ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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PAT QUINN, GOVERNOR DOUGLAS P. SCOTT, DIRECTOR

The Honorable Pat Quinn
Governor of Illinois
207 Statehouse
Springfield, IL 62706

Ms. Jillayne Rock
Secretary of the Illinois Senate
Room 401
Capitol Building
Springfield, IL 62702

June 30, 2010

Mr. Mark Mahoney
Clerk of the Illinois House of Representatives
300 State House
Springfield, IL 62702

Re: Public Act 96-26, the Illinois Green Infrastructure for Clean Water Act of 2009
Signed into Law June 30, 2009
Effective date of June 30, 2009

Dear Governor Pat Quinn and the Honorable Members of the Illinois General Assembly:

I submit here today the Illinois Environmental Protection Agency's recommendations as required by Public Act 96-26, The Illinois Green Infrastructure for Clean Water Act of 2009. Enclosed please find: 1) "Using Green Infrastructure to Manage Urban Stormwater Quality: A Review of Selected Practices and State Programs," a study report that was completed by University of Illinois at Chicago (UIC) and partners. This study meets the requirements outlined in Section 15 of PA-96-26. Within the report you will find an Abstract, an Executive Summary, the report, two appendices and references; 2) "Illinois Department of Natural Resources (IDNR) Addendum on Green Infrastructure," a document which considers a broader definition of green infrastructure than that which was used for this study; and 3) all the public comments received during a short comment period when the draft study was released.

Please consider the following recommendations, which respond to recommendations in the report:

State-wide Performance Standard—IEPA is receptive to setting performance standards to retain stormwater runoff that would be applicable in urban and urbanizing areas statewide. Additional technical and stakeholder work is needed to identify appropriate standards, structure, logistics, phase-in and applicability.

IEPA recommends that a workgroup be formed that includes stakeholders from all sectors to assist us over the next 12 months in this effort. In addition, IEPA will conduct a legal review of its current statutory authorities to determine if additional authority would be required to establish performance standards and how that would need to be structured.

Education and Outreach—The first step in promoting green infrastructure is an aggressive and comprehensive education and outreach campaign for municipalities and counties. IEPA will work with our partners to design and deliver outreach. The IEPA will also use opportunities in administering our programs to promote the use of green infrastructure. Over the next 6 months, IEPA will identify and work with partners to design and deliver education and outreach on green infrastructure.

State Revolving Loan Fund (SRF) Funding—IEPA is already committed to using the Green Project Reserve for green infrastructure projects. There is a federal requirement for FY10 and beyond that a state reserve 20% of its annual capitalization grant for its SRF program to be directed toward green infrastructure, energy or water efficiency, or environmentally innovative projects. This is called the Green Project Reserve. IEPA is committed to educating municipalities and other eligible loan recipients about the value of green infrastructure and soliciting applications for green infrastructure projects to be funded through the Green Project Reserve.

In order to effectively pursue these objectives, further work is needed. IEPA's existing loan program rules do not have a prioritization approach for green infrastructure projects. Establishing this approach is needed to allow staff to credibly rank projects for funding. Similarly, the current rules do not identify a subsidization approach to offer a higher level of principal forgiveness or grants than for traditional projects. We are currently developing an Illinois Green Infrastructure Grants program (separate from the SRF program) to be implemented in FY11 that will yield a prioritization approach that could also be used for ranking green infrastructure projects under the SRF program. Further, IEPA has a Clean Water SRF Advisory Committee which is actively working on updating many aspects of the existing SRF program. IEPA will use this Advisory Committee to help decide the degree of subsidization appropriate for SRF funding of green infrastructure projects under the SRF Green Project Reserve.

Working with County and Municipal Stormwater Management Agencies—IEPA's role is to promote green infrastructure as a cost effective tool for reducing water pollution caused by stormwater and improving water quality in urban and urbanizing areas. It is not IEPA's role to recommend how local government funds their activities. Therefore, IEPA is eager to work with local officials on implementing state goals for managing stormwater to improve water quality through their existing, new or improved local programs and ordinances. But how to fund such programs will remain a local decision.

I appreciate your consideration of these recommendations. Any questions can be directed to Marcia Willhite at (217)782-1654.

Very truly yours,

Doug Scott

Douglas P. Scott
Director

USING GREEN INFRASTRUCTURE TO MANAGE URBAN STORMWATER QUALITY: A Review of Selected Practices and State Programs

A DRAFT REPORT TO
THE ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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June 24, 2010

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American Recovery and Reinvestment Act of 2009

TABLE OF CONTENTS

ABSTRACT

Green infrastructure practices, for purposes of this study, are urban stormwater management techniques that rely on natural systems to retain more stormwater on-site through infiltration, evapotranspiration and harvesting for reuse. Implementing green infrastructure practices helps attenuate nutrients and other pollutants and reduce runoff volumes and peak flows. Based on our review of peer-reviewed scientific reports and articles, we found that, on average, many of these practices are as effective as conventional on-site detention basins in reducing total suspended solids and total nitrogen being discharged to waterways and that they can also reduce runoff volumes and peak flows discharged to urban streams, reducing erosion, sedimentation and flood risks. Using an economic model, we also found that using green infrastructure can result in substantial savings in both construction and life-cycle costs when compared to using conventional infrastructure to manage runoff in suburban, urban residential and commercial projects. Research addressing the valuation of ecosystem services also suggests that using green infrastructure can provide significant indirect economic benefits, as well, by increasing the amount of open space, vegetation, habitat and groundwater recharge occurring in developed areas. Since there is considerable experience in using green infrastructure in northeastern Illinois and in five other states we surveyed -- and since green infrastructure is already required under the state‘s General NPDES Permit No. ILR40 (―the MS4 permit”) -- we conclude that promoting the greater use of these practices would be a cost-effective way for Illinois to improve urban stormwater management programs and the water quality of our lakes and streams. It would have the additional benefit of helping municipalities covered by the MS4 permit to meet their legal responsibilities.

Based on these findings, we recommend that IEPA consider the following:

- Adopt a set of state-wide minimum volumetric standard for urban runoff, which would vary based on site conditions;
- Phase-in green infrastructure practices over a number of years, such as by adopting a portfolio standard similar to the one already being used by Illinois for renewable energy;
- Implement these practices in all new development, in redevelopment and major maintenance, repair and replacement activities undertaken by both public and private parties;
- Earmark funding for green infrastructure projects in state revolving loan funds, and develop a simple and transparent method for prioritizing these projects; and
- Encourage county and municipal stormwater management agencies to charge fees for providing stormwater management services, including managing and maintaining stormwater facilities, with the use of green infrastructure practices treated as a credit against such fees. Periodic performance monitoring and reporting should be required to retain any credit earned for using green infrastructure practices.

EXECUTIVE SUMMARY

I. INTRODUCTION

Stormwater discharges from urbanization remain a significant water quality issue in Illinois. Impervious surfaces, such as the roofs, alleys, roads, sidewalks and parking lots characteristic of urban development, change the hydrology of cities compared with undeveloped areas. Rain is unable to infiltrate on site, and the resulting stormwater becomes runoff. Runoff and flooding contributes to erosion, combined sewer overflows, sedimentation, and nonpoint source pollution and threatens human and ecosystem health. At the same time, the lack of infiltration prevents our groundwater resources from being recharged, which in turn reduces the ability of the aquifers to contribute to and maintain the baseflow rates and water levels of our urban lakes and streams.

Our conventional stormwater systems – structures such as curbs and gutters, storm sewers and detention ponds – are inadequate to handle our future (and in many places, current) stormwater management needs. According to the Illinois Environmental Protection Agency (IEPA 2009), 1,218 stream miles are already impaired by urban runoff and storm sewer discharges. The National Research Council (2009) and the Center for Watershed Protection both found a direct relationship between urban land cover and the biological condition of downstream receiving streams, confirming that the alterations in hydrology caused by urbanization poses severe threats to the nation‘s waterways, and suggested that ―a number of additional actions, such as conserving natural areas, reducing hard surface cover (e.g., roads and parking lots), and retrofitting urban areas with features that hold and treat stormwater are recommended."

Green infrastructure practices use natural systems to manage urban stormwater discharge to waterways through preserving and mimicking natural pre-development hydrology.[1] Green infrastructure practices address the specific stormwater management goals of reducing runoff flow rates and minimizing the pollutant loads entering waterways, the same goals addressed by conventional stormwater infrastructure. But it also offers additional valuable community benefits not provided by conventional infrastructure, such as groundwater recharge, runoff volume reduction, improved air quality, temperature moderation and associated energy cost savings, increased open space for recreation and wildlife habitat and increased land values. Green infrastructure can be applied on the site, neighborhood, or regional scales. On the regional scale, green infrastructure can be an interconnected network of natural areas. It includes the floodplains, wetlands and other natural and constructed areas that use predevelopment hydrological systems to store, infiltrate and evaporate large quantities of stormwater, protecting developed areas from

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[1] Section 5 of PA 96-0026 defines "green infrastructure" in part as "any storm water management technique or practice employed with the primary goal of preserving, restoring, or mimicking natural hydrology. Green infrastructure includes, but is not limited to, methods of using soil and vegetation to promote soil percolation, evapotranspiration, and filtration." Green infrastructure practices have also been called "best management practices (BMPs)," "stormwater control measures (SCMs)," or "low-impact development (LID) practices" by various practitioners. We deem all these phrases to be functionally synonymous, and will employ the phrase "**green infrastructure practices**" in this report to describe any of the urban stormwater management techniques relying on natural systems to provide on-site stormwater infiltration, pollutant and nutrient attenuation, and volume and peak flow reductions.

flooding and preserving the quality of our waterways by buffering them from constructed impermeable surfaces. On the neighborhood scale, green infrastructure strategies include a variety development practices that increase the effective permeability of the area and which aim to preserve the natural hydrology of a site to the greatest extent possible. Green infrastructure used at the site level is similar and includes the practices set forth in Table ES-1.

Table ES-1: Description of Stormwater infrastructure Practices Assessed in this Study

Infrastructure	Description
Bioinfiltration	Vegetated systems designed to facilitate the infiltration of stormwater and remove pollutants through infiltration media and/ or vegetation uptake. Examples: bioretention areas, swales, infiltration basins, urban forests.
Permeable Pavement	Pavement which allows stormwater to infiltrate into underlying soil. Filters some pollutants.
Filtration	A variety of devices which actively or passively filter pollutants out of stormwater. Many are proprietary designs. Often used in conjunction with other green infrastructure or as retrofits to existing storm drains.
Green Roof	Roofs with a vegetated surface and substrate designed to reduce runoff through transpiration and evaporation and filter rainwater through media, vegetation, and geotextiles.
Constructed Wetland	Manmade wetland intended to intercept runoff, reduce peak flows, decrease runoff volume and mitigate pollution.

The use of natural areas, or green infrastructure practices, to replace or supplement conventionally-engineered urban stormwater management systems has gained considerable interest both within the United States and internationally.[2] Our report explores the science of green infrastructure practices and evaluates existing and potential policies, regulations and administrative tactics that could be adopted in the State of Illinois to promote the widespread, appropriate use of green infrastructure stormwater management strategies and techniques. Our research is intended to assist IEPA in evaluating and documenting the seven specific criteria mandated by section 15 of P.A. 96-0026, the ―Illinois Green Infrastructure for Clean Water Act," adopted by the Illinois General Assembly and signed into law on June 30, 2009.

II. THE EFFECTIVENESS OF GREEN INFRASTRUCTURE

We examined the effectiveness of green infrastructure by using data from peer-reviewed journals and comparing them other self-reporting databases, such as the U.S. Environmental Protection Agency's

[2] Reductions in stormwater runoff using green infrastructure principles have also been mandated for all federal facilities with footprints exceeding 5,000 square feet by section 438 of the Energy Independence and Security Act of 2007. Further, congressional recognition of the benefits of promoting green infrastructure practices is reflected in the American Recover and Reinvestment Act of 2009 (ARRA), where state Clean Water State Revolving Loan funding was expressly earmarked for green infrastructure, energy conservation and other innovative projects.

International Stormwater Best Management Practices Database.[3] Peer-reviewed studies have all undergone a critical evaluation by several experts in the field, and only studies that are able to stand up to this scrutiny are published. To assess the cost-effectiveness of green infrastructure, we used a literature review, data from past research and a green infrastructure economic model called the Green Values® Calculator, developed by the Center for Neighborhood Technology (CNT) to compare different urban stormwater management technologies – both green and conventional – over their useful lives.

Since sedimentation, nutrient enrichment and flooding are among the three biggest stormwater problems threatening ecosystem and human health, mitigation of total suspended solids (TSS), total nitrogen (TN), runoff volume, and peak flow were selected for comparison between types of green infrastructure. It is important to note that this analysis looked at green infrastructure practices separately, and not as potential supplements to conventional stormwater management structures.

Green infrastructure categories analyzed include on-site stormwater filtration systems, bioinfiltration infrastructure (including rain gardens, bioretention, biofiltration, bioswales, and grass swales), permeable pavement, green roofs, and constructed wetlands. After examining 57 peer-reviewed journal articles, some of which monitored more than one site (for a total of 173 sites), we found that green infrastructures generally reduced total suspended solids and total nitrogen, and decreased runoff volume and peak flow. We also identified in our recommendations emerging green infrastructure practices that have shown strong potential.

Green infrastructure works on average at least as well as conventionally-engineered detention and retention basins in reducing water pollution risks (see Figs. ES-1A and 1B, below). Green infrastructure practices are effective in reducing both stormwater peak flows and runoff volumes which, if unmanaged, increase flooding and sedimentation risks (see Fig. ES-1C). Among the significant benefits that green infrastructure offers are the volume control and water quality improvements that almost all these practice provide (and which may not be the case with conventional structures that focus on controlling stormwater release rates). Treatment trains, which combine multiple infrastructures in series, and drainage-basin scale approaches, which combine multiple infrastructures in parallel, may be even more effective than individual green infrastructure practices.

In terms of cost, CNT's Green Values Calculator shows that green infrastructure is frequently 5-30% less costly to construct and about 25% less costly over its life cycle compared with traditional infrastructure. These cost values assume that recommended maintenance is conducted on schedule and that green infrastructure is performing as expected; the same assumptions apply to gray infrastructure, however. In addition, green infrastructure allows for more flexibility in adapting to changes in conditions and/or knowledge, whereas once gray infrastructure is built, it becomes more costly to reverse or modify it.

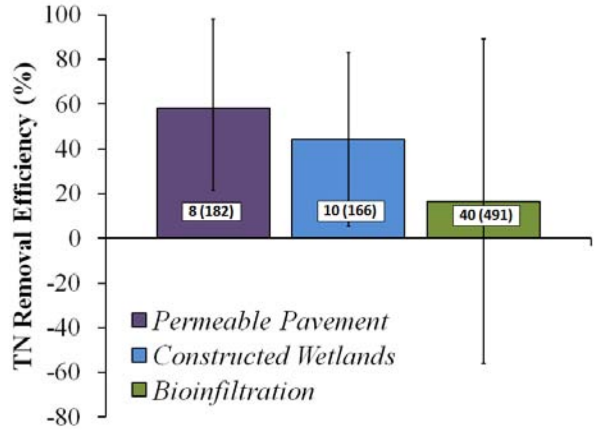
III. FUNDING GREEN INFRASTRUCTURE

The Clean Water Act's state revolving loan fund (SRF) program has always been available for use in helping to fund stormwater management projects, although the vast majority of SRF money has typically gone to wastewater treatment projects. The American Recovery and Reinvestment Act of 2009 (ARRA),

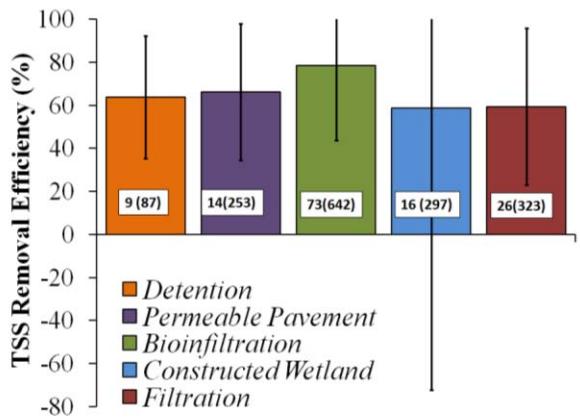
[3] http://www.bmpdatabase.org.

Figures ES-1, A-C: Weighted Mean Percentage Difference Between the Influent and Effluent for TN, TSS, Peak Flow, and Runoff Volume[4]

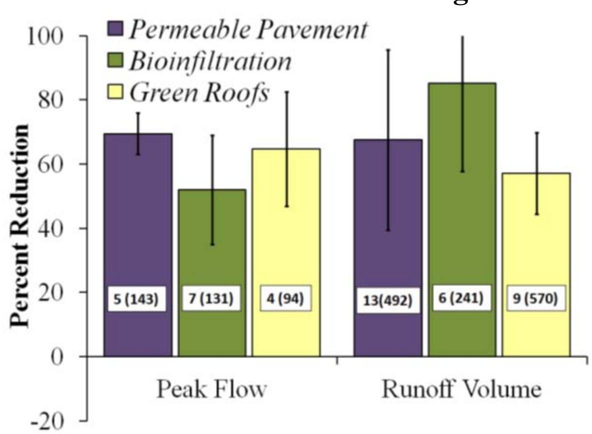
ES-1A) Effectiveness of Green Infrastructure in Removing Total Nitrogen.



ES-1 B) Effectiveness of Green Infrastructure in Removing Total Suspended Solids



ES-1 C) Effectiveness of Green Infrastructure in Reducing Peak Flows & Runoff Volumes



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[4] Means are weighted to remove bias caused by sites monitored for very few storm events. Error bars represent the weighted standard deviation, a measure of how close together the mean removal efficiency values are across all sites. Values on the bars are the number of sites included in the analysis and, in parentheses, the total number of storm events monitored. All data are from peer-reviewed literature on green infrastructure functional efficiency. Only infrastructure types with data from three or more sites are presented in each graph.

however, specifically required that states earmark 20% of their State Revolving Loan Fund (SRF) capitalization grants for innovative stormwater management practices such as green infrastructure, in addition to energy and water conservation initiatives (the Green Project Reserve). This requirement also applies to the FY10 regular SRF capitalization grant. Both ARRA and the FY10 regular SRF program also required states to provide a portion of their total SRF assistance in the form of subsidization (principal forgiveness or grants). Counties and municipalities qualifying for principal forgiveness could easily apply these more favorable funding terms to their green infrastructure projects

Notwithstanding the financial incentives provided by the Green Project Reserve, cost-effectiveness is one of the driving forces behind the increasing, widespread national adoption of green infrastructure practices. In general, national and Illinois examples indicate that properly scaled and sited green infrastructure can deliver equivalent hydrological management of runoff as conventional stormwater infrastructure at comparable or lower costs than conventional conveyance and treatment infrastructure. Moreover, green infrastructure also delivers additional economic, social and ecological benefits that are normally not monetized, contributing value to community health and vitality beyond their hydrologic performance.

When green infrastructure performance for volume control and water quality can offset regulatory requirements, i.e., when using green infrastructure counts as a credit against detention volume requirements, scenarios that evaluate green infrastructure life cycle costs also demonstrate savings in comparison to equivalent conventional infrastructure. For example, Table ES-2 below shows estimated costs and hydrological results of three development scenarios (a suburban subdivision, an urban townhouse project, and a commercial building) using CNT‘s Green Values® Calculator.

IV. CURRENT PRACTICES

We reviewed three types of current stormwater regulatory programs with performance standards incorporating green infrastructure concepts. First, we reviewed the Illinois statewide stormwater permit, known as the MS4 Permit. Second, we reviewed existing county and municipal stormwater management ordinances in Northeastern Illinois, the region with the greatest experience in using green infrastructure. Finally, we reviewed five state programs outside Illinois that have in place statewide stormwater management performance standards that expressly encourage or require the use of green infrastructure as a means of meeting those standards.

ILLINOIS MS4 PERMIT

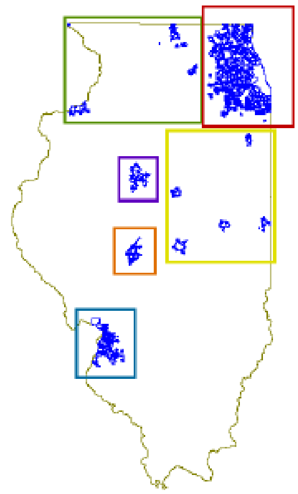
Under the Clean Water Act, states must issue National Pollution Discharge Elimination System (NPDES) permits for stormwater discharges from industrial, construction and municipal activities. The permit for small municipalities, those with fewer than 100,000 people, is known as the small municipal separate storm sewer system or ―MS4" permit. IEPA first issued its Phase II MS4 permit in 2003, designated as

Table ES-2: Comparison of Green and Conventional Stormwater Technology Costs for Three Case Studies

Case Study	Description	Green Components	Construction Cost Savings for Green Scenario	Green Construction Savings as % of Conventional	30-year Life Cycle Savings for Green Scenario	Green Life Cycle Savings as % of Conventional	Green Scenario Annual Hydrologic Benefits
Exurban Development	20-acre site with 14 homes on undeveloped land	Rain gardens, native vegetation, trees, and roadside swales	$190,800	31%	$507,800	24%	1,411,000 gallons reduced runoff through increased groundwater recharge
Blue Island Riverfront	3.0-acre site with 59 townhomes on former parking lot	Rain gardens, permeable pavement, trees, and roadside swales	$91,900	23%	$168,600	29%	2,409,000 gallons reduced runoff to sewers
Chicago Center for Green Technology	3.3 acre site with office building, parking and wetland on former industrial land	Partial green roof, cisterns, vegetated swales, gravel parking lot, wetland and native vegetation	$18,100	4%	$161,500	20%	2,468,000 gallons reduced runoff

—General NPDES Permit No. ILR40.”[5] There are about 440 Illinois municipalities, townships and state agencies now subject to the permit, all concentrated in about six regions of the state (see Figure ES-2).[6]

Figure ES-2: Illinois MS4 Communities



In 2009, IEPA revised its MS4 general permit to require that permittees adopt —green infrastructure” stormwater management strategies and techniques as part of their programs. These revisions included requiring information on green infrastructure practices in education and outreach programs, the incorporation of green infrastructure techniques in stormwater management practices used during construction (including the construction and reconstruction of municipally-owned impervious surfaces, along with the training of municipal employees and contractors in green infrastructure practices). Post-construction storm water management must also incorporate green infrastructure strategies of infiltration, evapo-transpiration and harvesting for reuse, and must favor these strategies over conventional ones.

LOCAL PROGRAMS

We met with local officials in northeastern Illinois and surveyed local and county ordinances to identify stormwater management programs that employ green infrastructure practices. Our findings indicate that an important objective of most stormwater management ordinances is to limit the stormwater runoff rate to a prescribed maximum, typically through onsite detention storage and other best management practices (BMPs). Some ordinances also establish retention requirements, to permanently reduce the volume of stormwater runoff that enters the stormwater sewer conveyance systems. Some ordinances encourage or require the use of green infrastructure practices to meet these retention performance standards. These well-established local programs in northeastern Illinois can serve as models for other communities in Illinois that have to manage urban stormwater discharges under the state‘s MS4 permit program.

Local and county ordinances specify required storage volume based on the size of the development project and other factors, and require detention basins to limit the rate at which they release water. Required storage volume varies, although maximum release rates are relatively consistent throughout the region. These ordinances also address the use of green infrastructure practices to control runoff volume and water quality, but the requirements and level of detail in the ordinances‘ language on green infrastructure practices vary by county. These standards and practices are summarized in Table ES-2, below. A number of municipal stormwater ordinances and plans were also reviewed for greeninfrastructure implementation, due to existing green infrastructure interest and experience. These municipalities included the cities of Aurora, Chicago, and Crystal Lake and the village of Homer Glen.

[5] A “general permit” is essentially a regulation that applies to all regulated entities in a class of entities. Each permittee in the class must meet the exact same permit requirements.

[6] For the Illinois Environmental Protection Agency’s list of municipalities and townships currently holding MS4 permits, *see* http://www.epa.state.il.us/water/permits/storm-water/ms4-status-report.pdf.

We interviewed staff of the region's stormwater management agencies and the Illinois Department of Transportation to identify the most significant issues involving the implementation and administration of green infrastructure practices in the state, in order to better assess the transferability of these practices state-wide. During these discussions, the interviewees also identified what they believed were some potential barriers to further implementation of green infrastructure, although many of these concerns (such as site variability and maintenance) might apply equally to conventional stormwater infrastructure as well. These issues and barriers include:

- Difficulties in requiring and crediting green infrastructure practices against traditional detention requirements, given the diverse soils, cold winters and high urban densities in parts of the state;
- The specialized maintenance requirements of green infrastructure needed to ensure its long-term performance;
- Difficulty in funding and administering the installation and maintenance of green infrastructure (since it typically does not generate fees needed to retire bonds or repay loans from SRFs);
- Recognition that the benefits of increasing groundwater recharge by encouraging stormwater infiltration can also increase the risks of aquifer contamination; and,
- Perceptions about the poor aesthetics of low-impact design and natural landscaping, and, in some cases, the lack of political will to mandate green infrastructure practices on private property.

STATE PROGRAMS

Maine, Maryland, Minnesota, New Jersey, and Wisconsin all use statewide stormwater performance standards that go beyond the Clean Water Act's NPDES requirements and that also require or encourage the use of green infrastructure to meet those standards. These states can serve as models for Illinois. Table ES-4, below, summarizes the types of performance standards contained in these programs.

V. RECOMMENDATIONS

PERFORMANCE STANDARDS

IEPA should adopt, at the very least, a set of stormwater retention performance standards or volume control requirements that can vary according to the conditions at a particular site. Such performance standards have become the norm around the country, and are seen as the best method of reducing flooding and sewer overflows while improving water quality at the same time. In its 2008 Urban Stormwater Management report, the National Research Council recommended that "flow and related parameters like impervious cover should be considered for use as proxies for stormwater pollutant loading" because of the difficulty and expense of compliance monitoring urban stormwater for specific pollutants. A flow reduction requirement – such as retaining the first inch or half-inch of runoff on-site by using green infrastructure practices – is a stormwater management proxy that makes sense for Illinois, because (a) infiltration, evapotranspiration and harvesting stormwater for reuse are already accepted practices in Illinois that are effective in retaining stormwater on site and (b) reducing the volume of stormwater discharge with green infrastructure practices reduces the amount of pollution reaching ourorurban streams, while also reducing associated flood risks. Using one simple, clear performance standard also means that less training is needed and landowners have the freedom to choose a mix of different green infrastructure practices to meet the standard, based on their project design and site characteristics.

Table ES-3: Local and County Stormwater Ordinances in Northeast Illinois

Governing Body	Release Rate	Volume Control Mechanism	Water Quality Measures	Green Infrastructure Allowance
Draft Cook County	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	The first 1" of runoff to be retained on site	Infiltration and flow-through practices	Retention based practices, e.g. permeable pavements, infiltration basins and trenches are required to achieve volume control requirement
DuPage County	100-year, 24-hour: 0.10 cfs/acre	Requires BMPs be incorporated to the maximum extent practical	Requires BMPs to provide water quality benefits	Green Infrastructure, e.g. vegetated filter strips and permeable pavers are incorporated into a BMP Manual
Kane County	100-year, 24-hour: 0.10 cfs/acre	The first 0.75" of runoff to be retained below the primary gravity outlet of the site	Native wetland plantings required	Stormwater BMPs may be implemented in lieu of traditional detention practices for developments which require less than 1 ac/ft.
Kendall County	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	Hierarchy to minimize increases in runoff volumes and rates	Promotes retention and infiltration to provide water quality benefits	Promotes the use of BMPs and native plantings for increased infiltration and evaporation
Lake County	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	Runoff Volume Reduction Hierarchy	Runoff Volume Reduction Hierarchy and mechanical measures	Preserving natural infiltration is incorporated into the Runoff Volume Reduction Hierarchy through a number of BMPs
McHenry County	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	BMP Hierarchy to during site design incorporates practices which will reduce volume	Requires that a number of BMPs be evaluated for site design incorporation	Addressed in Conservation Design and Subdivision Ordinances that require the use of BMPs and use density bonuses for open space that is placed under conservation easements maintained by professional land managers
Will County	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	The first 0.75" of runoff to be retained below the site's primary gravity outlet	Utilize BMPs before discharging on to agriculture land	The Will County Subdivision Ordinance offers density bonuses for BMPs and the provision of open space
City of Chicago	Variable depending on development type and local sewer capacity	Capture the first 0.5" of runoff from impervious surfaces or reduce impervious surfaces by 15% from existing conditions	Requires BMPs for sites directly discharging to waters	Requires the use of BMPs, including green infrastructure, through volume control requirements and for sites directly discharging to waters

Table ES-4: Performance Standards in Reviewed State Programs

	Maine	Maryland	Minnesota (CRWD)	New Jersey	Wisconsin
Reduce impervious surface		X		X	
Volume control	X	X	X		X
TSS removal	X		X	X	X
Groundwater recharge		X		X	
Groundwater protection	X				X
Erosion & Sediment control	X	X	X	X	X
Detention release rates	X	X	X	X	
County water Resource Management plans			X		
County ordinance or model		X			X
Local plans			X	X	
Local ordinances or model		X	X	X	X
Maintenance	X	X		X	
Spill prevention	X				
Temperature Control	X				
Watershed Planning	X				

Other performance requirements that should be considered include those that are currently in use in other states and in some Illinois counties, such as the development of stormwater management plans, erosion and sediment control measures, detention release rates, removal of Total Suspended Solids, temperature reduction, groundwater recharge and protection, and long-term plans and agreements for the maintenance of stormwater management facilities. **Some flexibility is needed in developing a regulatory program using green infrastructure practices.** Because of variations in soils, infiltration rates, surficial geology, proximity to waterways, slopes structures and other physical factors affecting the amount and rate of runoff discharge and its environmental impacts, a state-wide ―one size fits all” will not work.

Illinois' green infrastructure standards should be phased-in over time, to enable communities to develop the training and experience needed to manage urban stormwater using green infrastructure practices. The planning and preparation for the wide-spread use of green infrastructure would be improved if communities were either encouraged or required to set long-term goals to gradually increase the amount of their existing impervious surfaces subject to the green infrastructure performance standard.

The process we recommend is based on the concept of a ―portfolio standard," similar to the one adopted by Illinois to phase-in a gradually larger portion of renewable energy as part of its mix (or portfolio) of energy resources, with an increasing percentage of the state's energy budget being met by renewable energy until a target percentage (25%) is reached at some target date (2025). **We recommend that IEPA work with county and local officials, stormwater agencies, drainage districts, soil and water conservation districts and others to initiate a process that establishes realistic annual goals for adopting green infrastructure practices statewide in a timely manner**. These collaborations should additionally identify the boundaries for the portfolio standards (i.e., whether they should coincide with a HUC-12 watershed or with county or municipal boundaries) and use a percentage of effective impervious area as a potential proxy for the adoption of green infrastructure practices.

Staff and financial resources must be dedicated to program elements that create economic incentives and train county, municipal, stormwater management agency and drainage district staff in using green infrastructure practices until their use not only is accepted by county and municipal staff and within the development community but becomes the standard for stormwater management programs statewide. **Illinois should fund staff and other resources needed to bring green infrastructure and its benefits into practice in all communities.**

ADMINISTRATION

The National Research Council recommends that urban stormwater should best be managed on the watershed level, rather than on the local scale. In Illinois, counties are the governmental units whose jurisdictions best correspond to watershed-scaled management, so **we recommend that IEPA rely on the counties to develop appropriate rules and ordinances to locally administer the performance standards established at the state level** and work directly with municipalities to promote the use of green infrastructure to meet those standards and their other MS4 program responsibilities. **The state should also provide adequate resources to meet these responsibilities or authorize the counties to charge fees sufficient to cover the costs of the program.** Counties also have, or can readily develop, the technical expertise necessary to train municipal staffs on how best to use green infrastructure as a component of their local urban stormwater management programs and can also turn to the existing regional expertise that may be available to assist them in promoting green infrastructure practices.

This expertise includes the staffs of regional planning agencies, county stormwater management agencies, soil and water conservation districts, and drainage districts. County stormwater management agencies exist in all the collar counties of northeastern Illinois, while both soil and water conservation districts (which are currently revising the Illinois Urban Manual to embrace green infrastructure) and drainage districts are also highly respected agencies in more rural areas of the state. **We therefore recommend that more financial resources (through grants and stormwater management fees) also be provided to these agencies and districts** to assist the counties in their stormwater management responsibilities. Counties should consider entering into intergovernmental agreements with these other agencies and districts to provide technical services, training and monitoring the use and effectiveness of green infrastructure for urban stormwater management.

APPLICABILITY

We recommend that the stormwater retention performance standard first apply to all projects and entities currently subject to a NPDES stormwater permit in Illinois, including MS4s of all sizes, industrial sites, and construction projects. **Over time, applicability of the standards should be expanded to include more urban and suburbanizing areas, based on the density of impervious surfaces, rather than on population**. At the watershed level, studies show that it is very difficult to maintain predevelopment stream quality when watershed development exceeds ten to 15 percent impervious cover. Using the percentage of impervious cover within a watershed to guide the state's stormwater management efforts would have the dual benefits of (a) applying the standards first to those areas most significantly affecting water quality and (b) encouraging a limitation on new impervious surfaces, which will have many of the same benefits as applying the standards.

We also recommend that the standards apply to existing as well as new development, to publicly-owned as well as private property. For example, there should be a commitment by government agencies to apply the standards to manage stormwater runoff whenever public infrastructure undergoes significant maintenance, repair or replacement, or when private development is substantially improved or redeveloped. State agencies and regional governments should also set an example by using green infrastructure in their construction and maintenance activities, to help build awareness and experience with these practices. Green infrastructure retrofits are already part of the Illinois MS4 program. The state should develop guidance to ensure that green infrastructure practices are used appropriately to work most effectively in reducing pollution, erosion and sedimentation, and flood risks, while providing the additional benefits of healthier, cooler communities, improved habitat and aquifer recharge opportunities.

FUNDING GREEN INFRASTRUCTURE

The Clean Water Act's state revolving loan fund (SRF) program has always been available for use in helping to fund stormwater management projects, although the vast majority of SRF money has typically gone to wastewater treatment projects. In fact, in Illinois, the statutory language that originally gave IEPA authority to administer the SRF program specifically limited eligibility only to wastewater projects. The American Recovery and Reinvestment Act of 2009 (ARRA), however, specifically earmarked 20 percent of its state capitalization grants to State Revolving Loan Funds (SRFs) for innovative stormwater management practices such as green infrastructure (the Green Project Reserve) in addition to energy and water conservation initiatives, adding a mandate that some of the money be provided as grants as opposed to low interest loans. This required the Illinois legislature to amend the IEPA authority language to expressly include such grant funding.

The Fiscal Year 2010 federal appropriation bill passed in October 2009 provided another round of exceptionally large water infrastructure grants to states and repeated the mandates for green infrastructure projects and grants. We understand, based on comments made by U.S. Environmental Protection Agency officials and the current draft of the Fiscal Year 2011 federal appropriation bill, that Congress intends to continue these two requirements for the foreseeable future in its annual appropriations. To make best use of these federal funds, **IEPA must adopt a clear prioritization system that determines which municipal green infrastructure projects will receive funding under its earmarked Green Project Reserve**. This system should be designed to encourage applications for a wide variety of green infrastructure project all over the state. Training and outreach should also be provided to help agencies concerned with stormwater and wastewater to understand how to develop acceptable green infrastructure projects and apply for such grants.

Historically, the SRF program has funded only about ten percent of the water infrastructure needs of the applicants. Therefore, the SRF cannot be relied on for funding a major portion of either the sorely-needed upgrades to existing conventional wastewater and stormwater infrastructure or the green projects that will be completed in the next few years to supplement that infrastructure. Instead, the State of Illinois and its counties and municipalities should be hard at work developing additional funding sources for these projects. For example, the responsibility for stormwater management on private land should begin with the landowners, by requiring all developers to meet the performance standards described above, and to encourage and credit the use of green infrastructure practices to meet these standards in their projects.

The costs of constructing and maintaining stormwater infrastructure on private property should be borne by the landowner – by the developer during construction and by the occupants after construction. The residual runoff from such property should continue to be managed by local government. However, instead of using the general tax revenues to fund stormwater infrastructure, **the state should encourage local governments to adopt a stormwater management fee system, in which rate-payers are given clear information on the costs associated with such infrastructure.** This should ensure that polluted runoff is not treated as an economic externality, and that landowners causing the runoff pay for the treatment and management of runoff flow and volume needed to protect our urban streams – in the same way that landowners pay for the connection fees and sewage treatment charges for pollution discharged directly into streams by publicly-owned sewage treatment plants. **Green infrastructure practices should be eligible for appropriate performance credit against stormwater fees to encourage their adoption.** If green infrastructure practices do not receive credit, land managers are less likely to utilize them because they would represent additional cost above otherwise required and compliance-credited measures.

MAINTENANCE

Green infrastructure practices – like conventional ―grey” stormwater infrastructure -- require maintenance to ensure continued effectiveness over time and performance as initially designed. **We recommend that communities which encourage or require the use of stormwater infrastructure, including green infrastructure practices, employ restrictive covenants to ensure that all stormwater infrastructure used on private property is adequately maintained.** These agreements should be filed in land records, so they are perpetual and subsequent owners know their responsibilities.

If a fee system established to fund stormwater management allows credits for the use of green infrastructure practices, as we recommend above, **periodic performance monitoring and compliance reporting (perhaps every 3-5 years) should be included with other green infrastructure measures to promote long-term reliability and performance**. Such monitoring and reporting will ensure that the green infrastructure is still performing as designed and will monitor compliance with stormwater credit requirements. **The State or municipalities should establish an easement authority to enter properties receiving compliance credit for green infrastructure practices,** and to charge responsible parties who neglect to maintain their green infrastructure features, similar to the nuisance regulations currently used to prevent neglect of conventional landscape maintenance. Under such easements, based on the compliance reports, municipalities could enter the property to undertake maintenance if the landowner is unwilling or unable to do so, and then to charge the landowner or Home Owners Association for these services.

As part of our recommendation that the State encourage regional and local governments to utilize a stormwater fee system instead of general tax revenues for stormwater management, these **governments should also consider establishing stormwater utilities with budgets that are independent of wastewater and drinking water budgets**. An alternative to landowner maintenance is for such a utility to be given the right and obligation to maintain all stormwater facilities, whether on private or public land, and charge the landowners for the service.

EMERGING GREEN INFRASTRUCTURE PRACTICES

Published, peer-reviewed literature and the technical reports and studies comprising the ―gray literature" (including many entered into the U.S. EPA's International Stormwater BMP Database) find that green infrastructure practices are as effective as conventional stormwater facilities in reducing flood and pollution risks, with little uncertainty**. Some emerging practices have already shown great promise and should be considered for implementation, as they may already be readily applicable.** These include the use of urban trees for pollution attenuation, street sweeping to manage sediment, and more education and training in the use and design of green infrastructure practices. These practices can reduce runoff volume and improve stormwater quality by an additional 15-20 percent.

Published data are absent for numerous types of green infrastructure, important details regarding infrastructure design and the size of the drainage area treated by the green infrastructure are often missing from published accounts, and little information is available about the use of multiple infrastructure in combination in treatment trains or across watersheds. **There is also a need for more consistent reporting of green infrastructure performance**. Monitoring green infrastructure performance and submitting the data to the BMP Database will provide a larger and more consistent dataset and will assist practitioners with selecting the most appropriate infrastructure for each project. We recommend that the State select appropriate projects and that the monitoring results from the use of green infrastructure in these project be provided to the BMP Database. Over the next few years, **IEPA should work with county and local officials, regional stormwater management agencies, soil and water conservation districts, and drainage districts to begin to develop uniform protocols for the green infrastructure compliance monitoring and state-wide guidance for the reporting requirements**.

CHAPTER I: INTRODUCTION

The use of natural areas, or green infrastructure practices, to replace or supplement conventionally-engineered urban stormwater management systems has gained considerable interest both within the United States and internationally.[7] Our report explores the science of green infrastructure practices and evaluates existing and potential policies, regulations and administrative tactics that could be adopted in the State of Illinois to promote the widespread, appropriate use of green infrastructure stormwater management strategies and techniques.

Our research is intended to assist the Illinois Environmental Protection Agency (IEPA) in evaluating and documenting the specific criteria mandated by section 15 of P.A. 96-0026, the ―Illinois Green Infrastructure for Clean Water Act," adopted by the Illinois General Assembly and signed into law in July, 2009. Specifically, Section 15 requires the agency to examine and report back to the General Assembly by June 30, 2010, their recommendations on the following seven issues:

a. The nature and extent of urban storm water impacts on water quality in watersheds in Illinois;

b. Potential urban storm water management performance standards to address flooding, water pollution, stream erosion, habitat quality, and the effectiveness of green infrastructure practices to achieve such standards;

c. The prevalence of green infrastructure use in Illinois;

d. The costs and benefits of green versus grey infrastructure;

e. Existing and potential new urban storm water management regulatory programs and methods and feasibility of integrating a State program with existing and potential regional and local programs in Illinois

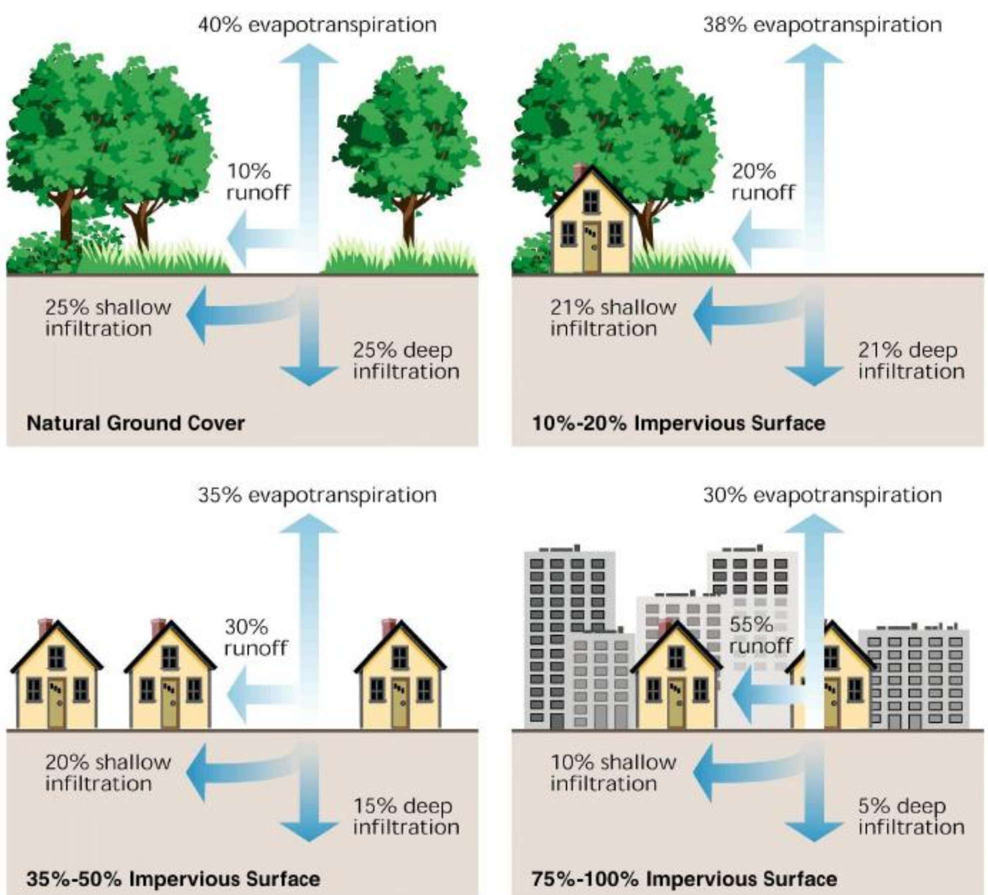
f. Findings and recommendations for adopting an urban storm water management regulatory program in Illinois which includes performance standards and encourages the use of green infrastructure to meet those standards; and

g. The feasibility and consequences of devoting 20% of the Water Revolving Fund to green infrastructure, water and energy efficiency improvements, and other environmentally innovative activities on a long-term basis.

[7] Reductions in stormwater runoff using green infrastructure principles have also been mandated for all federal facilities with footprints exceeding 5,000 square feet by section 438 of the Energy Independence and Security Act of 2007. Further, congressional recognition of the benefits of promoting green infrastructure practices is reflected in the American Recover and Reinvestment Act of 2009 (ARRA), where state Clean Water State Revolving Loan funding was expressly earmarked for green infrastructure, energy conservation and other innovative projects.

