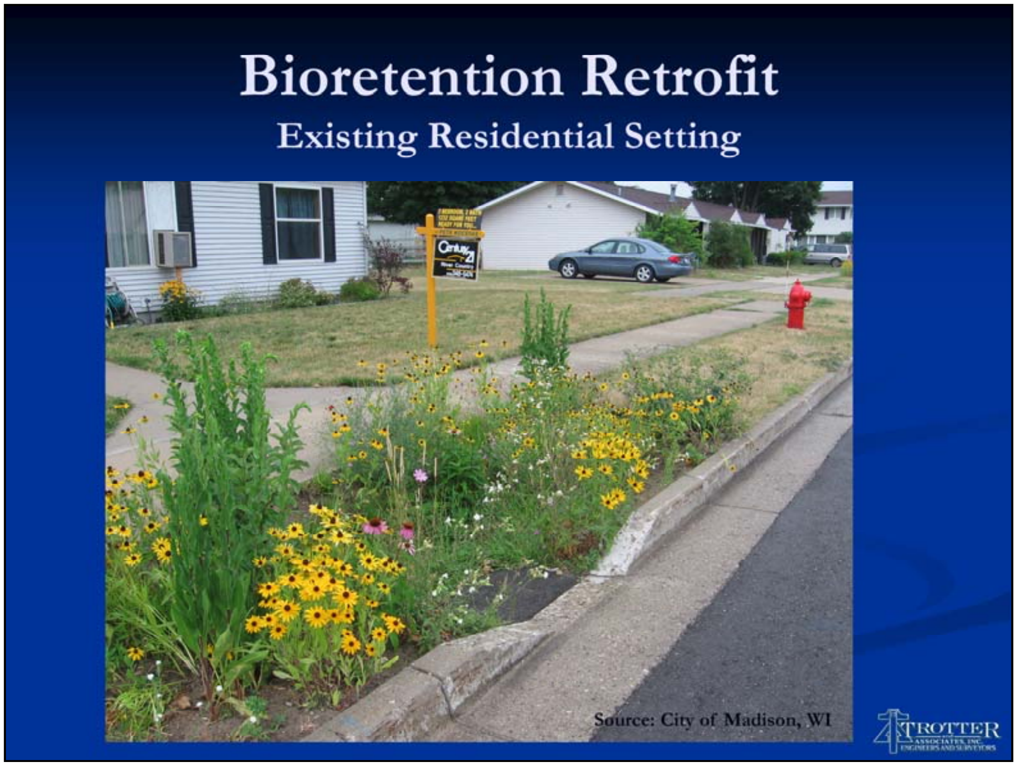


One alternative is to raise the underdrain outlet pipe up off the bottom of the basin to promote more recharge to the underlying soils. These systems can also be used in areas where the underlying soils do not permit much infiltration – simply connect the underdrain system to an adjacent storm sewer. Studies show that much of the stormwater entering these basins with poor infiltration underneath STILL reduce annual runoff dramatically simply through the evapo-transpiration that occurs during the growing season by the landscaping growing in the basin.

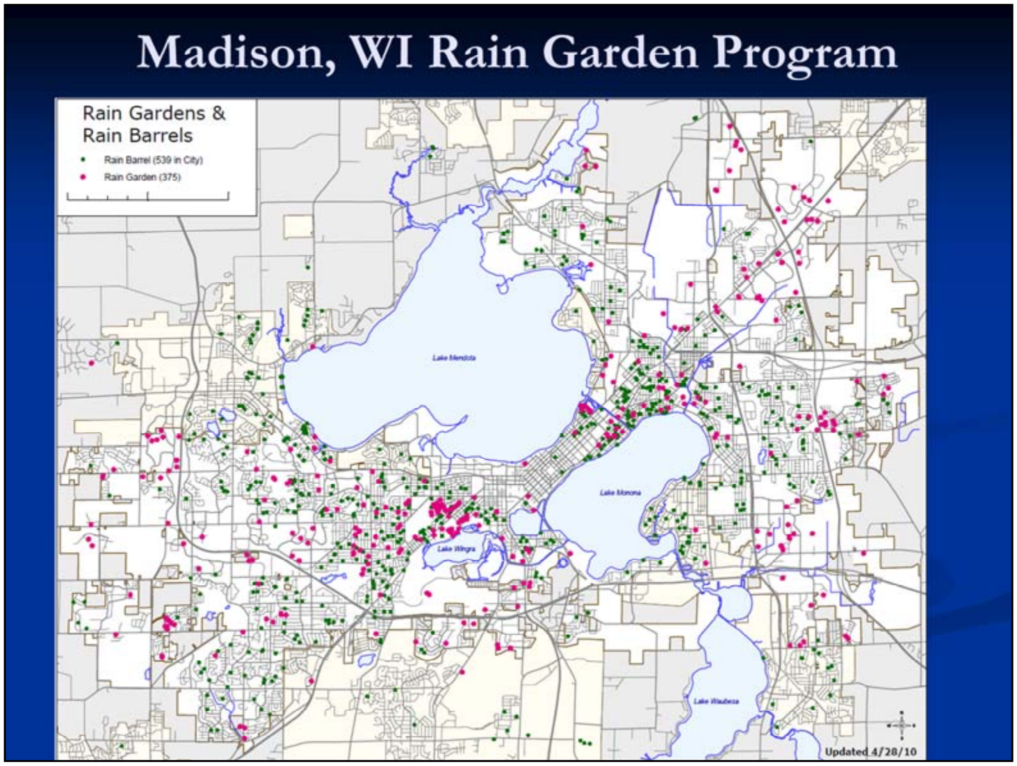
Goal is to work these features into the proposed landscaping (yellow dots on this proposed commercial development template).

Retrofits in highly urbanized areas can be expensive – this BMP retrofit in Lansing, MI cost more than $1,000,000 to install a linear bioretention basin along a 2 block section of town to reduce flow to their combined sewer system.