Stormwater discharges from urbanization remain a significant water quality issue in Illinois. Impervious surfaces, such as the roofs, alleys, roads, sidewalks and parking lots characteristic of urban development, change the hydrology of cities compared with undeveloped areas (Figure 1). Rain is unable to infiltrate on site, and the resulting stormwater becomes runoff. Runoff contributes to erosion, combined sewer overflows, sedimentation, and nonpoint source pollution and threatens human and ecosystem health. At the same time, the lack of infiltration prevents our groundwater resources from being recharged, which in turn reduces the ability of the aquifers to contribute to and maintain the flow rates and water levels of our urban lakes and streams.

Fig. 1: Changes in Hydrology from Increased Impervious Surface



Source: CMAP, Stormwater Management Strategy Report (2008)

Recent research suggests that urban streams begin to become impaired when the impervious surface within a watershed exceeds ten percent of the watershed's land area (Schueler et al. 2009, Center for Watershed Protection 2003). As the Center for Watershed Protection (2003) notes (p. 1):

> —When evaluating the direct impact of urbanization on streams, researchers have emphasized hydrologic, physical and biological indicators to define urban stream quality. In recent years, impervious cover (IC) has emerged as a key paradigm to explain and sometimes predict how severely these stream quality indicators change in response to different levels of watershed development. The Center for Watershed Protection has integrated these research findings

> into a general watershed planning model, known as the impervious cover model (ICM). The ICM predicts that most stream quality indicators decline when watershed IC exceeds 10%, with severe degradation expected beyond 25% IC."

Especially in our urbanized areas, our conventional stormwater systems are inadequate to handle our future (and in some places, current) stormwater management needs. According to the IEPA, 1,218 stream miles are already impaired by urban runoff and storm sewer discharges (IEPA 2009). The National Research Council (2008) also found a direct relationship between urban land cover and the biological condition of downstream receiving streams, confirming that the alterations in hydrology caused by urbanization poses severe threats to the nation‘s waterways, and recommended that ―a number of additional actions, such as conserving natural areas, reducing hard surface cover (e.g., roads and parking lots), and retrofitting urban areas with features that hold and treat stormwater are recommended." Figure 2, below, summarizes the Center for Watershed Protection‘s most recent, reformulated Impervious Coverage Model, showing that environmental impacts begin to become pronounced and water resources begin to become degraded when imperviousness reaches roughly ten percent within a watershed.

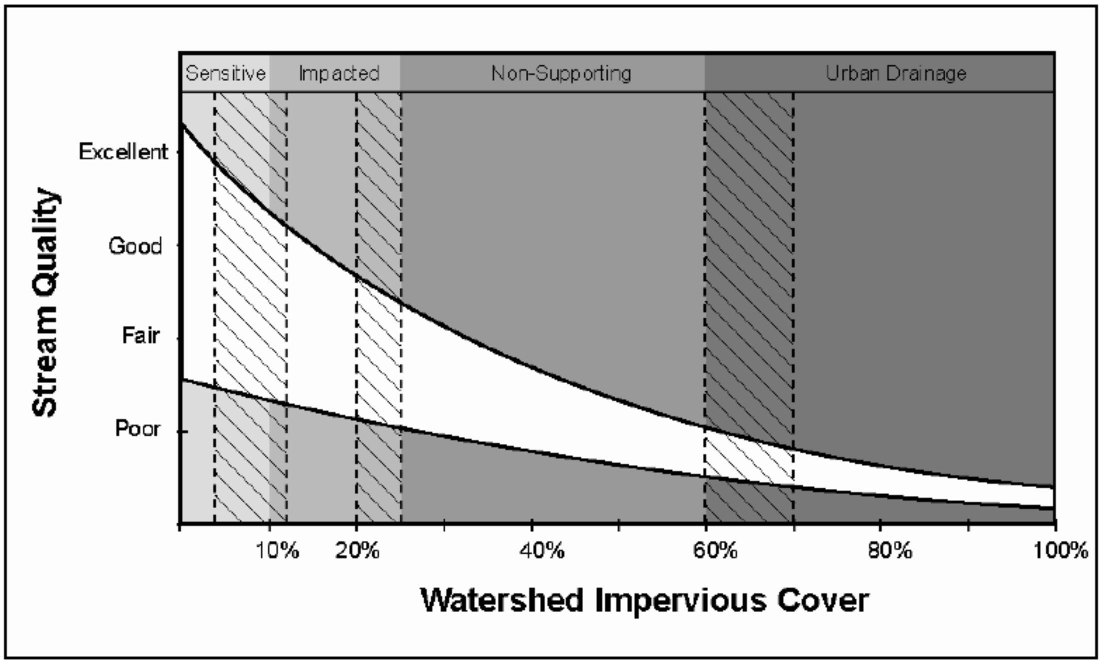
Conventional stormwater management infrastructure consists of the integrated systems of curbs and gutters, stormwater grates and catch basins, stormwater sewer systems, oil and grit separators, detention and retention basins (both dry and wet bottom), and outfalls and control structures, all of which are designed to catch and manage runoff, the precipitation or snowmelt that cannot naturally infiltrate into the ground because development activity has changed the natural hydrology of a site (by grading, removing vegetation, compacting the soils, or paving over the ground). The principal design function of these conventional systems is to reduce flood risks by allowing runoff to be discharged to adjacent waterways over a longer period of time, which reduces the stream levels, peak flows and the velocity of the stream-flow (which can erode stream banks). If the runoff is detained for a sufficiently long time in the conventional system before being discharged, then some attenuation of the pollutants carried by the stormwater is possible, by being settled out of the standing water, by being taken up by plants within the basin, or by natural processes within the soils (e.g., by filtration, sorption or ion exchange).

Green infrastructure practices, in contrast, use natural systems designed to manage urban stormwater discharge to waterways through preserving and mimicking natural pre-development hydrology.[8] Green infrastructure practices address the specific stormwater management goals of reducing runoff flow rates and minimizing the pollutant loads entering waterways, the same goals addressed by conventional stormwater infrastructure. But it also offers additional valuable community benefits not provided by conventional infrastructure, such as groundwater recharge, runoff volume reduction, improved air quality, temperature moderation and energy cost savings, increased open space for recreation and wildlife habitat

[8] Section 5 of PA 96-0026 defines "green infrastructure" in part as "any storm water management technique or practice employed with the primary goal of preserving, restoring, or mimicking natural hydrology. Green infrastructure includes, but is not limited to, methods of using soil and vegetation to promote soil percolation, evapotranspiration, and filtration." Green infrastructure practices have also been called "best management practices (BMPs)," "stormwater control measures (SCMs)," or "low-impact development (LID) practices" by various practitioners. We deem all these phrases to be functionally synonymous, and will employ the phrase "**green infrastructure practices**" in this report to describe any of the urban stormwater management techniques relying on natural systems to provide on-site stormwater infiltration, pollutant and nutrient attenuation, and volume and peak flow reductions.

and increased land values. Landscaping and design guidelines for using green infrastructure to improve wildlife habitat are presented in Appendix I.

Fig. 2: The Reformulated Impervious Cover Model



Source: Schueler et al. 2009

Green infrastructure can be applied on the site, neighborhood, or regional scales. On the regional scale, green infrastructure is an interconnected network of natural areas. It includes the floodplains, wetlands and other natural and constructed areas that use predevelopment hydrological systems to store, infiltrate and evaporate large quantities of stormwater, protecting developed areas from flooding and preserving the quality of our waterways by buffering them from constructed permeable surfaces. On the neighborhood scale, green infrastructure strategies include green streets and alleys, with trees, bioswales, curb-cuts, porous pavement and cisterns that increase the effective permeability of the area and which aim to preserve the natural hydrology of a site to the greatest extent possible. Green infrastructure used at the site level is similar and includes the practices set forth in Table 1. Some examples of what these practices look like when constructed and in place are presented in Appendix II. These examples are drawn largely from green infrastructure in use in the Chicago metropolitan region and more information about the design and effectiveness of these practices is also presented in this Appendix.

To best protect our water resources, it is necessary to manage both the quantity and quality of the runoff entering our urban streams. The combined sewer overflow problems generated by our older, urban combined sewer systems best show the need to manage both of these impacts. Our modern, separate conventional stormwater sewer facilities are primarily designed to manage stormwater quantity issues, especially the large volumes of stormwater generated by relatively extreme events – often a 10-year, a 25-year or a 100-year storm – that pose significant flooding risks. This means that they tend to be oversized and overbuilt to manage the typical ―everyday” storms comprising most of our precipitation events, while often not providing the retention times needed to attenuate some pollutants. In contrast, green infrastructure is most effective, and we believe significantly more cost-effective if properly scaled, in managing the stormwater impacts generated by our ―everyday” rainstorms, besides providing substantially more ecological benefits (such as improved habitat and carbon sequestration) and environmental services (such as temperature moderation, air quality improvement, groundwater recharge and more open space) than do traditional infrastructure facilities. Because of the lower cost and increased flexibility of many green infrastructure practices, they may also play a more important role in

Table 1: Description of Stormwater Infrastructure Practices Assessed in this Study

Infrastructure	Description
Bioinfiltration	Vegetated systems designed to facilitate the infiltration of stormwater and remove pollutants through infiltration media and/ or vegetation uptake. Examples: bioretention areas, swales, infiltration basins, urban forests.
Permeable Pavement	Pavement which allows stormwater to infiltrate into underlying soil. Filters some pollutants.
Filtration	A variety of devices which actively or passively filter pollutants out of stormwater. Many are proprietary designs. Often used in conjunction with other green infrastructure or as retrofits to existing storm drains.
Green Roof	Roofs with a vegetated surface and substrate designed to reduce runoff through transpiration and evaporation and filter rainwater through media, vegetation, and geotextiles
Constructed Wetland	Manmade wetland intended to intercept runoff, reduce peak flows, decrease runoff volume and mitigate pollution

addressing the future hydrologic impacts of increased climate change variability, when used in combination with our conventional stormwater management facilities to expand or supplement their storage and treatment capacity should today‘s rarer storm events become tomorrow‘s everyday storms.

In developing this study, we not only reviewed the current literature on green infrastructure practices in urban stormwater management but also relied on information provided by a large number of stormwater management experts, who freely shared with us their insights about and experiences with the use of green infrastructure. They are listed in Appendix II and in Chapter IV. Thirty-six stormwater managers and professional engineers working in state, county and local agencies, stormwater management commissions, and consulting firms in northeast Illinois – all knowledgeable about the design, use and application of green infrastructure practices – also periodically met with us to review our research design and methodologies, our interim findings and our proposed recommendations. Their advice and suggestions (offered at three meetings held in Chicago on December 8, 2009, and on April 28 and May 3, 2010) were an important resource to us. Equally important were the comments received from members of the public who attended a green infrastructure stakeholder meeting held by IEPA in Springfield on January 12, 2010, many of whom also submitted their comments with respect to a draft of the study report that was posted on IEPA‘s website in early June, 2010. We greatly appreciate their contributions.

CHAPTER II: THE EFFECTIVENESS OF GREEN INFRASTRUCTURE

Stormwater management is a challenge faced by urban and agricultural development at all scales. As the percent of impermeable cover within a watershed increases, stormwater volume, peak flow and concentration of nonpoint source pollutants increase (USEPA 1983). In urban areas, traditional gutter and storm sewer systems are inadequate for reducing the quantity of stormwater or decreasing pollutant loads (Hood et al. 2007). In agricultural or rural areas, drainage systems quickly channel large volumes of water, sediment, and dissolved pollutants to waterways (Nelson 2002). In both urban and rural settings, inadequate stormwater management can lead to flooding, erosion, and impaired aquatic habitats (Finkenbine et al. 2000).

Best management practices (BMPs), such as detention and retention basins, are typically recommended by planning agencies to control discharge rates in developed and developing areas. However, the effectiveness of such measures is very sensitive to context and the identification of ―best” can be difficult. Moreover, many common practices ignore the broader interactions in the hydrological cycle and thus fail to support other functions of a sustainable system, especially groundwater recharge.

The need for improved stormwater management has led to increased interest in the use of green infrastructure and a number of state and local governments are actively promoting the use of green infrastructure (USEPA 2000). In particular, the present review is motivated by legislation being proposed by the state of Illinois that would incorporate green infrastructure into urban areas to preserve pre-development levels of runoff (Illinois Public Act 96-0026). It is our intent to synthesize data on green infrastructure effectiveness to inform stormwater management policy and encourage the informed adoption of green infrastructure where appropriate.

At the regional scale, green infrastructure is broadly defined as a network of green spaces that provide natural ecosystem function and benefits to people through recreation, aesthetics and ecosystem services (Schilling and Logan 2008). In the context of stormwater management at the neighborhood scale, green infrastructure includes low impact development (LID) strategies implemented at the site level, such as vegetated swales, green roofs and permeable pavement, which aim to minimize the generation of urban stormwater runoff and associated pollution by using and mimicking natural systems to collect, treat, and infiltrate rain where it falls (Montalto et al. 2007).

Green infrastructure can facilitate stormwater management in several ways and at different scales. Runoff volume can be reduced through infiltration in soils, evaporation, and evapotranspiration by plants (Hatt et al. 2009). Mechanisms for pollution removal include sedimentation, plant uptake (Vought et al. 1994), filtration (Urbonas 1999), biofiltration (Hatt et al. 2007), biodegradation, and retention (Volesky and Holan 1995). Biofiltration encompasses a wide variety of engineered systems with specially selected media and vegetation combinations designed primarily to filter but also to infiltrate stormwater (Hatt et al. 2009). Green infrastructure such as swales or constructed wetlands are designed to achieve both runoff quantity and quality goals, while others are primarily designed to improve water quality (e.g. filters) or to reduce runoff volume (e.g. rain barrels) (USEPA 2000, Larson and Safferman 2008). We also examined emerging practices, such as urban forestry, discussed in greater detail in our recommendations. Our goal is to consolidate and analyze effectiveness data for all categories of green infrastructure from peer-reviewed literature and inform decisions on green infrastructure adoption.

Does green infrastructure work effectively to reduce the impacts of stormwater? This is probably the most important question which must be addressed in a systematic manner prior to implementation of a statewide green infrastructure policy. To answer this question, we examined data in published, peer-reviewed studies to evaluate the effectiveness of green infrastructure. Such studies have all undergone a critical evaluation by several experts in the field, and only studies that are able to stand up to this scrutiny are published. We also looked at some of the data from sources that were not rigorously peer-reviewed, including the U.S. Environmental Protection Agency's International Stormwater Best Management Practices Database.[9]

Since our aim is to inform policy with science, our sources of data include only compiled peer-reviewed studies that can provide statistical rigor to identified outcomes. There was sufficient published data to examine effectiveness of buffers, constructed wetlands, bioinfiltration systems, filtration systems, permeable pavement and green roofs, and to compare them to traditional stormwater approaches like retention and detention basins. In addition to effectiveness, we examine potential sources of variability in the effectiveness of green infrastructure use, including design, size, influent pollution, geographical variation and climate, and maintenance. We further compare our findings to the US EPA/American Society of Civil Engineers (ASCE) International Stormwater Best Management Practices Database (BMP Database), a prominent resource for BMP practitioners, to identify commonalities, disparities, and shortcomings in both sources of information. Finally, we discuss the policy implications of our findings. Our recommendations in Chapter V identify important data gaps that should be filled to inform policy-making.

Indicators of Effectiveness

We selected four relevant and widely used factors to compare the effectiveness of green infrastructure: runoff volume, peak flow, total suspended solids, and total nitrogen. Each of these factors is representative of common stormwater management challenges in urban areas. Runoff volume and peak flow are both measures of the quantity of runoff produced by a storm. The impervious surfaces that accompany urbanization lead to increases in runoff volume, or the amount of surface water resulting from a given storm event, and peak flow, which is the maximum runoff volume per unit time. Changes in runoff volume and peak flow are responsible for many of the negative impacts of stormwater (i.e. flooding, combined sewer overflows, erosion, low baseflow, and streambank entrenchment) (Finkenbine et al. 2000, Montalto et al. 2007). Because reducing runoff volume and peak flow is a fundamental goal for most green infrastructure, it is vital to include these metrics in this performance assessment. These two metrics have been suggested as key performance standards for green infrastructure and tools have been developed to predict how green infrastructure implementation will affect them. Calculators are available which estimate the impact of green infrastructure on peak flow and runoff volume (Center for Neighborhood Technology 2009), but ultimately an analysis of field data on green infrastructure effectiveness is needed to evaluate real-world performance capabilities and inform policy-making.

[9] http://www.bmpdatabase.org.

Runoff quantity measurements do not tell the full story of how green infrastructure benefit urban environments; therefore, we also compared effectiveness in terms of water quality. While dozens of chemicals are found in stormwater, it is prohibitively expensive to monitor all possible contaminants. As a result, agencies that regulate urban nonpoint source pollution typically use surrogate measures of water quality to manage the cost of stormwater monitoring (Wisconsin Department of Natural Resources 2002, Turner and Boner 2004). Two commonly used surrogate measures of water quality are total suspended solids (TSS) and total nitrogen (TN). Our analyses confirmed these are good integrators of water quality.

Total suspended solids, the amount of particulate matter suspended in water, is both easy to monitor and an important component of water quality (Horowitz 2009). Suspended solids in stormwater can cause sedimentation in rivers and streams and aid in the transport of heavy metals and phosphorous (Thomson et al. 1997, Kayhanian et al. 2007, Horowitz 2009). However, TSS is not highly correlated with dissolved pollutants, so removal of TSS through sedimentation and other techniques will not necessarily reduce concentrations of all metals and nutrients, especially dissolved forms of nitrogen and phosphorus (Bolton et al. 1991, Horowitz 2009).

A thorough evaluation of water quality should therefore include at least one pollutant which is found predominantly in dissolved form. We selected total nitrogen, the sum of the organic and inorganic nitrogen in a water sample, as a surrogate for dissolved pollutants. This is particularly important to monitor because excess nitrogen causes eutrophication and algal blooms, leading to reductions in dissolved oxygen and degradation of aquatic communities in riverine systems (Carpenter et al. 1998). Combined TSS, TN, peak flow and runoff volume are sufficient to represent threats to property and to ecosystem and human health caused by stormwater: sediment and associated particulate pollutants, dissolved nutrients, flow, and volume.

Sources of Data for Assessing Green Infrastructure Effectiveness

Our review focused on the five categories of green infrastructure for which sufficient published data exist to evaluate removal efficiency of TSS and TN and reduction of runoff volume and peak flow (see Table 1, supra). We used keyword searches on ISI Web of Knowledge to compile an initial database of articles containing these keywords that were published in October 2009 or earlier. Our initial database contained 490 peer-reviewed journal articles. We excluded articles which did not contain usable data on green infrastructure effectiveness, resulting in 236 articles which contained data. We excluded pilot studies and other research with no form of replication and those exclusively quantifying within-infrastructure characteristics such as the distribution of pollutants among sediment layers. Finally, we excluded those articles which did not specify the number of storm events monitored and those which included only pollutant load data, not pollutant concentration. Only a small number of articles from our initial database met these criteria, resulting in a sample size of 57 journal articles and 173 sites in our review. Some articles contained data on more than one type of green infrastructure practice. See Table 2.

Table 2: List of Green Infrastructure with Brief Descriptions and the Number of Individual Sites with Data on TN Removal Efficiency, TSS Removal Efficiency, Peak Flow Percent Reduction and Runoff Volume Percent Reduction[10].

Infrastructure	Total Sites	Total Articles	TN Sites	TSS Sites	Peak Flow Sites	Runoff Volume Sites	Definition
Bioinfiltration	77	16	40	69	7	6	Vegetated systems designed to facilitate the infiltration of stormwater and remove pollutants through infiltration media and/ or vegetation uptake. Examples: bioretention areas, swales, infiltration basins
Permeable Pavement	23	14	8	11	5	12	Pavement which allows stormwater to infiltrate into underlying soil. Filters some pollutants.
Filtration	26	8	N/A	26	N/A	N/A	A variety of devices which actively or passively filter pollutants out of stormwater. Many are proprietary designs. Often used in conjunction with other green infrastructure.
Green Roof	9	6	N/A	N/A	6	6	Roofs with a vegetated surface and substrate designed to reduce runoff through transpiration and evaporation and filter rainwater through media, vegetation, and geotextiles
Constructed Wetland	19	9	10	16	N/A	N/A	Manmade wetland intended to intercept runoff, reduce peak flows, decrease runoff volume and mitigate pollution

[10] Some articles include multiple sites and some sites had data for multiple parameters. N/A = not enough data available for analysis.

For each source, we extracted the number of infrastructures (or infrastructure configurations), the number of storm events, peak flow, runoff volume, TN, and TSS and their standard deviations. To simplify terminology throughout the paper, we used the term ―site” to indicate a single infrastructure configuration that was monitored over time, whether it was a set of all identical replicates in a laboratory study or a field site such as a permeable pavement installation, a bioswale, a single wetland, or a green roof.   Lab studies constituted 43% of sites and the remaining studies were conducted in the field (57% of sites).

From the extracted data we calculated percent reduction of volume and/or event mean concentration of TSS and TN, also termed ―removal efficiency”— a common, dimensionless measure of effectiveness. This approach normalizes variation due to the type of study or methods used (Hossain et al. 2005).   Raw data for each storm event were not available for most sites; however, average removal efficiencies are presented in Appendix III.

Weighted averages were used to avoid unwarranted biases in the data introduced by a small number of outlier data values. We calculated the weighted average reduction and weighted standard deviations for runoff volume and peak flow for each green infrastructure by the number of sites. This is different from the standard deviation calculation for TN and TSS, which incorporated between storm-event variability values (SD or variance) reported for sites.   In addition, weighted average runoff volume or peak flow reductions for permeable pavement, bioinfiltration and green roofs were also evaluated. We used a weighted variance equation which includes both between-storm-event and between-site variation to calculate standard deviations (Ledolter and Hogg 2009, Millsap and Maydeu-Olivares 2009) for our statistical analyses. All these methods ensure our metrics are readily scalable to consider issues of green infrastructure size, runoff volume and loads.

Green Infrastructure Performance

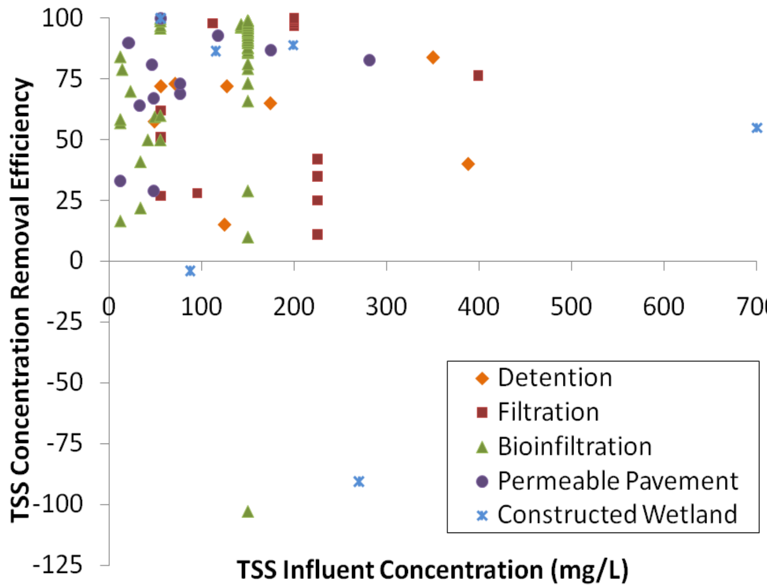
Influent concentrations of pollutants vary among sites and events and this variability can challenge the validity of removal efficiency as a useful metric to compare green infrastructure practices. There was no relationship between influent concentration and event mean concentration removal efficiency for TSS (Figure 3A) and TN (Figure 3B), validating the use of removal efficiency to assess and compare the removal efficiency effectiveness of green infrastructure practices.   Statistical criteria for TSS and TN were met for all green infrastructure practices except buffers and green roofs, and for TN by bioinfiltration.   There was no statistical power to test for differences in removal efficiency among infrastructure types.

Removal Efficiency for TSS and TN

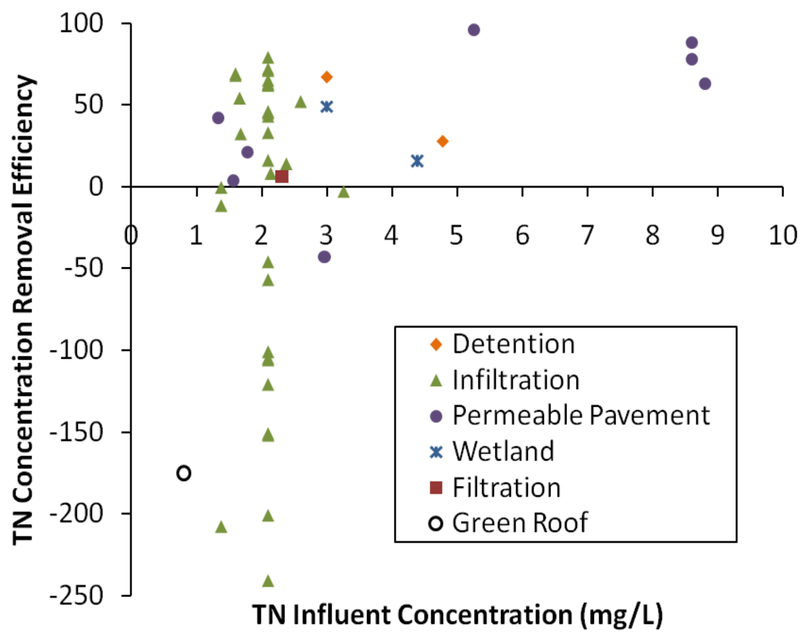
Green infrastructure generally succeeds in reducing both TSS and TN event mean concentration, removing between 58 and 86% of TSS (Figure 4A-C). Constructed wetlands were the least consistent in their performance, evident in the very large standard deviation in TSS removal efficiency (131 percent as shown in Figure 4A, when compared to detention basins, which had a 28 percent variation). This is due to the fact that wetlands may release sediments to the effluent during very large storm events (Carleton et al 2001). We conclude that green infrastructure—with the possible *caveat* of constructed wetlands—is a viable option for reducing TSS levels in stormwater and potentially reducing the associated negative impacts on aquatic ecosystems related to sediment and particulate materials, including heavy metals.

Figure 3: Relationship Between Influent Concentration and Removal Efficiency by Green Infrastructure Techniques for TSS and TN[11]

3A) Relationship Between Influent Concentration and TSS Concentration Removal Efficiency



3B) Relationship Between Influent Concentration and TN Concentration Removal Efficiency



[11] Scatterplots show relationship between TSS and TN influent concentrations and removal efficiency of green infrastructure. Only sites with reported average influent concentrations were included in these graphs. Sample sizes were as follows. For TSS, Detention = 8, Bioinfiltration = 70, Filtration = 15, Permeable Pavement = 13, Constructed Wetlands = 6, Green Roof = 0. For TN, For TN, Detention = 2, Bioinfiltration = 34, Filtration = 1, Permeable Pavement = 8, Constructed Wetlands = 2, Green Roof = 1.

Green infrastructure reduced the TN levels of the effluent to a lesser extent than TSS. In fact, no infrastructure consistently reduced the concentration of TN by more than 58 percent (Figure 4B), compared to a 58-to-80 percent reduction of TSS. This substantial but low TN removal efficiency is in part due to the small sample sizes and variability between storm events, but is also related to the amount of time the stormwater is retained and treated by these infrastructures. Our findings are consistent with other studies indicating that, while green infrastructure is successful at reducing concentration of TN (USEPA 2000), dissolved pollution is generally more difficult to remove from stormwater than particulate pollution (Vymazal 2006).

Removal efficient is in general high for TN and TSS (Figs. 4A and 4B), but by itself cannot be used to predict contaminant loads on effluent waters. Pollutant load measures, the total mass of pollution in runoff, are valuable because they can be reduced both by decreasing pollutant concentration and by reducing runoff volume. Load reduction efficiency data were available for 29 sites for TN and 39 sites for TSS. The average load reductions are presented in Table 3, which shows the effectiveness of filtration systems at reducing both TSS and TN loads.

Table 3: Average Load Reductions for TN and TSS by Green Infrastructure

	Total Nitrogen		Total Suspended Solids	
Infrastructure Type	**Sites**	**Average Load Reduction**	**Sites**	**Average Load Reduction**
Detention	4	7.3	6	-4.6
Filtration	4	41.5	5	95.0
Bioinfiltration	7	48.1	5	33.8
Constructed Wetland	14	20.9	23	68.0

Reduction in Runoff Volume and Peak Flow

In addition to examining water quality measures, we also evaluated the effectiveness of green infrastructures at reducing runoff volume and peak flow. Runoff quantity is particularly important because it is strongly related to water quality as reductions in runoff volume, even in the absence of any changes in pollutant concentrations, result in lower total pollutant loads entering stormwater systems.

Runoff volume and peak flow reductions were reported less frequently than TN or TSS removal efficiency (Figure 4C). Only 18 sites with data on peak flow and 24 sites with runoff volume reduction data from our original database of 490 articles met our criteria for inclusion in this analysis. Permeable pavement, bioinfiltration, and green roofs reduced both peak flow and runoff volume from 52 to 85 percent (Figure 4C). Detention and the other categories of green infrastructure did not have sufficient data for analysis. Peak flow and runoff volume reductions may depend partially upon storm event and catchment characteristics. Therefore reduction in effluent volume can by itself decrease 50 to 80 percent of pollutant loads in effluent water. This reduction in combination with TSS and TN removal efficiency means that green infrastructure practices could decrease up to 90 percent of the pollution in effluent water.

The potential of green infrastructure to reduce peak flow by 50 percent or more may alleviate impacts on aquatic systems such as overflows in combined sewer systems, flooding, and structural changes including erosion, bank scouring and stream entrenchment in waterways. Additionally, reducing overall runoff volume has the potential to reduce the risk of flooding and combined sewer overflows and increase groundwater recharge. However, effluent flow rates and storm characteristics may cause variability in peak flow and in the performance of green infrastructure at reducing peak flow.

The International BMP Database

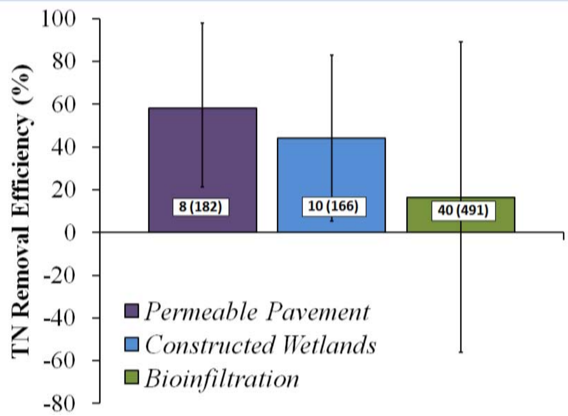
The BMP Database was started in 1996 and is funded and managed today by a coalition of water resources and civil engineering entities including the USEPA. It is widely used as a source of information by practitioners (Strecker et al 2001). However, there are well-documented shortcomings in this dataset (Barrett 2008). For example, while the database contains 238,292 water quality data points from 264 BMPs throughout the US, over 50% of data points originate from 24 sites. Only 20 states are represented in the BMP database and more than half of all sites are in 4 states with year-round moderate to warm climates and distinct storm patterns (California, Florida, Virginia, and Texas).

Despite its shortcomings, the BMP database represents one of the most accessible and comprehensive source of information about the effectiveness of green infrastructure. We compared our data to the data in the most recent (December 15, 2009) version of the BMP database as a way to validate the BMP database with the same statistical rigor as the peer-reviewed data. Only 22 out of the 66 field sites (33.3 percent) in the United States in our analysis were included in the BMP Database. None of the studies in our dataset that were conducted outside of the United States were entered in the BMP database. Only two international sites (one each in Canada and Sweden) are included in BMP Database, and neither was published in the peer-reviewed studies included in this review.

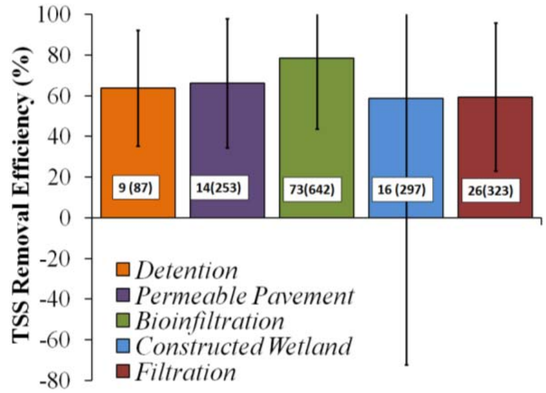
Although direct comparisons between peer-reviewed effectiveness data and the BMP database should be done with caution, Geosyntec Consultants and Wright Water Engineers analyzed water pollution data in the BMP database (2008) using 95 percent confidence intervals to determine whether effluent had significantly lower concentrations than influent for a number of pollutants. Removal efficiencies were not reported. They found that runoff quality improvements varied by infrastructure type. Detention basins (n=22), constructed wetlands (n=17) and hydrodynamic filters (n=30) did not show a significant effect on TSS removal. However, biofilters (a type of bioinfiltration, n=56), media filters (n=33), and retention ponds (n=43) showed a statistically significant difference between influent and effluent for average TSS concentration. For TN, this analysis showed that detention basins (n=9), biofilters (n=46), retention ponds (n=12), and channel-type constructed wetlands (n=3) showed a significant reduction in average TN removal. However, hydrodynamic filters (n=4) and other constructed wetlands (n=5) had no significant effect on TN and media filters (n=19) showed a significant net increase in TN. To summarize, they found that retention ponds and biofilters were the only infrastructure which resulted in significantly lower concentrations of both TN and TSS. This contrasts with our analyses (see Figure 4A-C) that provided better overall performance results of green infrastructure for TSS and TN than did the BMP database.

Figure 4A-C: Weighted Mean Percentage Difference Between the Influent and Effluent for TN, TSS, Peak Flow, and Runoff Volume[12]

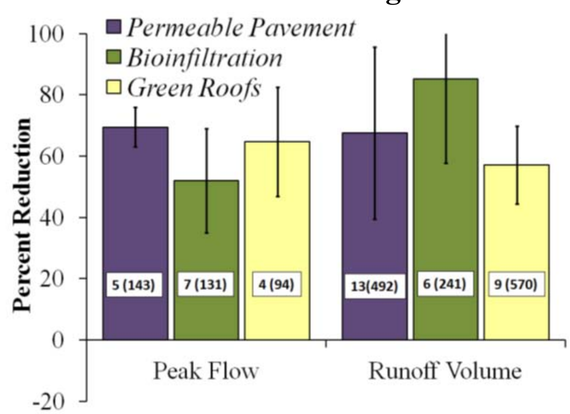
4A: Effectiveness of Green Infrastructure in Removing Total Nitrogen.



4B: Effectiveness of Green Infrastructure in Removing Total Suspended Solids



4C: Effectiveness of Green Infrastructure in Reducing Peak Flows & Runoff Volumes



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[12] Means are weighted to remove bias caused by sites monitored for very few storm events. Error bars represent the weighted standard deviation, a measure of how close together the mean removal efficiency values are across all sites. Values on the bars are the number of sites included in the analysis and, in parentheses, the total number of storm events monitored. All data are from peer-reviewed literature on green infrastructure functional efficiency. Only infrastructure types with data from three or more sites are presented in each graph.

Overall, the shortcomings in the BMP database shares some of the issues we encountered with published manuscripts on green infrastructure effectiveness. Together, the published sites we evaluated and those in the BMP Database account for a very small proportion of all green infrastructure in use (Strecker et al. 2001), which underscores the need for more widespread monitoring, publication, and data standardization and sharing, especially for infrastructures in regions with cold winters.

Sources of Variation

Although we found that green infrastructure generally removed pollutants and reduced peak flows and runoff volumes, our findings also show how variable the effectiveness could be within a particular infrastructure type. For example, among the 16 sites of constructed wetlands with data on TSS, removal efficiencies ranged from -170 percent to 100 percent. While this was one of the largest ranges we found, variability in effectiveness in all of the categories of green infrastructure that we investigated needs further attention.

We evaluated the variability in effectiveness of each green infrastructure with regard to differences in design, scaling (drainage area size), influent pollution, geographical distribution, climate and maintenance. Although we were unable to directly test whether these variables influenced the effectiveness of green infrastructure, trends were identified and the current state of knowledge related to each potential source of variability was summarized.

Design Variation and Effectiveness

Green roofs, permeable parking lots, constructed wetlands, swales and other bioinfiltration systems, and detention basins are designed individually for each site based upon criteria including soil types, average rainfall, magnitude of storm events, and the percent impervious surface in the catchment (Wong and Somes 1995, Murray-Guide et al. 2005, Getter et al. 2007, Davis et al 2009). Variation in green infrastructure design may be partially responsible for the variability we found in pollutant removal and runoff volume and peak flow reduction. Substrate choice may impact the ability for a green infrastructure to infiltrate and filter stormwater. For example, the percentage of fine grains in the substrate is often modified in engineered substrates to maximize removal of targeted pollutants (Hunt 2006b).

Plant species choices for systems which include biological elements can also influence how the infrastructure functions. Studies have shown that pollutant removal can vary markedly between plant species, with some species up to 20 times better at removing certain pollutants than other species (Read 2008). Underdrains may impact the effectiveness of rain gardens, a type of bioinfiltration (Dietz and Clausen, 2006). Generally, the authors provided limited information about the design parameters. For example, only 70 percent of field sites in our dataset reported the size of the infrastructure in meters or hectares and only 58 percent of the sites reported both infrastructure size and drainage area.

Design variations extend not just to scale, substrate, and biota, but also to all other engineered aspects. We investigated whether pollutant removal effectiveness for commercially available stormwater filters varies among designs. Our study encompassed several distinct categories of filters, including hydrodynamic separators (number of sites = 8), sand filters (number of sites = 3), and several types of proprietary filtration devices which rely on a combination of screening, absorption, adsorption, and/or sedimentation (number of sites = 15). We calculated weighted averages and standard deviations for TSS removal by these three types of filtration systems (TN removal data was only available for one filtration site).

In general, TSS removal was very similar for the three filter designs. Hydrodynamic separators removed on average 54 percent of TSS (SD=36%), sand filters removed 60 percent (SD=34%), and proprietary filtration systems removed on average 60 percent (SD=36%). Other studies have found that the effectiveness of various filter designs varies, and filters can serve different purposes depending upon the design (Morgan et al. 2005, Hipp et al. 2006, Wilson et al. 2009). For example, zeolite filters did not remove any TSS from synthetic stormwater, however, Xsorb filters removed almost 95 percent of TSS under the same conditions (Hipp et al. 2006). Similarly, the AbTech Catch Basin Insert was almost four times better at removing total suspended solids than the Aquashield Catch Basin Insert under the same conditions (Morgan et al. 2005). It is important that practitioners take into consideration the wide range of design variability when selecting filtration systems for a given site (Morgan et al. 2005. Hipp et al. 2006).

Scaling of Drainage Area Size to Green Infrastructure Size

Green infrastructure must be properly scaled for its site. For most infrastructures, engineers use data regarding the size of the drainage area, proportion of impervious surface, and historical rainfall data to create a design which will be effective for a given size of storm. Improperly sized green infrastructure may not meet performance expectations, especially if runoff bypasses the infrastructure or has an insufficient residence time. Generally, scaling variables are highly site-dependent, and an ideal ratio of infrastructure size to drainage area has not been defined (Heitz et al. 2000, Akan 2002, Mungasavalli and Viraraghavan 2006). However, for constructed wetlands, design guidelines recommend a ratio of wetland area to drainage area of at least 1 to 100 (Carleton et al. 2001). To examine the effect that scale might have on variation in effectiveness, we compared the removal efficiency for TSS, TN, and the reduction in runoff volume and peak flow for wetlands which were small for their drainage areas to those which were properly sized. Properly scaled wetlands (infrastructure to drainage area ratio ≥ 0.01) were no more effective at removing TN or TSS from effluent than those with a ratio below 0.01. Although scaling is expected to be important for green infrastructure design, we didn't find sizing to be a prominent source of variability in constructed wetland performance. This is consistent with the results of Carleton et al. (2001) who found that detention time and hydraulic loading rates (the amount of water flowing into a wetland each day) were the most important determinants of the effectiveness of constructed wetlands, regardless of the scale.

Geographic Variation and Cold Climate Studies

Variability in effectiveness of green infrastructure may be related to geographical and climatic variation. For example, cold temperatures are known to adversely affect pollution removal and infiltration capacity (Roseen et al. 2009). Although we were not able to directly test this, it is likely that climatic and geographic variation play a role in the variability we found in the effectiveness of green infrastructures.

Seasonal variability in runoff infiltration, due to lower hydraulic conductivity in lower temperatures, has been demonstrated in climates with frequent winter freezes (Emerson and Traver 2008). Concentrations of pollutants such as chlorine are higher in winter runoff in places where road salt is used (Semadeni-Davies 2006). Some, but not all, infrastructures have reduced winter performance at removing pollutants. For example, winter and summer TSS removal performances were similar for filtration, bioinfiltration, and retention infrastructure but winter removal efficiency declined for stone swales and hydrodynamic separators (Roseen et al. 2009). Seasonal effects can also vary by pollutant. Previous studies have shown that wet detention ponds show decreased removal efficiency for lead, zinc, and TSS during winter, but no declines in cadmium and copper removal (Semadeni-Davies 2006).

Regional differences in climate may also impact the effectiveness of green infrastructure. Studies in our dataset were primarily located in humid continental, marine west coast and dry summer subtropical temperate climates. We were particularly interested in studies in humid continental climates since this is the dominant climatic zone in most of the eastern half of the United States and it is characterized by wet, freezing winters.

Maintenance and Effectiveness

Regular maintenance, or lack thereof, can greatly impact effectiveness of green infrastructure. We noted for each article in our dataset whether maintenance issues were addressed. Although the data did not allow for a detailed analysis of the impact of maintenance on green infrastructure effectiveness, we found that about half of the articles in our initial database contained data or recommendations concerning maintenance. Clogging was the most common concern, followed by ineffective maintenance regimes.

Bioinfiltration, permeable pavement and filtration infrastructure have reduced effectiveness when clogged. Le Coustumer et al. (2007) tested hydraulic conductivity in 40 biofilters which were eight years old and younger and found that infiltration rates in more than 40 percent of sites were below Australian guidelines. Without maintenance, sedimentation can completely impede infiltration, causing bioinfiltration infrastructure to retain water and possibly facilitating pollutant leaching into groundwater (Datry and Gilbert 2004). Older infiltration basins (>20 years old) which have not been maintained tend to have both lower infiltration rates and higher pollutant concentrations in sediments compared with equivalent infiltration basins (Dechesne et al. 2005).

The infiltration rate for permeable pavements is also affected by clogging. Researchers have postulated that without maintenance to alleviate clogging, permeable pavement is unlikely to provide a water quality benefit (Barrett 2008). Clogging effects may vary with local conditions and the choice of paving materials. Within a permeable pavement installation, localized clogging may occur, especially in heavy traffic areas and places where snow is piled in winter (Boving et al. 2008). However, Pratt (1995) reported that concrete block pavers in a nine-year old parking lot continued to have acceptable infiltration rates despite an absence of maintenance.

Another important maintenance step relates to filters: pollution removal can be maximized by customizing the maintenance regime for the surface area of the filter, the amount of impervious surface in the catchment area and the typical rainfall. Filters with smaller surface areas compared to the percent of impervious area in their catchments will clog more rapidly and require more frequent maintenance (Hatt et al. 2007). Modeling techniques can reliably predict sediment trapping in some types of filters and may be useful in determining maintenance schedules and maximizing performance (Siriwardene et al. 2007).

Reducing initial pollution concentrations in runoff through source control, education, and street sweeping is another strategy worth consideration. Studies have shown that a 15% reduction in pollutant loads can be achieved on a catchment scale through source control (Davis and Birch 2009). Education and street sweeping may achieve additional load reductions, however limited data are available on the effectiveness of these techniques (Sartor and Gaboury 1984, Davis and Birch 2009).

Conclusions

Our review showed that green infrastructure decreases pollutant concentrations in effluent and reduces runoff volume and peak flow. Together, reduced concentrations and reduced volume result in up to 90 percent lower total pollutant loads. No infrastructure has clear performance superiority. There was no apparent relationship between influent concentration and removal efficiency for TSS or TN, suggesting removal efficiency is a good metric to support the analyses of this study. Variability is high for all types of green infrastructure, but cannot be directly attributed to climate, design of filtration or bioinfiltration systems, influent concentration, maintenance (or lack thereof), or infrastructure size. Previous research has found that reducing the concentration of pollutants in effluent may vary based upon these factors as well as variations in influent quality, antecedent conditions and storm characteristics. There is a need for more consistent reporting of green infrastructure performance. Most sites we found in the literature have not been included in the BMP database. More widespread utilization of this database will provide a larger and more consistent dataset and will assist practitioners with selecting the most appropriate infrastructure for each project.