Bioretention Basin - Retrofit
621
Typical Cross-Section
MICHIGAN AVENUE
GUTTER
CURB
BUILDING
Michigan Avenue Bioretention Facilities

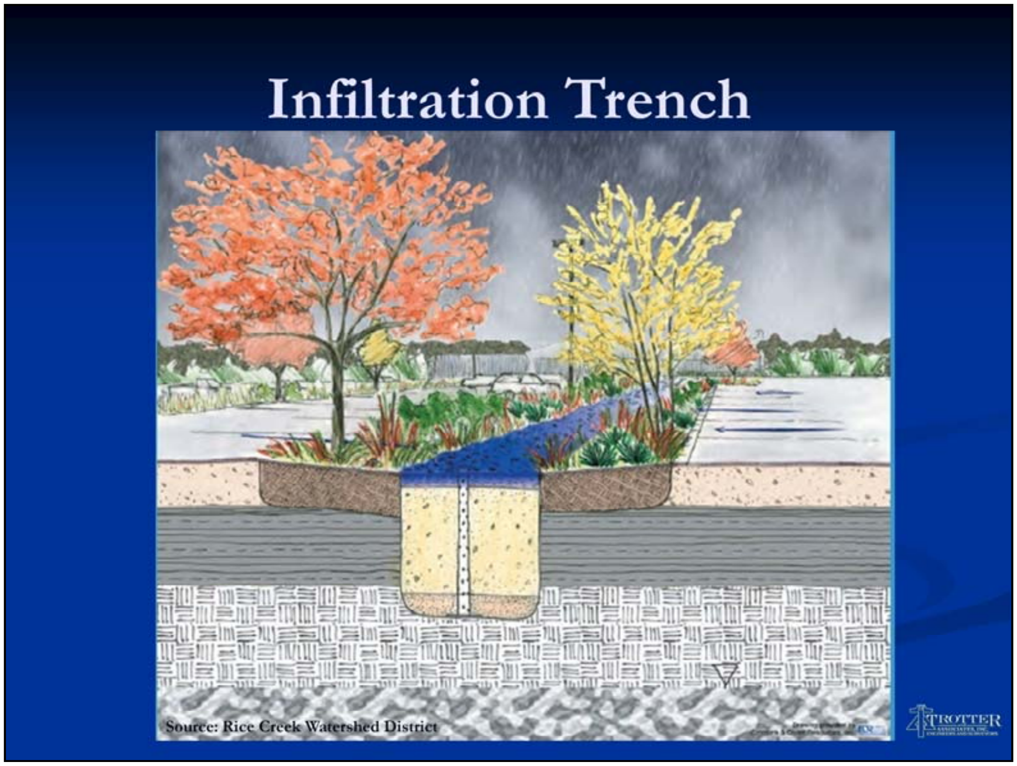


BMP retrofit on a much smaller scale – residential neighborhood (and no – the resident is NOT selling his house because the City installed the bioretention basin in front of his house!)



Map of Madison, Wisconsin's rain garden program. Even though each rain garden & rain barrel only captures part of the runoff from a single parcel, they can have a significant impact on stormwater runoff area-wide if you can get good buy-in from residents & businesses.


Madison, WI Rain Garden Program
Adams Street
Spaight Street
TROTTER



Similar to a bioretention basin, only no landscaping is needed on the surface of the BMP (landscaping shown above acts as a pre-treatment filter for the infiltration trench in the center of the parking island in this example).

BMPs for Urban Areas

Drainage Swales

Conventional	Conservation
	
Turf grass drainage swale designed for conveyance.	Drainage swale planted with native vegetation and designed to slow down runoff and retain as much as possible.

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Source: Blackberry Creek Alternative Futures Project (Kane County 2003)

Conventional ponds are usually ringed with stone rip rap around the edges, which typically sloughs off over time into the bottom of the pond. The side slopes are too steep and the turf grass edge encourages geese to take up residence. Naturalized detention basins have shallow slopes, native wetland & wet prairie vegetation along the side slopes and shoreline. This discourages geese and creates habitat for local & transient wildlife (cranes, herons, etc.), not to mention the water quality improvement as the diverse vegetation can provide significant nutrient & pollutant uptake.

Structural Water Quality Devices

- Modular design
- Intended for Urban Retrofit
- Can be Expensive (last resort option)

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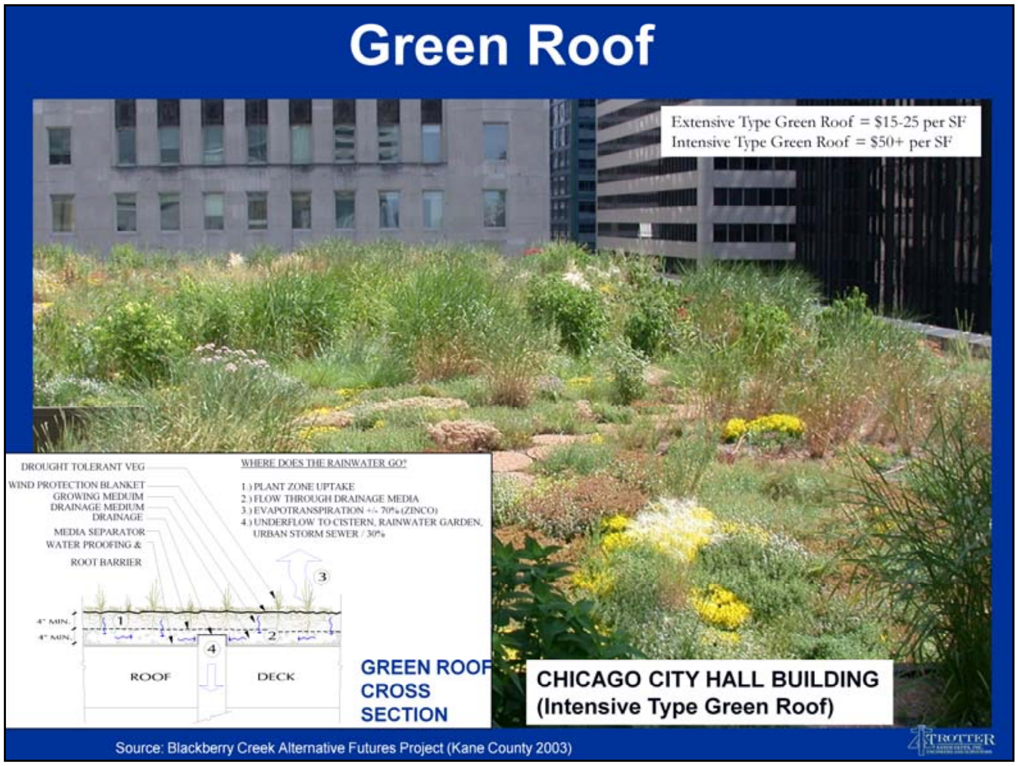
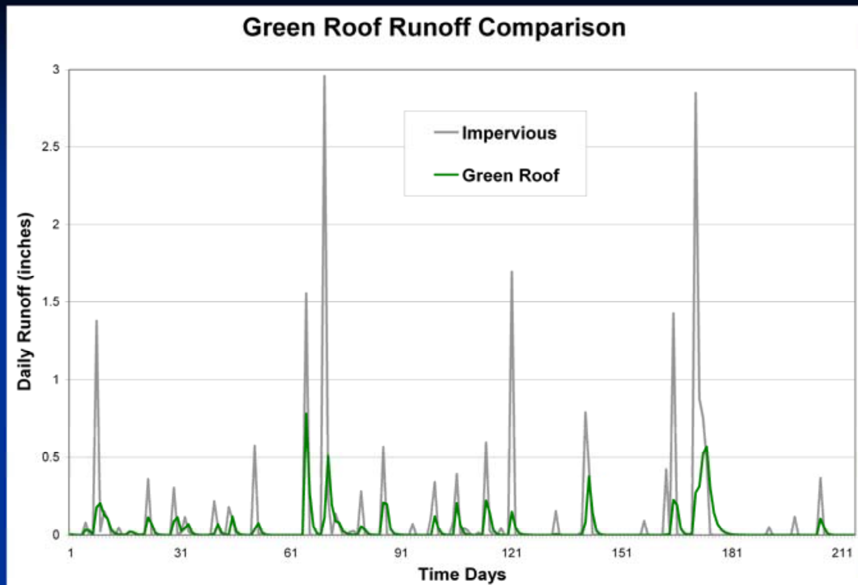