We found that the performance of green infrastructure is at the very least comparable to detention approaches to stormwater management, and thus recommend its wide-scale adoption for both water quality and volume control of stormwater runoff. Although we are not able to conclude that green infrastructure demonstrates superior performance when compared to conventional detention basins, it provides additional environmental benefits and is more cost effective. Many types of green infrastructure offer green space, increase the natural beauty (and economic value) of developed areas, provide habitat and connectivity for plants and animals, and improve hydrological functions. Systems such as green roofs and rain gardens that include biological components may improve air quality and provide benefits for the climate. We also identified, in the recommendations chapter, emergent new practices that have shown great potential to improve the water quality of stormwater runoff, such as urban trees and more education about green infrastructure practices.

Given the variability in performance observed in the scarce data available, we recommend two types of measures accompanying any green infrastructure regulation. The first is the implementation of a systematic monitoring and reporting program requiring submission of standardized data to the BMP Database in the format required by this database. Initially, incentives may need to be provided to educate and recruit stakeholders for this purpose. In parallel, any regulation of green infrastructure adoption for stormwater management will need to build in flexibility as more information is collected and the knowledge base is developed further to update the regulation.

CHAPTER III: FUNDING GREEN INFRASTRUCTURE

There are two dynamics affecting the economics of green infrastructure practices. The first involves direct subsidies while the second is the cost-effectiveness of the practices relative to conventional stormwater management facilities. Subsidies focused on green infrastructure are offered by some state revolving loan programs, which received large influxes of funding last year from the federal government‘s economic recovery legislation (the American Recovery and Reinvestment Act of 2009). The cost-effectiveness of green infrastructure practices can be best assessed by reviewing municipal studies that have compared green and conventional infrastructure costs. In addition, various economic models have been developed, including one by the Center for Neighborhood Technology called the ―Green Values Calculator” that enables the hydrological and economic benefits of green infrastructure to be projected for different scales of projects over different time horizons. Almost all of these models indicate that, in most cases, green infrastructure practices are more economical than conventional stormwater infrastructure over their respective useful lives. The various approaches for analyzing the economics of green infrastructure are surveyed in this chapter.

The American Recovery and Reinvestment Act (ARRA)

The Clean Water Act‘s State Revolving Loan Fund (SRF) program has always been available for use in helping to fund stormwater management projects, although the vast majority of SRF money has typically gone to wastewater treatment projects. In fact, in Illinois, the statutory language that originally gave IEPA authority to administer the SRF program specifically limited eligibility only to wastewater projects. The American Recovery and Reinvestment Act of 2009 (ARRA), however, specifically required that states earmark 20% of their State Revolving Loan Fund (SRF) capitalization grants for innovative stormwater management practices such as green infrastructure, in addition to energy and water conservation initiatives (the Green Project Reserve). This requirement also applies to the FY10 regular SRF capitalization grant. Both ARRA and the FY10 regular SRF program also required states to provide a portion of their total SRF assistance in the form of subsidization (principal forgiveness or grants). This required the Illinois legislature to amend IEPA authority language to expressly allow principal forgiveness.

The Clean Water Act‘s SRF program was established by Congress to assist local communities in paying for upgrades and expansions of their waste water treatment systems. Each year a federal appropriation feeds the state funds, to be combined with a state match and loan repayments from the previous years‘ projects. Illinois has historically used the money from its Clean Water State Revolving Fund (CWSRF) to fund dozens of waste water treatment projects around the state. This CWSRF, as distinguished from a similar fund under the Safe Drinking Water Act, contained about $224 million for project funding in 2009.

The picture changed significantly with the passage of the American Recovery and Reinvestment Act of 2009 (also known as the ―Stimulus Bill” or ―ARRA”). The ARRA contained $4 billion for states to invest in water infrastructure under the Clean Water Act, and $2 billion more for projects under the Safe Drinking Water Act, and determined that that project funding should be managed through the existing SRFs. In Illinois, the ARRA added $177 million to the 2009 CWSRF, for a total of about $400 million.

The ARRA also imposed strict requirements on states for the use of this stimulus money, and states were forced to modify their programs in order to ensure that they would be allowed to spend their ARRA capitalization grants. For example, it required that 20% of the money be set aside for —green infrastructure, energy and water efficiency improvements and other environmentally innovative activities", also known as the Green Project Reserve (GPR). Eligible projects in each of these categories were described by the U.S. Environmental Protection Agency in a March 2, 2009 guidance document entitled —Award of Capitalization Grants with Funds Appropriated by P.L. 111-5, the —American Recovery and Reinvestment Act of 2009."[13] For many states, including Illinois, funding such —green" projects was new.

Another requirement of the ARRA was that 50% of the federal grant was required to be used for principal forgiveness, negative interest loans or grants, or any combination of these. Illinois did not have the legal authority to provide these kinds of subsidies, and the Illinois General Assembly amended the state law to allow for it. Large stimulus-type grants were again made by Congress to the SRFs in an appropriation bill in October 2009 for calendar 2010[14], and Illinois' grant for the 2010 CWSRF was about $94 million. The 20% green project reserve set aside was included again as a requirement in the appropriation bill. Furthermore, at least 30% of the federal grant in the new appropriations bill is still required to be used for principal forgiveness, negative interest loans and grants.

It is clear that Illinois municipalities and regional storm water management agencies need additional funding for green infrastructure projects. Aside from having to manage storm water with small budgets, these municipalities face new green infrastructure requirements in the revised MS4 general permit, ILR-40. In some areas, where outreach and education have been strong, municipalities have shown a great interest in using green infrastructure. For example, DuPage County established a green infrastructure grant program in 2000, and has been funding portions of such projects all over the county.

In spite of all the benefits of green infrastructure and the regulatory requirements, however, municipal interest in green infrastructure has been spotty. At least in Illinois there has not been an outpouring of applications for green project funding from the CWSRF, and municipalities have only rarely invested their own money in such projects.[15] The first and most important reason for this is the lack of knowledge of the benefits of, and experience working with, green infrastructure.

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[13] See: http://www.epa.gov/water/eparecovery/docs/2009-03-02_Final_ARRA_SRF_Guidance.pdf, Attachment 7.

[14] Fiscal Year 2010 Appropriation Law (P.L. 111-88), see: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_public_laws&docid=f:publ088.111.pdf.

[15] According to IEPA's Green Project Reserve List, http://www.epa.state.il.us/financial-assistance/economic-stimulus/wpc-gpr.pdf, only four green infrastructure projects were funded from the GPR through January 22, 2010. These totaled $10,406,790, about 27% of Illinois' CWSRF GPR allocation.

That situation is slowly changing, but it has been further delayed by the limited nature of IEPA‘s funding of such projects in 2009 and 2010. IEPA‘s effort to reach out to municipalities and encourage them to apply for the ARRA and 2010 funds for green projects was inadequate to generate any real interest. This was compounded by the policy decision to provide grant funding for only 25% of project costs, a number many municipalities said would not support an application for innovative projects. In contrast, states with strong education and outreach programs have received many applications for green infrastructure projects and have given out millions of dollars in grants for green infrastructure project costs. We conclude that outreach and education are critical elements of any program attempting to increase interest in, and use of, green infrastructure practices, and we recommend that IEPA significantly increase the resources and effort in this portion of its program.

With respect to the SRFs in general, historically they have been able to fund only about 10% of estimated infrastructure project costs, nationally, and this number may be even lower in Illinois. We recommend that IEPA use its current SRF prioritization policy effort to clarify that in the future the majority of projects will not be funded from the SRFs. Instead of applicants putting off necessary infrastructure upgrades because of the hope that someday they will be funded from the SRFs, IEPA should encourage them to take several steps to ensure that they can cover their long-term infrastructure costs without the need for SRF funding. For example, municipalities should

a. engage in long-term planning to identify the ―least-cost" methods of maintaining their infrastructure;

b. establish alternative funding sources, such as fee programs and utilities to ensure that there is a permanent, dedicated revenue stream for important infrastructure projects; and

c. Develop prioritization policies that favor projects with multiple benefits and that have the lowest life-cycle costs so that they are less likely to require additional outside funding in the future. These projects will more likely be funded from the SRFs.

The Cost-Effectiveness of Green Infrastructure

If green infrastructure does work as intended, is it still affordable when compared to the costs of the conventional technologies used to manage urban stormwater? To assess the cost-effectiveness of green infrastructure, we used a literature review, data from past research and a green infrastructure economic model called the Green Values™ Calculator, developed by the Center for Neighborhood Technology (CNT) to compare different urban stormwater management technologies – both green and conventional -- over different time periods at various scales (municipal, neighborhood and site) and in various settings (suburban and urban).

CNT‘s Green Values™ Stormwater Toolbox is designed to estimate comparisons between conventional and green infrastructure alternatives. The National Green Values™ Calculator estimates the effectiveness of alternative site designs to meet on-site storage requirements of local agencies. The National Calculator was re-designed from the original Calculator and launched in 2009. It identifies costs and benefits of 16 different infrastructure components. Over 70 sources of data (R.S. Means standard engineering source books, publications of city engineering and public works departments, factsheets, and published articles, reports and studies) contributed to the Calculator‘s construction costs, maintenance costs and component life spans. All of the data are readily available in the Toolbox so that an experienced user, such a Professional Engineer, will be able to substitute other costs into the results to yield conclusions with a high degree of confidence.

Life cycle estimates include the construction cost plus periodic maintenance and, where appropriate, replacement within a designated life cycle. For example, in the case of the 100 year life cycle, a roof that has a life span of 37 years will accumulate construction costs approximately three times for that life span and maintenance for each year in between. The calculator contains data (which can be seen by the user) on the life span and maintenance costs, as well as the construction costs, of each infrastructure component – both grey and green.[16]

Cost-effectiveness is one of the driving forces behind the increasing, widespread national adoption of green infrastructure practices. In general, national and Illinois examples indicate that properly scaled and sited green infrastructure can deliver equivalent hydrological management of rainwater/stormwater at comparable or lower costs than conventional conveyance and treatment infrastructure. Green infrastructure features also deliver a range of additional economic, social and ecological benefits, contributing community health and vitality beyond their hydrologic performance.

The following section examines evidence of green infrastructure‘s cost and effectiveness. It includes life-cycle cost and benefit comparisons of a sampling of individual green infrastructure practices, which can be seen as the building blocks of a community scale green infrastructure programs. Because green infrastructure practices tend to be designed in combinations to fit context-specific conditions, the analysis also considers scenarios and examples of site and neighborhood scale developments.

Cost and benefit ranges cited here derive from nationally published studies evaluated within CNT‘s Green Values™ Calculator, from CNT monitoring of Northeast Illinois demonstration sites, and from recently published results from St. Paul, MN‘s Capitol Region Watershed District‘s (CRWD) green infrastructure program, conducted in climatic and urban development conditions like those in Illinois. Potential scenarios apply the cost and performance values within the Green Values™ Calculator to example development sites. Finally, community-scale green infrastructure programs from other metropolitan areas give indications of how cities are recognizing the performance and additional benefits of green infrastructure approaches at this scale. The degree to which green infrastructure‘s benefits accrue to either utilities, property developers or the public depends in part on policy measures. We discuss policy factors affecting cost effectiveness at the conclusion of this section

The U.S. Environmental Protection Agency (USEPA 2007) evaluated construction costs at development and neighborhood scale projects (Low Impact Development or LID) employing green infrastructure in their construction. Their report concluded that ―In the vast majority of

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16 See <http://greenvalues.cnt.org/national/cost_detail.php>.

cases, the U.S. Environmental Protection Agency (USEPA) has found that implementing well-chosen LID practices saves money for developers, property owners, and communities while protecting and restoring water quality." Of 13 cases where green and conventional comparisons were feasible, 12 projects demonstrated capital (construction) cost savings by using LID, saving from 15-85%. The USEPA study, however, examined only construction costs, where many infrastructure systems are evaluated based on their full life-cycle cost.

The following Table 4 indicates the unit costs, over a 30 year life-cycle, for a sample group of green infrastructure practices. The table contains information from three sources: CNT's research during the past three years, research reported by the Capitol Region Watershed District of Minnesota (2010), and a review of national of data sources that have been incorporated into the Green Values™ National Calculator at http://greenvalues.cnt.org. Gross construction and maintenance costs are allocated two ways: BMP construction costs per square foot of its surface area; and the cost per cubic foot of runoff that is expected to be intercepted during the 30-year life cycle. Life cycle costs are based on the net present value of the construction cost and estimated annual maintenance costs discounted by a rate of 3.1% per year over 30 years.

The number of gallons managed by the BMP during the 30-year life cycle is estimated by first determining the maximum amount of water that can be accommodated by the BMP through storage and infiltration in 24 hours. Then determining how much of a storm that volume represents over the drainage area of the BMP, and finally using existing data on the percent of annual rainfall that is captured with the BMP having that capacity. This annual volume is multiplied by 30 years to get the total gallons captured. This is divided by the 30-year life cycle cost of the BMP.

CNT has constructed and monitored the performance of four rain gardens, two bioswales, one vegetated swale and one permeable pavement facility during 2007 through 2009. The ranges of construction costs experienced for rain gardens and bioswales are reflected in the table. (It should be noted that monitored demonstration BMPs can be more expensive than their community counterparts: costs for 20 CNT non-research demonstration rain gardens range from zero to $10 per square foot, depending on how much work is done by the owner and volunteers and whether the plants are donated.) The relatively low cost per cubic foot for the permeable pavement results from a design where only a portion of the parking lot is permeable: water from 18.3 square feet of impermeable pavement drains to each square foot of pervious concrete that surrounds the parking lot drains. The construction costs reported by the CRWD are averages for eight rain gardens and eight infiltration trenches, two infiltration-oriented BMPs that comply with the CRWD ordinance. The CRWD costs per cubic foot are based on measured volumes of runoff reduction during 2007 and 2008 (CRWD also estimated the amount and cost of removal of pollutants, but those data are not included here.)

Construction costs for the Green Values™ National Calculator estimates are mid-points selected from the ranges of costs identified in the Calculator's 2009 update (the low and high values identified for construction costs are also available). The higher National Calculator costs per cubic foot result because the BMPs are designed to meet regulatory on-site storage volumes, but the calculations give no credit for infiltration of the stored water. Many green infrastructures practices are designed to infiltrate runoff, so the cost presented here per cubic foot of water intercepted is conservative. Costs per volume of water managed would be significantly lower if infiltration volume were taken into account.

Table 4: Costs of Green Infrastructure

BMP	CNT research		CRWD		CNT National Calculator	
	$/sq.ft.	$/cu.ft.	$/sq.ft.	$/cu.ft.	$/sq.ft.	$/cu.ft.
Rain Gardens	$9.00-$32.00	$0.04-$0.11	$8.55	$0.04-$0.07	$7.00	$0.25
Bioswales	$13.00-$31.00	$0.02-$0.03			$7.10	$0.39
Vegetated Swales	$2.40	$0.01				
Infiltration Trenches			$11.77	$0.02-$0.03		
Permeable Pavement	$7.10	$0.01			$7.10	$0.59
Green Roofs					$15.75	$0.58

Source: CNT 2009

Counting avoided costs stemming from green infrastructure features can provide an additional level of comparison with conventional stormwater conveyance and treatment infrastructure. When green infrastructure performance for volume control and water quality can offset regulatory requirements, scenarios that evaluate green infrastructure life cycle costs also demonstrate savings in comparison to equivalent conventional infrastructure. The following examples in Table 5 estimate cost and hydrological results of three development scenarios using the Green Values™ Calculator.

- The first scenario evaluates a “greenfield” new, low density residential development in McHenry County with 14 lots spread across 20 acres. It employs rain gardens, native plantings, trees and swales to replace nearly half of otherwise required detention, saving life-cycle cost and contributing more than 1.4 million gallons of equivalent annual groundwater recharge.
- The second assesses a residential re-development sited in an existing parking lot, assuming 59 townhomes on a three-acre site. Rain gardens, porous pavement, swales and trees could eliminate required detention, with accompanying life-cycle savings, while removing approximately 2.4 million gallons of runoff per year from sewers.

- The third scenario assesses the Chicago Center for Green Technology, a retrofit of an existing commercial building on a 3.3 acre brownfield site that employs a partial green roof, native plantings, water harvesting in cisterns, permeable pavement and a constructed wetland.

Although the actual construction costs for this project were likely higher than what the Green Values™ Calculator estimates (since the project was a first-generation demonstration completed in about 2002), the scenario evaluates costs and performance assuming the same features were constructed at 2009 rates. The modeled results, which the city has monitored as diverting 81 percent of annual runoff volume, would reduce life cycle costs by 20 percent and prevent nearly 2.5 million gallons of runoff from entering sewers.

Cost-benefit calculations from the Green Values™ Calculator include preliminary estimates of selected additional benefits that green infrastructure practices have been documented to produce, such as ground water recharge, energy savings, and carbon sequestration.[17] Philadelphia evaluated the additional economic and social benefits stemming from a community scale program of green and conventional stormwater practices, designed to deliver similar stormwater performance in several watersheds. The analysis tallied estimated benefits in 11 categories, attributing a greater than $2.7 billion additional benefit to the option utilizing 50% green infrastructure (Table 6).

Kansas City, Missouri, has also developed a city-scale plan for green infrastructure as part of its combined sewer overflow long-term control plan (Kansas City Water Services Dept. 2008). Evaluating the degree to which planned conventional upgrades could be eliminated with street trees, pervious pavement, green roofs, stormwater planters, and curb extension swales, local authorities identified three sub-watersheds that can achieve equivalent stormwater service using green infrastructure as a portion of the infrastructure investment (Leeds 2008). See Table 7, below.

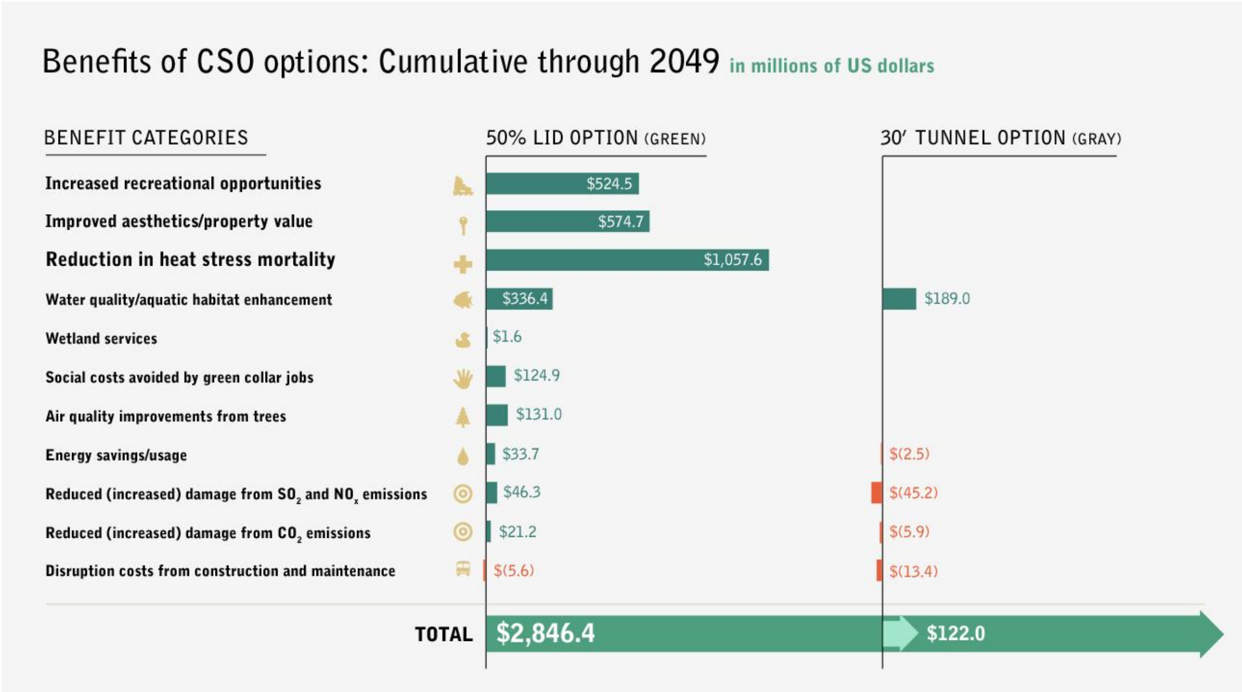
Kansas City also recognized that green infrastructure solutions leverage private investment, in the form of anticipated green roofs and permeable pavement on private property, so that ―Public investment can be reduced with significant investment by [the] private sector.”
Kansas City‘s analysis also includes estimates of construction costs for green infrastructure practices. Depending on the type of practice, the cost estimates range from $2.28 to $7.13 per gallon (rain garden or bioretention retrofits) to $10.86 per gallon for curb extension swales, $5.50 per gallon for permeable parking lots, $11.24 per gallon for permeable sidewalks, $22.68 per gallon for green roofs. The gallons refer to the design capacity of the practice. (This is in contrast to the volumes, in cubic feet, in Table 4 where the reference is to volume infiltrated over the life of the practice).

[17] See http://greenvalues.cnt.org/national/benefits_detail.php for a list of benefits associated with green infrastructure practices and published references to their quantification.

Table 5: Estimated Costs, Savings, and Hydrologic Benefits for Use of Green Infrastructure in Three Development Scenarios

Case Study	Description	Green Components	Construction Cost Savings for Green Scenario	Green Construction Savings as % of Conventional	30-year Life Cycle Savings for Green Scenario	Green Life Cycle Savings as % of Conventional	Green Scenario Annual Hydrologic Benefits
Exurban Development	20-acre site with 14 homes on undeveloped land	Rain gardens, native vegetation, trees, and roadside swales	$190,800	31%	$507,800	24%	1,411,000 gallons increase groundwater recharge
Blue Island Riverfront	3.0-acre site with 59 townhomes on former parking lot	Rain gardens, permeable pavement, trees, and streetside swales	$91,900	23%	$168,600	29%	2,409,000 gallons reduced runoff to sewers
Chicago Center for Green Technology	3.3 acre site with office building, parking and wetland on former industrial land	Partial green roof, cisterns, vegetated swales, gravel parking lot, wetland and native vegetation	$18,100	4%	$161,500	20%	2,468,000 gallons reduced runoff

Table 6: Benefits of Green vs. ConventionalInfrastructure to Manage CSO Issues



Source: Philadelphia Watersheds (Stratus Consulting) 2009

The degree to which green infrastructure's benefits accrue depend in part on policy measures, particularly the degree to which a property owner or developer gains credit for compliance with local ordinance requirements. For the benefits cited in the scenario examples above, for example, savings occur when green infrastructure measures are deemed to replace conventional detention or other storage. If, as is often the case, local ordinances do not allow green infrastructure to be used as a partial credit against stormwater detention requirements, then the cost savings related to green infrastructure can be limited or even disappear, because the property owner must still construct conventional drainage structures in addition to installing their green infrastructure practices.

Table 7: Comparisons of Green and Grey Project Costs in Kansas City, MO

Watershed	Area	Grey Cost	Grey Cost/gallon	Grey + Green
OK Creek	4,770 acres (52% impervious)	$256 million	$5	$295 million ($230 million green)
Brush and Town Fork Creeks	6,930 acres (45% impervious)	$439 million	$8.70	$552 million ($274 million green)
Middle Blue River	744 acres (34% impervious)	$51 million	$17	$35 million – all green

Source: Leeds (2008)

Similarly, the degree to which private or public interests realize benefits from green infrastructure can also affect its implementation. Adoption of green infrastructure features on private property, as envisioned in the Kansas City plan, will benefit public infrastructure performance. When policies, such as stormwater utility/service fee or tax credits are in place, private property managers have incentives to invest in green infrastructure practices. In addition, some of green infrastructure's additional community benefits such as potential climate cooling, energy reduction, and neighborhood amenity improvement, are shared public-private benefits. Financing and investment criteria that recognize and prioritize the additional benefits may be necessary to encourage practices that meet multiple social, ecological, and economic objectives.

One problem is the manner in which water infrastructure projects are funded by local government. It is common for such infrastructure to be funded either with general tax revenue or with the proceeds of bond issues that are then paid back with taxes. Either way, it seems clear that municipalities have not been willing to increase taxes to the level required to adequately maintain their water infrastructure, which includes traditional waste water infrastructure as well as stormwater green infrastructure. There are exceptions to this generalization, of course. The City of Chicago has over four million square feet of green roofs on city buildings either completed or proposed. The city is determined to reduce stormwater volume in its sewers through the evapotranspirative properties of these green roof projects. A number of other cities around the country have also benefitted from large investments in green infrastructure. Yet, in order for communities and landowners skeptical about green infrastructure to commit money to these practices at this point in time, a strong financial incentive appears to be required.

CHAPTER IV: CURRENT PRACTICES

Section 15(e) of the Green Infrastructure for Clean Water Act requires that this study review and report on ―existing and potential new urban storm water management regulatory programs and methods and feasibility of integrating a State program with existing and potential regional and local programs in Illinois."[18] To address this mandate, we reviewed current stormwater regulatory programs with performance standards that incorporate green infrastructure concepts. First, we reviewed the Illinois statewide stormwater permit, known as the MS4 Permit. Second, we reviewed existing county and municipal stormwater management ordinances in Northeastern Illinois, the region with the greatest experience in using green infrastructure. We also assessed the transferability of green infrastructure state-wide and identified issues that might impede the wider use of these practices. Next, we reviewed five state programs outside Illinois that have in place statewide stormwater management performance standards that expressly encourage or require the use of green infrastructure as a means of meeting those standards. Finally, we examined the utility of adopting a state green infrastructure portfolio standard – similar to the renewable energy standard currently in place in Illinois – that could be used to help phase-in green infrastructure practices, statewide.

THE ILLINOIS MS4 PERMIT

States issue permits for stormwater discharges from industrial, construction and municipal activities. The permit for small municipalities, those with fewer than 100,000 people, is known as the small ―municipal separate storm sewer system" or ―MS4" permit. It is of interest here because it regulates stormwater management activities on public and private land both during development and post-construction, and because the Illinois MS4 permit contains requirements for municipalities to use or require the use of green infrastructure practices. It is important to understand the reach and limits of this permit to determine the need for additional stormwater regulations in Illinois as suggested by P.A. 096-0026.

IEPA issued its first MS4 permit[19] in February 2003, designated as ―General NPDES Permit No. ILR40". Such permits must be reviewed and revised every five years, and on February 20, 2009, IEPA issued a revised MS4.[20] Among other revisions, the new permit requires permittees to adopt ―green infrastructure" stormwater management strategies and techniques as part of their programs.

IEPA defines small MS4s generally as municipalities serving fewer than 100,000 people in an urbanized area (the list also includes several state and federal agencies with similar sized populations of employees within the State).[21] In accordance with federal regulations, IEPA has waived permit coverage for most

[18] For this review, we have utilized a website maintained by StormwaterAuthority.org, including a page linking to summaries of all the state stormwater management programs in the country: http://www.stormwaterauthority.org/regulatory_data/state.aspx. We have quoted liberally from these summaries and refer the reader to them for further research.

[19] A "general permit" is essentially a regulation that applies to all regulated entities in a class of entities. Each permittee in the class must meet the exact same permit requirements.

[20] Additional information about the Illinois MS4 general permit and related documents may be found on the IEPA's website at: http://www.epa.state.il.us/water/permits/storm-water/ms4.html.

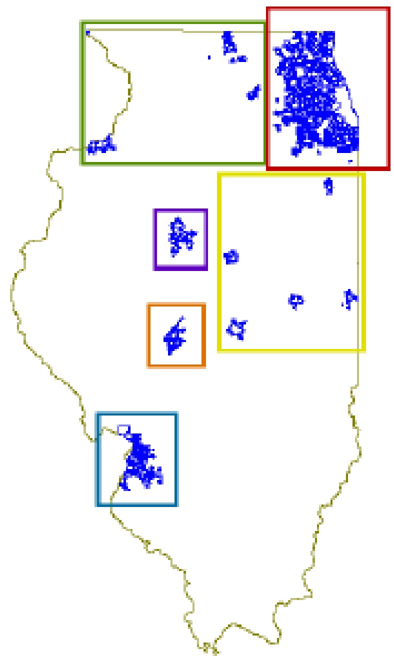
[21] An urbanized area as delineated by the Bureau of Census is defined as a central place or places and the adjacent densely settled surrounding area that together have a residential population of at least 50,000 people and an

systems serving fewer than 10,000 people. The resulting list of permittees in Illinois contains about 440 municipalities, townships and agencies that are subject to Permit ILR40, generally concentrated in six regions.[22] See Figure 5, below.

The most significant new green infrastructure requirements are contained in Part IV.B. of the Permit, which requires that MS4 stormwater management programs address the following six issues, which are discussed in more detail below:

1. Public education and outreach on stormwater impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site stormwater runoff control
5. Post-construction stormwater management in new development and redevelopment
6. Pollution prevention/good housekeeping for municipal operations

Fig. 5: Illinois MS4 Communities



<u>Section IV.B.1. – **Public education and outreach on stormwater impacts**</u>. The revised subsection requires that each permit-holder to incorporate information about green infrastructure strategies into its education materials, discuss the benefits and costs of such strategies and provide guidance to the public on implementation.

<u>Section IV.B.4.a.ii. and iv. – **Construction site storm water runoff control**</u>. MS4 programs have always been required to reduce pollutants in stormwater runoff from construction activities. The revised subsection contains specific new requirements to use green infrastructure practices to meet this goal ―when appropriate and practicable”. This ensures that green infrastructure will be part of the project design and in place prior to the commencement of construction.

<u>Section IV.B.5.a. and b. – **Post-construction stormwater management in new development and redevelopment**</u>. The new subsection says that each permittee should ―adopt strategies that incorporate stormwater infiltration, reuse and evapotranspiration of stormwater into the project to the maximum extent practicable.”

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overall population density of at least 500 people per square miles. (See IEPA's website explanation at http://www.epa.state.il.us/water/permits/storm-water/ms4.html.)

[22] For the Illinois Environmental Protection Agency's list of municipalities and townships currently holding MS4 permits, *see* http://www.epa.state.il.us/water/permits/storm-water/ms4-status-report.pdf.

Subsection B.5.b. provides a definite structure for incorporating green infrastructure practices into site design. “When selecting BMPs [best management practices] to comply with requirements contained in this Part, the permittee should adopt one or more of the following general strategies, in order of preference. Proposal of a strategy should include a rationale for not selecting an approach from among those with a higher preference.

i. preservation of the natural features of development sites, including natural storage and infiltration characteristics;
ii. preservation of existing natural streams, channels, and drainage ways;
iii. minimization of new impervious surfaces;
iv. conveyance of stormwater in open vegetated channels;
v. construction of structures that provide both quality and quantity control, with structures serving multiple sites being preferable to those serving individual sites; and
vi. construction of structures that provide only quantity control, with structures serving multiple sites being preferable to those serving individual sites.”

The first four of these strategies represent accepted green infrastructure practices, in declining order of effectiveness at addressing water quality and runoff volume problems. The final two strategies can incorporate green infrastructure practices, traditional BMPs, or a combination of the two stormwater management practices.

Section IV.B.5.c. and d. – **Post-Construction stormwater management in new development and redevelopment**

Local stormwater ordinances typically apply only to new private development and redevelopment and not existing developed land (sometimes called “retrofits”) or the construction or reconstruction of public buildings and surfaces such as roads, sidewalks, alleys and parking lots. However, in recognition of the fact that these existing impervious surfaces have caused the current degradation in water quality and stream conditions, and that development in any given year affects less than one percent of impervious surfaces, the revised language expands the applicability of stormwater management provisions to clearly include municipal development and redevelopment activities, as well as activities on developed, private land.

New Training Requirement. In another important revision, the new Section IV.B.5.c. requires municipal permittees to provide appropriate training for all MS4 employees and contractors who manage or are directly involved in (or who retain others who manage or are directly involved in) the routine maintenance, repair or replacement of public surfaces in current green infrastructure or low impact design techniques applicable to such projects.

The new language in the MS4 Permit should result in permittees and their communities becoming more familiar with green infrastructure through the education and training requirements. However, the permit still lacks clear performance standards for the use of green infrastructure practices. For example, permittees and developers must “minimize the volume of stormwater runoff and pollutants…through the use of BMPs that…result in…load reduction, increased infiltration, evapotranspiration and reuse of stormwater.” Yet, permittees are not told exactly how much they must “minimize” runoff and pollution. There are no objective performance goals imposed, such as a specific volume of stormwater to be retained on site or the percentage of pollutant loading to be removed. Such standards are becoming commonplace in ordinances and state regulations, as we explain in the following sections.

LOCAL PROGRAMS

Northeastern Illinois has been a leader in stormwater management since the 1960s when flood control and stream improvement projects were implemented. The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) was one of the first agencies to require detention storage in 1972. That same year the Tunnel and Reservoir Plan (TARP) was adopted. TARP is a series of underground tunnels and above ground reservoirs that hold stormwater runoff during large storm events to limit the number of Combined Sewer Overflows (CSOs)[23].

In 1986 and 1987 the Chicago area experienced two devastating storm events. The 1986 storm was preceded by two weeks of consistent rainfall. In 1987, 13 inches of precipitation fell during a single storm in less than 24 hours. Although the two storms were quite different, they both resulted in widespread flooding and record river levels[24]. These events spurred the General Assembly to pass Public Act 85-905 (55 ILCS 5/5-1062.2), which gave several northeastern Illinois counties the authority to create a Stormwater Management Planning Committee (SMPC) to prepare a stormwater management plan, to implement it through a countywide ordinance, and to fund stormwater management activities through a property tax levy. These counties were DuPage, Kane, Lake, McHenry and Will, and each has passed a countywide ordinance. In P.A. 94-675 (55 ILCS 5/5-1062.2) the authority was extended to Kendall and five other counties. Kendall currently has an ordinance that is applicable only in unincorporated Kendall County. P.A. 93-1049 (55 ILCS 5/5-1062.1) gave the MWRDGC the authority to develop a countywide stormwater management program for Cook County. MWRDGC has completed its stormwater management plan and is now drafting the Cook County ordinance.

This unique system is central to stormwater management in northeastern Illinois and allows each county to prepare its own stormwater management plan, ordinance, and projects. The ordinances are adopted by the County Board and provide minimum standards for all municipalities and unincorporated areas within the county, although a municipality may then create stricter criteria if it chooses to do so.

The objective of most stormwater management ordinances is to limit stormwater runoff to a prescribed maximum. This is accomplished mainly through onsite detention storage. Traditionally detention basins were constructed to hold a specified amount of runoff. This amount is based on the specific county ordinances as well as the size of the project and a number of other factors. Each detention basins is equipped with a flow restrictor to only release flow at a specified release rate. These release rates are relatively consistent throughout the region and are summarized in Table 7.

Ordinances also address issues regarding volume control and water quality, which can involve the use of green infrastructure practices. Volume control practices require that a specified amount of runoff volume be infiltrated on site when possible. Some regulations specify a certain volume be retained on site while others require practices that encourage water infiltration. Water quality requirements typically specify that stormwater best management practices be incorporated into site design or that mechanical devices

[23] http://www.mwrd.org/irj/portal/anonymous/tarp
[24] http://dnr.state.il.us/owr/chicago.htm

treat stormwater runoff. We reviewed the ordinances in northeastern Illinois for release rate, volume control and water quality practices (Table 8).

Cook County

As discussed above MWRDGC was one of the first entities to require stormwater detention storage in the 1970s. For the purposes of this study the Draft Cook County Watershed Management Ordinance[25] was reviewed. The ordinance was under public review in the later part of 2009 and is now under revision after the public comment period. It is important to note that the final ordinance may be different from what was studied and included in this report. The current draft of the ordinance requires the first inch of runoff be treated by a retention based practice. These practices include:

- Infiltration trenches
- Infiltration basins
- Porous pavement
- Dry wells
- Open channels
- Retention storage
- Constructed wetlands with forebays

These practices also provide water quality benefits. The ordinance allows for flow through practices for areas that are not required to provide volume control. The retained volume of water can be credited against the required detention volume. The ordinance calls for a dual release rate requirement of 0.04 cubic feet per second per acre (cfs/acre) and 0.15 cfs/acre for the 2-year, 24-hour and the 100-year, 24-hour storm events respectively.

Green Infrastructure Allowance: The draft ordinance currently requires retention based practices to be used to control a specified volume of water. Many of the approved retention based practices incorporate the use of green infrastructure.

DuPage County

The DuPage County Countywide Stormwater and Flood Plain Ordinance[26] was first adopted in September 1991 and has since been amended a number of times most recently in August 2008. The ordinance incorporates a Best Management Practice Hierarchy to reduce the runoff rates, volumes and pollutant loads. The hierarchy contains the following elements:

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25 http://www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://2eee6bcf4aa1e461b1e99d195d53321f&LightDTNKnobID=114980813

26 http://www.dupageco.org/emplibrary/SW%20Ordinance2008%20(complete).pdf

Table 8: Summary of Current Stormwater Management Requirements in Northeastern Illinois

Governing Body	Release Rate	Volume Control Mechanism	Water Quality Measures	Green Infrastructure Allowance
Draft Cook	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	The first 1" of runoff to be retained on site	Infiltration and flow through practices	Retention based practices, e.g. permeable pavements, infiltration basins and trenches are required to achieve volume control requirement
DuPage	100-year, 24-hour: 0.10 cfs/acre	Requires BMPs be incorporated to the maximum extent practical	Requires BMPs to provide water quality benefits	Green Infrastructure, e.g. vegetated filter strips and permeable pavers are incorporated into a BMP Manual
Kane	100-year, 24-hour: 0.10 cfs/acre	The first 0.75" of runoff to be retained below the primary gravity outlet of the site	Native wetland plantings required	Stormwater BMPs may be implemented in lieu of traditional detention practices for developments which require less than 1 ac/ft
Kendall	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	Hierarchy to minimize increases in runoff volumes and rates	Promotes retention and infiltration to provide water quality benefits	Promotes the use of BMPs and native plantings for increased infiltration and evaporation
Lake	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	Runoff Volume Reduction Hierarchy	Runoff Volume Reduction Hierarchy and mechanical measures	Preserving natural infiltration is incorporated into the Runoff Volume Reduction Hierarchy through a number of BMPs
McHenry	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	BMP Hierarchy to during site design incorporates practices which will reduce volume	Requires that a number of BMPs be evaluated for site design incorporation	Addressed in Conservation Design and Subdivision Ordinances that require the use of BMPs and use density bonuses for open space that is placed under conservation easements maintained by professional land managers
Will	2-year, 24-hour: 0.04 cfs/acre 100-year, 24-hour: 0.15 cfs/acre	The first 0.75" of runoff to be retained below the primary gravity outlet of the site	Utilize best management practices before discharging on to agriculture land	Addressed in the Will County Subdivision Ordinance which offers density bonuses for BMPs and the provision of open space
City of Chicago	Variable depending on development type and local sewer capacity	Capture the first 0.5" of runoff from imp surfaces or reduce imp by 15% from existing conditions	Requires BMPs for sites directly discharging to waters	Requires the use of BMPs through volume control requirements and for sites directly discharging to waters

- All runoff from rooftops and parking lots, and discharge from sump pumps that does not discharge into a site runoff storage facility shall be diverted onto vegetated swales or filter strips for a distance of 50 feet;
- Vegetated swales shall be utilized, where appropriate, as an alternative to storm sewers to promote infiltration of stormwater and the infiltration of stormwater pollutants;
- Effective impervious surface area should be limited by site designs which minimize the area of streets, parking lots, and rooftops and/or utilize permeable paving material such as concrete grids in low traffic areas;
- Other BMPs such as infiltration basins and trenches (where permeable soils are present) and filtration basins and sand filters (on highly impervious or industrial developments) shall be utilized where appropriate

The ordinance also has a 100-year, 24-hour allowable release rate of 0.10 cfs/acre for all areas other than those designated Stormwater Economic Redevelopment Zones (SERZ), where a two-year, 24-hour allowable release rate of 0.04 cfs/acre will be in effect instead of the 100-year provision. DuPage County does not utilize a dual release rate.

Green Infrastructure Allowance: In March 2008, DuPage County developed the Water Quality Best Management Practices Technical Guidance document[27] which defines and describes a number of BMPs including conservation design, permeable pavers, infiltration systems and grit chambers. These techniques are intended to improve water quality and reduce stormwater runoff volume.

Kane County

The Kane County Stormwater Management Ordinance[28] was adopted on January 1, 2005. This ordinance applies to the entire county (in both incorporated and unincorporated areas) as well as in other counties where Kane County municipalities straddle the county's boundaries.

For volume control measures, the ordinance requires that runoff from up to a 0.75 inch rainfall event over the hydraulically connected impervious area of the new development shall be stored below the elevation of the primary gravity outlet (retention) of the site's runoff storage facility. The storage facility may be designed to allow for evapotranspiration or infiltration of this volume into a subsurface drainage system and shall not be conveyed through a direct positive connection to downstream areas. Native plantings are also required to be incorporated into storage facility design, specifically requiring that the area not be covered by more than 25% of the following species, Buckthorn, Reed Canary Grass, Purple Loosestrife and Giant Reed.

A release rate of 0.10 cfs/acre is required under the Kane County ordinance for the 100-year storm, 24-hour event and applies to disturbed areas only. The ordinance allows for credit for various green infrastructure practices, including leaving soils undisturbed during construction or preparing them to maximize infiltration, and planting deep-rooted grasses or other vegetation to promote infiltration and

[27] http://www.co.dupage.il.us/emplibrary/Final%206-18-08.pdf

[28] http://www.co.kane.il.us/kcstorm/ordinance/adoptord.pdf

evapotranspiration. This credit can be used to reduce the amount connected impervious area in the detention requirement calculations.

Green Infrastructure Allowance: Under the requirements of the Kane County Ordinance, stormwater BMPs may be implemented in lieu of traditional detention practices for developments which require less than 1 acre-foot of detention.

Kendall County

The Kendall County Stormwater Management Ordinance[29] was adopted in October 2002. Unlike the other ordinances in northeastern Illinois, this is not a county-wide ordinance, i.e. it only applies to unincorporated areas. Currently, the county is undergoing a process to develop a stormwater management plan that may lead to the development of a county-wide ordinance.

The ordinance requires that there should be no change in run-off volume and flow rate from pre-development conditions. The county employs a hierarchy for volume reduction that requires the following, in order from the most to the least preferred option:

- Minimize impervious surfaces and establish best management practices consistent with the needs of the project;
- Preserve, establish, and/or restore native plantings and natural areas to increase and promote infiltration and evaporation;
- Preserve natural resource features of the development site, including but not limited to flood plain, wetlands, prairies, and woodlands;
- Attenuate flows through the use of open vegetated swales and natural depressions;
- Preserve, enhance, and incorporate existing natural stream channels and quality wetlands, stream channels and drainageways;
- Infiltrate runoff on-site;
- Provide stormwater retention facilities;
- Provide stormwater detention facilities;
- Construct storm sewers.

Release rates allowed under the Kendall County Ordinance are 0.04 cfs/acre for the 2 year, 24 hour event and 0.15 cfs/acre for the 100-year, 24 hour event.

Infiltration, retention and the use of native plantings are measures that the ordinance employs for addressing water quality. Additionally, the ordinance requires that stormwater storage facilities be designed to give preference to wet bottom and wetland designs and to incorporate multiple uses where practicable, so that portions of the property are not used exclusively for stormwater management. Uses considered compatible with stormwater management include open space, aesthetics, aquatic habitat, recreation (boating, trails, playing fields), wetlands and water quality mitigation.

[29] http://www.co.kendall.il.us/zoning/ordinances/StormwaterManagement.pdf

Green Infrastructure Allowance: The Kendall County Stormwater Management Ordinance promotes the use of BMPs and native plantings for increased infiltration and evaporation.

Lake County

The Lake County Stormwater Watershed Development Ordinance[30] became effective on October 18, 1992. The current ordinance requires that an applicant adhere to the following release rates: two-year, 24-hour of 0.04 cfs/acre and a 100-year, 24-hour of 0.15 cfs/acre. There is also a provision for alternate release rates if specified by an approved basin plan or floodplain study. The applicant is required to choose from the following strategies to minimize the increase in runoff volumes and rates:

- Preservation of natural resource features on site (wetlands, floodplains and water features designated as Isolated Waters of Lake County);
- Preservation of exiting natural streams, channels and drainageways;
- Minimize impervious surfaces;
- Utilize open vegetated swales and channels;
- Preserve natural infiltration and storage characteristics on a site;
- Incorporate structural measures that provide water quality and quantity control;
- Incorporate structural measures that provide only quantity control and conveyance.

The ordinance further specifies that, prior to discharging runoff to the Waters of US, Isolated Waters of Lake County or adjoining property, all development shall divert and detain at least the first 0.01 inches of runoff for every 1% of impervious surface for the development with a minimum volume equal to 0.2 inches of runoff. The ordinance also ensures that wetland hydrology is being maintained by requiring that 80 to 150% of the existing runoff from the 2-year, 24-hour storm event be maintained and routed to Isolated Waters of Lake County

Green Infrastructure Allowance: Green Infrastructure is encouraged through the Runoff Reduction Hierarchy listed above. The Lake County Stormwater Management Commission is currently drafting a volume control component to the ordinance that would require a specified volume of water to be retained on site through green infrastructure practices.