Cost $15-$25 per SF for extensive type roofs. $50 or more per SF for intensive type roofs (intensive types are those with a very deep planting medium – 8" to several feet in depth; think of intensive types as a rooftop garden).



For a 3" rainfall, a 100,000SF roof (big box store) would generate 187,000 gallons of stormwater runoff. Using a green roof design, this could be reduced to less than 32,000 gallons, 1/6th the runoff produced using a standard roof.

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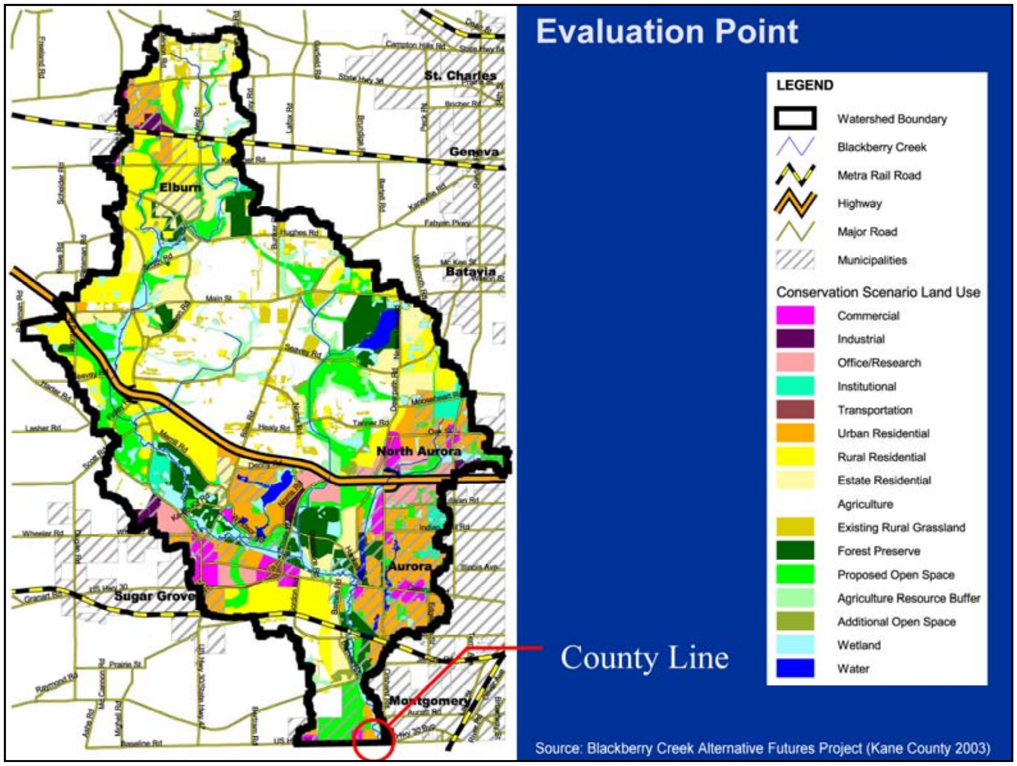