McHenry County

The McHenry County Stormwater Management Ordinance[31] was adopted on April 2008. Volume control standards in the current ordinance apply only to developments that discharge into Isolated Waters of McHenry County. These standards are require that the design maintain between 80% and 150% of the existing condition storm event runoff volume to the wetland up through the 2 year-24 hour storm event. Developments also must meet either the total off-site release rate requirements of the ordinance, or the

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[30] http://www.lakecountyil.gov/Stormwater/Documents/Regulatory/WDO%2011-18-08.pdf

[31] http://www.ci.mchenry.il.us/PDF/City%20Code/McHenry%20Co%20Storm%20Water%20Management%20Ordinance.pdf

minimum single pipe outlet size requirements (four-inch diameter). The following treatment methods shall be evaluated and incorporated wherever feasible to reduce pollution and stormwater volumes to the maximum extent possible: wet detention facilities, sedimentation facilities, infiltration basins, infiltration strips, filer strips, and vegetated swales.

Similar to other counties in the region, the release rate requirements in McHenry County are: 0.04 cubic feet per second per acre for the 2-year, 24-hour storm event and 0.15 cubic feet per second per acre for the 100-year, 24-hour storm event. For water quality management, the ordinance lists the following best management practices, ordered hierarchically:

- Preservation of natural resource features;
- Preservation of existing natural streams;
- Minimization of impervious surface;
- Use of natural landscaping;
- Use of vegetated channels, filter strips, and infiltration;
- Preservation of natural infiltration and storage characteristics;
- Installation of structural measures that provide water quality and quantity control;
- Installation of structural measures that provide water quantity control.

In addition to the McHenry County Stormwater Management Ordinance, developments are subject to provisions and standards laid out in the recently completed work of the Groundwater Recharge Taskforce. For example, this taskforce recommends the following: “*for Residential Development, 90% of the pre-development infiltration volume should be maintained. For Commercial/ Industrial Development, 60% of the pre-development infiltration volume should be maintained*.” Additionally, the county is considering further amendments to the stormwater ordinance that incorporate requirements from the Crystal Lake watershed-based ordinance..

Green Infrastructure Allowance: In addition to the Groundwater Recharge Taskforce recommendations, McHenry County has Conservation Design and Subdivision Ordinances that require the use of BMPs for stormwater management and use density bonuses for open space that is placed under conservation easements maintained by professional land managers. Several green infrastructure practices are included in the BMP hierarchy.

Will County

The Will County Stormwater Management Ordinance[32] was adopted in March 2004. The ordinance requires that the runoff generated from a 0.75-inch rainfall over any new impervious area be stored below the primary outlet of the site storage facility. Release rates shall not exceed 0.04 cfs/acre for the 2-year, 24-hour storm event, or 0.15 cfs/acre for the 100-year, 24-hour storm event.

The ordinance also requires a number of practices to be used when 25,000 square feet or more of development or construction occurs. These approved practices are:

[32] http://willcountylanduse.com/DevReviewDiv/SubEng/SubEngDocs/StormwaterOrd.pdf

- Vegetated Grass Waterways
- Contour Buffer Strips
- Critical Area Planting and Cover Crops
- Terrace Ridges and Diversions
- Contour Strip Cropping
- Contour Farming
- Crop Rotation
- Conservation Tillage and Crop Residue Management
- Other conservation planning standard practices in accordance with Natural Resources Conservation Service (NRCS) Field Office Technical Guide or approved by Will County (NRCS) District Conservationist

The Will County Subdivision Ordinance offers density bonuses for incorporating green infrastructure techniques and BMPs. Within the Ordinance, there is a chapter devoted to conservation design, which requires limits to impervious areas and BMPs to protect water quality and preserve natural hydrology. Furthermore, the county has taken steps to remove the administrative barriers against conservation design developments in zoning processes. Before these changes, developments following conservation design principles were treated as Planned Unit Developments, which is a separate review process.

Green Infrastructure Allowance: The Subdivision Ordinance gives density credits to incentivize the use of green infrastructure and other BMPs.

Will County identified a number of local municipalities for further study, based on their existing green infrastructure interest and experience. With few exceptions, all of the municipalities must have at a minimum the requirements of the applicable county ordinance.

City of Aurora

The City of Aurora adheres to Kane County's Stormwater Management Ordinance. There are a few differences between the City and County Ordinance. One difference is that the City of Aurora has created a specific Rainfall-Frequency data set[33] that must be used in calculating ordinance requirements. The City has also created vision plans for neighborhoods that have land use controls and require green infrastructure. One such plan is the Countryside Vision Plan[34] created in 2001. Requirements include 40 foot open space setbacks between lots and road drainage to swales. One of the goals of this plan was to disconnect impervious surface runoff from detention basins through the use of swales. Four subdivisions have since been developed under this plan and all have implemented backyard swales and native vegetation.

The City is currently developing a Naturalized Stormwater Management Corridor Plan which aims to reduce nonpoint source pollution and reduce combined sewer overflows through the use of green infrastructure techniques and BMPs. As part of this plan, a number of demonstration sites are being constructed in the downtown area. One such project, located in a residential area, is a series of bio-

33 http://www.aurora-il.org/publicworks/engineering/standardspecs/sectionfour.php
34 http://www.aurora-il.org/documents/planning/Countryside_Vision_Plan.pdf

infiltration facilities featuring ornamental, aesthetically pleasing native plantings in the right-of-way between the street and sidewalk. This project was funded in part under Section 319 of the Federal Clean Water Act.

City of Chicago

The City of Chicago is unique because of its age, density and combined sewer system; and the Chicago Stormwater Ordinance[35] reflects these characteristics. The Ordinance has been in place for over two years (took effect on January 1, 2008) and places an emphasis on impervious area reduction and implementation of green infrastructure techniques. The ordinance requires either the capture of 0.5 inch of runoff from all impervious surfaces or a 15% reduction in impervious surfaces from existing conditions[36]. The City has developed a Microsoft Excel Spreadsheet to help applicants in meeting these requirements. The City also has an integrated process in which the Stormwater Reviewer has a seat on the Concept Review Committee. This allows stormwater requirements to be incorporated in the initial design process and review. The City of Chicago has only issued one variance since the ordinance has been in place and considers this is a sign of the success and feasibility of the requirements. The City itself has incorporated green infrastructure into retrofit projects as well as in new construction. One example of this is the City Hall Green Roof, Figure 6.[37]

City of Crystal Lake

The City of Crystal Lake became a certified community under the McHenry County Stormwater Committee on January 1, 2005 with the creation of the Crystal Lake Stormwater Ordinance[38]. The City is concerned about the quantity and quality of stormwater reaching the lake, and this ordinance provides consistent regulation for the entire Crystal Lake Watershed[39]. The current program includes design implementation plan and a design manual. The design manual has specifications for design and pretreatment requirements. An emphasis is placed on pretreatment because soils within the Crystal Lake Watershed have high infiltration rates, which increases the risks of potential water quality impacts. The manual discusses a number of BMPs as well as green infrastructure techniques aimed to accomplish the goals of the program.

Village of Homer Glen

The Village of Homer Glen Water Resource Ordinance[40] uses the same release rates as the Will County ordinance requirements, namely 0.04 cfs/acre for a two-year, 24-hour storm event and 0.15 cfs/acre for the 100-year, 24-hour event. In addition to the requirements set forth by the Will County Ordinance, the Homer Glen ordinance stipulates that increases in run-off be minimized through a BMP hierarchy. This hierarchy includes the preservation of natural features, restoration of wetlands, preservation of existing swales, drainage ways, streams, and depressions, minimization of impervious surfaces, and the

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[35] http://www.cityofchicago.org/city/en/depts/water/provdrs/engineer/svcs/2009_sewer_constructionandstormwatermanagementrequirements.html

[36] 15% reduction only for developments that do not directly discharge to waters or a municipal separate storm sewer

[37] http://www.explorechicago.org/city/en/about_the_city/green_chicago/Green_Roofs_.html Courtesy of the City of Chicago, Summer 2004.

[38] http://www.crystallake.org/Modules/ShowDocument.aspx?documentid=234

[39] Email dated 3/23/10 from the City of Crystal Lake

[40] http://www.homerglenil.org/regulations/WaterResourceManagement.aspx

Figure 6: Chicago City Hall Green Roof

preservation of natural infiltration characteristics of sites. Furthermore, the ordinance contains infiltration provisions that require the use of BMPs to ensure that the post development infiltration volume is 90% of the predevelopment for residential and 60% for non-residential sectors.

Of particular interest is the regional detention clause in the ordinance which encourages adjacent properties to utilize a common regional detention basin through owner participation in cost sharing. Management of water quality is addressed in wet detention basin requirements through provisions for water-tolerant native vegetation for the bottom and shorelines of the facilities.

Local Program Transferability

Currently, parts of the state have legislation that enables the establishment of Stormwater Management Planning Committees and the preparation of countywide plans for management of stormwater run-off and for setting minimum standards for floodplain and stormwater management.[41] The counties covered under this legislation have largely taken the necessary actions to adopt and enforce stormwater management ordinances. Several municipalities built on this initiative by implementing regulations that exceeded county-wide stormwater management rules. Meanwhile, some areas in the state that do not have the enabling legislation have enacted erosion control ordinances to manage stormwater run-off. Ordinances adopted in 2004 in Peoria County require on-site stormwater retention so that post-development run-off rates must not exceed pre-development rates. The Peoria County Soil and Water Conservation District is under contract with the county to review development plans. If property owners/developers wish to employ green infrastructure practices, they have to prove that such practices meet the release rate requirements. Other communities, such as the City of Decatur, have chosen to adopt the Illinois Urban Manual for Best Management Practices strategy.

[41] Illinois General Assembly: (55 ILCS 5/5‑1062.2)

The City of Bloomington started charging stormwater utility fees based on area of impervious surface in 2004. Billing is based on Impervious Area Units (IAU) which is defined as 1 IAU = 1,000 square feet of impervious area. Additionally, property owners may receive stormwater rate reduction credits by proving that on-site stormwater facilities reduce peak run-off rates according to specified ordinance criteria. By contrast, the City of Moline charges a flat rate for stormwater utility for properties up to 2 acres. For larger size properties, service is charged based on Equivalent Hydraulic Acreage, which is a formula calculated to assess impervious coverage of a site. The Village of Rantoul adopted a similar approach in 2001 upon the implementation of the Storm Drainage Tax. Residential properties have a flat rate while non-residential properties are charged according to lot size and land use. The funds collected in the above examples are mostly used to maintain and improve existing stormwater infrastructure systems.

From the analysis above, it is clear that many communities in the state are re-thinking stormwater management to add flexibility that can potentially allow the incorporation of green infrastructure practices. However, all communities in the state still face the same barrier, mainly funding for the implementation of green infrastructure. The problem is more severe for areas that do not have staff or resources for stormwater management due to lack of enabling legislation that permits the establishment of commissions and the necessary staffing. In spite of this setback, some regional planning councils, e.g. the Tri-county Regional Planning Commission of Peoria, Tazewell and Woodford counties, have undertaken significant initiatives to address stormwater management by providing unified model stormwater ordinances, watershed planning activities and incorporation of stormwater management in comprehensive planning such as Long Range Transportation Plans. Some communities have benefited from these initiatives and many adopted proposed ordinances and/or recommendations from watershed plans that aim to protect the more sensitive areas that have the greatest impact on surface waters. It is important that regional planning agencies and Soil and Water Conservation Districts are adequately funded to continue assisting communities that do not have the staff resources to promote green infrastructure in stormwater management.

To better understand the issues involving the transfer of green infrastructure practices from northeastern Illinois to downstate communities, we met with local stormwater managers in the Chicago metro region as to what they considered the most significant impediments to the wider use and adoption of these practices. During our discussions with the staff of the region‘s stormwater management agencies and the Illinois Department of Transportation, we gathered data on the state of green infrastructure in the region and explored their perceptions about the potential barriers to further or future implementation of green infrastructure practices. Through these conversations, the following issues were identified.

Feasibility under Diverse Conditions

The overall feasibility of requiring green infrastructure in the state of Illinois was a reoccurring issue. The general consensus was that green infrastructure has definite benefits, including water quality improvements and water quantity reductions. However requiring green infrastructure and crediting it against traditional detention could pose complications especially when considering the long term integrity of the green infrastructure. Some of these concerns will be further addressed under Maintenance Issues.

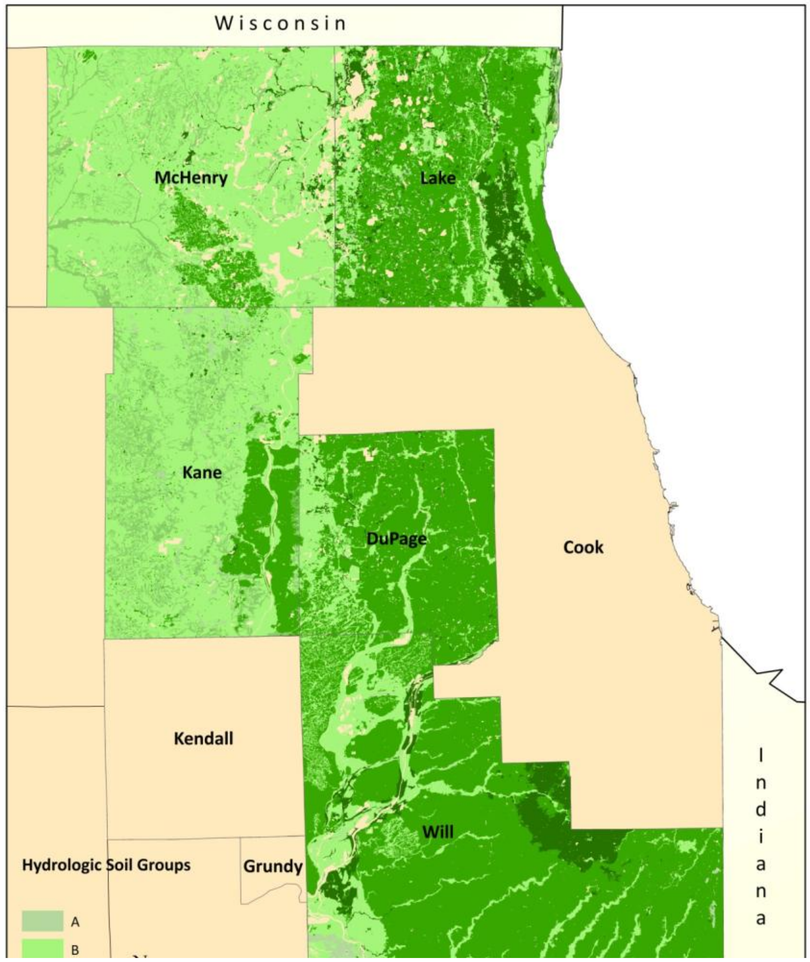

Figure 7: Hydrologic Soil Characteristics in Northeastern Illinois

Also, the northeastern region has a very diverse soil composition. Successful infiltration practices rely on underlying soils with good infiltration rates. Figure 7 shows the diversity of the soil throughout the region.[42] The dark green regions are areas with soils that have poor infiltration characteristics. The National Association of Floodplain and Stormwater Management Agencies (NAFSMA) provided testimony to the U.S. House of Representatives Committee on Transportation and Infrastructure, Subcommittee on Water Resources and the Environment regarding Green Infrastructure[43]. One of the barriers they cited was poor soils, stating the following:

> *"Naturally occurring clay and plastic soils limit infiltration measures, making them very difficult, ineffective and expensive to construct and maintain. These areas rely on modifications to Green Infrastructure techniques including, but not limited to providing pipe systems to drain the system artificially, thus providing treatment with minor reductions in runoff and little groundwater recharge. If Green Infrastructure is to be used in such areas, it will be necessary to supplement those techniques with conventional stormwater management techniques to achieve pollutant removal efficiencies necessary to meet regulatory requirements and accomplish clean water goals."*

[42] SSURGO data is currently not available for Cook and Kendall Counties

[43] http://www.nafsma.org/pdf/2009-annual-meeting/NAFSMAGI-LID%203-19-09%20final.pdf

Figure 8: Illinois Fall Frost Date Map[44]

The performance of infiltration based practices drastically decreases as the ground freezes. Figure 8 displays the date of the first fall frost in Illinois. The concern is that during the fall, winter and spring months, the evapotranspiration and infiltration potentials will be drastically reduced and precipitation will mostly be converted to surface run-off.

The overall perception of lack of performance data of green infrastructure practices as they pertain to Illinois conditions is a barrier to implementation. However, this is only a perceived barrier. As our research shows, more than 57 peer-reviewed research articles have been published with data on the effectiveness of green infrastructure at removing TSS, TN, reducing peak flow, and reducing runoff volume. This does not include research on green infrastructure‘s impact on other pollutants or data which has been submitted to the BMP Database. Furthermore, many successful green infrastructure projects have been implemented throughout the state despite these perceived barriers. The issues identified can be addressed during the proper site design phase and continued maintenance can help to ensure the long time integrity of these structures. There are many examples of successful green infrastructure projects throughout the region which have overcome these design issues.

Maintenance Issues

Maintenance was a major concern when talking to regional stormwater agencies. Green, as well as grey, infrastructure requires specialized long term maintenance. Some green infrastructure techniques, e.g. permeable pavement and porous asphalt, rely on void space to treat and retain stormwater runoff. These void spaces can become clogged with debris and sediment over time requiring routine maintenance. Furthermore, the small scale and cumulative nature of green infrastructure techniques may apparently make implementation inefficient particularly in an urban environment and/or higher density areas. NAFSMA cites this as a concern also stating the following:

[44] Illinois State Water Survey http://www.isws.illinois.edu/atmos/statecli/Frost/first_fall_frost.htm

"Since the techniques employed in Green Infrastructure seek to mimic pre-development conditions, it is necessary to capture stormwater runoff at or near its source... This requirement creates the need to construct many small structural features, such as rain gardens to accomplish this… As a result, administration and maintenance is simplified, aesthetic and functional issues are more easily addressed, the inspection and logistics of repair are reduced, and effectiveness of performance is more easily maintained[45]."

In addition, responsibility for and funding of maintenance of structures are not broadly addressed in current regulations which is a cause for trepidation for stormwater managers. These are all issues that can be addressed when developing a green infrastructure program. Answering the following questions listed in Table 9 will help to structure a successful program.

Table 9: Detailed Questions on Maintenance of Green Infrastructure

- **Who will be responsible for this maintenance once green infrastructure is implemented?**
- **If it is residential development, is the homeowner knowledgeable in green infrastructure maintenance?**
- **Should there be requirements to hire professional landscaping companies to maintain private property?**
- **Once the property changes hands, who will be responsible for maintenance?**
- **Is it the stormwater management agency's responsibility to ensure that green infrastructure is still properly being maintained?**
- **If so, how are they to fund and staff these inspections?**

The regulating agencies can also aid landowners, homeowners associations and individual homeowners in performing appropriate maintenance by providing educational brochures and workshops. Lake County Stormwater Management Commission, for example, hosts free workshops for associations and property owners who are responsible for maintaining detention ponds, wetlands and natural areas[46]. Such programs can ease the burden on property owners as well as raise awareness on maintenance requirements.

Funding

Although there is a recognition that green infrastructure may be more cost-effective than conventional approaches over the long term, specifically if the value of water quality improvements and reduced flooding incidents are added in the calculations, some green infrastructure practices may cost more than conventional practices over the short term. This is particularly true for large-scale execution of permeable

[45] http://www.nafsma.org/pdf/2009-annual-meeting/NAFSMAGI-LID%203-19-09%20final.pdf
[46] http://www.lakecountyil.gov/Stormwater/Documents/Public%20Information%20and%20Mapping/Educational%20Workshops/2010/2010FlyerAgendaMap.pdf

pavements.[47] While permeable pavements may not have to be frequently replaced, there are still costs associated with maintenance, as is the case with other green infrastructure measures. In most cases, such maintenance requires professional personnel and/or equipment to insure integrity of structures over a long time, all of which come with a price tag that necessitates the availability of a secure funding source. A study conducted by The Civic Federation[48] cited cost as one of the barriers to green infrastructure implementation for many of the same reasons listed above. Although some communities use Special Service Areas to fund stormwater management, e.g. several municipalities in Kane County, others do not and the necessary political will to enact such procedures might be absent. Additionally, there is a general feeling among northeastern Illinois stormwater managers that current budgets do not include funding for maintenance or enforcement of green infrastructure practices.

Culture

Although in many cases green infrastructure is being viewed as an attraction and an amenity, some communities still face resistance in implementing green infrastructure. There is a belief among many that native plantings appear weedy and are not aesthetically pleasing. We heard this concern from one community encouraging homeowners to install rain gardens to remedy nuisance backyard flooding. Residents are reluctant to plant native plantings because they are not aware of the multitudes of options.

Demonstration sites with many species of native plants with varied colors and heights could help convince residents that native plants can be aesthetically pleasing. The Conservation Foundation is very active in providing information to individual property owners and municipalities throughout northeastern Illinois about native plantings and green infrastructure through their Conservation@Home[49] Program. Figure 9 was provided by The Conservation Foundation as an example of aesthetically pleasing native plantings.

Figure 9: Natural Landscaping

There is a belief that stormwater management is not necessary in more rural areas. Since agricultural areas are often exempt from stormwater management requirements, adjacent properties may feel they should be also. Implementation of green infrastructure regulations may potentially be viewed as infringement on property rights. These are issues that may be overcome with increased awareness of the benefits of green infrastructure.

[47] An analysis of the Elfstrom Stadium in Kane County (The Cougar Stadium) which was fitted in 2004 with permeable pavers, shows that initial costs were 75% higher when compared to the initial construction costs of asphalt pavement. However, over 48 years, the total costs of the permeable pavement, which included initial costs and maintenance/replacement costs, was that same as the total for asphalt pavement. Source: Kane County Department of Environmental and Building Management.

[48] http://www.cnt.org/repository/GreenInfrastructureReportCivicFederation%2010-07.pdf

[49] http://www.theconservationfoundation.org/index.php?option=com_content&view=article&id=323&Itemid=200038

Groundwater quality

One of the acknowledged benefits of green infrastructure is that it can potentially increase groundwater recharge. Although initially this is a benefit, many communities are concerned about possible groundwater contamination, should soils and plants not sufficiently attenuate pollutants, especially since many infiltration based practices are designed to capture the ―first flush" of runoff which typically contains an increased amount of pollutants.

Unless proper treatment is also incorporated in the design of these practices the contamination of shallow groundwater aquifers is possible. NAFSMA also cited this concern in their testimony stating: *"Infiltration of surface waters to groundwater has been shown to, in some instances, increase certain pollutant concentrations in groundwater. These potential risks must be considered when evaluating Green Infrastructure as a stormwater system component*[50]*."* As previously stated, pretreatment prior to infiltration can help ensure groundwater quality protection.

STATE PROGRAMS

Section 15(e) of the Green Infrastructure for Clean Water Act requires that this study review and report on ―existing and potential new urban storm water management regulatory programs and methods and feasibility of integrating a State program with existing and potential regional and local programs in Illinois."[51] We selected five state programs that have in place statewide stormwater management performance standards that go beyond the Clean Water Act NPDES permit requirements adopted by Illinois, and encourage or require the use of green infrastructure as a means of meeting those standards.

We reviewed the stormwater management programs of Maine, Maryland, Minnesota, New Jersey, and Wisconsin, including the statutes, regulations, and guidance manuals. We also contacted staff within the office of the agency administering each program to obtain personal descriptions of the programs and candid views of their strengths and weaknesses. Each of these five states administers a Clean Water Act National Pollution Discharge Elimination System (NPDES) Permit Program which includes stormwater permitting. However, our focus here is on statewide stormwater regulations separate from the NPDES programs, with specific performance standards and provisions that require or encourage the use of green infrastructure to meet those standards.

In describing each state program, we briefly report on the format and content of the state statutory law, in part to illustrate the different levels of detail other state legislatures have used when authorizing their state environmental agencies to establish stormwater performance standards. This should be useful to the Illinois General Assembly and the IEPA as they contemplate the development of a stormwater regulatory program here in Illinois. We focus more attention on the regulations and performance standards themselves, as well as technical guidance manuals relied on in each program. Finally, we provide state

[50] http://www.nafsma.org/pdf/2009-annual-meeting/NAFSMAGI-LID%203-19-09%20final.pdf

[51] For this review, we have utilized a website maintained by StormwaterAuthority.org, including a page linking to summaries of all the state stormwater management programs in the country: http://www.stormwaterauthority.org/regulatory_data/state.aspx. We have quoted liberally from these summaries and refer the reader to them for further research.

contact information, notes from our interviews with state program staff and website and other reference information for the reader wishing to pursue further research.

Maine. The Maine Department of Environmental Protection (MEDEP) is responsible for administering the state‘s stormwater management program, which includes the NPDES permit program and separate stormwater regulations. The Department maintains a helpful website that provides links to the statutes, regulations and guidance documents at: http://www.state.me.us/dep/blwq/docstand/stormwater/index.htm.

The contact for the Maine program is:

Don Witherill
Director, Division of Watershed Management, Bureau of Land & Water Quality
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333
(207) 287-7725

1. Statutory provisions

Maine‘s stormwater program is based on three statutes:

a. —Site Law”, Title 38 of the Maine Revised Statutes, Sections 481 to 490
b. —Stormwater Management Law”, 38 M.R.S. §420-D
c. —Waste Discharge Law”, 38 M.R.S. §413

The Site Law, 38 M.R.S. §484, contains language governing the siting of new development and requires compliance with the Stormwater Management Law, 38 M.R.S. §420-D. The Stormwater Management Law lays out the framework for the stormwater management regulations, as well as the authority for the DEP to adopt them. The Waste Discharge Law provides the basis for the state license by rule standards for stormwater infiltration contained in Appendix D of the regulations.

2. Regulatory provisions – Code of Maine Regulations 06-096 Chapter 500

Maine‘s stormwater regulations, contained in this one Chapter of the Code, are easily located on the above website. The regulations originally took effect in July 1997, were significantly revised on November 16, 2005, and have been amended since then. They focus on four primary stormwater treatment objectives: pollutant removal, temperature reduction, channel protection, and flood control. To achieve these goals, the regulations establish six categories of stormwater performance standards. They can be summarized as follows:

1. **Basic standards** – all projects disturbing one or more acres must meet the basic standards. They include grading, erosion and sedimentation control, inspection and maintenance, and housekeeping. Threshold: one acre of disturbance.

2. **General standards** – in addition to the basic standards, a general retention standard applies to developments over a certain size in the watershed of an impaired stream. Projects must include treatment systems that reduce erosive channel flows, remove pollutants and reduce water temperature. The primary mechanism for achieving these objectives is either detention or retention of the runoff volume equivalent to 1.0 inch over the impermeable surface and 0.4

inch over the landscaped area. The general standards also contain a slightly less stringent retention standard for linear projects, such as roads.

Threshold: one acre of disturbance AND 20,000 square feet of impervious surface or 5 acres of developed area in the direct watershed of an urban impaired stream or one acre of impervious surface in any non-urban stream, coastal or wetland watershed.

Of particular note is the following language inserted in the body of the section:

> Note: The department strongly encourages applicants to incorporate low-impact development (LID) measures where practicable. LID addresses avoidance of stormwater impacts by minimizing developed and impervious areas on the project site. LID project design considers the location of any protected natural resources, and maintaining natural drainage patterns and pre-construction time of concentration. If practicable, LID incorporates runoff storage measures dispersed uniformly throughout a site rather than single point collection of stormwater through conventional end-of-pipe structures.

3. **Phosphorus standard** – in lake waters, this standard applies instead of the general standards. DEP establishes a phosphorus allocation on a project-by-project basis, based on current water quality, water chemistry of the watershed, land use, volume and flushing rate, and projected population growth.

4. **Urban impaired stream standard** – applies in addition to the other standards to larger projects located in the watershed of an urban impaired stream or a listed stream. This standard requires either the payment of a fee to compensate for the adverse impacts of the project or the mitigation of those impacts through treatment or the reduction or elimination of impervious surface.

5. **Flooding standard** – applies in addition to other standards where a project involves three acres or more of impervious surface or 20 acres or more of developed area. Stormwater management systems for these projects must detain or retain the additional volume from the project for the 2-year, 10-year and 25-year storm such that the peak flow is not increased by the project.

6. **Additional standards** – apply to projects that involve concentrated discharges, discharges to freshwater or coastal wetlands, threatened or endangered species habitat and other special cases as determined by the DEP.

7. **At-risk and threatened watersheds.** The DEP has identified —watersheds most at risk from new development”, as well as those that are —sensitive and threatened,” and the more stringent performance standards apply to those waters.

3. Manuals

Maine Stormwater Best Practices Manual:
http:/www.state.me.us/dep/blwq/docstand/stormwater/stormwaterbmps/index.htm#manual

The Maine DEP also maintains a number of guidance documents for stormwater management, some of which are linked to the following website: http://www.maine.gov/dep/blwq/docwatershed/materials.htm#cpfh

LID Guidance Manual for Maine Communities - Approaches for Implementation of Low Impact Development at the local level. September 21, 2007. The purpose of this guidance manual is to help municipalities implement Low Impact Development (LID) practices on small, locally permitted development projects. This manual provides a recommended set of low impact development (LID) standards and guidance on implementing LID practices to comply with those standards.

Maine DEP has undertaken an effort to map the imperviousness of its urban areas: http://www.state.me.us/dep/blwq/docstand/stormwater/stormwaterbmps/index.htm#manual

4. Notes from Interview with State Contact: Don Witherill

- Don has been involved in stormwater management for many years, and has been a manager for the last 14 years. He has been the lead staff person since the regulations went into effect in 1997, including two revisions to the regulations.
- The original regulations did not involve the NPDES program, because there were no national requirements until after the Maine regulations took effect. There is some integration of the two programs now.
- An area of Portland with heavy retail businesses and dense residential neighborhoods is associated with an impaired stream. The Conservation Law Foundation petitioned the U.S. EPA to designate the landowners in the area as stormwater permittees. As a result, 110 landowners received notice that they are subject to a general permit that was developed for the watershed under the NPDES stormwater program. More information is provided at www.restorelongcreek.org.
- Did not investigate other states at time regulations were adopted.
- Chapter 500 of the regulations is being redrafted and strengthened. The LID ―Note‖ is expected to be dropped in favor of a requirement to use LID.
- When the regulations were adopted, there was a close vote in the state legislature approving them. In order to make the case, DEP provided information on the degradation of lakes due to stormwater. Maine residents care a lot about their water resources, which probably contributed to the positive outcome.
- Moved away from TSS removal as a performance standard; it did not solve the problem because many BMPs do not remove the nutrients as well as they reduce volume.
- Fees are charged for development applications, but they are not enough to run the program; general fund resources are also required.
- The Maine Department of Transportation and Highway Authority are exempt from the regulations, but are required to have memoranda of agreements with DEP committing to comparable standards in their policies and procedures; BMP Manual standards apply to their projects.
- LID is a very good idea; we need to treat stormwater in a decentralized way, mimicking natural conditions, requiring natural hydrology, getting people‘s attention on maintenance; landowners are required to certify every five years that their stormwater BMPs are performing well.
- With the $4 million received for the state revolving fund green project reserve in Maine, many LID projects are being done; The Maine Department of Transportation has put in some porous

pavement in the Long Creek project; local community organizations have installed bio-retention cells. Contact: Steve McLaughlin: 207-287-7768.

- There are no utilities yet, although some municipalities are considering fees and utilities.

5. Websites

A description of the stormwater program, including the integration of these statutes is set forth in a well organized manner on the DEP's Stormwater Program website at: http://www.state.me.us/dep/blwq/docstand/stormwater/index.htm.

Maryland. The Maryland Department of the Environment (MDE) is responsible for administering the state's stormwater management program. Maryland is one of the most progressive states in the nation with respect to stormwater management, although there has been a recent attempt by members of the business community to repeal some of the newer, more aggressive provisions of the regulations. The program has a history dating back to the passage of the Stormwater Management Act by the Maryland General Assembly in 1982. Under the 1982 Act, all new development was required to use infiltration as the first option for mimicking the two-year and ten-year storm pre-development hydrographs. In 2000, the state adopted regulations and the Maryland Stormwater Manual, which included these requirements. Through this Manual, environmental site design (ESD), another term used to describe green infrastructure practices, is encouraged. In accordance with the Stormwater Management Act of 2007, MDE issued regulations requiring that ESD be implemented to the maximum extent practicable.

The contact for the Maryland program is:

Brian Clevenger
Environmental Program Manager
Program Review Division
Maryland Department of the Environment
1800 Washington Boulevard, Baltimore, MD 21230
410-537-3554
bclevenger@mde.state.md.us.

1. Statutory Provisions

Maryland storm water management regulations are based on the provisions of the state statutes with the following headings[52]:

- o Environ. Article, Title 4, §§101 to 116 Sediment Control
- o Environ. Article, Title 4, §§201 to 215 Stormwater Management

[52] For complete versions of the Maryland code and regulations, see: http://www.michie.com/maryland/lpext.dll?f=templates&fn=main-h.htm&2.0

- **Sediment Control.** In a manner characteristic of statewide programs, the legislative findings are extensive and emphasize the value of the land and waters of the State. The findings describe the degradation of the waters of the state and place the blame squarely on the uncontrolled discharge of eroded materials to land and water. In addition, the findings cite the need for procedures to obtain immediate compliance with the law when violations occur. While findings are not enforceable performance standards, they set forth a state's policies and can be worded to give the responsible agency legal support for the development of regulations that contain such standards.

  This section of the code also requires developers to have comprehensive grading and sediment control plans. At the same time, the statute requires counties and municipalities to establish ordinances covering grading and construction practices that affect water quality. Somewhat less common is the statutory requirement that managers of construction projects involving on-site clearing and grading must be trained in erosion and sediment control prior to the start of the project.

  We also note that MDE is required to review and approve the erosion and sediment control plans for construction to be carried out by a state or federal agency, a recognition of the cumulative impact of government projects on water quality and quantity.

- **Stormwater Management.** The legislative findings in the stormwater management section of the code are broader, though no less powerful in their effect, than those in the sediment control section. They state the intended goal "to reduce as nearly as possible the adverse effects of stormwater runoff and to safeguard life, limb, property, and public welfare." This expansive language gives MDE latitude to develop a program with few legal constraints.

  The requirement for each county and municipality to adopt ordinances necessary to implement a stormwater management program within 2 years is also expansive and potentially much more burdensome than the requirement to develop grading and erosion control programs. Because erosion control plans are arguably critical components of comprehensive stormwater management programs, some of these requirements could be considered redundant.

The code directs MDE to adopt rules and regulations to achieve the primary goal of maintaining, after development, the predevelopment runoff characteristics of a site. These regulations are to include the following elements:

- Make allowance for the difference in hydrologic characteristics and stormwater management needs of different parts of the State
- Specify that watershed-wide analyses may be necessary to prevent undesirable downstream effects of increased stormwater runoff
- Specify the exemptions a county or municipality may grant from the requirements of submitting a stormwater management plan
- Specify the minimum content of the local ordinances or the rules and regulations of the affected county governing body to be adopted which may be done by inclusion of a model ordinance or model rules and regulations; and
- Establish regulations and a model ordinance that require

- The implementation of ―environmental site design” to the maximum extent practicable (similar to ―green infrastructure”)
- The review and modification, if necessary, of planning and zoning or public works ordinances to remove impediments to environmental site design implementation; and
- A developer to demonstrate that
  - Environmental site design has been implemented to the maximum extent practicable; and
  - Standard best management practices have been used only where absolutely necessary

This level of detail in the statute seems to be appropriate, as it provides good guidance without establishing specific performance standards.

2. Regulatory Provisions

The section of the Maryland regulations implementing the sediment control section of the statute is Title 26, Subtitle 17; Chapter 01: Sediment Control. It does not contain any specific performance standards. In contrast, the regulations implementing the stormwater management section are found in Title 26, Subtitle 17; Chapter 02: Stormwater Management, and contains the following specific requirements and standards:

The primary water quality treatment goal in Maryland is removal of 80% of the annual Total Suspended Solids load and 40% of the Total Phosphorus. Other performance standards include groundwater recharge, volume control through retention, and detention volume and release rates. Only Best Management Practices (BMPs) approved by the MDE and designed in accordance with Maryland‘s Stormwater Design Manual may be used to meet these treatment objectives. Exceptions may be made in retrofit situations or where the MDE approves a particular device for a unique project.

1. <u>Ordinances</u> – each county and municipality must adopt ordinances that require

- Comprehensive stormwater management plans
- Exemptions and waivers
- Criteria and procedures
- Proper implementation of plans
- Maintenance requirements
- Penalties

2. <u>Applicability</u> – unless a particular activity is exempt, a person may not develop any land without an approved final stormwater management plan

- There is a threshold of 5,000 square feet or more of development
- The plan must conform to the Maryland Stormwater Design Manual
- Redevelopment is required to
  - Reduce existing (disturbed) impervious area by at least 50%
  - Implement ESD to the maximum extent practicable (MEP) to provide water quality treatment for at least 50% of the existing (disturbed) impervious area or
  - Combination of these two approaches

3. Minimum Control Requirements – each county and municipal ordinance must contain the following minimum control requirements as well as those contained in the Maryland Design Manual.

- Must use methods specified in Design Manual to implement ESD to the MEP
- Design must use
  - Sizing criteria and specifications contained in Design Manual
  - Recharge volume – maintain 100% of average annual predevelopment groundwater recharge
  - Water quality volume – minimize nonpoint source pollution
    - Treatment of the WQ_v is required; designed to be 90% of the average annual rainfall; determined to be 0.9: or 1.0 inches, depending on the part of the state
    - Minimum of 0.2 inches per acre must be retained at sites with less than 15% impervious cover
  - Channel protection storage volume – 24 hour extended detention of the one-year, 24-hour storm event
  - Overbank Flood Protection Volume – for 10-year, 24 hour event, maintain predevelopment peak discharge rate; required if local agency has no control over development or conveyance system downstream
  - Extreme flood volume – detention of 100-year 24 hour event to maintain predevelopment peak discharge rates; required if downstream development is located in the 100-year floodplain
  - Structural practices may not be used unless absolutely necessary
- If local agency determines additional control is necessary because of historic flooding and lack of control over downstream development and conveyance system design, control of 2-year or 10-year storm event, or both is required
- Flexibility for approving agency to require more if hydrologic or topographic conditions warrant
- Development may not increase downstream peak discharge for the 100-year event

4. Planning Techniques – ordinances must also require that the following techniques be used to the maximum extent practicable:

- Preserving and protecting natural resources
- Conserving natural drainage patterns
- Minimizing impervious area
- Reducing runoff volume
- Maintaining 100% of the average annual predevelopment groundwater recharge volume
- Using green infrastructure (green roofs, porous pavement, etc.)
- Limiting soil disturbance, mass grading and compaction
- Clustering development

3. Manuals

Maryland Stormwater Management Guidelines: provide information necessary for submittal of stormwater management plans by State and federal agencies

2009 Model Standard Stormwater Management Plan

2009 Model Stormwater Management Ordinance

4. Notes from Interview with State Contact: Brian Clevenger

- Mr. Clevenger has 20 years experience working with the regulations
- Program requires adequate staffing; site by site review; permit fees for dedicated funding source; 8 people on staff, 40-50 field inspectors for all water programs
- Threats of driving development away with new regulations are common and should not deter the administration‘s objective of protecting the resource
- Need to treat redevelopment differently, consider site conditions
- Volume control or retention requirement is necessary; contained in Design Manual
- Detention is not a recommended practice
- Maintenance may be the biggest problem; local governments need staff support
- It would be wise to address urban stormwater first; regulate impervious surface

5. Websites

For guidance, DOE maintains a website on the stormwater management program at: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/index.asp, and a good explanation of the program is on line at http://www.mde.state.md.us/assets/document/sedimentStormwater/MSWM_MFR.pdf.

In addition, because of the political effort to roll back the regulations, DOE has issued emergency regulations which provide some grandfathering and exemptions of some activities from the rules. The Department provides up-to-date information on these changes on the following website: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/swm2007.asp.

Maryland Stormwater Management Guidelines for State and Federal Projects: http://www.mde.state.md.us/assets/document/sedimentstormwater/SWM_guidelines.pdf

Maryland‘s Stormwater Management Program (two-page summary sheet): http://www.mde.state.md.us/assets/document/sedimentStormwater/SWM_Program_fs.pdf

Maryland Water Quality Standards Website: http://www.mde.state.md.us/Programs/WaterPrograms/TMDL/wqstandards/index.asp

1994 Maryland Specifications for Soil Erosion and Sediment Control: http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/erosionsedimentcontrol/standards.asp

Maryland Stormwater Design Manual, Volumes I and II (Effective October 2000): http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

Minnesota. The Minnesota Pollution Control Agency (MPCA) is responsible for administering the state‘s stormwater management program. Currently, Minnesota does not have stormwater performance standards at the state level. The Minnesota Statutes require the MPCA to develop such performance standards, design standards, or other tools to enable and promote the implementation of ―low-impact development" and other stormwater management techniques. ―Low-impact development" is a term considered synonymous with ―green infrastructure.” The purpose of this requirement is to ensure that ―stormwater is managed on-site and the rate and volume of predevelopment storm water reaching receiving waters is unchanged.” Instead of adopting performance standards, MPCA has left this to local governments and watershed districts such as the Capitol Region Watershed District (CRWD). Through its permitting program, the CRWD imposes several performance standards, including erosion & sediment control, volume control, removal of suspended solids and runoff release rates. After taking a brief look at the state statutory provisions, we summarize the CRWD stormwater management regulations.

The contact for the Capital Region Watershed District program is:

Mark Doneux, Administrator, CRWD
1410 Energy Park Dr.
Suite 4
St. Paul, MN 55108
651-644-8888
mark@capitolregionwd.org

1. Statutory Provisions

The provisions of the Minnesota Statutes dealing with stormwater are found in several chapters from Chapter 103A to 114I, as follows.

One section within the Water Pollution Control section of the Minnesota Statutes, Section 115.03(5c)(b), authorizes the Minnesota Pollution Control Agency (MPCA) to adopt and enforce rules regulating point source storm water discharges. Section 115.03(5c)(c) goes on to require the Agency to

> …develop performance standards, design standards, or other tools to enable and promote the implementation of low-impact development and other storm water management techniques. For the purposes of this section, "low-impact development" means an approach to storm water management that mimics a site's natural hydrology as the landscape is developed. Using the low-impact development approach, storm water is managed on-site and the rate and volume of predevelopment storm water reaching receiving waters is unchanged. The calculation of predevelopment hydrology is based on native soil and vegetation.

This section is implemented through Chapter 7090 of the Minnesota Rule, Minnesota Pollution Control Agency, Storm Water Regulatory Program, which requires an NPDES/State Disposal System storm water permit program. However, the MPCA has not developed any state-wide runoff requirements for impaired waters. Instead, runoff control is left to local units of government and to watershed management districts.

The MPCA has developed the Minnesota Stormwater Manual to provide guidance to local governments and watershed management agencies implementing local storm water management programs. It includes recommended on-site BMPs (many of which include green infrastructure practices) and is downloadable from: http://www.pca.state.mn.us/water/stormwater/stormwater-manual.html. There is also an

Assessment of Stormwater BMPs Manual prepared by the University of Minnesota that can be downloaded at: http://stormwater.safl.umn.edu/.

Separately, Chapter 103B.101(2) subdivision 9 of the Minnesota Statutes authorizes the state's Board of Water and Soil Resources to:

> (1) coordinate the water and soil resources planning activities of counties, soil and water conservation districts, watershed districts, watershed management organizations, and any other local units of government through its various authorities for approval of local plans, administration of state grants, and by other means as may be appropriate….

Chapter 103B.102 gives the state Board of Water and Soil Resources oversight authority over "local water management entities" (including watershed districts, soil and water conservation districts, metropolitan water management organizations, and counties operating separately or jointly in role as local water management authorities under chapter 103B, 103C, or 103G and chapter 114D). The evaluation is to be undertaken every five years and to be posted on the Board's website (103B.103, subdivision 3).

The Board is also charged with the preparation of the state's water resources plan (103B.155), and with the preparation of guidelines, criteria and standards for local water resources plans. It is authorized to review draft plans prepared by local watershed districts (103B.231, subdivision 7) and to approve final plans (subdivision 9) and plan amendments (subdivision 11). The same plan review and approval authority is given the Board of Water and Soil Resources for metropolitan groundwater management plans (103B.255) and for county water management plans (103B.301-335).

2. Regulatory Provisions

Rules adopted by the Capital Region Watershed District were effective October 1, 2006; see: http://www.capitolregionwd.org/documents/AdoptedRule01_07_09.pdf, Highlights of performance standards contained in the Stormwater Management section of the rules are as follows:

Rule C: STORMWATER MANAGEMENT

2. Regulation.

- Permit required for land disturbing activity one acre or greater
- Approved stormwater management plan required

3. Criteria.

- Stormwater management plans must comply with the following:
  - Runoff Rate – runoff rates for the proposed activity shall not exceed existing runoff rates for the 2-year, 10-year, and 100-year critical storm events, and runoff rates may be restricted to less than the existing rates when the capacity of downstream conveyance systems is limited.
  - Runoff volume – stormwater runoff volume retention shall be achieved onsite in the amount equivalent to the runoff generated from one inch rainfall over the impervious surfaces of the development.
  - Infiltration for volume reduction must meet the following requirements:

- Infiltration volumes and facility sizes shall be calculated using the appropriate hydrological soil group classification and design infiltration rate from Table 1. Select the design infiltration rate from Table 1 based on the least permeable soil horizon within the first five feet below the bottom elevation of the proposed infiltration BMP.
- The infiltration area shall be capable of infiltrating the required volume within 48 hours for surface and subsurface BMPs.
- Stormwater runoff must be pretreated to remove solids before discharging to infiltration areas to maintain the long term viability of the infiltration areas.
- Specific site conditions may make infiltration difficult, undesirable, or impossible. Some of these conditions may qualify the applicant for Alternative Compliance Sequencing.

- Water Quality – developments shall incorporate effective nonpointsource pollution reduction BMPs to achieve 90% total suspended solids removal from the runoff generated by a NURP water quality storm (2.5" rainfall). Runoff volume reduction BMPs may be considered and included in the calculations showing compliance with achieving the 90% TSS removal requirement.
- Maintenance – all stormwater water management structures and facilities, including volume reduction BMPs, shall be maintained to assure that the structures and facilities function as originally designed. The maintenance responsibilities must be assumed by either the municipality's acceptance of the required easements dedicated to stormwater management purposes or by the applicant executing and recording a maintenance agreement acceptable to the District.

3. Manuals

Minnesota Stormwater Manual

4. Notes from Interview with CRWD Contact, Mark Doneux

- CRWD is a special purpose unit of government whose board is appointed by county officials (in order to help insulate it from political pressures).
- The District has tax levy and regulatory authority (as well as eminent domain authority) with respect to stormwater management pemitting, flood hazard mitigation, and wetlands protection within its boundaries.
- CRWD's region is heavily urbanized and is currently 42% impervious.
- The District works with municipalities within its borders, in some cases taking the lead in reviewing and issuing stormwater permits and, in other cases, just monitoring local permits.
- Local governments can adopt their own stormwater regulations; to assist them, the Metropolitan Council has developed a draft stormwater ordinance, which can be found at: http://www.metrocouncil.org/environment/water/planning/model_sw_ord.pdf and its own Urban Small Sites BMP Manual, found at http://www.metrocouncil.org/environment/water/bmp/manual.htm.
- Of the three standards, runoff rate, volume control and water quality, the District stresses volume reduction. The one-inch retention standard was adopted because 90% of the storms in the region are less than one-inch.

- Doneux noted that stormwater retention ponds don‘t work well in heavily urbanized areas, so infiltration must be required. He also noted that pre- and post-development runoff volumes cannot be calculated accurately, so the District instead focuses on the one-inch on-site retention standard.
- The District sets the standards, but leaves it up to the landowner to determine how the standards will be met – through either grey or green infrastructure, or both (whichever is cheapest for the landowner). They will use the Pollution Control Agency‘s manual‘s infiltration rates where there is only general soils information available.
- Public stormwater improvements and facilities are established in a capital improvement program adopted as part of the CRWD‘s watershed plan. The draft plan can be found at: http://www.capitolregionwd.org/planning.html.
- A strength of the District approach to stormwater management is that it is a tax-levying unit of government and can therefore adequately finance its program.
- CRWD‘s levy is currently about $14/house/year. Another is the state‘s requirement that the District and local governments develop and adopt water resources management plans that are reviewed and approved by the Board of Soil and Water Resources. This makes the program proactive (since locals can adopt regulatory standards and policies that meet their own needs).
- The district has also been able to work cooperatively with municipalities in education, monitoring, and the development of Capital Improvement Programs to manage stormwater.
- Weaknesses of the District approach are that the long-term effectiveness of many of the BMPs are unknown – they may work well for five or ten years, but nobody knows if they will still be working in 30-years – and that lack of knowledge makes it hard to know the long-term cost- effectiveness of some practices. Also, some of the municipalities may be half in the district and half out of the watershed, leading to different regulations imposed by cities and the district.

5. Websites

Minnesota Pollution Control Agency Stormwater Program
http://www.pca.state.mn.us/water/stormwater/index.html

New Jersey. The New Jersey Department of Environmental Protection (DEP) is responsible for administering the state‘s stormwater management program. The New Jersey program has some of the most stringent stormwater regulations in the country. The program is based on parts of several statutes that were passed at different times and with different goals. As a result, a summary of the statutory basis of the regulatory program is somewhat complex, but various provisions of the different statutes may provide useful examples for Illinois. Of note is the requirement that every municipality in New Jersey develop a stormwater management plan and ordinance. Such plans must be approved by the county and coordinated with other plans in the watershed. A number of agencies may be involved. Also noteworthy is the authority given to the state agency, as opposed to the local government, to approve or deny an application for construction in a flood hazard area.

The contact for the state program is:
Sandy Blick, Supervisor
Stormwater Management Unit
Bureau of Nonpoint Pollution Control, Division of Water Quality
New Jersey Department of Environmental Protection,
Camden, New Jersey

609-633-7021.

1. ***Statutory Provisions***

The following statutory sections provide the basis for the State's storm water management regulations:

a. Municipal Land Use Law – NJSA 40:55D-93 through 99
b. Water Pollution Control Act – NJSA 58:10A-1 et seq
c. Water Quality Planning Act – NJSA 58:11A-1 et seq.
d. Flood Hazard Area Control Act – NJSA 58:16A-50 et seq.

<u>Municipal Land Use Law</u>

Highlights:

- Every municipality is required to prepare a storm water management plan and ordinance(s), which must be submitted to and approved by the county planning agency or county water resources association.
- The Department of Environmental Protection is required to adopt regulations to protect the public safety with respect to storm water detention facilities.
- Municipal plans must be coordinated with the appropriate soil conservation district and with any storm water management plans prepared by any other municipality or any county, area-wide agency or the State relating to the river basins located in that municipality.
- Plans and ordinance(s) must conform to federal and state statutes, rules and regulations concerning storm water management or flood control and be designed to:

  a. reduce flood damage, including damage to life and property;
  b. minimize storm water runoff from any new land development where such runoff will increase flood damage;
  c. reduce soil erosion from any development or construction project;
  d. assure the adequacy of existing and proposed culverts and bridges;
  e. induce water recharge into the ground where practical;
  f. prevent, to the greatest extent feasible, an increase in nonpoint pollution;
  g. maintain the integrity of stream channels for their biological functions, as well as for drainage; and
  h. minimize public safety hazards at any storm water detention facilities constructed as part of a subdivision or pursuant to a site plan.

Plans must include structural changes and additional nonstructural measures and practices as may be necessary to manage storm water. "Nonpoint pollution" covers pollution from any source other than from any discernible, confined conveyance, and includes pollutants from agricultural, silvicultural, mining, construction, subsurface disposal and urban runoff sources.

<u>Water Pollution Control Act</u>

Highlights:

- Very broad legislative findings declaring the policy of the State to restore, enhance and maintain the integrity of the State's waters, protect public health, safeguard fish and aquatic life, scenic and ecological values and enhance domestic, municipal, recreational, industrial and other uses of water
- Authorizes DEP to adopt regulations to carry out intent of act without further elaboration

Water Quality Planning Act

Highlights:

- Again, very broad legislative findings with regard to the need to implement water quality management programs in concert with other social and economic objectives
- Encourages development of area-wide waste treatment management planning processes to restore and maintain the chemical, physical and biological integrity of the waters of the State
- Suggests that planning areas be coterminous with counties where feasible
- Requires plans to identify urban storm water runoff systems and necessary financing
- Plans must identify processes to control the disposal or deposition of pollutants on land to protect groundwater and surface water quality

Flood Hazard Area Control Act

Highlights:

- Authorizes DEP to adopt land use regulations for flood hazard areas
- Exempts damaged preexisting structures from the regulations
- Gives DEP the ultimate authority to grant or deny approval of construction in flood hazard areas
- Prohibits municipalities from approving such construction

2. Regulatory Provisions

In spite of the number of pieces of legislation that make up the foundation of the New Jersey stormwater program, its regulations have been consolidated in a single chapter of the Administrative Code: Title 7 Environmental Protection, Chapter 8.

Highlights:

- Threshold is 1 acre of land disturbance ¼ acre of new impervious surface
- There are specific requirements for the content of storm water management plans and programs
- Nonstructural storm water management measures must be incorporated and have priority over structural measures
- Maintenance plans are required in all projects
- Hierarchy used to limit grey infrastructure approaches
- Performance standards include:
    - Erosion control: Minimum design standards are those established under Soil Erosion and Sediment Control Act and implementing regulations
    - Groundwater recharge: the project must maintain 100% of the average annual pre-construction groundwater infiltration volume post-construction for the 2-year storm
    - Runoff quantity: Three alternatives:
        - Demonstrate that pre-construction runoff for 2, 10 and 100-year storm events does not increase post-construction, at all points in storms, demonstrated through hydrologic analysis
        - Demonstrate that increased peak runoff from 2, 10 and 100-year events and the increased volume or change in timing of runoff will not increase damage at or downstream of site, or
        - Design stormwater management measures so that post-construction peak runoff for 2, 10 and 100-year events does not exceed 50, 75 and 80% of pre-construction peaks
    - Pollutant removal:

        - Reduce anticipated post-construction TSS load by 80% (regulation provides presumed removal rates for certain BMPs)
        - Reduce the nutrient load from the site to the max. extent feasible, using a combination of nonstructural and structural measures that optimize nutrient removal while achieving the other performance standards
        - Establish special resource protection areas along waterways of special significance, such as 300-foot zone, no encroachment, no storm water discharge
    - Sensitive areas: Projects must avoid impacts of concentrated flow on sensitive areas
    - Nonstructural practices: Projects must incorporate nonstructural strategies to the maximum extent practicable, identify practices used and explain claims of infeasibility
        - Protect certain areas
        - Minimize or break up impervious surfaces
        - Maximize natural drainage features and vegetation
        - Minimize the decrease in “time of concentration” from pre-construction to post-construction
        - Minimize land disturbance
        - Minimize soil compaction
        - Provide low-maintenance landscaping that encourages infiltration
        - Provide vegetated open-channel conveyance systems
        - Provide controls to prevent or minimize discharge of pollutants into the system
        - Protect land areas used as stormwater control measures by establishing restrictive covenants and conveying to government agencies in perpetuity
    - Maintenance plans: Projects must have plans with specific maintenance tasks, schedules, responsible persons and contact information, as well as
        - Documentation of agreement for responsibility if other than developer
        - Recording on deed if responsible entity is not a government agency
        - Detailed log or other documentation of maintenance activities
        - Annual evaluation of maintenance plan

3. Manuals:

The State of New Jersey has established a Nonstructural Stormwater Management Strategies Point System, the guidance for which may be found at:
http://www.njstormwater.org/pdf/nsps_userguide2006013.pdf

New Jersey Stormwater Best Management Practices Manual
http://www.state.nj.us/dep/stormwater/bmp_manual2.htm

4. Notes from Interview with State Contact, Sandy Blick

- In writing the regulations, New Jersey staff met with people in several other state programs and/or attended many conferences in Maryland, Delaware, Minnesota, California, Florida and Pennsylvania, each of which has program elements that are worth replicating. They also set up an advisory committee of about 20 people, including environmental groups and the development community, that still meets regularly every month or two to discuss the program and possible modifications.
- The program is focused on flood control, water quality and groundwater recharge. The performance standards were selected with these goals in mind.
- Volume control is not used as a performance standard, due to a concern about putting too much water into the ground in confined spaces and creating groundwater mounding. Green

infrastructure can result in infiltration rates several times the natural infiltration rate. Site conditions must be carefully evaluated to determine what level of infiltration is appropriate. Instead, the groundwater recharge standard attempts to restore natural filtration rates for the two-year storm event.

- Assistance is provided most efficiently through the state website, phone call and published guidance, such as in manuals.
- The state set up a Permit Efficiency Task Force, which recommended higher staffing levels for storm water management. There are three full time people in the storm water management group and 5 in the NJPDES permit group. There are 506 municipalities that are subject to the programs, and each has storm water staff that we work with. The counties are not very active.
- Other recommended contacts include: Eric Livingston, Florida, Stu Comstock, Maryland, agency staff in Delaware, Bill Hunt, North Carolina, California, Pennsylvania, and Wisconsin; the New England Interstate Water Pollution Control Commission may also be helpful.
- Something that appears to be working well is the point system for non-structural BMPs, which developers can run on-line to help them comply with the regulations.
- The staff spends a lot of time evaluating pretreatment devices and is considering writing some device guidelines or requirements. The University of Florida has a protocol for testing devices. There are 10-15 companies that are marketing new devices in New Jersey.
- Personal opinion, not representing the position of the Department: —Green infrastructure is a great way to go, I am totally supportive. There are many benefits that we did not consider or account for. —

5. Websites

Department of Environmental Protection: Stormwater in New Jersey
http://www.njstormwater.org/.

Wisconsin. Stormwater is currently regulated at the state level in Wisconsin by three agencies: the Department of Natural Resources (DNR), the Department of Transportation (DOT), and the Department of Commerce (COMM). DNR and DOT regulations address runoff from developed urban areas within permitted municipalities as well as construction site and post-construction site runoff from new development larger than one acre. COMM regulations address runoff from new development smaller than one acre as well as stormwater managed through plumbing systems. Each Agency rule contains its own performance standards, although in most cases standards are the same. This summary addresses only the DNR regulations.

The statute requires the Department of Natural Resources (DNR) to develop a state stormwater management plan and performance standards and thresholds for construction activities carried out by state agencies and to encourage municipalities to comply with such standards by including them in their local ordinances. DNR is also required to develop minimum standards for non-state construction activity that meets certain thresholds of size, impervious area or impacts from storm water runoff. DNR must prepare a model zoning ordinance for construction site erosion control and stormwater management and distribute it to any county or municipality that submits a request. Performance standards for construction cover sediment load, suspended solid and peak discharge reduction, infiltration volume as a percent of pre-development volume, a ban on impervious surfaces in —protective areas," and specific practices in developed urban areas. Some performance standards become stricter over time.

These regulations contain standards of performance that determine how stormwater management practices, including proprietary devices, are evaluated for compliance with state laws. Wisconsin's stormwater management program is one of the most stringent in the nation, requiring that stormwater management comply with specific treatment objectives including 80% removal of the annual total suspended solids (TSS) load from new development and 40% removal of the annual TSS load from redevelopment and certain in-fill development. However, enforcement of these standards is limited, and BMP's are often approved on a Maximum Extent Practical basis regarding treatment efficiencies.
In addition to the requirements of the federal National Pollution Discharge Elimination System (NPDES) program, which requires stormwater be treated to the maximum extent practicable (MEP), Wisconsin has established specific stormwater treatment requirements for stormwater runoff.

The contact for the Wisconsin program is:

Roger Bannerman, Water Resources Management Specialist
Wisconsin Dept. of Natural Resources
Roger.Bannerman@Wisconsin.gov
608-266-9278

1. Statutory Provisions

Two chapters within the Natural Resources section of the Wisconsin Statutes address storm water management:

Chapter 281 "Water and Sewage" – requires the Department of Natural Resources to establish rules for state agencies and private developers, including performance standards that are enforceable at the state level.

Chapter 283 "Pollution Discharge Elimination" – implements the federal NPDES storm water permitting program.

Both chapters can be found at:
http://nxt.legis.state.wi.us/nxt/gateway.dll?f=templates&fn=default.htm&d=code&jd=top

Highlights:

- The Wisconsin Legislature sets forth in the statutory language the broad purpose of the law to "to grant necessary powers and to organize a comprehensive program under a single state agency for the enhancement of the quality management and protection of all waters of the state, ground and surface, public and private."
- The DNR is required to set performance standards for nonpoint sources that are not agricultural facilities or agricultural practices. The performance standards must be designed to achieve water quality standards by limiting nonpoint source water pollution.
- The department shall, by rule, specify a process for the development and dissemination of technical standards to implement the performance standards under par. (a).

- Note that the stated purpose is to protect water quality, as opposed to reducing flooding or erosion or protecting habitat
- It requires DNR to develop a state stormwater management plan, and performance standards and thresholds for the construction activities of state agencies
- Requires DNR to promulgate regulations with minimum standards for construction activity that meets certain thresholds of size, impervious area or impacts from storm water runoff.
- It requires DNR to prepare model ordinances

2. Regulatory Provisions – Wisconsin Administrative Code; Department of Natural Resources; Environmental Protection – General

   a. Section 151: statewide regulations on storm water management

   b. Section 152: model ordinances

These sections can be found at:
http://nxt.legis.state.wi.us/nxt/gateway.dll?f=templates&fn=default.htm&d=code&jd=top

Highlights:

- Performance standards for non-agricultural construction site stormwater management (NR 151.11)
  - Landowner is responsible
  - Stormwater management plan is required for all projects
  - Sediment load: project must use best management practices (BMPs) that reduce sediment load in runoff by 80% as compared with no controls; a credit is awarded for limiting the duration or the area of activity or other appropriate strategy. If 80% is not achievable, a written explanation must be submitted and sediment load shall be reduced to the maximum extent practicable.

- Performance standards for non-agricultural post-construction stormwater management (NR 151.12)
  - TSS control: BMPs must be designed, installed and maintained to achieve
    - New development – 80% reduction over no control
    - Redevelopment – 40% reduction over no control
    - Infill <5 acres, prior to 10/1/2012 – 40% reduction
    - Infill post 10/1/2012 – 80% reduction
    - If standard is not achievable, written explanation required and sediment load must be reduced to the maximum extent practicable
  - Infiltration:
    - Residential – at least 90% of pre-construction infiltration volume must be maintained, and 25% of post-development runoff volume
    - Non-residential – at least 60% of pre-construction infiltration volume and 10% of post-development runoff volume
    - Pretreatment required to prevent system clogging and protect groundwater
    - Prohibition of infiltration in areas with anticipated contamination
    - Exemptions for low permeability soil; frozen soil, small parcels
    - Credit provided for alternative uses of runoff, such as toilet flushing, laundry or irrigation

- Protective areas
  - Prohibition of impermeable surfaces
  - If land disturbance occurs, at least 70% vegetative cover required
- Fueling and vehicle maintenance areas
  - BMPs to prevent visible sheen

- Developed Urban Areas: specific BMPs required (NR 151.13)

- Transportation Facility Performance Standards (NR 151.20-26)
  - Transportation authority responsible
  - Performance standards for construction activities
    - Sediment load: same as non-agricultural standard
    - Additional design requirements to manage the use, storage and disposal of chemical, cement and other compounds on site
  - Performance standards for post-construction activities
    - TSS control: same as non-agricultural standards
    - Infiltration:
      - at least 60% of pre-construction volume, based on average annual rainfall
      - 10% of post-construction runoff volume from the 2−year, 24−hour design storm with a type II distribution
      - Some areas prohibited from infiltration
      - Some areas exempt

- Developed Urban Area Performance Standard
  - Beginning March 10, 2008 – 20% reduction in TSS entering waters of the state as compared with no controls
  - Beginning March 10, 2013 – 40% reduction in TSS

3. Manuals

Wisconsin Storm Water Manual. Originally published in 1994, this technical manual was developed to aid local units of government, developers, contractors, and consulting engineers in controlling storm water pollutants from existing and new developments. Part One is an overview; Part Two is an elaboration of technical design guidelines for storm water management practices.
http://www.dnr.state.wi.us/runoff/stormwater/publications.htm#uwex

4. *Notes from Interview with State Contact: Roger Bannerman*

- Program resources: 1 Engineer in each of 5 regions in Wisconsin; 2 people at the main office; under the program, developers need quite a bit of assistance from the state staff, which means human resources.
- Performance standards:
  - The 90% infiltration rate is not unreasonable for a residential subdivision, and 80% for TSS is within current capabilities
  - 40% TSS in in-fill areas, though not very high, can be expensive in some applications
  - Should look at examples like McHenry County, IL, Dane County, WI; and examples of projects from engineers with experience in the field.
  - If IEPA imposes performance standards, TMDLs may later take over as driving force, due to stresses on fish from dissolved oxygen and chloride

    - Recommends taking an incremental approach to regulations; at the beginning better not to be too aggressive in built-out areas. The Wisconsin performance standards are appropriate, but developers need flexibility. Retro-fit should have lower requirement at first (e.g., lower TSS removal), to make sure it is realistic but that everyone does something. Redevelopment can have a higher standard, and requirements can be strengthened over time.
- The Wisconsin DNR‘s timing was good for using performance standards in an administrative rule to promote green infrastructure. As a nation we had gathered enough information to identify stormwater as a problem and green infrastructure was being demonstrated in many places as part of the solution. The information published by the Center for Watershed Protection helped establish green infrastructure as a permanent part of stormwater management.
- The work in Wisconsin and of many others around the country has clearly demonstrated the impact of urban runoff on urban water ways. Any solution must address both the increased flows and the level of pollutants. The impact of high flows on stream morphology are highly visible and our biologist describe these impacts in terms of impacts on the health of the stream ecosystems.
- The first challenge is to reduce the impact of new development as much as possible. This is addressed in the administrative rules by reducing the TSS by 80% and requiring some degree of infiltration.
- Although the administrative rules are not prescriptive in how to accomplish the performance standard, we prepared technical standards that supported the use of green infrastructure, such as rain gardens, bioretention, and grass swales.
- Since our engineers accomplish the standards by design, we have also worked hard to provide them with design tools to properly size some of the green infrastructure. We continue to gather information needed to improve our technical standards and design tools.
- The use of green infrastructure to reduce stormwater runoff from new development is showing positive benefits across the state of Wisconsin. Developers have successfully incorporated green infrastructure, such as grass swales, infiltration basins, and rain gardens, into their site designs. Sometimes the green infrastructure becomes another attractive feature to the buyers.
- Side by side comparisons of development with conventional stormwater conveyance and green infrastructure consistently show much less runoff with the green infrastructure.
- Studies of green infrastructure in Wisconsin show large reductions in runoff when green infrastructure is employed. A combination of grass swales, reduce street widths, and infiltration basin can reduce the annual runoff from a medium density residential site by over 90 %.
- Some developers actually save money with cost reducing ideas as reducing the amount of impervious area.

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4.a. Notes from Interview with Independent Engineer: Matthew Bardol

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- Did not work on the development of the regulations, but has worked on projects using the Wisconsin performance standards in Illinois
- In one example, the U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service requested that the developer follow the Wisconsin infiltration (―stay-on”) requirement; a natural resource evaluation and soil testing led to the establishment of a watershed-specific infiltration

requirement of nearly 80%; the requirement was met by maximizing open space and other best management practices throughout the development site for current and all future phases of the development.

- Recommend that retention standard be higher for more open sites; even with heavier clay soils in Illinois, at least 60% infiltration is a reasonable requirement and usually 80% is achievable; flexibility is critical to a workable standard, but some amount of retention should be required for all sites. Wisconsin does not have a requirement to detain the 100-year event, but infiltration and detention must be considered in an integrated stormwater management plan for any site.
- Expertise and funding need to be provided at the state level for assistance to developers and municipalities; currently neither the Illinois Department of Natural Resources nor the IEPA has adequate human resources to manage such a program. An Illinois BMP monitoring program should be supported and integrated into the EPA BMP international database.

5. Websites

Primary Stormwater Management website for the Wisconsin DNR:
http://www.dnr.state.wi.us/runoff/stormwater.htm

Common Elements of the State Programs

Legislative findings and policy that underpin the stormwater programs, as well as requirements for the responsible state agency to adopt the relevant regulations, are typically set out within the statutes establishing the state stormwater management programs. While not universal, we frequently find a strong statement regarding the adverse impacts of stormwater and the need to establish a robust program to prevent them. For example, the Maryland statutes, Section 4-101 states in part:

> The General Assembly … finds that lands and waters comprising the watersheds of the State are great natural assets and resources. As a result of erosion and sediment deposit on lands and in waters …, these waters are being polluted and despoiled to such a degree that fish, marine life, and recreational use of the waters are being affected adversely.

The statutes vary in the detail used to direct the state agencies to adopt stormwater regulatory programs. The most important details to be included at the statutory level are the basic structural characteristics of the program. For example, the responsible agency may be required to develop standards for stormwater management at the project level and then enforce these standards through a permit system. In others, the standards developed by the state agency are to be incorporated into county and local ordinances and enforces by those government bodies.

Performance Standards. As shown in Table 10 below, some performance standards are common to virtually all programs, while others are unique to only one or two states. The regulations and the table speak for themselves, but generalizations may be useful to the reader.

Green infrastructure is a priority for all states reviewed. The programs and their performance standards all encourage, require or simply presume the use of strategies and techniques that ―infiltrate, evapotranspire, capture and reuse stormwater,” or ―green infrastructure”, although the terminology varies. The contact people in each state were strong proponents of green infrastructure. The Maine program director, Don Witherill, said new regulations being developed currently will require, instead of encourage, the use of green infrastructure.

Erosion and sediment control is a universal performance standard, or set of standards. Most states have a separate, detailed regulatory section addressing erosion and sediment control. This makes sense because sediment from construction activities is said to be the single largest contributor to stream water quality degradation, and controlling the erosion of stream banks is a critical safety, land management and water quality practice.

Table 10: Performance Standards in Reviewed State Programs

	Maine	Maryland	Minnesota (CRWD)	New Jersey	Wisconsin
Reduce impervious surface		X		X	
Volume control	X	X	X		X
TSS removal			X	X	X
Groundwater recharge		X		X	
Groundwater protection	X				X
Erosion & Sed. control	X	X	X	X	X
Detention release rates	X	X	X	X	
County water res. mgt. plans			X		
County ordinance or model		X			X
Watershed planning			X	X	
Local plans			X	X	
Local ordinances or model		X	X	X	X
Maintenance	X	X		X	
Phosphorus removal	X				
Spill prevention	X				
Temperature control	X				
Effective date of regs.	July 1997, Nov. 2005	1983, 2009	Oct. 1, 2006 Jan. 7, 2009	2004	Oct. 1, 2002

Volume control standards are strong components of every program except New Jersey's (although New Jersey does have a groundwater recharge standard). Typically, between 1.0 and 1.5 inches of rainfall or 90% of the average annual rainfall is required to be retained, detained or otherwise controlled on-site, using some type of green infrastructure system.

Detention and controlled release. Most often these standards are expressed as a requirement to maintain or minimize peak runoff to the greatest extent practicable. Stricter rules require such controls at all points during a storm. Traditional dry detention basins are less commonly recognized as an appropriate practice. The emphasis is on wet detention facilities that discharge through a gravel or soil medium or infiltrate into the ground.

Groundwater recharge or protection. Almost all programs have performance standards for either groundwater recharge or groundwater protection.

Removal of total suspended solids (TSS). Reductions in anticipated TSS loads of 80% to 90% are commonly required. Removal of dissolved nutrients to the maximum extent practicable (MEP) is also frequently required, although there is recognition that removal of nutrients is difficult. A recent article published in "Stormwater", is titled "15 Reasons You Should Think Twice Before Using Percent Removal to Assess BMP Performance," [http://www.stormh2o.com/january-february-2008/pollutants-research-bmp.aspx], suggests that there are performance standards for the removal of TSS that are superior to a "% removal of TSS" standard.

Don Witherill, of Maine DEP, indicated that their program has moved away from TSS removal standards in general because the best management practices are much better at reducing volume than at reducing the concentration of TSS in the water. We also note that if the objective is to reduce the total load or mass of suspended solids entering the surface water or treatment plant, a reduction in volume accomplishes this without the need for expensive pretreatment.

Maintenance. Many programs have detailed requirements to ensure the long-term maintenance of green infrastructure systems. Common elements include a requirement to submit a maintenance plan for each stormwater management system as part of the project application, written agreements to perform maintenance activities, the recording of such documents in the land records, and regular inspections of BMPs post-construction. One example where there are no maintenance plan requirements, but enforcement provisions are relied on instead to ensure compliance, is the Capital Region Watershed District in Minneapolis. However, while this might seem a simpler strategy than maintenance plans, deed recording and regular inspections, its success depends upon the District "finding that a person has violated a prohibition or failed to meet a requirement." If there are thousands of stormwater management systems in place on as many private parcels of land, it is difficult to imagine how this process could efficiently be implemented to ensure compliance. We do not recommend this approach.

Manuals. Virtually all programs make liberal use of technical guidance manuals to explain and provide details of practices that are designed properly to meet performance standards. They provide assistance on the development of plans, include model plans and ordinances, and set out technical specifications for green infrastructure practices that are usually considered part of the regulations they support and are enforceable.

STATE PORTFOLIO STANDARDS

The use of green infrastructure for stormwater management in the United States has been somewhat random to this point in time, and has been based more on the attitudes of specific stormwater managers and departments than on broad policies or regulations directing its use. In addition, because stormwater infrastructure in existing urban areas is for the most part already constructed, the systematic addition to, or replacement of, a significant portion of that infrastructure with green infrastructure can only take place over a long period of time, with appropriate planning.

To address this situation, we propose the establishment of a long-term goal for increasing the use of green infrastructure strategies and systems, in order to provide an appropriate framework for the necessary planning with regard to prioritizing the types and sizes of projects, developing budgets, organizing human resources and setting construction schedules.

Many states have approached the need to increase the use of renewable energy sources to produce electricity by establishing just such long-term goals, known as ―renewable energy portfolio standards" or ―RPSs". These state energy programs typically involve regulations that require major utilities to gradually increase the percentage of the electricity they produce for the local market that is provided from renewable energy sources such as wind, solar and hydroelectric power. For example, the utilities may be required to increase the renewable portion of their energy portfolio by 1% or 1.5% per year, for a number of years, with a final target of 25% or more.

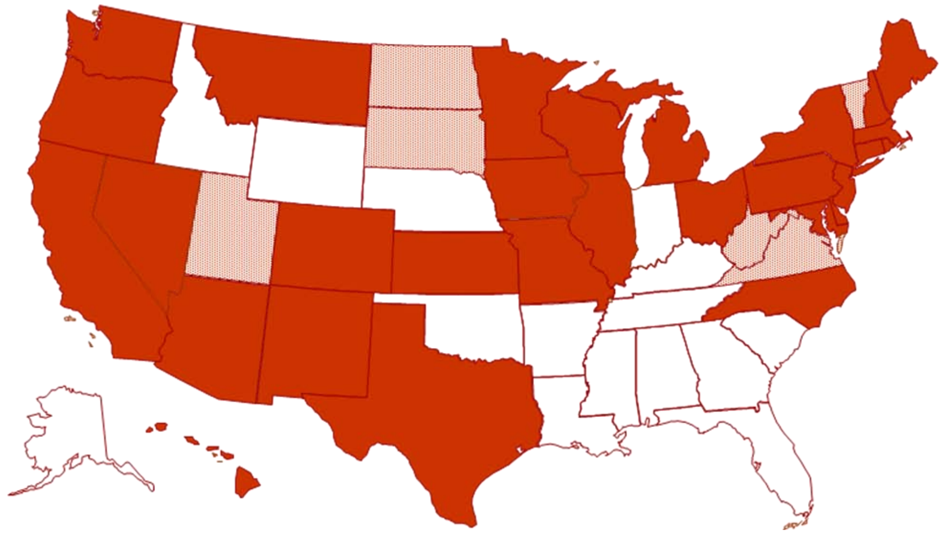
We believe this format could be an excellent tool for increasing the use of green infrastructure for stormwater management. We reviewed four state renewable energy portfolio standard programs and have begun the process of identifying potential elements of a ―green infrastructure portfolio standard" (GIPS) program in Illinois, as outlined below.

State Renewable Energy Portfolio Standard (RPS) Programs

Twenty-nine states and the District of Columbia have RPS programs with mandated increases in renewable energy sourcing (see Figure 10). Six more have programs with unenforceable goals. We selected four programs with mandated increases: Illinois, New York, Oregon and Wisconsin. Following are brief descriptions of each program.

Illinois. The Illinois RPS requires that investor-owned power utilities serving more than 100,000 customers provide at least 25% of their power from renewable sources by 2025. The Illinois Power Agency was established to oversee the program and craft plans for the utilities to purchase renewable energy. Retail electricity bill surcharges fund the program, but are strictly controlled by the IPA. As a result, the funding and target renewable requirements vary from year to year. The RPS allows for the trading of Renewable Energy Credits (RECs) to meet the renewable energy sale requirements, including RECs from power produced out-of-state. Priority for the purchases is placed first on cost, then on energy generated in Illinois. The Agency recommends that utilities enter into long-term purchasing agreements with energy producers. Local units of government may apply to the Illinois Department of Commerce and Economic Opportunity (DCEO) for project funding. The utilities help fund commercial, industrial and residential projects.

Figure 10: State RPS Programs



State Renewable Portfolio Standard

Source: Interstate Renewable Energy Council

State Renewable Portfolio Goal

New York. New York law requires that 30 percent of the energy produced by investor-owned utilities come from renewable sources by 2015. To accomplish this, the RPS ordered the major utilities to collect $741.5 million from rate payers and distribute that money to the state agency responsible for overseeing the program, The New York State Energy Research and Development Authority (NYSERDA). Because the target percentage increased in 2009 from 25 percent to 30 percent, and the end date was pushed back until 2015, NYSERDA is expecting a new funding requirement from the state legislature. NYSERDA uses the money it receives from utilities to buy ‗attributes,‘ which are similar to Renewable Energy Credits, from energy generators. Attribute contracts stipulate that the energy tied to the attributes must be sold into the New York State wholesale market. NYSERDA also administers a program that provides incentives for small-scale energy projects, such as installing solar panels on a house or hooking up a small wind turbine to a building.

Oregon. Oregon‘s RPS requires all utilities to scale up their sales of renewable energy—with the three major utilities targeted to sell 25 percent renewable by 2025, combined with smaller targets for the smaller utilities. There are annual scale-up targets for the major utilities, which increase by one percent each year. Oregon allows utilities to trade RECs, each of which represents one megawatt-hour of generated renewable energy. In-state utilities can buy these credits with or without the energy associated with them and they can buy them from most states in the American West, as well as the two southwestern-most provinces of Canada. The RPS stipulates that in lieu of buying energy for a portion of the requirement, utilities have the option of paying into a fund for buying renewable energy in the future or for energy efficiency programs. If the total cost of buying renewable energy exceeds 4% of annual revenue, utilities are not required to meet the annual target.

Wisconsin. Wisconsin‘s RPS requires that 10 percent of the energy sold to retail markets must come from renewable sources by 2015. As of March, 2010, all of the utilities are on schedule, with some already meeting that standard. The Public Service Commission of Wisconsin, which enforces the standards, has the authority to impose fines of $5,000 to $500,000 for failure to meet the standard. Renewable energy projects undertaken by utilities are funded either from retail fees or through “green pricing”. Green pricing is a program in which utility customers can choose to pay a premium for renewable energy, around 1.25 cents for each kilowatt-hour. The state also allows the trading of RECs, including the purchase of RECs from out-of-state producers, so long as that energy is sold to Wisconsin consumers.

Green Infrastructure Portfolio Standard Program Elements

We are not aware of any existing GIPS programs. The policy choices and program elements identified here are preliminary, based on our understanding of green infrastructure concepts and stormwater management in general, as well as discussions with several stormwater managers in northeastern Illinois.

1. <u>Covered Area.</u> At the state level, an RPS typically requires major utilities to meet the increasing standards each year, and the electricity supplied to all customers in the utilities‘ coverage area within the state must come from the required balance of energy sources. One option in the stormwater context would be to have the GIPS applicable to all entities subject to the NPDES MS4 general stormwater permit. Under such an approach, coverage should later be expanded to include more areas, using the percentage of impervious surface as the guide.

2. <u>Green Infrastructure Portfolio Standard</u>. In RPS programs, the unit of measure is typically a kilowatt hour. In the GIPS program, we recommend that the unit of measure be the area of impervious surface managed with green infrastructure practices to meet a performance standard, such as retention of the first 1” of rainfall on-site. For example, in the “Covered Area” the GIPS would require using green infrastructure to achieve the equivalent of retaining the first 1” of rainfall on a minimum percentage of the impervious surface; at least 1% more than the baseline within 12 months of the effective date of the requirement, and increasing by at least 1% each year thereafter up to at least 25%. Incentives should be provided for larger annual increases or achievement of the final goal in a shorter period of time. For example, a jurisdiction might currently have impervious surfaces covering 40% of its landscape. This would be the baseline value. The GIPS could require that this baseline be reduced by at least 1% for each year until a reduction of 25% (to a total of 30% impervious cover) is achieved.

3. <u>Baseline Determinations.</u> Just as utilities must determine the baseline percentage of energy derived from renewable sources, MS4 permittees will have to determine both the baseline quantity of impermeable surface within their jurisdiction and the baseline percentage of that surface meeting the performance standard using green infrastructure. Because permeability is a variable, such impermeable surface assessments should take into account the range of permeability of surfaces in the Covered Area, based on their “curve numbers”. A set of simple example permeability credits are shown in Table 11, below. The numbers in the “Retention

Credit” column refer to the number of inches of rainfall the listed condition is assumed to retain. These numbers are for purposes of illustration only, and not based on scientific research.

4. ―Retention of rainfall” defined. There is more than one objective of retaining rainfall on-site, including reducing the volume of water reaching the stormwater conveyance (sewer) system, recharging groundwater, recharging surface water, irrigating the land, infiltrating the water through the soil, improving water quality and reducing the volume of potable water used for non-drinking purposes. Therefore, ―retention” should include any practice or system that prevents a measurable amount of precipitation falling on the Covered Area from reaching the municipal storm sewer conveyance system, by using green infrastructure practices to infiltrate into the ground, evapotranspirate or capture the rain water for reuse. For simplicity, we recommend that the equivalent of one-inch of rainfall on a totally impervious surface be used as the standard retention requirement.

Table 11: Example of Site Retention Credits

Condition	Assumed Impermeability	Retention Credit
Conventional pavement surfaces **Compacted developed surfaces**	0.65 – 1.00	0.0
Compacted and Non-compacted lawn **Small green infrastructure practices with low infiltration, evapotranspiration or capture**	0.30 – 0.65	0.5
Garden **Forest** **Green infrastructure practices with amended soils and high infiltration, evapotranspiration or capture**	0.0 – 0.30	1.0

5. Retention Values and Green Infrastructure Credit System. In RPS programs it is relatively simple to measure the kilowatt hours derived from different sources of energy. For the Green Infrastructure Portfolio Standard, it may be more complicated, since actual retention cannot easily be measured. Therefore, we recommend that the state establish a set of assumed retention values applicable to common site conditions and stormwater management systems, as shown in Table X, above. The state should establish a similar set of assumed values for eligible green infrastructure practices (GIP) that meet minimum standards set forth in the Illinois Urban Manual, including appropriate maintenance plans. This combined set of retention values could be used to plan development projects and to provide standardized retention credits for projects once approved and constructed. The aggregate of all the net credits from installed GIPs would determine the permittee‘s compliance with the GIPS.

6. Green Infrastructure Portfolio Standard Resources Fund. RPS programs have a variety of sources of funding. Even though municipalities already impose taxes or charge fees to cover stormwater management services, the state and MS4 permittees may wish to consider establishing separate GIPS resource funds, to assist permittees and developers with the cost of new GIP installation, by providing loans or grants. To receive funding from the GIPS resource fund for a proposed GIP project, an applicant must meet all the requirements set forth in the IUM for such a project. In addition, an MS4 should be required to demonstrate continuous compliance with the MS4 permit.

7. Procurement Requirement. RPS programs typically require that the renewable energy sourced electricity sold to meet the standard be generated or purchased from sources within the state or region. Similarly, administrators of GIPS resource funds may want to consider some requirement concerning the source of the services and materials paid for from the fund.

8. Maintenance Plan and Agreement. To obtain retention credit, a GIP should be required to have a maintenance plan, a demonstration of financial ability to carry out the plan, and an agreement to carry out the plan approved by the state and recorded on the land records upon completion of the project, as we recommended in conjunction with the establishment of state regulations in an earlier section of this report.

9. Verification and Recording. Upon installation of a GIP, MS4 permittee should be required to verify compliance with the construction standards and the efficacy of the project and that the maintenance plan and agreement, running with the land, have been filed with the recorder of deeds.

10. Eligible GI Practices. There are many green infrastructure practices that have measurable retention benefits, and some are known by more than one name. We provide here a list of some of the more typical green infrastructure practices as examples of what we believe should be eligible for credit in a GIPS program.

   i. green roofs
   ii. porous pavement
   iii. bio-infiltration
   iv. disconnected downspout program
   v. tree planting
   vi. porous piping, dry wells
   vii. rainwater collection systems

11. Education Program. The MS4 stormwater management education and outreach program provides an excellent opportunity to inform the public in general and the regulated community in particular about the purpose and objectives of the GIPS.

12. Funding; Fees; Stormwater Utility. We recommend that MS4 permittees be required to revise their stormwater service fee structures over time to move gradually toward full cost pricing of stormwater services and the generation of adequate funding dedicated directly to program needs.

Table 11 below shows information about the state renewable energy programs we reviewed and examples of possible equivalent elements for a GIPS program, by way of illustration

Comparison of RPS and Potential Green Infrastructure Portfolio Standards

The purpose of both types of portfolio programs is to create a context for the planning necessary for making a major, long-term change in infrastructure, and at the same time educate and encourage a change in behavior by individuals, government units and entities that saves money and improves the quality of life in the community. The incremental nature of the programs is appealing also because it allows time for developing knowledge and experience in methodologies that have not been common in the past. This includes gradual changes to academic curricula, development of human resources with the appropriate skill sets to carry out the projects involved, and education of the community at large.

Government agencies administer both portfolio programs through a set of regulations. RPS programs are administered at the state level, primarily due to the limited number of utilities involved. In contrast, for GIPS, it is more likely that watershed, county or municipal agencies would manage the program. Since the number of regulated entities is likely to be much smaller for RPS, compared with the potential number of GIPS regulated entities where compliance takes place at the local level. However, if the GIPS utilized the existing MS4 regulatory framework, little additional bureaucracy would need to be created.

Both renewable energy and the green infrastructure programs require a change in the development of a product or service. In both cases, while it is not essential, it is certainly helpful to the success of the program for recipients of the products and services of the programs to participate and take on some responsibility through changes in behavior or other activities on their private property.

Both RPS and GIPS programs also allow for the trading of credits or payment of “fees in lieu” where it is infeasible or undesirable to carry out the changes required. On the other hand, because of the local impact of green infrastructure, the flexibility of such trading in a GIPS program would be more limited than for RPS programs.

Table 12. RPS Elements and GIPS Equivalents

	Renewable Portfolio Standard				
	Illinois	**New York**	**Oregon**	**Wisconsin**	**Green Infrastructure Portfolio Standard (proposed)**
Objective	Increase in percentage of electric power from renewable sources	Same	Same	Same	**Increase in percentage of rainfall on impervious surfaces managed with green infrastructure**
Administration	Illinois Power Agency	The New York State Energy Research and Development Authority (NYSERDA)	Oregon Dept. of Energy	Public Service Commission of Wisconsin	**I EPA**
Regulated Entities and Areas	Investor-owned power utilities serving more than 100,000 customers (3)	Investor-owned power utilities	All power utilities (3 major utilities, many smaller)	All power utilities	**MS4 permittees (about 440 municipalities and IDOT)**
Requirement	Annual increase of 1% - 1.5% in power from renewable sources, up to 25% by 2025	30% of power from renewable sources by 2015	25% of power from renewable sources by 2025 for majors, smaller targets for minors	10% of power from renewable sources by 2015	**Annual increase of 1% of rainfall on impervious surfaces managed with green infrastructure from baseline from 2014 to 2025 (incentives for more or faster implementation)**
Funding	**Retail utility bill surcharges**	**One-time charge to retail customers**		**Retail fees or optional green pricing**	**Private development budgets, Municipal taxes and storm water fees, IEPA Green Infrastructure Grants, State Revolving Fund**

CHAPTER V: RECOMMENDATIONS

PERFORMANCE STANDARDS

IEPA should adopt, at the very least, a set of stormwater volume retention performance standards that varies according to the conditions at a particular site. Such performance standards are becoming standard around the country, and are seen as the best method of improving water quality while at the same time recharging groundwater, conserving energy and other resources and helping to reduce flooding and sewer overflows. In its 2008 Urban Stormwater Management report, the National Research Council recommended that ―flow and related parameters like impervious cover should be considered for use as proxies for stormwater pollutant loading" because of the difficulty and expense of compliance monitoring urban stormwater for specific pollutants. A volume control performance standard – such as retaining the first inch or half-inch of precipitation on-site with zero resultant runoff by using green infrastructure practices -- is a stormwater management proxy that would work well for Illinois, since reducing the volume of stormwater discharge reduces the amount of pollution reaching our urban streams, while also reducing associated flood risks. By adopting a set of specific performance standards, rather than the more general ―maximum extent practicable" approach currently used in its NPDES permits, IEPA would provide clear direction to local governments and developers. Using performance standards also means that landowners have the freedom to choose a mix of different green infrastructure practices to meet the standard, based on their project design and site characteristics.