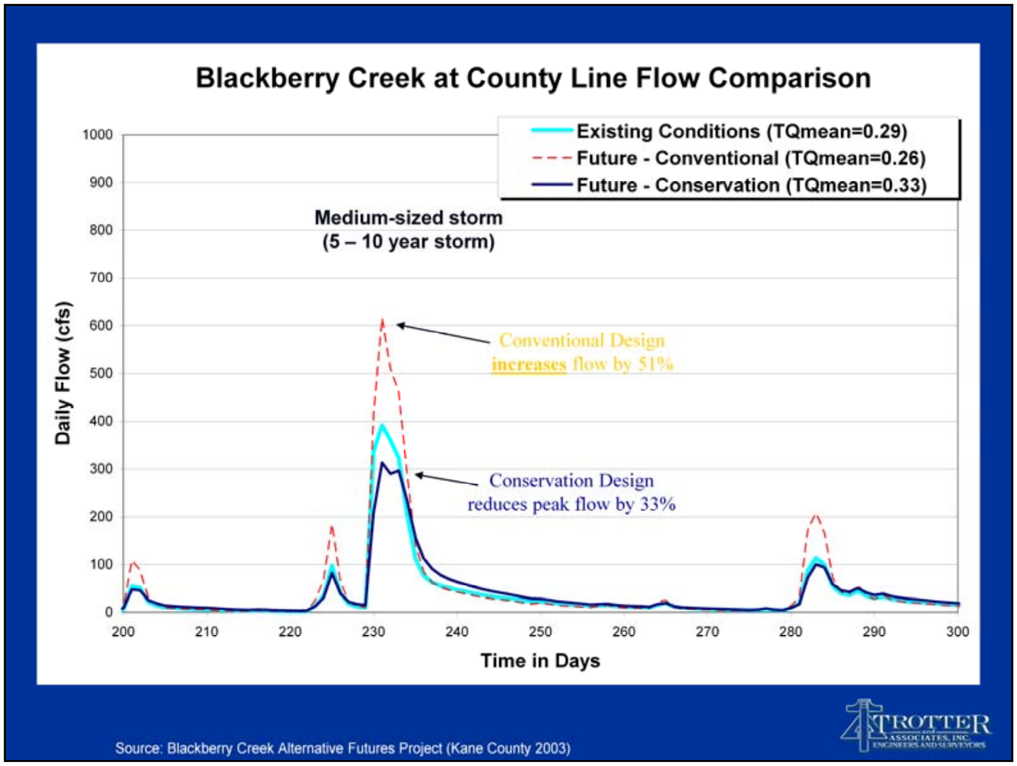
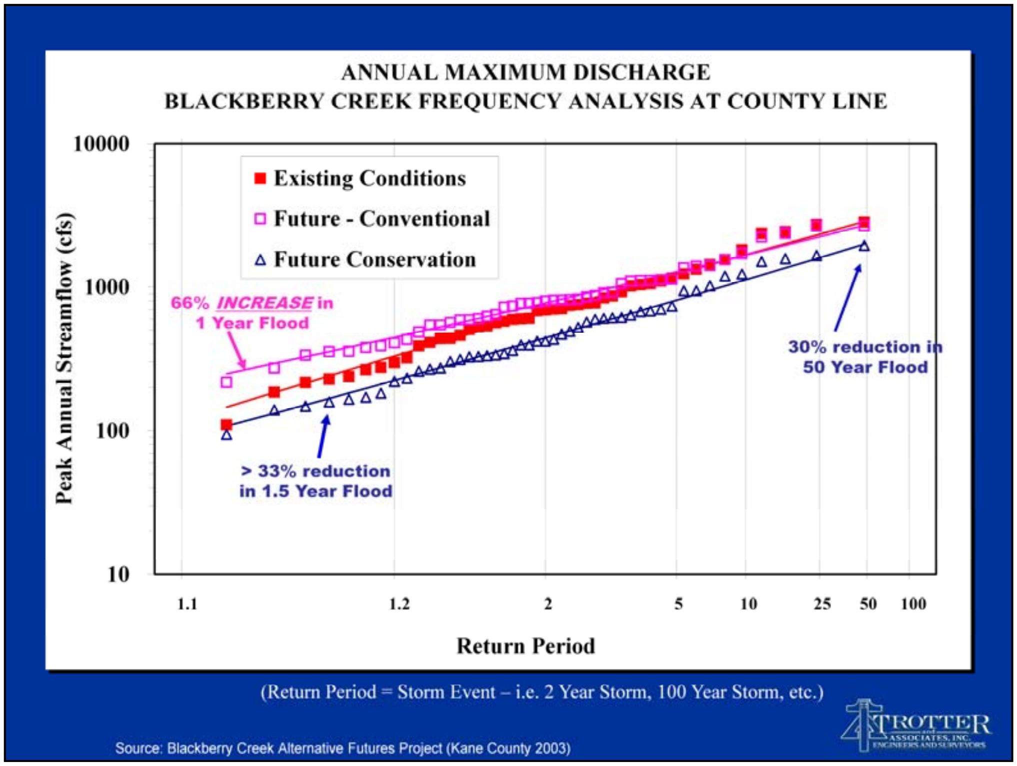


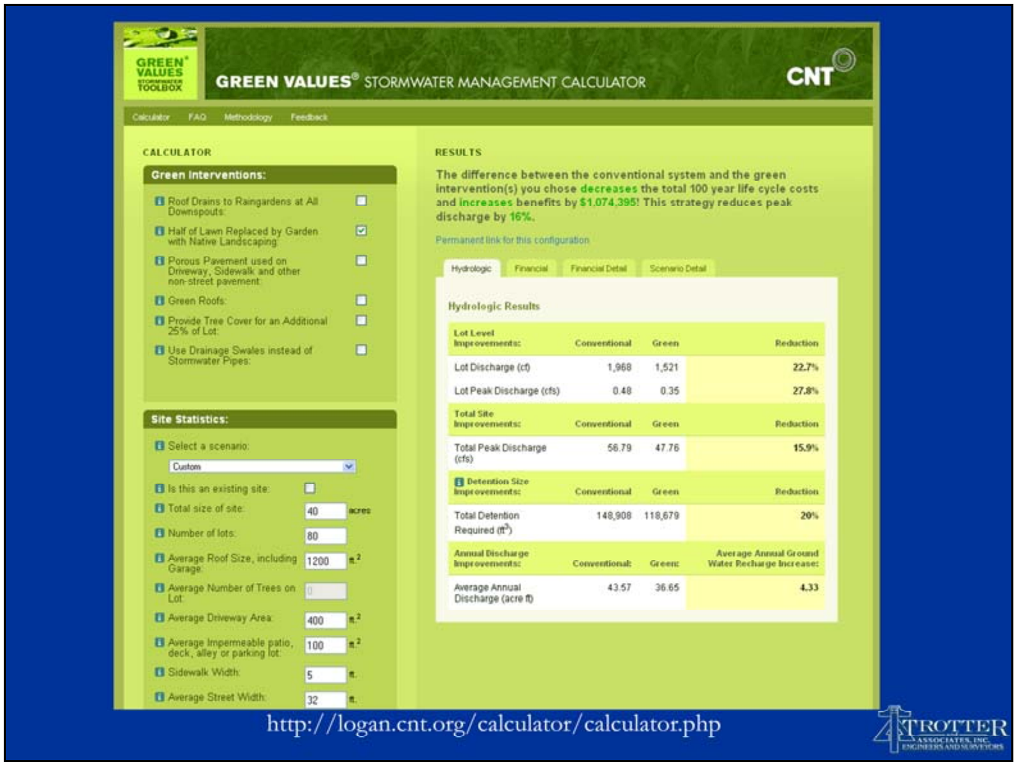
Kane County conducted an analysis in the Blackberry Creek watershed to quantify the impact of employing all these types of BMPs on the land yet to be developed in the watershed. The next few slides show the quantitative results their $200,000+ study produced (i.e. they spent the money to answer the question “will these BMPs really make a difference at the watershed scale?”).