Other performance standards that should be considered include those that are currently in use in other states and in some Illinois counties, such as standards for the development of stormwater management plans, erosion and sediment controls, detention release rates, removal of Total Suspended Solids, temperature control, groundwater recharge and protection, and long-term maintenance of stormwater facilities. In all cases, flexibility is needed to accommodate variations in soils, infiltration rates, surficial geology, proximity to waterways, slopes, structures and other physical factors affecting the amount and rate of runoff discharge and its environmental impacts.

We believe it would improve the planning and preparation for the wide-spread use of green infrastructure if communities were either required or encouraged to set a long-term goal to gradually increase the amount of existing impervious surface that is subject to the performance standards using green infrastructure. This would also enable communities to develop the training and experience needed to manage urban stormwater using green infrastructure practices. The approach we are recommending uses the concept of a ―portfolio standard." This process of implementing a green infrastructure portfolio standard would be similar to the one already adopted by Illinois in phasing-in a gradually larger portion of renewable energy as part of its mix (or portfolio) of energy resources, with an increasing percentage of the state‘s energy budget being met by renewable energy until a target percentage (25%) is reached at some target date (2025). We recommend that IEPA work with county and local officials, stormwater agencies, drainage districts, soil and water conservation districts and others to initiate a process that establishes realistic annual goals for adopting green infrastructure practices statewide in a timely manner (perhaps one based on IEPA‘s current 5-year MS4 permit cycle). These collaborations should additionally identify the boundaries for the portfolio standards (i.e., whether they should coincide with a

HUC-12 watershed or with county or municipal boundaries) and use a percentage of effective impervious area as a potential proxy for the volume of stormwater managed through the adoption of green infrastructure practices.

ADMINISTRATION

The National Research Council (2008) recommends that urban stormwater be managed on the watershed level, rather than on the local scale. In Illinois, counties are the governmental units whose jurisdictions best correspond to watershed- (HUC-10) and sub-watershed (HUC -12) scale management, so we recommend that IEPA rely on the counties to develop appropriate rules or ordinances to locally administer the performance standards established at the state level and work directly with municipalities to promote the use of green infrastructure to meet those standards and their other MS4 program requirements. The state should also provide adequate resources to the counties to meet these responsibilities or authorize the counties to charge fees that are sufficient to cover the cost of the program. Counties also have, or can readily develop, the technical expertise necessary to train municipal staffs on how best to use green infrastructure as a component of their local urban stormwater management programs.

Development of this expertise means that staff and financial resources should be dedicated to program elements that create economic incentives and train county, municipal, stormwater management agency and drainage district staff in using green infrastructure practices until their use not only is accepted by county and municipal staff and within the development community but also becomes the standard approach in stormwater management programs statewide. Illinois should fund staff and other resources needed to bring green infrastructure and its benefits into practice among communities.

For additional resources, counties can turn to the existing regional expertise that may be available to assist them in promoting green infrastructure practices. This expertise includes the staffs of regional stormwater management agencies, soil and water conservation districts, and drainage districts. County and regional stormwater management agencies exist in all the collar counties of northeastern Illinois, while both soil and water conservation districts (which are currently revising the Illinois Urban Manual to embrace green infrastructure) and drainage districts are also highly respected agencies in more rural areas of the state. We therefore recommend that more financial resources (through grants and stormwater management fees) also be provided to these agencies and districts to assist the counties in their stormwater management responsibilities. Counties should consider entering into intergovernmental agreements with these other agencies and districts to provide technical services, training and monitoring the use and effectiveness of green infrastructure for urban stormwater management.

APPLICABILITY

We recommend that the stormwater retention performance standard first apply to all projects and entities currently subject to a NPDES stormwater permit in Illinois, including MS4s of all sizes, industrial sites, and construction projects. Over time, applicability of the standards should be expanded to include more urban and suburbanizing areas, based on the density of impervious surfaces, rather than on population. At the watershed level, studies show that it is very difficult to maintain predevelopment stream quality when watershed development exceeds ten to 15 percent impervious cover (Schuyeler and Holland 2002). Using the percentage of impervious cover within a watershed to guide the state‘s stormwater management efforts would have the dual benefits of (a) applying the standards first to those areas most significantly affecting water quality and (b) encouraging a limitation on new impervious surfaces, which will have many of the same benefits as applying the standards.

We also recommend that the standards apply to existing as well as new development, to publicly-owned as well as private property. For example, there should be a commitment by government agencies to apply the standards to manage stormwater runoff whenever public infrastructure undergoes significant maintenance, repair or replacement, or when private development is substantially improved or redeveloped. State agencies and regional governments should also set an example by using green infrastructure in their construction and maintenance activities, to help build awareness and experience with these practices. Such green infrastructure retrofits are certainly within the scope of the Illinois MS4 program, even if not explicitly listed as a BMP. The state should develop guidance to ensure that green infrastructure practices are used appropriately to work most effectively in reducing pollution, erosion and sedimentation, and flood risks, while providing the ancillary benefits of improved habitat and aquifer recharge opportunities.

FUNDING GREEN INFRASTRUCTURE

Setting aside 20% of the Clean Water State Revolving Fund for a Green Project Reserve has not had any serious impact on IEPA‘s ability to fund traditional projects to date. We believe that in the future, with more municipalities applying for green project funding, there will be an increased interest and need for funding such projects and this need may very well exceed 20% of the annual fund. We further believe that the IEPA SRF allocation policy should recognize the enormous adverse impact of unregulated stormwater discharges on the water quality of state waters, and that the funding of stand-alone stormwater projects should have a much higher priority in the future relative to the funding of traditional wastewater projects. Assuming that IEPA takes this approach, there should be no negative consequences from a long-term policy that continues to set aside 20% of the SRF for a Green Project Reserve, especially if Congress continues to earmark funds in its SRF appropriations for green projects.

We also recommend that IEPA substantially increase prioritization of applications for funding the more sustainable traditional projects, as this will further enhance the effectiveness of IEPA funding investments. Increasing the sustainability or efficiency of all projects should reduce the need for yet more funding in the future, as systems are put in place that last longer and require less maintenance, repair and replacement. This is not so much an issue of being more ―green" as it is developing a wiser investment strategy.

The Fiscal Year 2010 federal appropriation bill passed in October 2009 provided another round of exceptionally large water infrastructure grants to states and repeated the mandates for green infrastructure projects and grants contained in the American Recovery and Reinvestment Act of 2009 (ARRA). It is also our understanding from discussions with the U.S. Environmental Protection Agency that the current draft language in the Fiscal Year 2011 federal appropriation bill shows Congress‘ intent to continue these two requirements for the foreseeable future in its annual appropriations. However, to make best use of these federal funds, IEPA must adopt a clear prioritization system to determine which of the municipal green infrastructure projects should receive funding first under its earmarked Green Project Reserve funds. This system should be transparent and designed to encourage applications for a wide variety of green infrastructure project all over the state. Prioritization criteria to be given the most weight should include water quality improvement; resource conservation; the sustainability of the projects being supported without the need for repeat funding; the value of all the benefits expected from the green infrastructure practices being proposed; the amount of existing impervious surfaces within the watershed; the flood hazard risk and the degree of impairment or the relative ecological vulnerability (determined by using tools such the Restorability Index being developed by the DuPage Salt River Creek Workgroup, for example, or an Index of Biological Integrity) of the receiving waters impacted by urban stormwater discharges.

Unlike Illinois' limited use of ARRA's Green Project Reserve to support green infrastructure practices for urban stormwater management, with only four green infrastructure projects funded through the CWGPR in 2009, states with strong education and outreach programs have received many applications for green infrastructure projects and have given out millions more dollars in grants to cover green infrastructure project costs. We conclude that outreach and education are critical elements of any program attempting to increase interest in, and use of, green infrastructure practices, and we therefore recommend that IEPA significantly increase the resources and effort in this portion of its program.

We would also note that historically, the SRF program has funded only about ten percent of the water infrastructure needs of the applicants. Therefore, the SRF cannot be relied on for funding a major portion of either the sorely-needed upgrades to existing conventional wastewater and stormwater infrastructure or the green projects that will be completed in the next few years to supplement that infrastructure. Instead, states, counties, and municipalities should be hard at work developing additional funding sources for these projects. Furthermore, responsibility for stormwater management on private land should begin with the landowners, by requiring all developers to meet the performance standards described above and to encourage them to employ green infrastructure practices in their projects.

The costs of constructing and maintaining green stormwater infrastructure on private property should continue to be borne by the landowner – by the developer during construction and by the occupants after construction – the same as with conventionally-engineered stormwater infrastructure. In some instances, the responsibility for funding and maintaining stormwater management structures was provisionally allocated to property owners within ordinance language, mainly in the form of establishing Special Service Areas (SSAs), often called dormant or back-up SSAs, for stormwater management. This requires that an additional property tax is levied based on the Equalized Assessed Value (EAV) of a property to enable a local government to maintain and/or enforce stormwater management infrastructure. Back-up SSAs take effect when structures fail, or when a management unit (e.g., a Home Owners' Association) becomes defunct and discontinues maintenance of stormwater management structures. This measure allows governments to charge fees to maintain infrastructure. If SSAs are used, their fee structures should be transparent, to enable landowners to be able to deduct the interest components of these charges.

The residual runoff from private property should continue to be managed by local government. However, instead of using the general tax revenues to fund stormwater infrastructure, the state should encourage local governments to adopt stormwater management fee systems, in which rate payers are given clear information on the costs associated with such infrastructure. This should ensure that polluted runoff is not treated as an economic externality, and that landowners causing the runoff pay for the treatment and management of runoff flow and volume needed to protect our urban streams – in the same way that landowners pay for the connection fees and sewage treatment charges for pollution discharged directly into streams by publicly-owned sewage treatment plants. Green infrastructure practices should be eligible for appropriate performance credit against these stormwater fees, to encourage their adoption. If green infrastructure practices do not receive credit, land managers are less likely to utilize them because they would represent additional cost above required measures.

MAINTENANCE

Green infrastructure practices -- the same as conventional –grey” stormwater infrastructure -- require maintenance to ensure continued effectiveness over time and performance as initially designed. Where stormwater management facilities are not dedicated to a county or municipality, we recommend that communities encouraging landowners to use green infrastructure practices employ a program using covenants running with the land to require landowners to maintain all stormwater management practices on private property. These contractual agreements should be filed in land records, so they are perpetual and subsequent owners know their responsibilities. In the absence of such covenants or when the contractual requirements are not being met by landowners, the state, counties or municipalities should establish easement authority to enter properties receiving compliance credit for green infrastructure practices, and to charge responsible parties who neglect to maintain their green infrastructure features, similar to the nuisance regulations currently used to prevent neglect of conventional landscape maintenance.

If a fee system established to fund stormwater management allows credits for the use of green infrastructure practices, as we recommend above, periodic performance monitoring and compliance reporting (perhaps every 3-5 years) should be included with green infrastructure measures to promote long-term reliability and performance. Such monitoring and reporting will ensure that the green infrastructure is still performing as designed in order for landowners to continue to receive their credits. Based on the compliance reports, municipalities can then enter the property to undertake maintenance if the landowner is unwilling or unable to do so, and then charge the landowner or Home Owners Association for these services.

As part of our recommendation that the State encourage local governments to utilize a stormwater fee system instead of general tax revenues for stormwater management, these governments should also consider establishing stormwater utilities with budgets that are independent of wastewater and drinking water budgets. SRF funds could also be used to supplement the fee-based funding for stormwater utility planning and implementation projects. An alternative to landowner maintenance is for such a utility to be given the right and obligation to maintain all stormwater facilities, whether on private or public land, and charge the landowners for the service.

Because monitoring is so critical to maintaining stormwater facility effectiveness (and for ensuring that any landowners taking advantage of any credits against stormwater fees for using green infrastructure continue to qualify for such credits), IEPA should work with county and local officials, regional stormwater management agencies, soil and water conservation districts, and drainage districts to begin to develop uniform protocols for the green infrastructure compliance monitoring and state-wide guidance for the reporting requirements.

EMERGING GREEN INFRASTRUCTURE PRACTICES

Our analyses of green infrastructure also identified new emerging strategies for stormwater management that are worth reviewing. These emerging green infrastructures and practices are showing great potential for reducing pollution loads and improving water quality and some of these deserve strong consideration for implementation, particularly in combination with the green infrastructure practices examined in Chapter II. Urban forestry, rain barrels and cisterns, disconnected downspouts, street sweeping, source control and education are a few additional approaches and infrastructure practices that may mitigate some stormwater runoff impacts. These practices do not have sufficient data to perform the statistical analyses used in Chapter II, but their implementation may include benefits that go beyond stormwater control, such as reducing urban heat island effects (in the case of urban trees), reducing water use (for cisterns), and increasing the adoption rate and effective use of green infrastructure practices (education and training).

Urban forestry, rain barrels and cisterns, and disconnected downspouts promote decentralized interception and infiltration or storage of rain before it can become runoff. Urban forestry reduces runoff volume and improves water quality through evaporation, transpiration, and infiltration of rainwater (Van Roon 2005). Street trees function similarly to bioinfiltration infrastructure when they are planted in engineered structural soils designed to improve water conduction (Bartens et al. 2009). While they are not a new technology, rain barrels and cisterns can also be used to store rainwater for non-potable uses or adapted to slowly release water and act as infiltration systems (Larson and Safferman 2008, Gilroy and McCuen 2009). Similarly, disconnecting downspouts from stormwater systems and directing the water into permeable soils can be effective at reducing runoff volume by essentially creating a decentralized network of small-scale infiltration systems (Coffman 2000). In Portland, Oregon, a program that gave homeowners a financial incentive to disconnect downspouts resulted in a decrease of 4.2 million cubic meters of runoff annually in the combined sewer system (Montalto et al. 2007).

Furthermore, source control methods such as street sweeping and public education have not been extensively applied in stormwater management, but have shown great promise for pollution prevention. Public education regarding stormwater management has become important in municipalities that have marked their storm drains “Drains to River.” Unpublished data from Madison, Wisconsin, indicate that residents in neighborhoods where these messages have been stenciled are more likely to be aware of stormwater issues (Packer and Shepard 1999). Studies have shown that a 15 percent reduction in pollutant loads can be achieved on a catchment scale by reducing nonpoint source pollution before it enters stormwater (Davis and Birch 2009). Street sweeping has been shown to reduce sediment mass by more than 55 percent (Tobin and Brinkman 2002). Although more data reporting is needed to better evaluate these source control practices, their use in combination with the green infrastructure practices we analyzed in Chapter II should be strongly considered.

Another area for future research is the effectiveness of combining multiple green infrastructure systems at both the site and watershed scale. At the site scale, treatment trains, systems in which runoff flows through two or more green infrastructure before flowing out into receiving water bodies, deserve serious consideration as a green infrastructure strategy. To date, limited research has been conducted to determine how combining multiple green infrastructure impacts stormwater quality. Greb (2000) found that a multi-chambered treatment train with a detention chamber, a settling chamber, and a filtration chamber reduced TSS event mean concentrations (EMC) by 98 percent and nitrate EMC by 32 percent. However, results of other studies have been mixed (Roseen et al. 2009). Effectiveness likely depends upon the infrastructure included in the treatment train, and further research is needed to determine the most effective combinations. At the watershed scale, it is not always clear whether the installation of multiple green infrastructure practices will have an additive effect on downstream water quality, flooding, or erosion risk.

An obvious large-scale stormwater management strategy is reducing impervious cover in new development. Cluster development, for example, which concentrates buildings on a small portion of a development property, and other techniques for reducing impervious cover may reduce runoff volume and improve water quality (Hood 2006). Creating compact developments by narrowing streets and concentrating buildings in small portions of catchments increases the percentage of pervious surface (Van Roon 2005). Studying the effectiveness of these development strategies in the field is difficult because it requires paired drainage designs; however studies conducted thus far have shown that these techniques can be successful (Hood et al. 2007).

There is also a need for more consistent reporting of green infrastructure performance. For example, most sites we found in the literature have not been included in the U.S. Environmental Protection Agency's International Stormwater BMP Database. IEPA should work with county and local officials, regional stormwater management agencies, soil and water conservation districts, and drainage districts to begin to develop uniform protocols for green infrastructure compliance monitoring and state-wide guidance for the reporting requirements. Developing uniform protocols for the monitoring of green infrastructure performance and submitting the data from selected appropriate case studies to the International BMP Database will provide a larger and more consistent dataset and will assist practitioners with selecting the most appropriate green infrastructure practices for each project. The usefulness and accuracy of the BMP database depends on the standardization of methodologies and the rigor of its data entries.

APPENDIX I: ENHANCING THE WILDLIFE HABITAT VALUES OF GREEN INFRASTRUCTURE

A number of green infrastructure practices can be designed to provide wildlife habitat. By carefully selecting the vegetative species used, making slight modifications in site design, or implementing maintenance practices that enhance wildlife use, some green infrastructure categories can support wildlife while also storing, improving, or infiltrating surface water.

Infiltration Areas and Buffers

Infiltration areas such as bioretention areas, swales, and infiltration basins, can be designed as discrete isolated structures or as linear features (swales). In either case, infiltration areas may need to be designed to handle concentrated flow or may be submerged for relatively short periods of time following storm events. Buffers, also referred to as vegetative filterstrips, are strips of vegetation located along streams, watercourses or wetlands. They generally are not designed for concentrated surface flow (as in swales or grass waterways) and are inundated only during natural flooding cycles. However, both of these types of green infrastructure are designed to perform the following functions: capture sediments, slow down water flow, allow water to infiltrate into the soil, sequester nutrients or pollutants attached to sediment particles or dissolved in water, allow for vegetative uptake of nutrients, and to potentially provide the substrate microbes need to break down pollutants or reduce nutrients (such as ammonia or nitrite) to other forms.

In every case, vegetation must be selected that meets the design criteria for the water quality or water quantity objective of the green infrastructure. It is possible to select vegetation that will meet the primary criteria and in addition provide valuable wildlife habitat (Macgowan and Miller 1999, Miller and McCreedy 1997). The USDA Natural Resource Conservation Service (NRCS) has developed specific management recommendations that meet water quality goals while providing beneficial habitat for target wildlife species (USDA-NRCS Fish & Wildlife Habitat Management Leaflets http://www.whmi.nrcs.usda.gov/technical/leaflet.htm). In each state, the NRCS convenes a technical committee composed of wildlife biologists and technical design experts to develop technical design, species mixes and planting standards for every approved practice that are state specific and designed to provide the best habitat for wildlife in that state (USDA-NRCS. Indiana NRCS Field Office Technical Guides http://efotg.nrcs.usda.gov/toc.aspx?CatID=4288). The Illinois Field office Technical Guide that contains these recommendations can be found at http://efotg.nrcs.usda.gov/treemenuFS.aspx . Grasses, trees, and shrubs are acceptable cover types for these practices. Use of all three cover types will enhance wildlife diversity. Filter strips and infiltration areas can be improved for wildlife by incorporating one or more of the following considerations (Macgowan and Miller, 2002).

- The grass species planted depends upon the site conditions, the grade of the slope, and the amount of sediment and contaminants in the runoff. If the slope is relatively steep and/or if the filter strip incurs a concentrated flow rate, high sediment, or contaminant load, then mixes of sod forming grasses (e.g., switchgrass or redtop) planted at high densities may be necessary. Planting fescue should be avoided when possible. If fescue must be planted, a low endophyte fescue (eg. Johnstone, Fawn, Kenhy, Forager vars.) should be used. Fescue endophyte is a fungus that grows between the cells of a tall fescue plant. High endophyte fescue (eg. Ky31 var.) has been found to reduce litter sizes in some species such as rabbits.

- If concentrated flow or high sediment conditions are not present (or concentrated flow areas are being expanded with additional width), then the above grass mixtures can be planted at lower densities or a grass/legume combination (such as clover, annual lespedeza or partridge pea), or native warm-season bunch grass mixtures (Macgowan 2001) suited to the soil and site conditions can be selected. Grasses are an excellent source of cover for many wildlife species, however, bunch grasses (grasses that do not form a sod) provide spaces for wildlife to move through making them particularly valuable for winter and brood cover.

- Adding forbs (non-woody plants other than grass, i.e., wildflowers and legumes) (Macgowan and Miller 2002 Table 2, page 11 and Table 3, page 12) to grass plantings will enhance its value to most wildlife species. Forbs provide a source of food and structure that attracts insects.

- When not restricted by local or regulated drain regulations, the addition of shrub species provide escape cover for many species and provides valuable nesting habitats for shrubland bird species, many of which are declining in the central hardwood region (Dettmers 2003, Hunter et. al 2001, and Herkert 1995). Shrub species suited to soil type provide food and nesting habitat for wildlife (Macgowan and Miller 2002 Table 4, pages 13-16). Placing one row of shrubs closest to the stream helps stabilize the stream bank while providing a setback for the first row of trees. This may be concern along watercourses with heavy scour erosion. In these situations, trees that are set back from the stream edge are less likely to fall into the stream in later years; however, they are still close enough to provide shade to the stream. Designing plantings with irregular edges will increase the edge and interspersion for many early successional and shrub dependent species (Thompson and Dessecker 1997).

- Select tree species that provide food and/or cover for wildlife (Macgowan 2003, Macgowan and Miller 2002 Table 5, pages 17-22). For example, many native tree species adapted to soil conditions along streams are excellent wildlife trees. A tree planting containing many species provides a diversity of food and structure. Thus, it becomes more valuable for wildlife than a planting that only contains one or two tree species. Planting a variety of tree species also minimizes the chance of incurring a high mortality rate due to micro site variability and potential diseases that might inflict the stand.

- Native plants species adapted to the site conditions should always be used when possible (Macgowan and Miller 2002 Tables 1-6, pages 10-23) to benefit wildlife. A mixture of plant species and habitat types such as grassland, old-field/brushland, and forestland provide escape, nesting, and foraging cover for a wide variety of wildlife species. Plants should be selected that meet the basic requirements of the priority wildlife species for a given planting or area.

Making minor alterations in width, shape, and landscape placement can greatly improve the value to wildlife.

- The minimum width of the filter strip depends upon the percent slope of the drainage area above the filter strip. However to benefit wildlife, filter strips should be designed as wide as possible. The old adage of bigger is better applies here. Many wildlife species utilize filter strips for nesting, cover, and travel ways. Filter strips need to be wide enough to allow nesting animals a chance to hide from mammalian predators that travel the edges of these areas. Filter strips 66 feet wide or greater on each side of the waterway provide good cover for wildlife, while meeting the setback requirement on the atrizine label and program requirements of NRCS programs – (USDA-NRCS 2008. Conservation Practice Standard 393 –Filter Strip http://efotg.nrcs.usda.gov/references/public/IN/Filter_Strip.pdf)

Making minor alterations in vegetation management or maintenance will also improve the habitat value for wildlife.

- Minimize or eliminate disturbance (mowing, machine traffic, grazing, etc.) during the nesting season (prior to August 15). Repeated mowing during the growing season prior to establishment is necessary for establishment of cool season grasses and control of weeds. Once established, mow the grassed waterway in a 2 to 3 year rotation so that only 1/2 to 1/3 of it is mowed in a given year. This will maintain the integrity of the waterway while providing some winter cover and early-spring nesting habitat for wildlife. Mow cool-season grass no shorter than 6 inches and native warm-season grass no shorter than 10 inches. (Macgowan and Miller 2002)

Constructed Wetlands

Wetland benefits and values include storm water storage, ground water recharge, nutrient recycling, sediment filtering, and wildlife habitat. The appearance, character and function of wetlands vary depending on the depth of the water, length of flooding and characteristics of the surrounding land. The different types of wetlands provide a unique array of habitats for many species of wildlife (Miller 1990, Mitsch and Gosselink 1986).

Constructed wetlands can be designed to enhance one or all of these values. One concern with constructed wetlands is that if they are designed to accumulate pollutants that can be harmful to wildlife, then they should be managed to discourage wildlife from using the affected areas. A classic example is the Kesterson National Wildlife refuge in California that received drainage water from agricultural areas to fill their wetlands used by migrating waterfowl. Selenium leaching from the farmland built up in the wetlands and began causing deformities in ducklings raised there. Consequently, the wetlands were drained and or managed to discourage waterfowl form using them (Ohlendorf et. al 1986, Popkin 1986).

Since that time, a systems approach has been used in wetland restoration and creation when wildlife habitat is a goal. Sediment traps, wetland treatment cells, and other bioremediation structures are often designed to receive polluted runoff at the beginning of the system (or at the top of the watershed) (Miller et. al 2000). These structures are designed to remove the pollutants harmful to wildlife and are designed to receive regular maintenance. Often redundant systems are built so one is performing while another is undergoing renovation (Reaves et. al 1994). Structures designed for this purpose are not designed to contain vegetation or structural characteristics that would be attractive to waterfowl and other aquatic wildlife. However, when wildlife habitat is a goal, additional wetlands are built or restored downstream of these initial structures. In these wetlands, nutrients and pollutants not harmful to wildlife (such as N and phosphates) can be removed while producing productive wildlife habitat. This systems approach also mimics the way natural wetlands are located and perform in a watershed (Van Der Valk, 1989).

Plant selection

Suitable environments for both aerobic and anaerobic microorganisms are present in the wetland and carry out the biological processes necessary to remove or transform pollutants such as nitrates, phosphates, ammonia, manganese, sulfur, and carbon carried by the water. Microbes (microscopic organisms) provide most of the treatment. Plants in the wetland remove nutrients and improve aesthetics, but their primary function is to provide a surface area for the growth of microbial films. More plant stems in the water column translate into more microbes cleaning the water. System design and operation should be aimed at enhancing features that improve these characteristics of the wetland system (Miller et. al 2003). Plants that have wildlife value and are suited to the wetland physical and chemical conditions should by favored and encouraged through planting or proper management (Lembi, 2003)

Sizing

Local or state regulations often mandate that constructed wetlands be sized for a 25 year, 24-hour storm event. However, there is flexibility in how a specific system will comply with this requirement. Individual components of the constructed wetland system can be sized to accommodate this level of water flow. If wetland cells are sized to retain open lot runoff from an extreme storm event, there will be insufficient water during the dry parts of the year to maintain plants and microbial populations beneficial to wildlife. If the wetland system dries, microbes will be lost. When water is returned to the system, treatment will be greatly reduced because of the lack of microbes. A significant amount of time will pass before these organisms are reestablished. This problem can be overcome by placing a structure with water storage capacity upstream of the wetland system, an arrangement that allows gravity to do the work of moving additional water through the system as needed. Upstream storage capacity also allows for wastewater to be captured during wet times of the year, typically winter and spring when a wetland system will not provide a high level of treatment. Wastewater can be held and released during warmer and drier parts of the year when wetland treatment will be at its peak. Captured precipitation can also be used as dilution water, reducing the possibility of overloading the system with a sudden pulse of wastewater with a high concentration of contaminants. Upfront storage capacity of both contaminated and fresh water allows greater control of water levels and water quality in the constructed wetland system throughout the year and can therefore enhance wildlife habitat value and use. (Miller et. al 2003).

System size is important in determining how well the wetland functions. A wetland should be sized to accommodate the normal expected flow, including rainfall, but should be conservative in treating contamination levels in the wastewater. For example, BOD (Biochemical Oxygen Demand) should be below 50 pounds per day per acre and nitrogen levels should be below 400 ppm (parts per million) for incoming wastewater, and preferably below 200 ppm. Samples of typical wastewater that will be treated by the constructed wetland should be analyzed to determine the expected levels of ammonia, nitrates, phosphates, and BOD. This will provide a more accurate basis for sizing the treatment system rather than relying on typical published values. Wetland cells should be sized to allow for 7 to 14 days retention time, meaning it will take 7 to 14 days for water to move from the inlet to outlet of the system. The quality of water exiting the system is dependent on the quality of water coming in and the length of time the water is retained (Miller et. al 2003).

Enhancements for Wildlife Habitat

The best rule to follow when designing a wetland with wildlife habitat management objectives as a priority, is more diversity equals more wildlife (Macgowan and Miller 2002 . Therefore, increasing the size, the diversity of water depths, and the number of plant species maximizes its value for wildlife. Cole et al. (1996) recommended the following design considerations:

- Install water control structures. They can be used to more accurately control water levels, and to allow for draw-downs to control or enhance wetland vegetation.

- Larger wetlands generally support more diverse plant and wildlife communities. Wetlands ranging in size from 0.5 to 5.0 acres can be expected to support a reasonably diverse wildlife community.

- Irregular shapes promote more structural diversity in and around the wetland basin. Coves, peninsulas, islands, and rough shorelines provide more habitat types.

- Gentle slopes (1:10) result in exposed mudflats and a diversity of emergent plants. These areas are used by many bird, amphibian, and reptile species. Plan for a high diversity of slopes with a higher percentage of gentle slopes.

- Providing variety of depths results in a diversity of plant communities, and subsequently, wildlife. Emergent plants favor depths less than 18 inches and are favorite habitats of dabbling ducks, herons, and frogs. Submergent and floating plants prefer water depths 18 to 48 inches. Depths greater than 6 feet provide permanent water. However, wildlife tends to be much more diverse and abundant in wetlands that are dominated by shallow (<3 feet) water.

Detention/Retention Areas

Detention basins can provide wildlife habitat benefits as one of the multi-objective uses for detention areas (Chuanqi 2009). Detention areas are designed to detain water in a manmade pond to reduce peak flow and allow pollutants to settle. One concern with detention areas is that if they are designed to accumulate pollutants that can be harmful to wildlife, then they should be managed to discourage wildlife from using the affected areas (fencing, wildlife deflecting devices, preventing attractive vegetation from establishing, covering the open water areas, designing systems with no surface flow, systems that drain within a few days of storm events; see the discussion of the Kesterson National Wildlife refuge above).

A treatment train approach can be used for detention/retention areas when wildlife habitat is a goal. Sediment traps, wetland treatment cells, and other bioremediation structures can be designed to receive polluted runoff at the beginning of the system. These structures are designed to remove the pollutants harmful to wildlife and also to receive regular maintenance. Often redundant systems are built so one is performing while another is undergoing renovation. Structures designed for this purpose are not designed to contain vegetation or structural characteristics that would be attractive to waterfowl and other aquatic wildlife. Additional retention areas containing open water and aquatic habitats can be built or restored downstream of these initial structures. In these areas, nutrients and pollutants not harmful to wildlife (such as N and phosphates) can be removed while producing productive wildlife habitat.

When contaminant loads that would deem an area unacceptable as wildlife habitat are not present, detention areas that retain water for extended periods of time can be designed to contain the structural components and vegetative structure of natural aquatic habitats. Different types of wetlands attract different communities of wildlife. Therefore, aquatic habitat design should reflect habitat requirements of desired species, or suites of species. For example, if you would like to manage for waterfowl, then a wetland with a 50/50 mix of open water and aquatic emergent plants is ideal.

The water depth for dabbling ducks (mallards, teal, wood duck, etc.) should not exceed 18 inches and should include depths <12inches. Generally, aquatic emergent plants grow in shallow areas less than 18inches in depth. They are important because these plants provide food and cover for many species of wildlife such as waterfowl, reptiles, amphibians, and the invertebrates they depend on for food (Macgowan and Miller 2002). Detention areas retaining water for extended periods can be designed in a terrace fashion creating shelves at 18 inch depths or less around the basin at different pool gradients. This results in flat bands of vegetation submerged vegetation required by wildlife. Such a design also provides a shallow shelf along deeper pools allowing a margin of safety when human access is allowed.

Deep-water areas provide habitat for diving ducks and many fish species. They are important to migrating (waterfowl, water birds) and overwintering (fish) wildlife. Predators of mosquitoes require deeper water refuges (usually > 8 feet that won't dry out easily (Knipp et. al 2008). Many birds, frogs, fish, and insects (dragonflies, damselflies, water striders, backswimmers, and diving beetles), all natural enemies of mosquitoes, inhabit wetlands having these characteristics ((Ladd and Frankenberger 2003).

Managing wetlands for fish populations is not compatible for all management goals. For example, fish management is compatible with waterfowl management, but not for amphibian species since fish are one of their primary predators (Macgowan and Miller 2002). Upland areas of dry detention or extended dry detention basins can be managed for wildlife using the upland habitat principles described above (Iowa Stormwater Management Manual, version 2 2008).

APPENDIX II: SUCCESSFUL GREEN INFRASTRUCTURE PROJECTS IN NORTHEASTERN ILLINOIS

Despite the many perceived barriers to green infrastructure, numerous successful projects have been implemented throughout northeastern Illinois. The following are a few of these projects and by no means is meant to describe all of the completed projects.

The Morton Arboretum[53] in Lisle, Illinois undertook a number of projects in 2004, one of which included the installation of permeable paving blocks in the visitor's parking lot (see Figure 11). The parking lot was installed to improve the water quality of stormwater runoff. The project has been an overwhelming success and has become an attraction at the Arboretum. The parking lot also utilizes bioswales to further provide water quality benefits. Arboretum staff have said that minimal maintenance has been required on the parking lot since installation and they have not observed decreased performance from the permeable pavers over the past five years.

Figure 11: Morton Arboretum Visitors' Parking Lot[54]

The Ryerson Woods Welcome Center[55] in Riverwoods, Illinois is a Lake County Forest Preserve District Building that utilizes green building techniques. The site design incorporates the use of rain gardens, porous asphalt and rainwater harvesting. This site has become an educational demonstration site where people can learn about the techniques being used. There are cutouts within the interior of the building for visitors to see the rainwater harvesting system and how it would be used as a water source for the fire sprinkler system. Collected water is also used to water the native plantings during dry periods. The building also incorporates recycled and recyclable materials, natural temperature control and natural lighting. See Figure 12.

[53] http://www.mortonarb.org/sustainable-practices/environmental-parking.html
[54] http://www.mortonarb.org/sustainable-practices/environmental-parking.html
[55] http://www.lcfpd.org/ryerson_woods_center/index.cfm?fuseaction=home.green_building_strategies

Figure 12: Ryerson Woods Welcome Center[56]

The Villa Park Police Station,[57] in the Village of Villa Park, was a redevelopment site that incorporates the use of a green roof, porous pavement and bioretention swales (see Figure 13). This site was able to take detention credit for the void space in the gravel layer below the parking lot because it is a small site (less than 1 acre). This project also had a monitoring component which will be able to provide the Village and the site designer's important information on the long term performance of the green infrastructure on site. The site was modeled and designed to reduce the 100-year, 24-hour storm event from 4.4 cfs in existing conditions to 0.07 cfs in proposed conditions.

Figure 13: Villa Park Police Station Green Roof[58]

[56] Presentation by Nan Buckardt at Chicago Metropolitan Agency for Planning, Water 2050 Summit, 3/22/2010
[57] Presentation given by Tom Price at IAFSM Conference and email correspondence dated 2/19/2010 from Tom Price
[58] http://www.dupageco.org/dec/generic.cfm?doc_id=4286

Elmhurst College in Elmhurst, Illinois recently built a new residence hall, West Hall[59] which incorporates the use of underground rainwater cisterns, permeable paver parking lot and bioswales with native plantings[60] (Figure 14). The college has made a commitment to green infrastructure and sustainability. West Hall also incorporates a number of sustainable practices such as lighting features, water efficient fixtures and use of local materials for construction. The project received support from the Illinois Department of Commerce and Economic Opportunity and DuPage County Stormwater Management Division. The College views the project as a success and has observed student interest in the building.

Figure 14: Elmhurst College West Hall Permeable Paver Parking Lot and Bioswales[61]

Lake County, Illinois recently completed construction of the New Lake County Central Permit Facility (Figure 15) that now acts as a one-stop shop for customers needing building permits within Lake County.[62] The building incorporates a number of BMPs and green infrastructure and was partially funded by an Environmental Protection Agency Section 319 Grant. The site contains three rain gardens, bioinfiltration swales (4,830 square feet), vegetated swales (26.831 square feet) and two wetland detention basins. The rain gardens are estimated to reduce runoff and pollution by 55-90%.

[59] http://public.elmhurst.edu/news/ecscene/31102584.html
[60] http://www.theconservationfoundation.org/BMPSeminar2010/site%20230%20Elmhurst%20College.pdf
[61] http://www.theconservationfoundation.org/BMPSeminar2010/site%20230%20Elmhurst%20College.pdf
[62] http://www.lakecountyil.gov/centralpermitfacility/default.htm

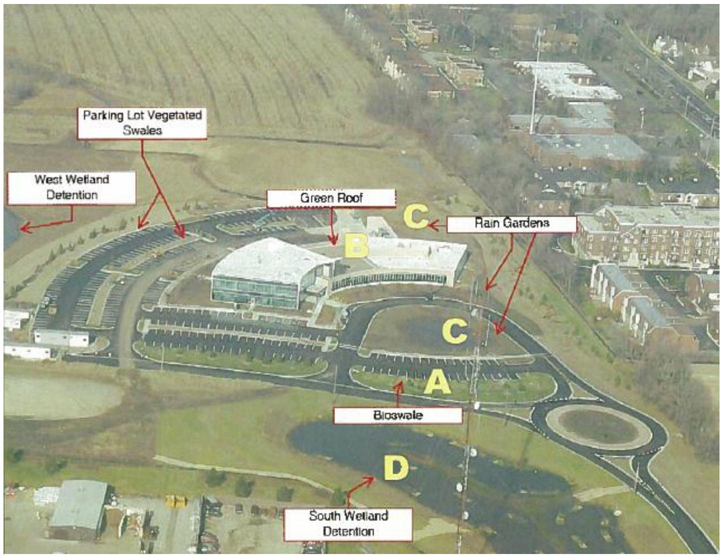


Figure 15: Lake County Central Permit Facility[63]

The City of Chicago developed the Green Alley Program in 2006 (Figure 16). The program retrofits existing alleys that have existing flooding issues. The specific design of each Green Alley is somewhat flexible to address the unique needs of the project but typically incorporates permeable pavements, open bottom catch basins, recycled materials and other green techniques[64]. The City has developed The Chicago Green Alley Handbook with design details and describes the benefits of the different components[65].

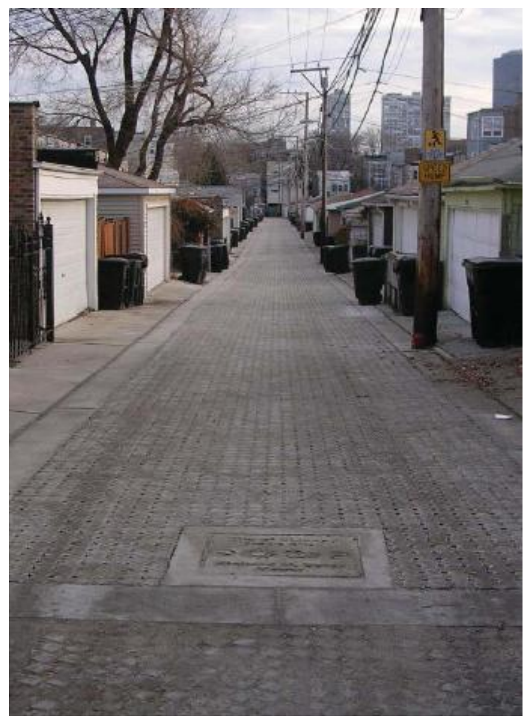


Figure 16: An Example of Chicago's Green Alley Program[66]

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[63] Handout provided by Lake County at the Lake County Stormwater Management Commission Technical Advisory Meeting on 5/21/2010

[64] http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html

[65] http://www.cityofchicago.org/content/dam/city/depts/cdot/Green_Alley_Handbook_2010.pdf

[66] http://www.cityofchicago.org/content/dam/city/depts/cdot/Green_Alley_Handbook_2010.pdf

APPENDIX III: DATA FOR PERFORMANCE ANALYSIS

Table III-1: List of Journal Articles Which Served as Data Sources for Analysis of Green Infrastructure Performance.

Article Number	First Author	Year	Article Title	Journal
85	Abbot	2003	In-situ hydraulic performance of a permeable pavement sustainable urban drainage system	Journal of the Chartered Institution of Water and Environmental Management
59	Andersen	1999	The role of urban surfaces (permeable pavements) in regulating drainage and evaporation: development of a laboratory simulation experiment	Hydrological Processes
452	Backstrom, M	2003	Grassed swales for stormwater pollution control during rain and snowmelt	Water Science and Technology
360	Bardin	2001	The purification performance of infiltration basins fitted with pretreatment facilities: a case study	Water Science and Technology
269	Barrett	2008	Effects of a Permeable Friction Course on Highway Runoff	Journal of Irrigation and Drainage Engineering
144	Bean	2007	Evaluation of Four Permeable Pavement Sites in Eastern North Carolina for Runoff Reduction and Water Quality Impacts	Journal of Irrigation and Drainage Engineering
424	Berbee	1999	Characterization and Treatment of Runoff from Highways in the Netherlands Paved with Impervious and Pervious Asphalt	Water Environment Research
425	Birch	2004	Efficiency of a constructed wetland in removing contaminants from stormwater	Wetlands
332	Birch	2005	Efficiency of a continuous deflective separation (CDS) unit in removing contaminants from urban stormwater	Environmental Monitoring and Assessment

565	Birch	2006	Efficiency of a retention/detention basin to remove contaminants from urban stormwater	Urban Water Journal
457	Birch, G F	2009	Efficiency of a continuous deflective separation CDS unit in removing contaminants from urban stormwater	Urban Water Journal
459	Blecken, G T	2007	The influence of temperature on nutrient treatment efficiency in stormwater biofilter systems	Water Science and Technology
177	Bliss	2009	Storm water mitigation using a green roof	Environmental Engineering Science
462	Bratieres, K	2008	Nutrient and sediment removal by stormwater biofilters: A large-scale design optimisation study	Water Research
464	Carleton, J N	2001	Factors affecting the performance of stormwater treatment wetlands	Water Research
119	Carter	2006	Hydrologic behavior of vegetated roofs	Journal of the American Water Resources Association
468	Chavan, P V	2008	Behavior of pilot-scale constructed wetlands in removing nutrients and sediments under varying environmental conditions	Water Air and Soil Pollution
264	Collins	2008	Hydrologic Comparison of Four Types of Permeable Pavement and Standard Asphalt in Eastern North Carolina	Journal of Hydrologic Engineering- ASCE
427	Davis	2007	Field Performance of Bioretention: Water Quality	Environmental Engineering Science
473	Davis, A P	2008	Field performance of bioretention: Hydrology impacts	Journal of Hydrologic Engineering
476	Deletic, A	2006	Performance of grass filters used for stormwater treatment - a field and modelling study	Journal of Hydrology
428	Dietz	2006	Saturation to improve pollutant retention in a rain garden	Environmental Science and Technology
122	Dreelin	2006	A test of porous pavement effectiveness on clay soils during natural storm events	Water Research

186	Duchemin	2009	Reduction in agricultural non-point source pollution in the first year following establishment of an integrated grass/tree filter strip system in southern Quebec (Canada)	Agriculture, Ecosystems and Environment
225	Farm	2002	Evaluation of the accumulation of sediment and heavy metals in a storm-water detention pond	Water Science and Technology
485	Farrell, A C	2003	An assessment of long-term monitoring data for constructed wetlands for urban highway runoff control	Water Quality Research Journal of Canada
152	Getter	2007	Quantifying the effect of slope on extensive green roof stormwater retention	Ecological Engineering
124	Gilbert	2006	Stormwater runoff quality and quantity from asphalt, paver, and crushed stone driveways in Connecticut	Water Research
495	Green, M B	1996	Constructed reed beds clean up storm overflows on small wastewater treatment works	Water Environment Research
279	Hathaway	2008	A field study of green roof hydrologic and water quality performance	Transactions of the ASABE
432	Hatt	2007	Hydraulic and pollutant removal performance of stormwater filters under variable wetting and drying regimes	Water Science and Technology
500	Hipp, J A	2006	Optimization of stormwater filtration at the urban/watershed interface	Environmental Science & Technology
505	Hossain, M A	2005	Efficiency and flow regime of a highway stormwater detention pond in Washington, USA	Water Air and Soil Pollution
435	Hsieh	2005	Evaluation and Optimization of Bioretention Media for Treatment of Urban Storm Water Runoff	Journal of Environmental Engineering
437	Hunt	2008	Pollutant Removal and Peak Flow Mitigation by a Bioretention Cell in Urban Charlotte, N.C.	Journal of Environmental Engineering
510	Jayasuriya, L N N	2007	Contributing to the sustainable use of stormwater: the role of pervious pavements	Water Science and Technology

197	Kalainesan	2009	Sedimentation basin performance at highway construction sites	Journal of Environmental Management
295	Latimer	1986	Treatment of Solids and Petroleum Hydrocarbons in Storm Runoff with an On-site Detention Basin	Bulletin of Environmental Contamination and Toxicology
438	Legret	1996	Effects of a porous pavement with reservoir structure on the quality of runoff water and soil	The Science of the Total Environment
526	Line, D E	2009	Performance of a bioretention area and a level spreader-grass filter strip at two highway sites in North Carolina	Journal of Irrigation and Drainage Engineering
527	Line, D E	2008	Evaluating the effectiveness of two stormwater wetlands in North Carolina	Transactions of the Asabe
538	Morgan, R A	2005	An evaluation of the urban stormwater pollutant removal efficiency of catch basin inserts	Water Environment Research
334	Mungasavalli	2006	Constructed Wetlands for Stormwater Management: A Review	Fresenius Environmental Bulletin
541	Muthanna, T M	2007	Heavy metal removal in cold climate bioretention	Water Air and Soil Pollution
440	Pagotto	2000	Comparison of the hydraulic behaviour and the quality of highway runoff water according to the type of pavement	Water Research
441	Passeport	2009	Field Study of the Ability of Two Grassed Bioretention Cells to Reduce Storm-Water Runoff Pollution	Journal of Irrigation and Drainage Engineering
31	Pratt, CJ	1995	UK research into the performance of permeable pavement, reservior structures in controlling stormwater discharge quantity and quality	Water Science and Technology
342	Roseen	2009	Seasonal Performance Variations for Storm-Water Management Systems in Cold Climate Conditions	Journal of Environmental Engineering ASCE
377	Rushton	2001	Low-impact parking lot design reduces runoff and pollutant loads	Journal of Water Resources Planning and Management
553	Semadeni-Davies, A	2006	Winter performance of an urban stormwater pond in southern Sweden	Hydrological Processes

555	Stanley, D W	1996	Pollutant removal by a stormwater dry detention pond	Water Environment Research
445	Stotz	1994	The pollution of effluents from pervious pavements of an experimental highway section: first results	The Science of the Total Environment
379	Tapia-Silva	2006	Ability of plant-based surface technology to improve urban water cycle and mesoclimate	Urban Forestry and Urban Greening
557	Terzakis, S	2008	Constructed wetlands treating highway runoff in the central Mediterranean region	Chemosphere
116	VanWoert	2005	Green Roof Stormwater Retention: Effects of Roof Surface, Slope, and Media Depth	Journal of Environmental Quality

Table III-2: Total Nitrogen and Total Suspended Solids EMC Removal Efficiencies for Green Infrastructure Sites.