This slide shows that in the Blackberry Creek Study, applying the BMPs across the undeveloped portions of the watershed results in a reduction in peak stormwater flows for the medium & small storm events, whereas the conventional development/stormwater approach actually INCREASES peak flows in the stream by more than 50%. It is these increases for the medium and small storm events that cause the instability in our stream channels and result in excessive stream bank erosion and channel incision (downcutting) that damages our properties and infrastructure (bridges, culverts, roads, etc.)



This plot of peak flows versus flood interval (i.e. 1 year, 2, year, 10, year storms, etc.) shows that developing a watershed's area using traditional stormwater methods (detention with no thought to conservation of water through infiltration) results in the smaller storms producing as much as 66% higher peak flows, whereas the conservation development approach actually reduces flows by 33% for the smaller storms. Note that the conventional development/stormwater approach does not increase the peak flood flows for larger storms (50 & 100 year storms on the right hand side of the graph), which means that they are doing their job at not increasing flooding for large storms. However, the conservation scenario indicates that a watershed could expect to see a reduction (as much as 30%) in peak flood flows for larger storms such as the 50 and 100 year events.

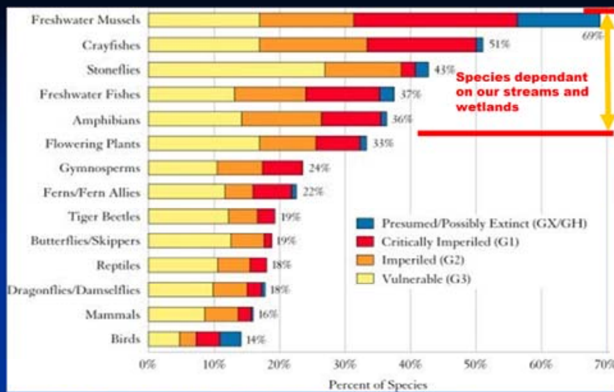


The Center for Neighborhood Technology has produced a stormwater management calculator that you can use to measure the cost of using certain stormwater BMPs on hypothetical developments (which you can also specify in the lower left box). It also estimates the reduction in annual runoff for the development as specified.

The End

Questions?

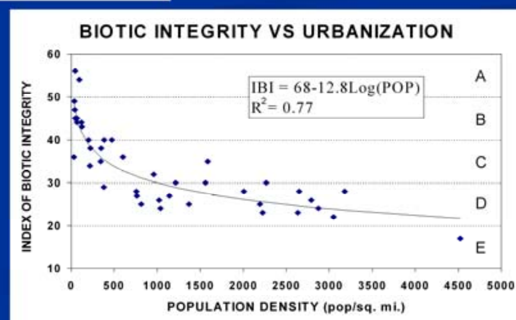
Additional Reference Materials



Source: "The State of the Nation's Ecosystems"2002, published by The Heinz Center using data from NatureServeDatabase and its Natural Heritage members

ECOLOGICAL IMPACTS

This slide shows the percentage of each group of plants and animals that are in danger of being wiped out across the country. It is based on published ecological data collected by state and federal agencies. Note that the most threatened groups of animals are those found in our wetlands and streams, which further emphasizes our need to minimize our impacts to the riparian ecosystem.



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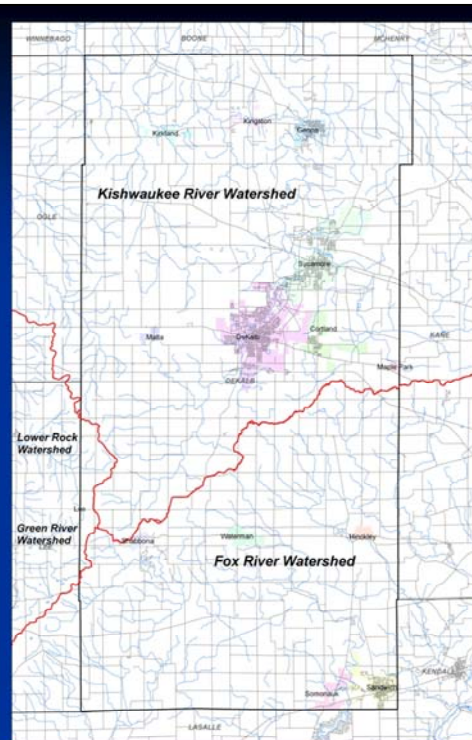
Development pattern typical of the 1990s.
Where's the Green Infrastructure?
Source: USGS
TROTTER

Watersheds in DeKalb County

- Kishwaukee River
- Fox River
- Small portions of Rock & Green River



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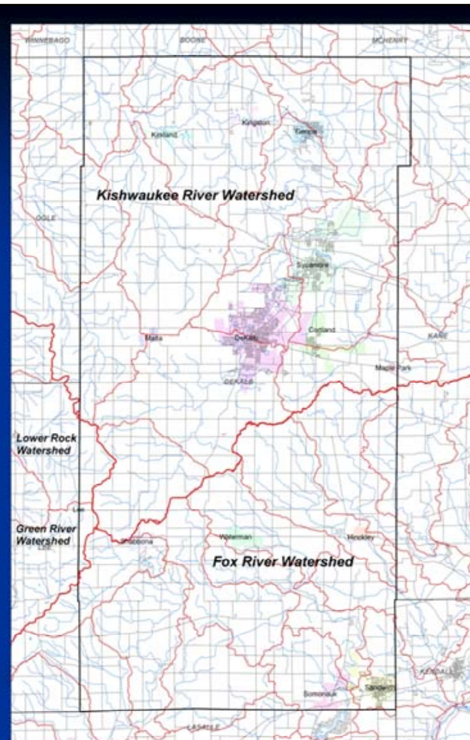
Watersheds in DeKalb County

- HUC-12 watershed boundaries shown



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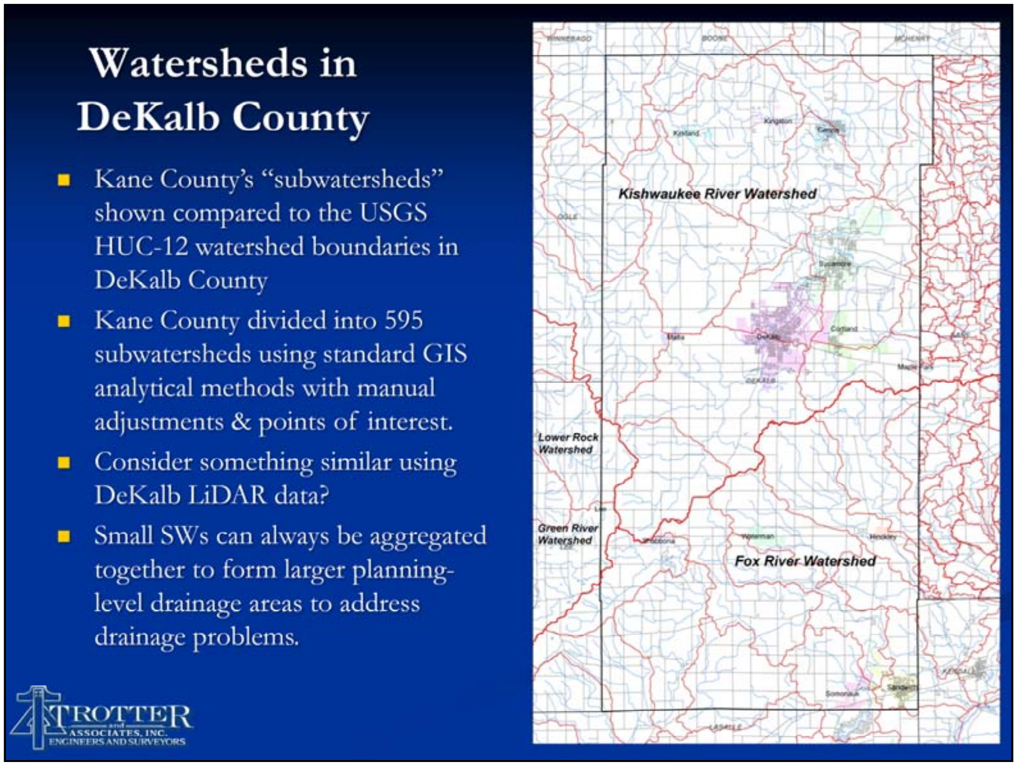
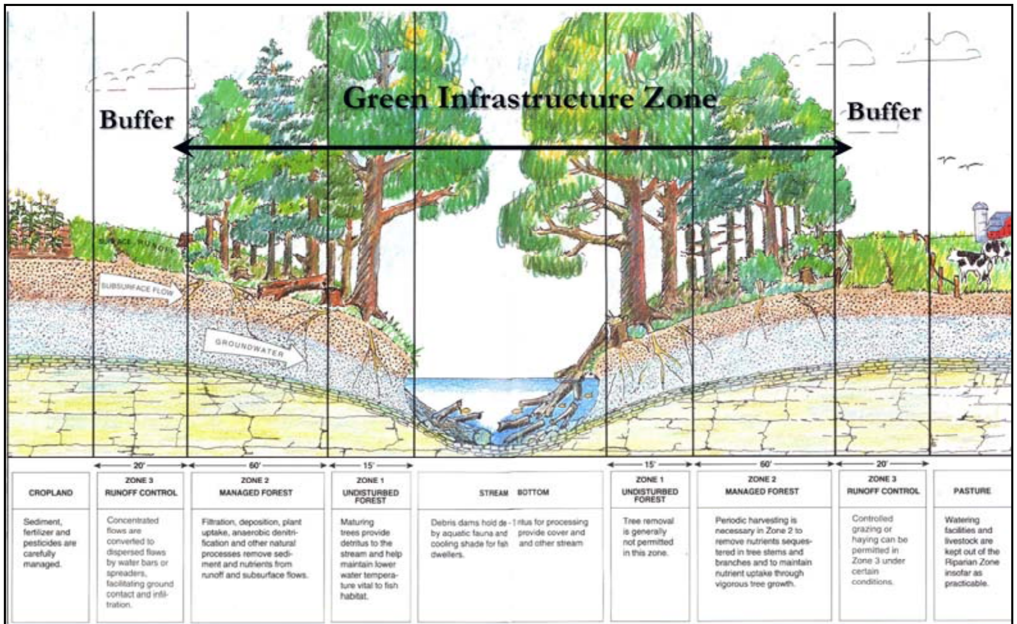


It yielded a delineation of 595 subwatersheds, which averaged out to about 1 square mile each. I would consider this a "quick-and-dirty" delineation because there are numerous small gaps & overlaps where the automated delineation for each subwatershed calculated a slightly different drainage boundary for two adjacent subwatersheds. Works for larger-scale planning, but the errors are very obvious when working at the parcel/subdivision scales. Another thing to consider is including flooding problem areas as secondary feature for delineating drainage areas. This would help streamline the analytical process later on as each floodplain problem is evaluated & prioritized.