Record	First Author	Year	Green Infra. Practice	TN Influent Concentration mg/L	TN % EMC reduction	TN Storm Events	TN Effluent (est.)	TSS Influent Concentration mg/L	TSS % EMC reduction	TSS Storm Events	TSS Effluent (est.)
452	Backstrom, M	2003	Bioinfil						96	1	
452	Backstrom, M	2003	Bioinfil						99	1	
452	Backstrom, M	2003	Bioinfil						99	1	
360	Bardin	2001	Filt						22	7	
360	Bardin	2001	Deten						74	7	
269	Barrett	2008	Pave	1.56	4	25	1.5	117.8	93	25	8.2
269	Barrett	2008	Pave	1.78	21	6	1.4	174.33	87	6	22.7
144	Bean	2007	Pave	1.33	42	14	0.8	12	33	13	8.0
424	Berbee	1999	Pave					21	90	5	2.1
424	Berbee	1999	Pave					21	90	5	2.1
424	Berbee	1999	Pave					77	69	5	23.9
424	Berbee	1999	Pave					77	73	5	20.8
332	Birch	2005	Bioinfil	2.14	8	4	2.0	42	50	7	21.0
425	Birch	2004	Wetland	4.38	16	4	3.7	87.5	-4	6	91.0
565	Birch	2006	Deten	4.78	28	5	3.4	388	40	6	232.8
457	Birch, G F	2009	Filt	2.31	6	4	2.2	95	28	6	68.4
459	Blecken, G T	2007	Bioinfil	1.38	-207.8	8	4.2	142.7	96.8	8	4.6
459	Blecken, G T	2007	Bioinfil	1.38	-11.6	8	1.5	142.7	96.4	8	5.1
459	Blecken, G T	2007	Bioinfil	1.38	-0.5	8	1.4	142.7	97.5	8	3.6
462	Bratieres, K	2008	Bioinfil	2.1	-241	5	7.2	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-201	5	6.3	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-152	5	5.3	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-151	5	5.3	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-121	5	4.6	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-106	5	4.3	150	98	5	3.0
462	Bratieres, K	2008	Bioinfil	2.1	-105	5	4.3	150	99	5	1.5

462	Bratieres, K	2008	Bioinfil	2.1	-101	5	4.2	150	98	5	3.0
462	Bratieres, K	2008	Bioinfil	2.1	-57	5	3.3	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	-46	5	3.1	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	16	5	1.8	150	98	5	3.0
462	Bratieres, K	2008	Bioinfil	2.1	33	5	1.4	150	96	5	6.0
462	Bratieres, K	2008	Bioinfil	2.1	43	5	1.2	150	96	5	6.0
462	Bratieres, K	2008	Bioinfil	2.1	45	5	1.2	150	95	5	7.5
462	Bratieres, K	2008	Bioinfil	2.1	46	5	1.1	150	97	5	4.5
462	Bratieres, K	2008	Bioinfil	2.1	62	5	0.8	150	97	5	4.5
462	Bratieres, K	2008	Bioinfil	2.1	62	5	0.8	150	98	5	3.0
462	Bratieres, K	2008	Bioinfil	2.1	63	5	0.8	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	65	5	0.7	150	98	5	3.0
462	Bratieres, K	2008	Bioinfil	2.1	71	5	0.6	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	72	5	0.6	150	99	5	1.5
462	Bratieres, K	2008	Bioinfil	2.1	79	5	0.4	150	99	5	1.5
464	Carleton, J N	2001	Wetland		-49	13			-170	13	
464	Carleton, J N	2001	Wetland		10.9	3			92.5	3	
464	Carleton, J N	2001	Wetland		20	3			-20	3	
464	Carleton, J N	2001	Wetland						27	17	
464	Carleton, J N	2001	Wetland						56	11	
464	Carleton, J N	2001	Wetland						74	21	
464	Carleton, J N	2001	Wetland						88	64	
464	Carleton, J N	2001	Wetland						92	43	
468	Chavan, P V	2008	Wetland		45	39					
468	Chavan, P V	2008	Wetland		87	39					
427	Davis	2007	Bioinfil					34	22	12	26.5
427	Davis	2007	Bioinfil					34	41	12	20.1
476	Deletic, A	2006	Bioinfil	2.6	43.85	2	1.5	150	79.33	2	31.0
476	Deletic, A	2006	Bioinfil	2.6	50	2	1.3	150	73.33	2	40.0
476	Deletic, A	2006	Bioinfil	2.6	53.85	2	1.2	150	81.33	2	28.0
476	Deletic, A	2006	Bioinfil	2.6	55.38	2	1.2	150	94.67	2	8.0
476	Deletic, A	2006	Bioinfil	2.6	56.92	2	1.1	150	86.67	2	20.0
428	Dietz	2006	Bioinfil	1.6	68	72	0.5				

428	Dietz	2006	Bioinfil	1.6	69	72	0.5				
122	Dreelin	2006	Pave	2.96	-43	9	4.2				
225	Farm	2002	Deten	3	67	4	1.0				
485	Farrell, A C	2003	Wetland					270	-90.7	15	514.9
485	Farrell, A C	2003	Wetland					700	54.9	15	315.7
124	Gilbert	2006	Pave	8.6	78	51	1.9	47.8	29	52	33.9
124	Gilbert	2006	Pave	8.6	88	51	1.0	47.8	67	52	15.8
495	Green, M B	1996	Wetland					115.3	86.49	3	15.6
279	Hathaway	2009	Roof	0.8	-225.5	5	2.6				
432	Hatt	2007	Filt					112	98	13	2.2
432	Hatt	2007	Bioinfil		2.1	13		150	91	13	13.5
432	Hatt	2007	Bioinfil		2.1	13		150	91	13	13.5
432	Hatt	2007	Bioinfil					150	88	13	18.0
432	Hatt	2007	Bioinfil					150	90	13	15.0
432	Hatt	2007	Bioinfil					150	95	6	7.5
500	Hipp, J A	2006	Filt						0	16	
500	Hipp, J A	2006	Filt						53	16	
500	Hipp, J A	2006	Filt						62	16	
500	Hipp, J A	2006	Filt						63.4	16	
500	Hipp, J A	2006	Filt						74.5	16	
500	Hipp, J A	2006	Filt						78.7	16	
500	Hipp, J A	2006	Filt						80.1	16	
500	Hipp, J A	2006	Filt						82.1	16	
500	Hipp, J A	2006	Filt						93.9	16	
500	Hipp, J A	2006	Filt						94.9	16	
505	Hossain, M A	2005	Deten					350	83.9	7	56.4
435	Hsieh	2005	Bioinfil					150	-103	6	304.5
435	Hsieh	2005	Bioinfil					150	10	6	135.0
435	Hsieh	2005	Bioinfil					150	29	6	106.5
435	Hsieh	2005	Bioinfil					150	66	6	51.0
435	Hsieh	2005	Bioinfil					150	86	6	21.0
435	Hsieh	2005	Bioinfil					150	88	6	18.0
435	Hsieh	2005	Bioinfil					150	91	6	13.5

435	Hsieh	2005	Bioinfil						150	92	6	12.0
435	Hsieh	2005	Bioinfil						150	93	6	10.5
435	Hsieh	2005	Bioinfil						150	93	6	10.5
435	Hsieh	2005	Bioinfil						150	93	6	10.5
435	Hsieh	2005	Bioinfil						150	94	6	9.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
435	Hsieh	2005	Bioinfil						150	96	6	6.0
437	Hunt	2008	Bioinfil		1.68	32.2	23	1.1	49.5	59.5	23	20.0
510	Jayasuriya	2007	Pave		5.26	95.7	1	0.2	281	82.8	1	48.3
510	Jayasuriya	2007	Pave							80	1	
197	Kalainesan	2009	Deten						124.4	15	10	105.7
295	Latimer	1986	Deten						48.65	57.5	2	20.7
438	Legret	1996	Pave						33	64	31	11.9
526	Line, D E	2009	Bioinfil		2.38	14	13	2.0	23.3	70	14	7.0
526	Line, D E	2009	Bioinfil		3.26	-3	13	3.4	14.3	79	13	3.0
527	Line, D E	2008	Wetland			21	4			64	4	
527	Line, D E	2008	Wetland			42	11			83	11	
538	Morgan, R A	2005	Filt						225	11	10	200.3
538	Morgan, R A	2005	Filt						225	25	10	168.8
538	Morgan, R A	2005	Filt						225	35	10	146.3
538	Morgan, R A	2005	Filt						225	42	10	130.5
334	Mungasavalli	2006	Wetland			11	9					
440	Pagotto	2000	Pave		8.8	63	25	3.3	46	81	25	8.7
441	Passeport	2009	Bioinfil		1.662	54	26	0.8				
441	Passeport	2009	Bioinfil		1.662	54	18	0.8				
342	Roseen	2009	Filt						55.54	27	27	40.5
342	Roseen	2009	Bioinfil						55.54	50	27	27.8
342	Roseen	2009	Filt						55.54	51	27	27.2

342	Roseen	2009	Bioinfil					55.54	60	27	22.2
342	Roseen	2009	Filt					55.54	62	27	21.1
342	Roseen	2009	Deten					55.54	72	27	15.6
342	Roseen	2009	Bioinfil					55.54	96	27	2.2
342	Roseen	2009	Bioinfil					55.54	97	27	1.7
342	Roseen	2009	Bioinfil					55.54	99	27	0.6
342	Roseen	2009	Pave					55.54	100	27	0.0
342	Roseen	2009	Wetland					55.54	100	27	0.0
342	Roseen	2009	Bioinfil					55.54	100	27	0.0
377	Rushton	2001	Bioinfil		-30.4	16		12.3	16.6	16	10.3
377	Rushton	2001	Bioinfil		-17	25		12.3	58.4	25	5.1
377	Rushton	2001	Bioinfil		-15.4	22		12.3	56.99	22	5.3
377	Rushton	2001	Bioinfil		28.8	17		12.3	84.2	17	1.9
553	Semadeni-Davies	2006	Deten					71	73	15	19.2
553	Semadeni-Davies	2006	Deten					174	65	5	60.9
555	Stanley, D W	1996	Deten					127	72	8	35.6
557	Terzakis, S	2008	Wetland	3	49	41	1.5	199	89	41	21.9
562	Wilson, M A	2009	Filt					200	97	3	6.0
562	Wilson, M A	2009	Filt					200	98	3	4.0
562	Wilson, M A	2009	Filt					200	98	3	4.0
562	Wilson, M A	2009	Filt					200	99	3	2.0
562	Wilson, M A	2009	Filt					200	100	3	0.0
564	Zhou, W F	2003	Filt					399	76.4	1	94.2

Table III-3: Average Peak Flow Reduction and Average Runoff Volume Reduction for Green Infrastructure Sites (with Data Cross-Listed with Reference Article Numbers in Tables III-1 & 2)

Article Number	First Author	Year	Green Infra. Practice	Average Peak Flow Percent Reduction	Peak Flow Storm Events	Volume Runoff Percent Reduction	Volume Runoff Storm Events
510	Jayasuriya, L N N	2007	Pave	52	1		
541	Muthanna, T M	2007	Infil	13	3	13	3
541	Muthanna, T M	2007	Infil	26	3	25	3
425	Birch	2004	Wetland	13.84	6		
527	Line, D E	2008	Wetland	72	11	27	11
279	Hathaway	2009	Roof	88	11	64	11
527	Line, D E	2008	Wetland	77	12	9	12
526	Line, D E	2009	Infil	63.2	13	-9	13
177	Bliss	2009	Roof	30.46	13	29.38	13
526	Line, D E	2009	Infil	-4	14	49	14
437	Hunt	2008	Infil	96.5	16		
119	Carter	2006	Roof	55.6	31	77.2	31
264	Collins	2008	Pave	60.3	34	99.5	40
264	Collins	2008	Pave	77.1	36	98.2	40
264	Collins	2008	Pave	73.5	36	99.3	41
264	Collins	2008	Pave	67.1	36	99.9	40
279	Hathaway	2009	Roof	77	39	64	39
473	Davis, A P	2008	Infil	44	41		
473	Davis, A P	2008	Infil	63	41		
445	Stotz	1994	Pave			4.47	8
31	Pratt, CJ	1995	Pave			34	56
186	Duchemin	2009	Buf			34.7	19
31	Pratt, CJ	1995	Pave			37	42
379	Tapia-Silva	2006	Roof			39	45
186	Duchemin	2009	Buf			40	19
379	Tapia-Silva	2006	Roof			42	45
31	Pratt, CJ	1995	Pave			45	59
31	Pratt, CJ	1995	Pave			47	59
116	VanWoert	2005	Roof			50.4	162
59	Andersen	1999	Pave			55	30
116	VanWoert	2005	Roof			60.6	162
124	Gilbert	2006	Pave			72	52
152	Getter	2007	Roof			80.2	62
144	Bean	2007	Pave			90.06	48
122	Dreelin	2006	Pave			93	9
428	Dietz	2006	Infil			95.4	104
428	Dietz	2006	Infil			95.4	104
124	Gilbert	2006	Pave			98	52

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ILLNOIS DEPARTMENT OF NATURAL RESOURCES (IDNR) ADDENDUM ON GREEN INFRASTRUCTURE (draft as of 5/27/10)

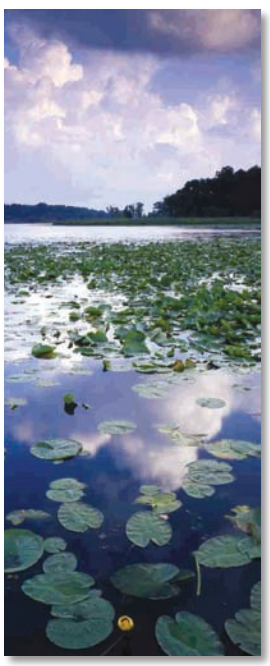
INTRODUCTION

The IDNR submitted comments on the IEPA's initial draft of the Green Infrastructure Plan. The intent of those comments was to recognize the limits the legislative language placed on the IEPA effort and subsequently request the Agency allow the IDNR to present an expanded application of green infrastructure via this addendum. Despite the IDNR advocating an expanding application of green infrastructure, the IDNR recognizes the IEPA's storm water green infrastructure initiative as a commendable and critical first step.

The green infrastructure concept is a rapidly evolving field; hence, a thorough expanded application is inherently difficult and could be quite voluminous, extending beyond an addendum format. Within this addendum, the IDNR seeks to succinctly answer four basic but important questions about the scope of green infrastructure. Those questions are addressed next.

I. Why does a broader definition of green infrastructure need to be considered?

Green infrastructure, and the ecological services provided by green infrastructure, goes beyond merely storm water benefits. This point is illustrated by Benedict's & McMahon's definition:



"Green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. In our view, green infrastructure is the ecological framework needed for environmental, social and economic sustainability—in short it is our nation's natural life sustaining system. Green infrastructure differs from conventional approaches to open space planning because it looks at conservation values and actions in concert with land development, growth management and built infrastructure planning." (Green Infrastructure: Smart Conservation for the 21st Century. Benedict, Mark and Edward McMahon. Sprawl Watch Clearinghouse Monograph Series (2001))

Nature has always served society well and is the foundation for our economic and social systems. Nature, through functions and services, furnishes a multitude of essential primary goods; our foods, fuels, materials for shelter, compounds to enhance our health and a sense of perspective important for our well being. Typically, we have only recognized these ecosystem services when the goods produced by these systems are manifested or become familiar parts of the economy. Arguably, decision making has either routinely ignored (unless when significantly obviously disrupted) or significantly misunderstood the importance 'of the whole' of ecological services. Strong scientific evidence supports the conclusion that these ecological services are essential to human civilization and humans are frequently disrupting and impairing ecological services which function best as an interconnected network. ("Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems"Daily, Gretchen C., Susan Alexander, Paul R. Ehrlich, Larry Goulder, Jane Lubchenco, Pamela A. Matson, Harold A. Mooney, Sandra Postel, Stephen H. Schneider, David Tilman, George M. Woodwell. *Issues in Ecology*. Ecological Society of America. Washington, DC 20036)

Thus, this narrow focus, this traditional mindset and the manifested efforts to improve the quality of life of our communities by considering only investments in the physical, built infrastructure, is shortsighted and wasteful. This approach has had detrimental effects not only on the environment, but on the very issues the investments were designed to help improve – the characteristics that define a high quality of life. Society has consistently undervalued ecological services whereby a broader understanding or accounting of these services could lead to better decision making. Achieving more sustainable decisions necessitates a departure from the traditional approach to decision making to take into account the appropriate valuation of the ecological services provided by green infrastructure. ("Technologies for Envisioning Sustainable Urban Futures " Deal, Brian, Meghna Dutta, and Tom Heavisides. The Journal of the Architectural Research Centers Consortium – (in press))

II. What are useful examples of green infrastructure?

Before providing useful examples (discussed in C), two key points need to be briefly considered. One (discussed in A) is given the complexity and vastness of the environment, what would an overall architecture for a comprehensive vision of green infrastructure look like. The second point (discussed in B) is, how to account within this vast architecture, for the fact that social/economic decisions and environmental processes are scale dependant, i.e. when/how to coordinate, local, regional, national decisions.

A. GREEN INFRASTRUCTURE ARCHITECTURE:

In order to advance a better accounting and consideration of ecosystem services in decision-making, the figure below presents an initial attempt towards a more organized method to categorize and understand ecosystems and their services.

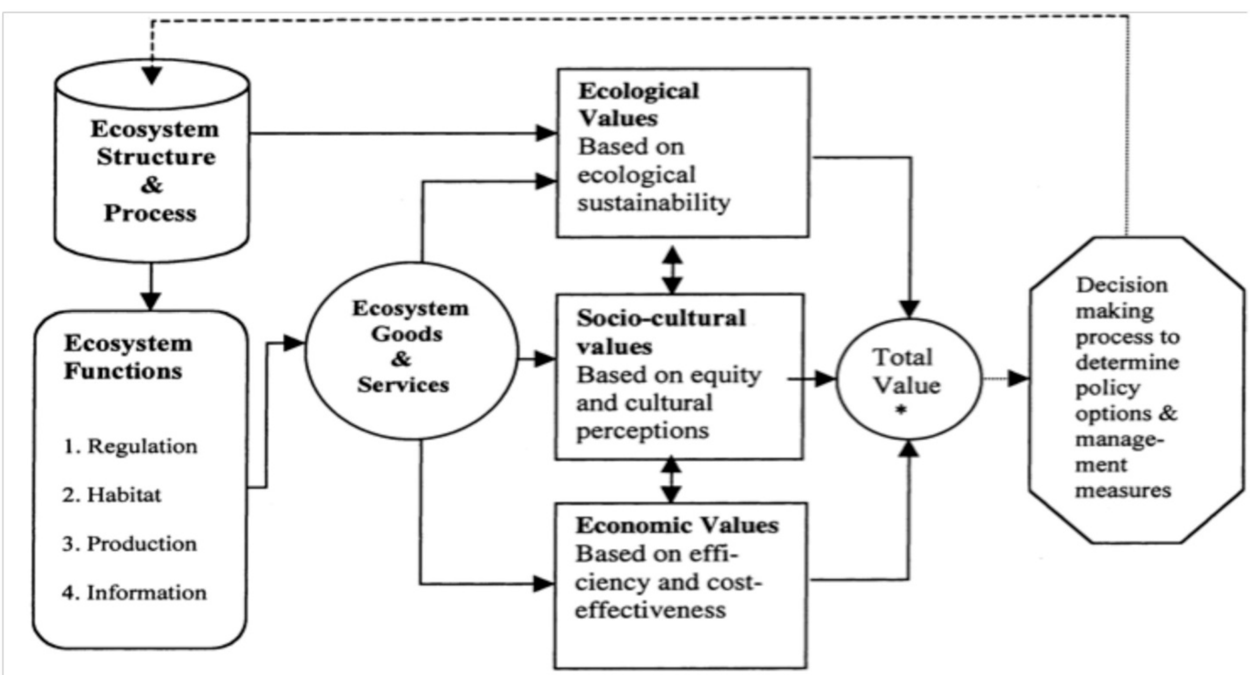


Figure 1. ("A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services".   De Groot, Rudolf, Matthew Wilson, Roelof Boumans. Journal of Ecological Economics. (vol 41 2002 p 393-408))

The reference translated a wide range of ecosystem functions into four primary categories useful for better accounting of these services; (For more, see the reference article which presents 23 examples of sub- functions and corresponding examples of ecosystem services).

1. Regulation function—regulating essential ecological process and life support systems, (climate, water cycle, pollination, photosynthesis);
2. Habitat function- beyond a landscape provision of refuge and reproductive aspects for plants/animals creating a "bank" of biological and genetic diversity/evolutionary processes;
3. Production functions—system providing the carbohydrate structures for the many goods that become suitable for human consumption (also known as provisioning services, food, fresh water, fuel, fiber);
4. Information functions—natural ecosystems provide an essential 'reference function' that contributes to maintenance of human health (also known as cultural services such as education, heritage, as well as recreation and tourism).

B. ISSUE OF SCALE:

Green infrastructure is a complex interrelated system and functions at different scales. Likewise, the State of Illinois is a complex interrelated political system that functions at different geo-political scales, e.g. local, regional, etc. Within this complex dynamic, the State of Illinois continues to encounter unprecedented change. Some parts of the state struggled to accommodate rapidly growing urban areas; other parts struggle with declining populations and loss of businesses. Community organizations and other entities, concerned with the rapid pace of change, are raising a number of important questions: *How can we ensure access to quality education for our children? How can we balance a rapid growth (or decline) in housing with jobs? How can we encourage infill redevelopment? How does the availability of resources (water, for example) affect our community's ability to grow?* In combination the questions seem to coalesce around the fact that a comprehensive effort is needed to help decision-makers across the state — at state, regional, county, and local levels — make better informed planning decisions and deal more effectively with the changes they face. The challenge of scale presented by the current seemingly disjointed, narrowly focused approach would be better addressed by comprehensive green infrastructure planning. USEPA speaks to the issue of scale in the Water Quality Scorecard/Green Infrastructure as such;

> *"Green infrastructure is a comprehensive approach to water quality protection defined by a range of natural and built systems that can occur at the regional, community, and site scales. At the larger regional or watershed scale, green infrastructure is the interconnected network of preserved or restored natural lands and waters that provide essential environmental functions. Large-scale green infrastructure may include habitat corridors and water resource protection. At the community and neighborhood scale, green infrastructure incorporates planning and design approaches such as compact, mixed-use development, parking reductions strategies and urban forestry that reduces impervious surfaces and creates walkable, attractive communities. At the site scale, green infrastructure mimics natural systems by absorbing stormwater back into the ground (infiltration), using trees and other natural vegetation to convert it to water vapor (evapotranspiration), and using rain barrels or cisterns to capture and reuse stormwater. These natural processes manage stormwater runoff in a way that maintains or restores the site's natural hydrology."* (http://www.epa.gov/dced/pdf/2009_1208_wq_scorecard.pdf)

C. EXAMPLES OF APPLICATION OF GREEN INFRASTRUCTURE

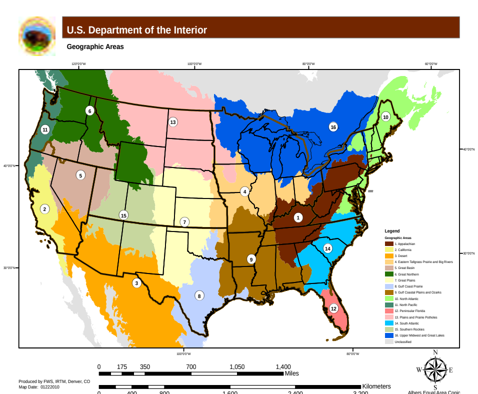
1. Federal Initiatives

"***The Office of Environmental Markets (OEM)*** is a new office created within the U.S. Department of Agriculture to catalyze the development of markets for ecosystem services. OEM has a unique role in the federal government's efforts to develop uniform standards and market infrastructure that will facilitate market-based approaches to agriculture, forest, and rangeland conservation. OEM is bringing experts and stakeholders together with government agencies to build a robust, accessible, and scientifically credible market system that will protect and enhance America's natural capital into the future."
(http://www.fs.fed.us/ecosystemservices/OEM/index.shtml)

US Fish and Wildlife Service Strategic Habitat Conservation **and** ***Landscape Conservation Cooperatives:*** In adopting Strategic habitat conservation (SHC) the Fish and Wildlife Service describes a work plan that will requires them to set biological goals for priority species populations, make strategic work decisions, and allow FWS to constantly reassess and improve actions. They describe their actions as motivated by "landscape-scale resource threats such as development, invasive species, and water scarcity--all magnified by accelerating climate change," as the impetus for their agency direction. The five key principles, which FWS describe as "an ongoing process that changes and evolves", are:

- *Biological Planning (setting targets)*
- *Conservation Design (developing a plan to meet the goals)*
- *Conservation Delivery (implementing the plan)*
- *Monitoring and Adaptive Management (measuring success and improving results)*
- *Research (increasing our understanding)*

To help implement SHC, the FWS and USGS have developed a national geographic framework for implementing strategic habitat conservation at landscape scales called ***Landscape Conservation Cooperatives.*** Within this framework the Service will be working with "partners to connect project- and site-specific efforts to larger biological goals and outcomes across the continent." This framework will be used as a base geography to locate the first generation of Landscape Conservation Cooperatives (LCCs) and in planning a second generation of LCCs during the FY 2011 budget formulation process.



"Landscape Conservation Cooperatives are management-science partnerships that inform integrated resource management actions addressing climate change and other stressors within and across landscapes. They will link science and conservation delivery. LCCs are true cooperatives, formed and directed by land, water, wildlife and cultural resource managers and interested public and private organizations. Strategic habitat conservation is designed to meet 21st Century conservation challenges by ensuring that we accomplish the right things, in the right places, at the right times based on sound science."

2. State/Regional examples:

Maryland Green infrastructure Assessment –

Maryland has two million acres of ecologically significant land remaining that has not been consumed by some kind of human development. Of these two million acres of green infrastructure, nearly 70% are unprotected. Through *Green Infrastructure Planning* "Maryland can ensure cleaner air and water for its citizens, safeguard habitat needed to spare native animals and plants from extinction, and preserve outdoor recreational opportunities that a large and increasing number of people enjoy."

Maryland mapped their green infrastructure using satellite imagery, road and stream locations, biological data, and other information then brought together scientists, local government officials, and conservation groups to ground-truth the information. They identified the state's most important natural lands as those that are large and intact enough to provide a full range of environmental functions and identified these as "hubs" – "un-fragmented areas hundreds or thousands of acres in size, and are vital to maintaining the state's ecological health which " provide habitat for native plants and animals, protect water quality and soils, regulate climate, and perform other critical functions."

Their second step was to connect these identified hubs with "corridors" - "linear remnants of natural land such as stream valleys and mountain ridges that allow animals, seeds, and pollen to move from one area to another." The State cited the need to establish and reserve linkages between these hubs to "ensure the long-term survival and continued diversity of Maryland's plants, wildlife, and environment.

"In 2003, Governor Ehrlich helped institutionalize the Green Infrastructure into State Land Conservation Planning by expanding the criteria used to evaluate the State's land preservation purchases to include a comprehensive set of ecological indicators. Through this initiative, State land conservation programs such as Rural Legacy and Program Open Space will prioritize their conservation activities on areas identified as Green Infrastructure." (http://www.dnr.state.md.us/greenways/gi/gi.html)

New Jersey (green infrastructure) Valuation Study –

The state of New Jersey, working with the Trust for Public Lands developed a valuation analysis of New Jersey's green infrastructure. "New Jersey is blessed with a wealth of breathtaking and highly valuable natural resources. Our beaches, forests, wetlands and other natural resources provide countless benefits to the public. In order to make wise policy, planning, and regulatory decisions, it is important to understand the worth of these resources. This report summarizes the results of a two-year study that aims to quantify the value of these resources. As a way of expressing the value, it estimates the dollar value of the services and goods produced by New Jersey's natural capital. Natural capital consists of components of the natural environment that provide long-term benefits to society. Many of the benefits provided by natural capital come from ecological systems or ecosystems, a dynamic complex of plant, animal, and microorganism communities and their nonliving environment, all interacting as a functional unit."
(http://www.state.nj.us/dep/dsr/naturalcap/)

Chicago Wilderness Green Infrastructure Vision -

In 2004, members of Chicago Wilderness came together to begin the framework for a Green Infrastructure Vision (GIV). The GIV map produced from that effort identifies 1.8 million acres for prospective protection, restoration, and thoughtful land development practices in the Chicago Wilderness region - spanning from southeast Wisconsin, through northeast Illinois into northwest Indiana and southwest Michigan. The Vision calls for the us to carefully think about how we can live in and among natural areas in a sustainable way and to mutual benefit, by using tools such as conservation development, conservation easements, and thoughtful land use planning. The 140 Resource Protection Areas mapped by the GIV serve as opportunities to focus land acquisition, expand restoration on private land, and promote greenway connections, conservation easements, conservation design practices, agricultural preservation, protection of sensitive groundwater recharge areas, implementation of wastewater reclamation alternatives, and protection of stream and wetland buffers.

Kansas City – MetroGreen -

"The MetroGreen Action Plan provides a greenprint for a metropolitan trails system that connects urban and rural green corridors throughout seven counties in the Kansas City region. The plan is also designed to protect and improve water quality in the region for the next 100 years, conserving and enhancing the region's existing natural elements. Above all, MetroGreen exists to ensure that area residents continue to enjoy a high quality of life. MetroGreen will preserve and protect stream corridors in the seven-county Kansas City area by helping to use floodplain lands to absorb floodwaters, thus reducing economic loss. The clean water component of MetroGreen will to support the biological diversity of streams, rivers and lakes through:

- Specifying waterways to be used for recreational purposes
- Offering watershed strategies for flood control and for protecting natural stream corridors
- Recommending local adoption of streamside buffer zones
- Restoring native habitat for indigenous plants and animals"

(http://www.marc.org/metrogreen/)

3. Local /County /Municipal scale:

McHenry County Conservation Design Ordinance "LAND FIRST" -

Under a campaign called "Land First" McHenry County IL recently adopted a countywide conservation design ordinance with a stated purpose to **"**preserve and enhance the community character and natural resources of the County while providing for a high quality of life for the residents of McHenry County now and for future generations." They cite among their reasons the need to protect groundwater resources, streams and natural areas, quality of life and a healthy, sustainable economy. This neighborhood-scale Green Infrastructure practice calls for an initial site analysis to determine highest priority for preservation and restoration and when completed will identify the least environmentally sensitive areas that are most suitable for development. Resources that must be included in the Natural Resource Inventory are: topography, water bodies, wetlands, floodplain, field tiles, designated natural areas, threatened and endangered species, vegetation communities, tree inventory, soil suitability, groundwater recharge potential, farmland, and historical sites. (Under "Ordinances" at: http://www.co.mchenry.il.us/departments/planninganddevelopment/Pages/index.aspx)

Other Efforts –

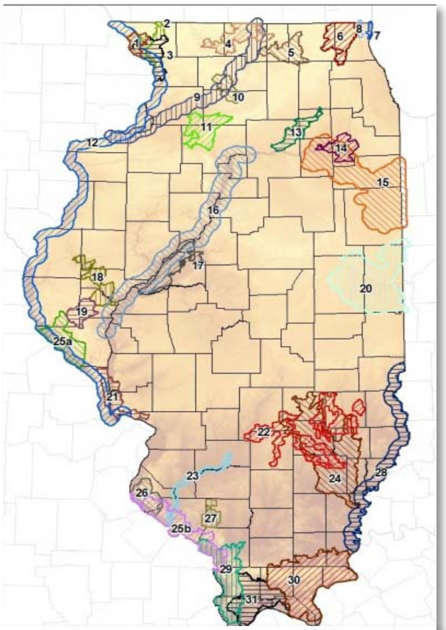
There are numerous examples of green infrastructure, at various scales, that were not identified or described at length within this addendum. These practices range from landscape linkages, habitat restoration, stream buffers, to plantings for carbon sequestration. Examples of these efforts throughout the state include: Forest Preserve and Conservation Districts in northern Illinois, through successful passage of more than $1.3 Billion in Open Space referenda, have been seriously engaged in acquisition and restoration of natural areas. Their strategies include "landscape-scale conservation", " core and hub linkages" and stream buffering and protection such as Lake County Forest Preserve District has assembled along the Des Plaines River corridor. Other efforts include: Peoria Ravine Overland protection; coordinated trail efforts in the Metro East; and multiple partners' efforts to restore the Cache River in southern Illinois.

III. What DNR programs policies and/or authorities are relevant to green infrastructure? **(see http://www.dnr.state.il.us/ for Section III)**

The Department of Natural Resource has a variety of programs, policies and authorities related to natural resources functions and ecological services. Below are examples of some of the significant programs; however no attempt has been made to neither capture all efforts, nor at this time present an integrated application of the green infrastructure concept.

A. WILDLIFE ACTION PLAN (ILWAP)

In the early 2000's, Congress asked each state to develop a wildlife action plan, known technically as a comprehensive wildlife conservation strategy. These proactive plans examine the health of wildlife and prescribe actions to conserve wildlife and vital habitat before they become rarer and more costly to protect. Illinois Plan, adopted in 2005, delineated seven "campaigns" designed to achieve the Plan's goals - the Farmland & Prairie, Forest, Wetlands, Streams, Invasive Species, Land and Water Stewardship and the Green Cities.



Conservation Opportunity Areas (COA) identified in IL Wildlife Action Plan

For all "campaigns," the Plan lists the following challenges to achieving the stated goals:

1. *Increase the percentage of Illinois' lands which are not plowed, paved, drained, or landscaped.*
2. *Increase the quality of Illinois' natural lands as measured by their ability to support robust (abundance and richness) communities of native plants and animals.*
3. *Improve the capacities of Illinois' agricultural and urban lands to support populations of native fish and wildlife. Increase access to Illinois' lands and waters for outdoor recreation purposes.*
4. *Meet or exceed recreational and commercial demands upon Illinois' plant and animal populations.*
5. *Restore populations of plant and animal species that have become rare or are declining.*
6. *Eradicate, control, and prevent the introduction of invasive exotic species.*

To achieve these actions ILWAP calls for *"coordination among federal and state agencies and private groups with county and local units of government, citizens and stakeholders to develop strategic plans for smart growth, redevelopment, and infrastructure projects that protect or enhance important habitats, provide adequate green space and green infrastructure (i.e. for flood protection), minimize the need for additional infrastructure and minimize loss of agricultural lands, yet allow for economic development and human population growth"* and the need to *"mitigate loss, degradation and fragmentation of important wildlife habitats lost to development."* (http://dnr.state.il.us/orc/Wildliferesources/theplan/)

B. PRIVATE LANDS INITIATIVES

Private interests own the vast majority of land in the state. IDNR has developed programs often in cooperation with federal agencies to assist landowners with protection and enhancement of ecosystem functions and services. Some examples of those programs include:

1. Conservation Reserve Enhancement Program (CREP)

The Illinois River Conservation Reserve Enhancement Program (CREP) was initiated as a joint federal/state program with the goal of improving water quality and wildlife habitat in the Illinois River basin. Based on numerous research and long-term data, the two main causes of water quality and habitat degradations in and along the Illinois River were known to be related to sedimentation and nutrient loads. Based on this understanding, the two main objectives of the Illinois River CREP were stated as follows:

- Reduce the amount of silt and sediment entering the main stem of the Illinois River by 20 percent.
- Reduce the amount of phosphorous and nitrogen loadings to the Illinois River by 10 percent.

Illinois CREP is a voluntary, incentive-based approach to water quality and habitat issues. CREP utilizes Federal, State, and Local resources to retire frequently flooded and environmentally sensitive cropland through conservation easement and to achieve restoration and long-term protection benefits. The goal is to establish conservation practices to reduce sedimentation and nutrients in the Illinois River while enhancing habitat to increase fish and wildlife populations. The entire Illinois River Basin is targeted with an emphasis on the 100 year floodplain. There has been a significant increase in the implementation of conservation practices in Illinois in recent years with CREP making a major contribution.

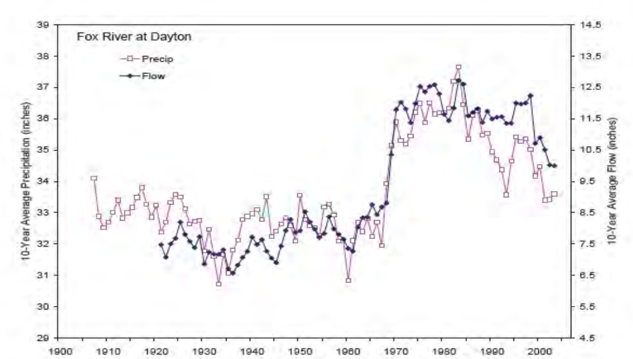


Figure 3-13. Ten-year average precipitation and streamflow, Fox River at Dayton

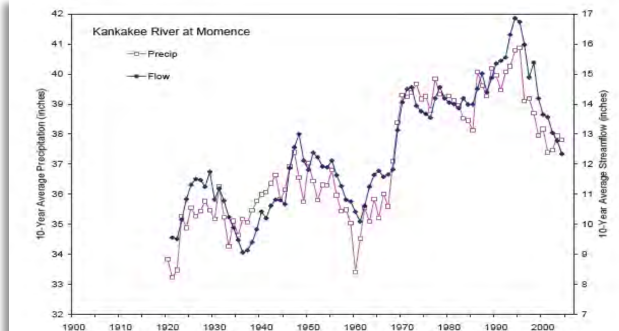
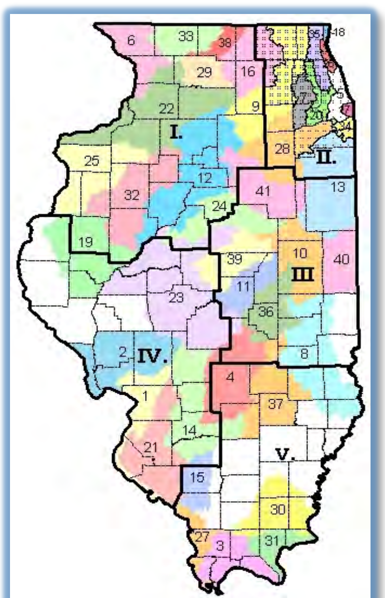


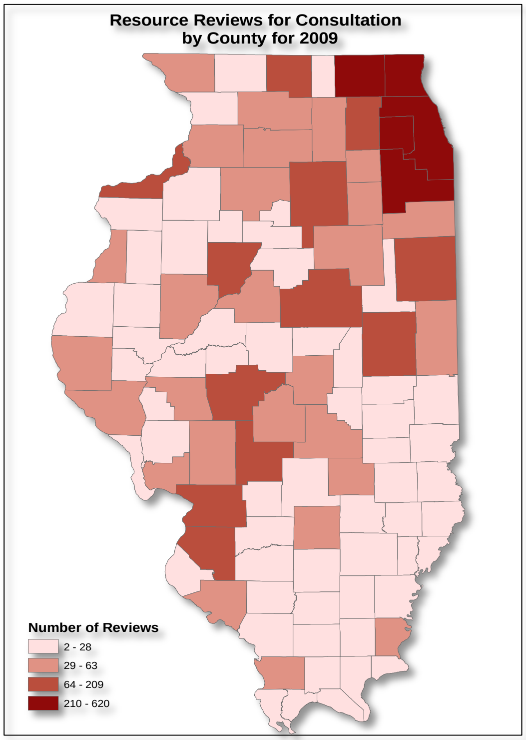
Figure 3-14. Ten-year average precipitation and streamflow, Kankakee River at Momence

Data in trends in precipitation and streams flow vary across the Illinois River watershed. Increasing trends are particularly evident in the Upper Illinois River watershed and its two primary tributaries, the Fox and Kankakee River. The Green infrastructure Study specifically addresses the urban areas, and the Illinois River Watershed is the recipient of much of the increase of stream flow and precipitation from the rapidly expanding urban area located at the top of this watershed. CREP is a both a viable and practical example of how the concept of green infrastructure can be expanded into non-urban areas.

2. *Partners for Conservation (Formerly C2000):*



Conservation 2000 (C2000) was renamed Partners for Conservation and extended until 2021. This multi-agency, multimillion dollar comprehensive program is designed to take a holistic, long-term approach to protecting and managing Illinois' natural resources. The Illinois Department of Natural Resources administers the Ecosystems Program and the Critical Trends Assessment Program (CTAP), a statewide ecosystem assessment and monitoring program. This program is a systematic effort to assess the condition of Illinois' ecosystems (i.e. functions). The Ecosystems Program consists of an extensive network of local volunteers working to leverage technical and financial resources to promote ecosystem based management, i.e. restoration or protection of ecosystems, primarily on private lands. Ecosystem Partnerships are formed to develop plans and projects on a watershed scale with an ecosystem-based approach.

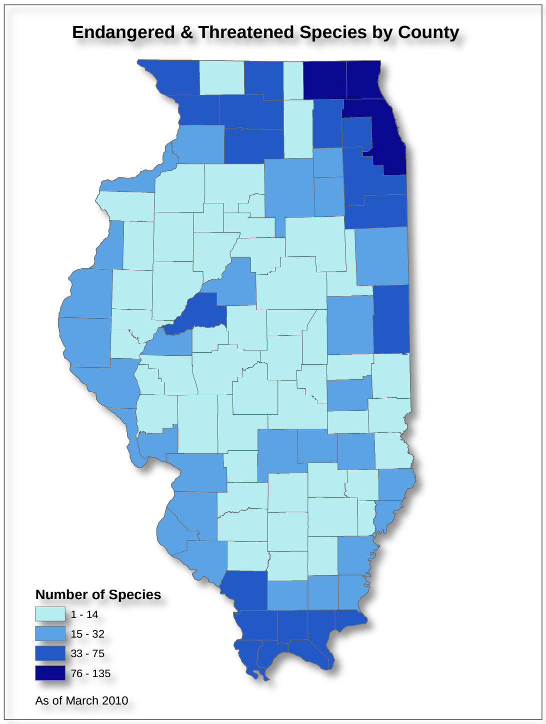


C. RESOURCE REVIEWS, ASSESSMENTS AND RESTORATION

The IDNR has programs established by state and federal laws that attempt to protect existing natural resource functions and their services as well as restore those resources that have been inappropriately impacted. An example of those programs include:

1. Consultation Process

State agencies and units of local government are required by law to consult with the Department about proposed actions that they will authorize, fund or perform *in order to see whether those actions will adversely impact protected natural resources such as threatened/endangered species and natural areas (i.e., Illinois Natural Area Inventory Sites or Nature Preserves).* Private parties do not have to consult, but they are liable for prohibited taking of state-listed plants or animals or for adversely modifying a Nature Preserve or a Land & Water Reserve. Based on the nature of the proposed action and the nature and location(s) of the protected resource(s), IDNR staff will assess the character of the potential adverse impacts and whether an adverse impact to the resource is likely. *Staff then recommends measures that will avoid or minimize potential impacts to resources in the vicinity of the development project. There appears to be a direct correlation between increased Green Infrastructure measures during and after construction and decreased adverse impacts to area resources.* For listed species, the assessment is based on the life requirements of the species. The assessment for Natural Areas and Nature Preserves is much broader, based on potential impacts to natural communities and the unique features of the Site or Preserve.