Source: Cayuga Watershed

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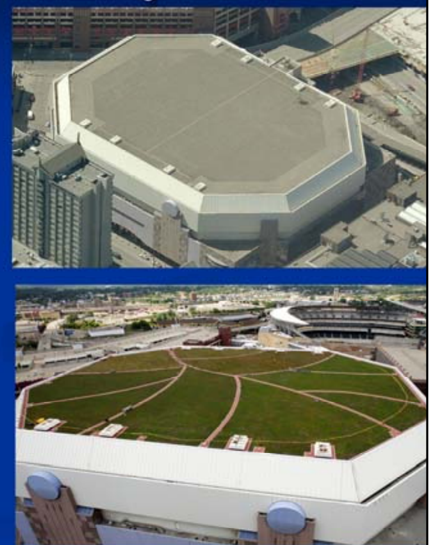
Extensive Green Roof Systems

- Most prevalent in US
- Cheaper than Intensive Type
- Excellent choice for roof retrofits
- Low-profile
- Limited human access
- 3”-6” growing media
- Weighs 15-50 lbs/ft2
- Roof slopes up to 3:1 (H:V)
- Costs \$15 - \$25/ft2 (including membrane)



Target Center, Minneapolis, MN

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Intensive Green Roof Systems

- More expensive than Extensive Types
- New construction (design must accommodate extra weight)
- Usually designed for human access & use
- Growing media = 8" up to several feet
- Weighs 80-120+ lbs/ft2
- Flat roof slopes
- Costs $25 to more than $100/ft2 (Depending on desired landscape)

Chicago City Hall

Commercial Template

Conventional	Conservation
	

Source: Blackberry Creek Alternative Futures Project (Kane County 2003)

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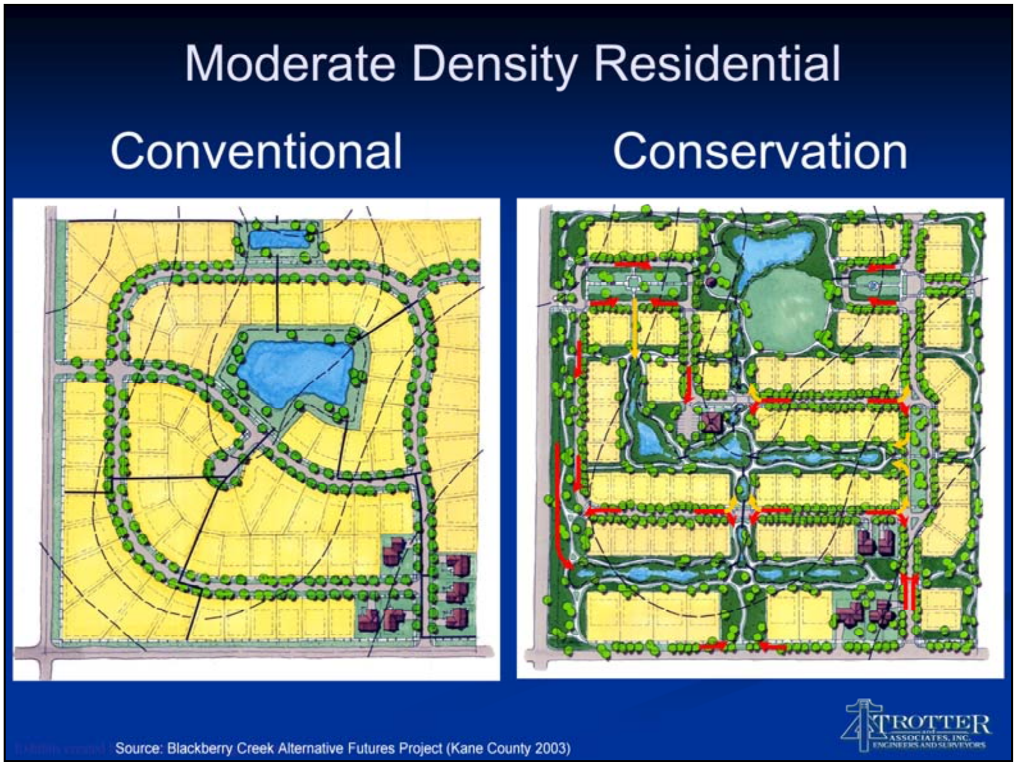
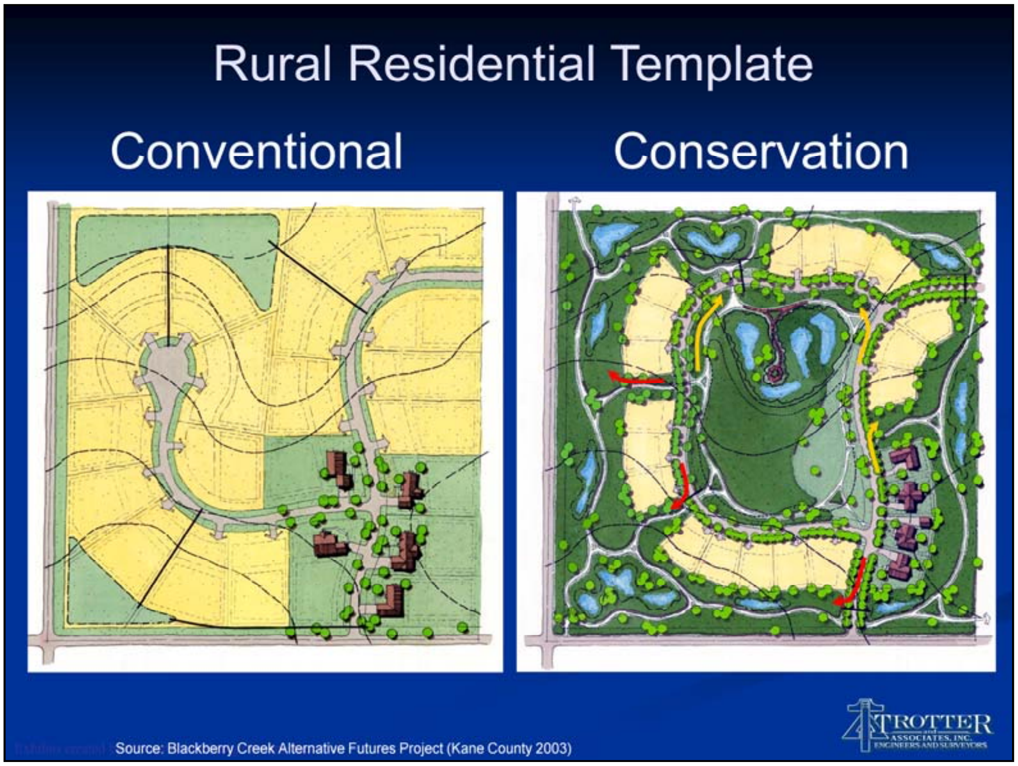


Both Conventional and Conservation provide detention

Conservation stormwater includes:

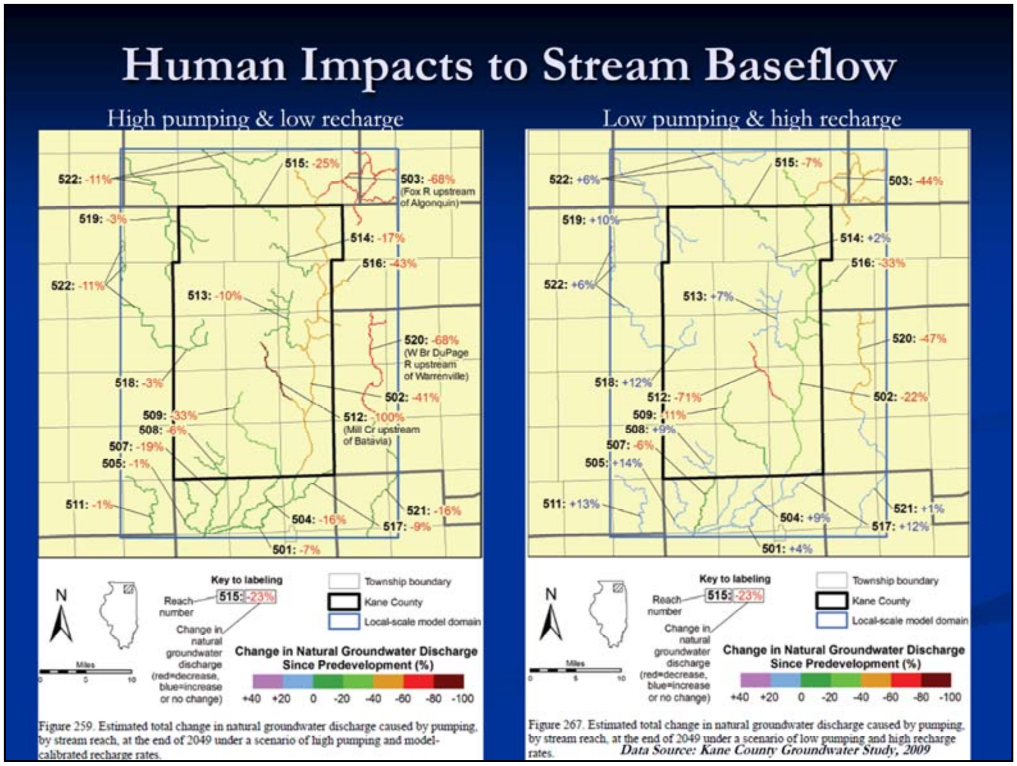
- Permeable pavement driveways
- Rainbarrels and/or drywells for roof runoff
- Roadway runoff routed to native landscaped open space for stormwater infiltration
- Level spreaders for detention discharge
- Very few storm sewers



Both Conventional and Conservation provide detention and use swale drainage

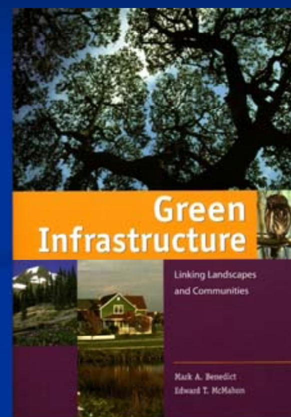
Conservation Stormwater includes:

- Permeable pavement driveways
- Naturalized swales and detention
- Level spreader on detention discharge
- Private septic tank but common constructed wetlands treatment system


Human Impacts to Stream Baseflow
High pumping & low recharge
522: -11%
515: -25%
503: -68% (Fox R upstream of Algonquin)
519: -3%
514: -17%
516: -43%
522: -11%
513: -10%
520: -68% (W Br DuPage R upstream of Warrenville)
518: -3%
502: -41%
509: -33%
512: -100% (Mill Cr upstream of Batavia)
508: -6%
507: -19%
505: -1%
511: -1%
521: -16%
504: -16%
517: -9%
501: -7%
N
Miles
0 5 10
Key to labeling
Reach number
515: -23%
Change in natural groundwater discharge (red=decrease, blue=increase or no change)
Township boundary
Kane County
Local-scale model domain
Change in Natural Groundwater Discharge Since Predevelopment (%)
+40 +20 0 -20 -40 -60 -80 -100
Figure 259. Estimated total change in natural groundwater discharge caused by pumping, by stream reach, at the end of 2049 under a scenario of high pumping and model-calibrated recharge rates.
Low pumping & high recharge
522: +6%
515: -7%
503: -44%
519: +10%
514: +2%
516: -33%
522: +6%
513: +7%
520: -47%
518: +12%
512: -71%
502: -22%
509: -11%
508: +9%
507: -6%
505: +14%
511: +13%
521: +1%
504: +9%
517: +12%
501: +4%
N
Miles
0 5 10
Key to labeling
Reach number
515: -23%
Change in natural groundwater discharge (red=decrease, blue=increase or no change)
Township boundary
Kane County
Local-scale model domain
Change in Natural Groundwater Discharge Since Predevelopment (%)
+40 +20 0 -20 -40 -60 -80 -100
Figure 267. Estimated total change in natural groundwater discharge caused by pumping, by stream reach, at the end of 2049 under a scenario of low pumping and high recharge rates.
Data Source: Kane County Groundwater Study, 2009

Recommended References

- **Green Infrastructure: Linking Landscapes and Communities** – Mark Benedict



Other good references on building sustainable communities can be found at the American Planning Association Bookstore:

www.planning.org/apastore

Local BMP Resources

Kane County Stormwater Management Website

www.co.kane.il.us/kcstorm/

- Kane County Technical Reference Manual – Article 16 (added Nov 2009)
- Blackberry Creek Alternative Futures Analysis

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