The review addresses the following policies and legislation:
Illinois Endangered Species Protection Act
[520 ILCS 10/11(b)]
Illinois Natural Areas Preservation Act
[525 ILCS 30/17] as set forth in procedures under *Title 17 Ill. Admin. Code Part 1075*.
Interagency Wetland Policy Act of 1989
[20 ILCS 830] as set forth in procedures under *Title 17 Ill. Admin. Code Part 1090* must be met.

2. Natural Resource Damages Assessment and Restoration

Environmental contamination affecting Illinois land and water often results in the loss of valuable natural resources such as clean water, wildlife habitat, natural areas, and the services natural resources provide for Illinois residents, wildlife, and visitors. Federal law requires the designation of federal and state officials to act as trustees to protect public interest in natural resources and the services they provide. The Director's of the IDNR and IEPA are designated as a natural resource co-trustees and have the regulatory authority to assess damages to natural resources and to undertake restoration of those injured natural resources and/or associated service losses. The restoration efforts typically focus on those ecological services that were lost or injured and are targeted in the region of impact.

D. PRESERVATION, CONSERVATION, ACQUISITION AND/OR RECREATION RELATED ECOLOGICAL PROGRAMS

One of the IDNR's primary missions is to enhance natural resources for variety of uses. Examples below demonstrate relevant programs / policies and potentially highlight the importance of comprehensive consideration of green infrastructure.

- **Conservation of Natural Resources:** Conservation of the state's significant natural resources, through acquisition, development, enhancement, management, and stewardship, continues to be the single-most important action to ensure a legacy of quality outdoor recreation opportunities for future generations of Illinoisans. This also includes protection and enhancement of high quality areas, such as the Illinois Natural Areas Inventory, and protection of threatened or endangered species.
- **State Parks:** Illinois state parks, national forests and wildlife refuges, and federal reservoirs are important destinations for citizens, offering nature discovery, direct recreation opportunity, and relaxation.

- **Greenways and Trails:** Greenways – linear ribbons of open space are effective means of preserving green spaces in urban and suburban areas especially as development occurs at the urban fringe. Greenways protect green corridors that provide and connect open space and often protect waterways and provide and connect wildlife habitat. Trails are linear recreation facilities that serve various purposes, including alternative transportation within and between communities. Trails: provide long-distance trails in new locations and connect and improve existing trails.
- **Acquisition:** responsible for acquiring all real estate used by the Department for parks, recreation areas, bikeways, natural areas, wildlife habitat, waterfowl, greenways and open space programs. Also complimenting acquisition is the related activities, such as outdoor recreation planning, program administration and project planning/coordination, for the above applications.

- **Open Space:** Program focuses on basic, close-to home outdoor recreation, including land for parks and outdoor recreation facilities such as ball fields and playgrounds. It provides funding for new and existing outdoor recreational projects including the renovation of existing outdoor recreation facilities.

- **Water Resources:** Rivers, streams, and lakes are important for many popular outdoor activities. Conservation and protection of water resources is necessary to maintain and expand water-based recreation. Further, the state acquires lands and develops facilities that expand and improve public recreational access to the state's rivers, streams, and lakes.
- **Fishing –** Illinois' water resources provide the basis for recreational opportunities associated with fishing.

- **Hunting –** Illinois' landscape provides Illinois hunters the opportunities to pursue white-tailed deer, turkey, small game, migratory waterfowl, doves and more through various coordinated state programs that provide economic benefits to the state.

- **Nature Preserves & Land and Water Reserves–**The Illinois Nature Preserves Commission assists private and public landowners in protecting high quality natural areas and habitats of endangered and threatened species in perpetuity, through voluntary dedication or registration of such lands into the Illinois Nature Preserves System. These sites range in size from 1 acre to over 2,000 acres and protect tall grass prairies, oak groves, sandstone bluffs, wetlands, forests, fens and bogs and more than 20% of all Illinois endangered species are in state dedicated nature preserves.

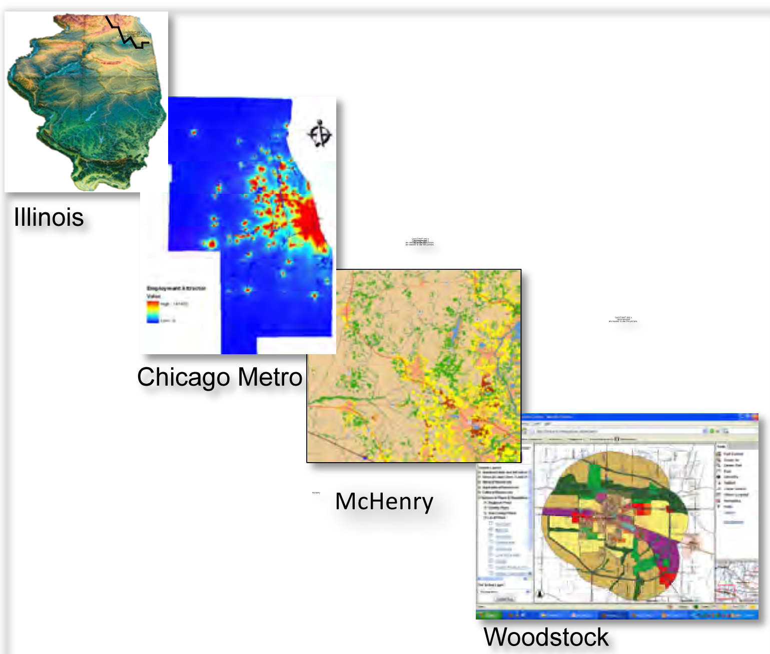
- **Illinois Natural Areas Inventory Sites -** completed in 1978, designates the state's most rare nature areas. It serves as a guide for the Illinois Nature Preserves Commission when determining the eligibility of lands for protection. Currently there are only 654 high-quality, undisturbed natural communities in the state. Approximately half of these areas are unprotected. The INAI is undergoing a comprehensive update to identify new high quality sites and existing sites are being re-evaluated. The update will include a Sustainable Natural Areas Plan with green infrastructure playing a role.

IV. How can a more comprehensive application of Green infrastructure be organized (including stakeholders) to better improve resource management decisions?

The addendum serves to provide sufficient evidence that a variety of national, state, regional and local interests recognize and have developed viable applications of 'Green Infrastructure' as a comprehensive concept. Towards that end, the IDNR would support a more formal organized effort in regards to: 1) complementing IEPA's storm-water/GI initiative and; 2) work with other public agencies and private interests to enhance a comprehensive Green Infrastructure initiative. The primary elements that need further development include:

- How to provide technical assistance
- How to increase and better direct funding
- How to advance ecological service valuation methods and applications
- Can state agencies better serve/ coordinate among various jurisdictions, by providing information and a technological framework via multi-jurisdictional planning structure *(See illustration below)*

MULTI-JURIDICTIONAL GREEN INFRASTRUCTURE PLANNING FRAMEWORK



- State agencies can identify possible conflicts with broad agency plans and comprehensively assess 'best management practices.'
- Regional agencies can foster regional thinking by demonstrating how actions in one part of the region can have effects in another part or at another time in the future.
- County planning organizations can look at regionally based plans and activities to identify potential conflicts and opportunities. They can also provide more relevant data sets for local planning within their jurisdictional boarders.
- Local planning entities can make more informed decisions based on the long-term implications of plans and actions.

GI Study Comments
Received as of 6/24/10

Submitted by	Organization	Pages	
Wills	Wills Burke Kelsey Associates, Ltd.	3	omitted in original release
Bannerman	Wisconsin DNR	1	
Knudsen	Village of Carol Stream	1	
Nowack	Quigg Engineering	2	
Murdock	Michael Baker Jr., Inc.	2	
Kacvinsky	Foth Infrastructure & Environment, LLC	2	
Glosser	Environmental Planning Solutions	2	
Eaton	TriCounty Regional Planning Commission	1	
Kane	MWRDofGC	3	
James	Prairie Rivers Network	2	
Meyers-Glen	Openlands	3	
Kircher	Forest Preserve District of Cook County	1	plus attachment
Novotney	Baxter & Woodman, Inc.	10	
Sheriff	MWRDofGC	10	
Swanson	DuPage County Stormwater Management	3	
Scharenbroch	The Morton Arboretum	2	
McCracken	DuPage River Salt Creek Workgroup	4	
Makra	The Morton Arboretum	4	
Cline	The Conservation Foundation	1	
Ludwig	Robinson Engineering	3	
Sullivan	Illinois Association of REALTORS	2	
Wickenkamp	Illinois Association for Floodplain and Stormwater Management	2	
Sulski	Illinois EPA	2	
		66	

From: John Wills [mailto:JWills@wbkengineering.com]
Sent: Thursday, June 10, 2010 10:29 AM
To: Tadla, Sarah
Cc: Walkenbach, Amy; Marcy Knysz; cburke@cbbel.com; Paul Sedory
Subject: RE: Green Infrastructure for Clean Water Act Draft Final Report

Sarah,
Please accept the following as written comments on the draft report.

1. I do not see how the recommendation for the State to administer a "volume Standard" would be implemented, or the real value of trying to administer it at the State level. Would this be in the form of a permit? Later in the report it recommends working through Counties and Municipalities, who already review projects individually. Why not allow at least those counties with the authority to do so to adopt their own volumetric standard and enforce it within the framework of existing permitting rather than adding yet another layer of permitting in stormwater management? Numerical Volume reduction standards are becoming more mainstream, but setting a statewide numerical standards is certainly not the norm nationally. The report recognizes that a "one-size-fits-all" approach wont work, so what is the justification for a statewide volume standard? Why not leave this to local jurisdictions whose grasp of local conditions will be much better than a centralized authorities will be?
2. We have previously commented that any abstraction from the State Revolving Loan fund will result in an increase in pollution from basic wastewater treatment services. As it is now, the backlog of conventional projects is overwhelming, and just meeting any increase in standards is beyond the means of many communities. If "green Infrastructure" is to be funded, it needs to be in addition to funding the backlog of conventional projects on the books.
3. Figures ES-1 (A-C) would benefit by noting what the range of storms was in calculating the % removal. If this is on an annual basis, the figures need to note this. For instance it is very unlikely that the peak rate from a very extreme event (100-year) would be reduced by 50% by infiltration alone. It is not clear to me that all storms monitored can be considered a population for application of the basic statistics used. What is the meaning of a "mean" of responses for storms that may vary from say 1" to 5"? Historically and in practice the general public will attempt to apply your % reduction in non-appropriate ways, like assuming that a rain garden is effective in protecting a home from flooding in a 100-year rainfall event.
4. Since Table ES-2 quotes real dollars, I expected that the report would contain at least a comment that says the "Green Values Calculator" was reviewed and found to be an appropriate indicator of costs in Illinois.
5. I question the assumption that infiltration in a dense Urban development can have any real groundwater recharge benefit. My experience is that virtually all developed cites are so crisscrossed with utility trenches of all sorts that what is counted as infiltration is really just "runoff conveyed by alternative stormsewer systems". Certainly no real "drinking water level" recharge of aquifers is occurring below cityscape regardless of how many green practices are applied. The real cost effective or green infrastructure in an urban landscape is the reduction of flow to combined sewers, which there is no question green infrastructure is effective at.
6. Is the "portfolio Standard" the only recommendation that this study could come up with? There seems to be almost no discussion of any other approach, including ones considered and discarded.
7. There has been a wealth of green Infrastructure "how-to" books and manuals published over the last few years. Before a lot of resources are spent developing yet another manual, the body

of existing guidance material should be reviewed with a bias towards selecting and promoting what has already been developed (the revised Illinois Urban Manual would be a good place to start).

8. How realistic is it to rely on a Federal funds for any part of this initiative or to defray the cost of a mandate? How much federal funding and for how long should we be counting on?
9. Restrictive covenants in and of themselves do not ensure maintenance. Who will be the "covenant police", and how will that process of inspection and enforcement be administered and funded? Unless the fee-funding recommendations are also implemented, this may not be feasible to implement at a municipal level without the added funding. The state of stormwater infrastructure now is that it is "orphaned". It is required to be built but noone wants to own or maintain it afterward.
10. How does one keep from using the discussion around Figure 1 to come to the conclusion that what we call low density development (say 2-acre residential lots) is much more environmentally friendly?
11. There are many published studies which conclude that the highest quality streams in Illinois exist in a mostly agricultural setting. Just scan the list of streams in Illinois. As well, the metric of watershed level % impervious also points to the rural and agricultural setting as a good stewarding land-use in Illinois. On that basis, Illinois agricultural interests routinely thwart any attempt at regulation for water quality purposes. The discussion in the study on "Effectiveness" does not seem to acknowledge this.
12. With the studies avowed intent to use only rigorously peer reviewed studies, do the authors feel the CNT 2009 citation on page 26 meets this standard?
13. Why so little discussion in the "Effectiveness" section on the effect of varying magnitude of storm event? It is evident that a volume reduction measure designed for a .5-inch rainfall will not be as effective in a 5-inch rain. As well, if one is talking about the runoff volume reduction at different sites, the variation in soils and land cover and topography between sites is extremely important. The lack of discussion of the range of magnitudes of events monitored and variation in these basic hydrological parameters as reported in the selected studies really reduces the impact of this discussion.
14. The conclusions on page 35 and 36 include several statements unsupported by the section of the report they are found in, particularly that green infrastructure is "more cost effective". The obvious question is cost effective for what purpose? Reducing overbank flood damages? The vast majority of discreet storm events in a year are of a magnitude of less than one inch. The vast majority of flood damages in a year are in rainfall events much greater than that. Green infrastructure is extremely effective in frequent events of small magnitude and very effective in reducing volume on an average annual basis, but not in extreme events where overbank flooding occurs. It is effective in combined sewer areas becase these occur in older and already densely urban centers comparatively, so any abstraction from runoff volume comes right out of the treatment stream. More cost effective than what? The report provides little context to asses this statement, as the "conventional design" components that the green infrastructure replaces are never fully discussed, and the lack of storm magnitude discussion makes all statements with regard to "flooding" hard to place in context.
15. The section on "cost effectiveness" does not seem to have much input to it outside of the material developed by CNT. Does this section meet the same "rigorous peer review" standard claimed in the previous report section? There is very little real discussion of designs for the three examples chosen. For instance a claim is made that green infrastructure could replace the detention basin—What volume is being designed for detention? McHenry county soils are highly permeable in many places, and are certainly not typical of the 8-county area. Without

those types of “hard-number” comparisons, the chance of misuse of the claims in this report is higher.

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Mediating the Built and Natural Environments

4. Notes from Interview with State Contact: Roger Bannerman

- Program resources: 1 Engineer in each of 5 regions in Wisconsin; 2 people at the main office; under the program developers need quite a bit of assistance from the state staff, which means human resources. Performance standards:
  - The 90% infiltration rate is not unreasonable for a residential subdivision, and 80% for TSS is within current capabilities
  - 40% TSS in in-fill areas, though not very high, can be expensive in some applications
  - Should look at examples like McHenry County, IL, Dane County, WI; and examples of projects from engineers with experience in the field.
  - If IEPA imposes performance standards, TMDLs may later take over as driving force, due to stresses on fish from dissolved oxygen and chloride
  - Recommends taking an incremental approach to regulations; at the beginning better not to be too aggressive in built-out areas. The Wisconsin performance standards are appropriate, but developers need flexibility. Retro-fit should have lower requirement at first (e.g., lower TSS removal), to make sure it is realistic but that everyone does something. Redevelopment can have a higher standard, and requirements can be strengthened over time.

From: Jim Knudsen [mailto:JKNUDSEN@carolstream.org]
Sent: Monday, June 14, 2010 9:19 AM
To: Walkenbach, Amy
Subject: Illinois Green Infrastructure Study

Amy,

I have reviewed the Study and have the following comments:

1) Many of the initiatives proposed by the Study are already being done in DuPage County and have been for some time. The successes we've had came about by including all stakeholders in the process, including skeptics. I would strongly encourage future implementation efforts to include all stakeholders. Unfortunately that wasn't done with this Study and as such will probably be disregarded by some who the Act is trying to reach. For example, the Study attempts to convince readers that green infrastructure technologies are affordable when compared to conventional technologies yet there wasn't any involvement by other stakeholders in the peer review process. We know that many, but certainly not all, of the green infrastructure technologies are affordable and even more cost effective than conventional technologies. However, by not including other stakeholders the Study doesn't engage them but distances them.
2) In order for this program to be successful a funding mechanism needs to be developed that is equitable and sustainable. The proposed method is to utilize "Earmark funding for green infrastructure projects in state revolving loan funds". This proposal is neither fair nor sustainable. "Earmark funding" is not a simple and transparent method for developing a program and is wrought with problems. Its basis for prioritization is based on the politic will of those in power. Furthermore, using state revolving loan funds for green infrastructure project grants will not be sustainable. The state revolving loan program was set up to be self sustaining which it has, but if grants are to be made for green infrastructure projects the program will no longer be self sustaining. This would have a devastating effect on water and wastewater facilities that heavily rely on these loans. I would suggest the IEPA utilize the millions of dollars they collect in MS4 permit fees to fund this program rather than being used in the general fund where it is not being used for storm water management purposes. This is a far more equitable funding approach. Secondly, I would suggest the IEPA utilize a system similar to the Restorability Index (RI) that is being developed by IEPA through a grant to the DuPage River Salt Creek Workgroup (DRSCW). The RI is an objective means used to evaluate projects based on their ability to improve or restore biological functions to a stream corridor or watershed. A similar index could be developed for green infrastructure projects.

James Knudsen

James Knudsen
Director of Engineering Services
Village of Carol Stream
500 North Gary Avenue
Carol Stream, IL 60188

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Fax: (630) 665- 1064

From: Rich Nowack [mailto:rnowack@quiggengineering.com]
Sent: Monday, June 14, 2010 1:28 PM
To: Walkenbach, Amy
Cc: Sara.Tadlah@Illinois.gov
Subject: IEPA Draft final Report Green Infrastructure

Dear Ms. Walkenbach;
Thank you for the opportunity to provide comments on the IEPA Draft Final Report on Green Infrastructure. Please find below my observations and comments. I have divided comments into General Comments regarding the subject of Green Infrastructure and Specific Comments to the Recommendations contained in the draft report.

<u>General Comments</u>

1. The report indicates there are a number of Illinois communities that are instituting some facets of Green Infrastructure already; mostly in the Chicago area. For a Green Infrastructure Program to be implemented statewide, a state wide educational effort geared toward municipalities, local highway agencies and elected officials will need to be undertaken. For example, the report indicates that local agencies, at the county level, adopt green infrastructure, pass rules and ordinances and performance standards when in fact many municipalities outside the Chicago land area are not familiar with Green Infrastructure benefits, practices, investment, and maintenance requirements even though the ILR40 permit requires the incorporation of green infrastructure components for MS4 permitted communities. The report recommendation under the MS4 permit discussion to better educate MS4 permit holders is the key first step in realizing a Green Infrastructure program for Illinois.
2. MS4 Permit Revisions. The report mentions proposed modifications to the ILR40 MS4 permit in the areas of performance standards to be achieved. Any revision to the MS4 permit should contain language regarding the specific storm event to be captured in order to design the appropriate green bmps. Currently, the only permit mention of the storm event to be included in any storm water program is the 24 hour 25 year event (ILR10). Green infrastructure background material indicates 75% of pollutants can be captured using green infrastructure designed to retain the first 1.0-1.5 inches of a storm event. Consideration should be given to revising the permit to include a storm water event more in line with what the research indicates.

<u>Comments on Report Recommendations</u>

Performance Standards.

Page 15.Line 4.While Infiltration, evapotranspiration and harvesting storm water are effective components of Green Infrastructure, and may already be acceptable practices in certain municipalities in North East Illinois, these practices are not already accepted practices in Illinois as the report indicates. Phasing a Green Infrastructure program in over a certain period of time as the report suggests, would assist the MS4 communities in developing a comfort level with BMPS and programs that, at the end of the time period, could then require the implementation of performance standards.

Page 15. lines 7-9. Would like to see further explanation regarding how one simple performance standard is applicable state wide and how this would lessen the training required. A comprehensive training effort will need to be initiated for all facets of Green Infrastructure, not just to identify performance standards to be met.

Applicability.

Lines 12-18. The report recommends using impervious surface cover as a tool to guide the state's storm water efforts. The report does not discuss the use of pervious pavements in the context of the state and local highway system which are some of the largest land holders and MS4 permit holders in the state. The report provides little explanation or research on the use of pervious pavements for highways with large traffic volumes and heavy truck traffic, associated maintenance issues for the state and local highway systems with pervious pavements, criteria for the use of pervious pavements and costs for these types of pavements. Recommend the report discuss research for pervious pavements for highway systems and the results of that research.

Maintenance.

The report section on Maintenance focuses on methods to ensure green infrastructure is maintained through the use of covenants, land use restrictions, easements, etc. It would be helpful if the report would present a much more fundamental section on the actual maintenance requirements and costs of the Green Infrastructure practices cited in the study. Green infrastructure appears to require more diligence, perhaps a more regimented inspection schedule to ensure practices are functioning, and different inspection parameters than the current grey practices municipal staff are familiar with inspecting; although the report indicates that maintenance may be more of a perceived issue (see page 13, Line 13)as a barrier to implementing green infrastructure. The report should discuss the maintenance practices required to keep the practices functioning, costs, manpower, and equipment requirements so that communities can make an informed decision on what green practices are appropriate for their situation.

Thank you for the opportunity to present comments on the draft final report. Please feel free to contact me with any questions.
Rich Nowack

Green Infrastructure for Clean Water Act Draft Final Report - Comments

Date: June 14, 2010

Comments by:

Bob Murdock, P.E., CFM
Water Resources Department Manager
Michael Baker Jr., Inc.
311 W. Monroe Street, Suite 1350
Chicago, IL 60606

312-575-3946
Rmurdock@mbakercorp.com

1. Figure ES-1 (C): The histogram for peak flow reduction is misleading, in that it shows reductions in peak flows from 45 to nearly 70 percent for the different green infrastructure practices. While this may be true for small frequent events occurring multiple times during the course of a year, green infrastructure will typically not significantly reduce peak flows from larger events (e.g. 2-yr, 5-yr, etc.). Care should be taken to avoid conveying the misperception that peak flows are reduced by these amounts for all rainfall events, since many stakeholders will not understand the distinction between these two levels (everyday versus flood producing).
2. The presentation of costs of Green Infrastructure as given in Table 3 is presented on the basis of unit costs per square foot and per cubic foot of runoff intercepted. The definition of "intercepted" should be explained. Is this total runoff received by the green infrastructure and ultimately leaving it, or only that part which is kept on site?
3. Further analyzing costs of Green Infrastructure starting on page 39, the costs of systems using gray infrastructure and traditional detention basins should be compared to costs for the use of green infrastructure to meet the same permit requirements. This would be of interest to the development community. In addition, the development community, as well as many public agencies, are under the impression that it is much more expensive to provide long-term maintenance to green infrastructure, when compared to grey infrastructure. This comparison should be done based on a unit that these stakeholders can relate to, such as cost per area of development served or cost per acre of impervious area served.
4. The use of a Green Infrastructure Portfolio approach outlined on page 91 of the report, with site retention credits and the need to monitor percentages of impervious area served by green infrastructure, may add unnecessary complexity and obstacles towards achieving use of green infrastructure in IL. Our suggestion is to establish a state-wide runoff volume reduction measure, such as the one-inch suggested in various parts of the report. As the report indicates, there is no evidence of any existing GIPS programs. It will be sufficiently difficult to establish runoff reduction requirements at a state level, without

adding the complex requirement of GIPS and all the new tracking requirements it will bring.

5. Currently there is very little knowledge in IL in the public sector concerning the Green Project Reserve described on line 7 of page 18. After the sentence “This system should be designed to encourage applications for a wide variety of green infrastructure projects all over the state.”, add “Training and outreach should be provided to help public entities concerned with storm and wastewater to understand how to develop acceptable projects and apply for such grants”.

From: Kacvinsky, Greg [mailto:Greg.Kacvinsky@Foth.com]
Sent: Monday, June 14, 2010 3:53 PM
To: Walkenbach, Amy
Subject: Comments on the Illinois Green Infrastructure Study

Amy,

I am a consulting engineer in Champaign, Illinois (Foth Infrastructure & Environment) and specialize in water resources planning and design. I have reviewed the referenced report and have the following comments:

1. Under the recommended ***Performance Standards***, the reference to controlling ("retaining") the first 0.5 to 1.0 inch of runoff should be reworded to state that "The first 0.5 to 1.0 inch of rainfall depth over impervious surfaces should be retained on site with zero resultant runoff." This helps to clarify the key goal, which isn't very clear in the existing language.
2. Under the recommended *Administration*, there is emphasis placed on County rule-making, management, and revenue generation. Although this may be appropriate in the Chicago area, most downstate counties do not have the organizational structure to take on this responsibility. Similarly, Soil and Water Conservation Districts and Drainage Districts are not equipped to handle the administrative and technical requirements necessary to lead stormwater management at the County level. Outside of the Chicago Metro area, the administration of stormwater programs should be done at the ***municipal*** level, where exists the majority of administrative and technical human resources.
3. Under the recommended *Applicability*, there is reference to phasing in the proposed rules, with no specific timeframe. These recommendations should include a timeframe. It is realistic to assume that communities should be able to "ramp up" their rules and enforcement within a 5-year period (similar to what the IEPA required with the 2003-2008 MS4 permit cycle). Also, instead of using a percent impervious measure to determine which areas should be subject to the new rules, the rules should apply to any urban area (regardless of population or density). This helps to simplify the process.
4. Under the recommended *Funding Green Infrastructure*, the SRF funding (20%) should also cover Stormwater Utility planning and implementation projects. This will help to increase the percentage of communities with dedicated funding sources for stormwater management.
5. There is no reference to pending US EPA rule changes, which may negate (or redirect) the efforts in Illinois to develop new standards. Although the US EPA rule changes will likely be somewhat consistent with the recommendations in this report, there should be (at a minimum) a recommendation to monitor the developments in US EPA rule changes, which will likely be reflected in the 2013-2018 MS4 permit cycle.

Regards,
Greg

My email address has changed to greg.kacvinsky@foth.com (please update your records accordingly)

Gregory P. Kacvinsky, P.E., Senior Project Manager
Foth Infrastructure & Environment, LLC

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June 14, 2010

Illinois EPA
Attn: Amy Walkenbach
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Amy Walkenbach:

I have reviewed the Illinois Green Infrastructure Study that was prepared pursuant to Section 15 of Public Act 96-0026, the Illinois Green Infrastructure for the Clean Water Act of 2009, and fully support all of the recommendations made in this study. The green infrastructure practices listed in Table ES-1, page 7, are an excellent start in implementing more natural methods of addressing water quality issues across the state. The results of the study are gratifying to know that green infrastructure practices are both effective at addressing stormwater management issues but are cost-effective in doing so.

Beyond the list of recommendations contained in the Abstract, there are several recommendations that I felt were noteworthy and fully support:

- On page 17, the report recommends that the “applicability of the standards should be expanded to include more urban and suburbanizing areas, based on the density of impervious surfaces, rather than on population”, which would reward those communities that adopted widespread green infrastructure practices.
- The study also recommended, “that the standards apply to existing as well as new development, to publicly-20 owned as well as private property”.

While I fully support this study and IEPA incorporating green infrastructure practices into its programs, there are two issues that I would like to address. First, the study relied almost solely on peer-reviewed articles, which has merit; however, for this subject, there has been extensive applied research that warrants inclusion. For example, Roger Bannerman, Wisconsin Department of Natural Resources, has done valuable research on the use of these practices in a wide range of circumstances that would apply to Illinois. While discretion needs to be used in determining which of these applied studies to include, I would recommend that quality, applied research results be considered in future studies.

The second issue I would like to raise relates to the definition of green infrastructure that applies at the regional level, as recommended by the Illinois Department of Natural Resources. While I realize that IEPA’s regulatory programs are related to water quality, identifying and protecting the network of natural areas that constitute green infrastructure would protect water quality and complement on-site green infrastructure practices. I work with local governments through

Chicago Wilderness' Sustainable Watershed Action Team (SWAT) in helping local governments to identify green infrastructure and review their ordinances to determine what changes need to be made to both protect green infrastructure at the regional level and implement on-site practices. Many do not have the resources to do this type of planning, so allowing the Clean Water Act's state revolving loan fund program to be used for this purpose would contribute towards IEPA's charge to improve and protect the state's water resources.

I appreciate the effort IEPA is making in incorporating green infrastructure practices into its regulatory and funding programs and encourage you to move forward with all of the recommendations in this study, as well as support the identification and protection of green infrastructure at the regional level. Thank you.

Sincerely,

Deanna Glosser

Deanna Glosser, Ph.D.
Environmental Planning Solutions, Inc.
22 Hollyhock Drive
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217-629-8949
Deanna_Glosser@comcast.net

From: meaton@tricountyrpc.org [mailto:meaton@tricountyrpc.org]
Sent: Tuesday, June 15, 2010 9:39 AM
To: Walkenbach, Amy
Subject: TCRPC comments_IL Green Infrastructuer Study

Good morning Amy,

TCRPC staff has the following comments on the IL Green Infrastructure Study draft:

1. All conclusions of The Illinois Green Infrastructure Study compliment the watershed and stormwater planning completed by Tri-County Regional Planning Commission to date.

2. TCRPC staff recommends that with future NPDES permits, IEPA includes precise language on volumetric and other parameters as opposed to the “maximum extent practicable” approach IEPA has used in the past. The ambiguity of the later does not provide the direction local governments need to make the necessary improvements.

Thank you for the opportunity to comment on this plan. This is certainly a step in the right direction. The authors did some very good work.

Have a good day,
Melissa Eaton
Tri-County Regional Planning Commission
211 Fulton St., Suite 207
Peoria, IL 61602
309/673-9330

From: Kane, Eleanor [mailto:Eleanor.Kane@mwrdgc.dst.il.us]
Sent: Tuesday, June 15, 2010 12:13 PM
To: Walkenbach, Amy
Subject: Comments on IL Green Infrastructure Draft Report

Dear Ms. Walkenbach,

Below please find my comments and suggestions for "The Illinois Green Infrastructure Study" draft report. These are provided in order to assist the State and the authors of the study in creating a document that is as useful and as accurate as possible. Beyond its value to the State, I am optimistic that this report will help local governments and other organizations advocate for and support green infrastructure policies and implementations in their areas.

Overall I found the draft report to be thorough and convincing, though I do note a few places where the conclusions did not seem to be fully supported by the preceding text. As a supporter of green infrastructure, I think it is extremely important that this report not overstate the benefits of green infrastructure. Those who remain skeptical about the applicability of green infrastructure for stormwater management will be looking for a way to discredit this study, and I therefore suggest being conservative and cautious with conclusions.

Some of the comments below are actually questions, and may do nothing more than demonstrate the limits of my own understanding. I include them here, however, because perhaps they will highlight areas that could benefit from further explanation or clarification.

Sincerely,

Eleanor Kane
eleanor.kane@mwrd.org
(312) 751-5692

<u>Comments on Draft Green Infrastructure Study for the State of Illinois</u>

Page 29, Table 2
The number of total articles (obtained when the values of column 3 are summed) is 53. However, the text states that 57 articles were included (page 27, line 39). What accounts for this difference?

Page 30
Paragraph 1: I'm not sure that the standard deviations f or the removal of TSS should be reported as percentage points. I understand why this was done, but it was confusing.
Line 28: The word "quantify" should read "quantity"

Page 31, Line 34
From the text above, it seems this should be for detention basins, not retention basins.

Page 32, Figure 2A
If I'm reading it correctly, the first chart indicates that while the average TN removal for infiltration was positive, for many sites there was substantial INCREASE in TN levels. If that's correct, I believe this needs to be discussed in the report.

Page 36, Lines 8-10
I don't believe this statement is substantiated within the preceding section. In fact, there was no discussion about how these really compare to conventional approaches, so this statement may be an overreach.

Page 38, Lines 26-31

This paragraph could be much improved by providing some actual figures about the number of applications submitted and the number accepted for funding, as well as the dollar amounts. What does it mean that "there has not been an outpouring"?

Page 40, Line 32
How sensitive were the results to the selection of the discount rate?

Page 42, Lines 24-26
This portion is unclear as to whether the reported numbers are from real data or from model predictions.

Page 45
Line 8: This sentence is unclear. Perhaps emphasizing that "*only* partial credit" is given will help?
Line 11: I suspect "benefits" doesn't convey what you mean. Credits or rebates?
Line 28: "The skeptics" is probably not a recognized group! Maybe "communities skeptical about GI"

Page 55, Line 34
Strike "are" so sentence reads: "These standards require…"

Page 59, Line 20 (through Page 65)
This whole section is not nearly as well written as the rest of the report. A lot of polish is needed to make it direct, concise and clear. There are many grammatical problems and punctuation errors. I include a few specific comments below, but in general this section should be carefully edited.

Page 60, Line 33
Not clear what this sentence is trying to say. Is it recommending more funding for SWCDs?

Page 62
Line 30: "Long time" should be replaced with "long term"
Line 39: This conclusion is unclear, and doesn't match the quote that follows (they seem to contradict).

Page 63
Table 13: In bullet point 5, agency should be possessive not plural.
Line 25: I find it hard to believe that the difference in payback is actually "several orders of magnitude". And, in either case, some numbers and/or references are needed to support such a claim.

Page 64
Line 5: The referenced organization is the Civic Federation, not Civic Foundation.
Footnote 51: Were other permeable pavement installations also evaluated? A wider range of projects may provide for a better sense of cost differences. For example the parking lot at U.S. Cellular Field (the IL Sports Facility Authority has numbers).

Page 65, Line 2
This section suggests that issues with quantity (recharge) and quality (contamination) are sequential, when in fact the outcomes are largely independent of each other.

Page 89, Line 1
How successful are these programs in moving towards their targets? In the description of each state program, it would be helpful to get a sense of whether progress is being made. And, in states that offer a fee-in-lieu, are utilities availing themselves of that option?
Also, would this GIPS system apply to MS4 communities only? What about CSO communities?

Page 93, line 32
Does "collection systems" refer to rain harvesting systems?

Page 98, Line 8

Line 8: Strike “should best.”
Line 35: Regulating based on percent impervious makes sense. However, I worry about the availability of this data, and would suggest devoting some time to outlining how the baseline data might be established and progress monitored.

Page 99
Line 21: This sentence needs clarification. Is the recommendation to prioritize projects which highlight sustainability elements?
Line 37: Project should be plural.

Page 100
Line 14: It’s unclear whether the authors are recommending establishing a backup fund or not.
Line 43: What is a restrictive covenant? What implications would this system have?

--
Eleanor S. Kane
Aide to Commissioner Debra Shore
Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street, Suite 213
Chicago, IL 60611

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June 15, 2010

Amy Walkenbach
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P.O. Box 19276
Springfield, IL 62794-9276

Re: comments on draft Illinois Green Infrastructure Study

Dear Ms. Walkenbach:

On behalf of Prairie Rivers Network, I am submitting the following comments on the draft final report of the Illinois Green Infrastructure Study. I realize the authors may not have adequate time to address some of the comments, but I think the report would be more informative if some additional information was provided.

General –

- Somewhere in the report, there should also be information about how long each practice can be expected to last. There are references to a 30-year life-cycle, but what is this based on?
- The report could possibly benefit from a Definitions section. Example: some readers might not know the difference between detention and retention.
- The report assesses percent pollutant removal, but toward the end there is brief mention of possible problems using percent removal. In the face of this criticism, the authors should at the beginning explain why they used percent removal and discuss the pitfalls.
- I think it would be helpful for the readers if, in addition to Table 1, there was a table that listed the universe of practices that can be considered green infrastructure.
- I think it would be helpful if there was a lifetime maintenance schedule for each of the featured practices.
- Tables are not always able to stand alone as they should; sometimes, in order to understand the table (because of names of column headings, lack of caption, etc.), one must have read the text.
- The report should more thoroughly address the issue of pollutant buildup within certain green infrastructures, and the options/costs for removal.
- I think it would be very helpful if the report included a section that discussed the annual cost to IEPA of implementing the recommendations of the report. How many staff

does IEPA need to run an effective green infrastructure regulatory program? What would staff duties be?

Page 36 Line 8 – I don't believe there was adequate discussion of traditional approaches to stormwater management to warrant this statement. Overall, I think the report would benefit from more discussion of gray infrastructure, so that comparisons between gray and green can more readily be made. For example, there could be more information on the costs and maintenance needs of gray infrastructure.

Page 40 Line 30 – I am unclear about the "cost per cubic feet of runoff that is expected to be intercepted during the 30-year life cycle." Is this part of the maintenance cost? How does one compute a cost per cubic foot, and why? Wouldn't this vary geographically depending on local precipitation totals? If one were to just look at Table 3, one might assume that cubic feet refers not to runoff volume, but to the volume of the practice.

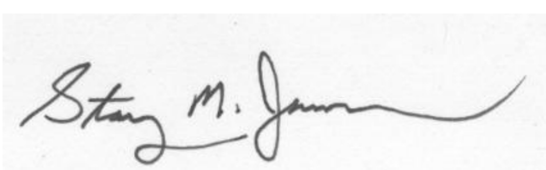
Page 44 Lines 13-16 – I do not understand the costs per gallon; what does "gallon" refer to? Are these costs for every gallon of rain that the system collects/filters over its lifetime, or does gallon refer to the design capacity of the practice?

Page 45 – I do not understand Table 6. At the very least, column headings could be more informative, or there could be an explanatory caption.

Page 91 Line 31 – I don't understand the concept of retaining "rainfall on a minimum percentage of the impervious surface." I also don't understand "1% more than the baseline"; baseline what?

Thank you for this public comment opportunity, and for funding this important report. Please contact me should you have any questions about my comments.

Sincerely,



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openlands
conserving nature for life

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June 15, 2010

Ms. Amy Walkenbach
Illinois EPA
Bureau of Water
P.O. Box 19276
Springfield, Illinois 62794-9276

Sent via email to: amy.walkenbach@illinois.gov

Dear Ms. Walkenbach:

Thank you for the opportunity to comment on the Illinois Green Infrastructure Study generated by the University of Illinois, Chicago Metropolitan Agency for Planning and the Center for Neighborhood Technology. Founded in 1963, Openlands protects open space throughout northeastern Illinois and the surrounding region to ensure cleaner air and water, protect natural habitats and biodiversity, and help balance and enrich our lives. As a longtime advocate for sustainable water resource management, Openlands applauds the study team for recommending that the Illinois EPA (IEPA) adopt green infrastructure (GI) performance standards for best management practices to safeguard water quality and quantity for people and wildlife. We strongly support the stance that local governments should phase in requirements for a portfolio of green infrastructure practices to address stormwater at a watershed level, guided by a regional vision and state oversight.

I. Performance Standards and Applicability

Openlands agrees with the importance of establishing performance standards for green infrastructure practices, especially for detention release rates (peak flow), volume, Total Suspended Solids (TSS) and Total Nitrogen (TN). While it may be more difficult to monitor soluable contaminants, such as metals and nitrogen, it would better protect the integrity of ground and surface waters that are sources of water supply. Phasing in these requirements first in MS4 areas and ultimately to other sites by percentage of impervious surface would promote smart growth and focus on areas most significantly impacting their waterways. Utilizing a Green Infrastructure Portfolio approach akin to the Illinois Renewable Energy Portfolio is an ingenious solution to help watersheds address threats to both water quality and quantity. GI performance requirements can bring more clarity and weight to that paradigm. The IEPA should set firm dates in its regulations for implementing standards in the GI portfolio.

By including county and municipal stormwater management ordinances and plans, the report demonstrates how local governments (especially in northeastern Illinois) are increasingly embracing green infrastructure as a viable alternative or counterpart to traditional stormwater solutions. As part of its recommendation that regional planning organizations, such as the Chicago Metropolitan Agency for Planning (CMAP), play an important role in creating an overarching vision and providing technical assistance to local governments, it would be helpful to describe the history and import of CMAP's model stormwater ordinances on the region's acceptance of GI practices.

While the report underscores the importance of appropriately siting and maintaining GI practices, it would be beneficial to understand how appropriate measures will reduce the variability of their performance to demonstrate how green infrastructure can be just as if not more efficient at handling stormwater runoff as traditional grey construction. By showing that both green and grey infrastructure depend on correct application, the report will lend confidence to local and regional agencies that are less familiar with the benefits of GI best management practices. To that end, the report could more strongly demonstrate the effectiveness of GI solutions by including more detailed information on Illinois projects referenced in the report and listed in the appendices, such as quantifying the size of GI sites, as well as the detention release rates and volume accomplished by implementing the particular GI practices. It would also help to compare these rates to applicable stormwater management requirements.

II. Maintenance and Monitoring

The report stresses the importance of maintenance and monitoring to both green and grey infrastructure. Openlands recommends reinforcing this point by demonstrating how much the proper siting and maintenance increases the rate of effectiveness for GI technology. Openlands agrees that structuring and funding maintenance and uniform monitoring is crucial to the long-term success of stormwater management solutions. Since GI solutions are often decentralized and are sited on private property, it is important to create incentives and penalties that ensure that the stormwater systems continue to function as designed.

The report findings parallel Openlands' conclusions in a recent analysis of conservation design (or low impact development) management practices. A proper legal and educational framework is essential to successful long-term management of GI solutions. Declaration, covenants and by-laws for homeowners associations (HOAs) should include clear criteria for hiring companies to maintain and monitor GI stormwater systems, and should set aside fees specifically for this purpose. The most successful development complexes also hire a land manager to provide ongoing education to the HOA (and landowners) and ensure proper management of stormwater systems. Developers should work with homeowners and local agencies to extend conservation easements over GI stormwater features, such as kettles or bioswales, so that they are protected and function in perpetuity. Easements should be recorded and included in deeds for the property. Dormant Special Service Areas (SSA) should extend over developments to give local governments the authority to ensure HOAs adequately maintain GI systems or pay for such through the latent tax to prevent stormwater problems onsite and in surrounding communities. To create a greater incentive for integrating an appropriate framework, the report makes an excellent recommendation to require easements for sites that receive stormwater credit for GI practices.

III. Funding

Local, regional and state-wide funding is necessary to successfully phase in GI stormwater practices. Openlands commends the IEPA for launching a $5 million GI grant program and reconstructing State Revolving Loan fund criteria to prioritize environmentally sound solutions, such as green infrastructure. This will create strong incentives for communities to explore green alternatives to stormwater management.

Since SRF only addresses 10% of the state's infrastructure needs, Openlands agrees that government on the local, regional and state level must secure dedicated alternative funding for implementing GI stormwater solutions. The report offers great overarching economic figures that demonstrate the benefits of GI practices over the life-cycle of the systems. Since municipalities are reticent to raise taxes, both public education and consideration of hidden costs of flood damage will be necessary to shift the current culture to accept real cost pricing.

IV. Further Study

The report is an excellent step towards demonstrating the benefits of GI solutions. However, it is evident that further monitoring data could help to quantify the effectiveness of these practices. Openlands strongly recommends that the IEPA require clear and robust uniform monitoring practices, and continue to revisit this issue to provide local governments with the confidence to require GI technology as a viable alternative or complement to grey infrastructure.

While the report confines its analysis to peer-reviewed examples of GI with particular sets of monitoring data, it would be valuable to initially include a larger list of types of GI practices utilized in Illinois. For instance, the introduction could mention current trends towards adopting urban forestry programs, and then set into context its choice to solely focus on the effectiveness of a few examples of GI practices. As part of its evaluation of complete life-cycle costs of GI, it may also be useful to offset the ecological benefits of such practices that are highlighted in Appendix I.

V. Conclusion

The report, as a first answer to the call of the 2009 stormwater legislative initiative, provides a valuable perspective and recognition of the benefits of GI stormwater controls. Openlands looks forward to the next steps by IEPA to implement these recommendations to strengthen GI requirements and incentives to augment protections of the quality and quantity of our regions waterways.

Thank you once again for the opportunity to comment on this important study.

Sincerely,

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FOREST PRESERVE DISTRICT
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Steven M. Bylina, Jr., GENERAL SUPERINTENDENT

June 15, 2010

Ms. Amy Walkenbach
Illinois EPA
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Walkenbach,

The Forest Preserve District of Cook County (FPDCC) has had an opportunity to review the Illinois Green Infrastructure Study. We commend you for the positive viewpoints you presented for green infrastructure. However, we were dismayed that you did not mention the FPDCC's Stormwater Management Policy (SMP). The enclosed copy of the SMP is for your use and possible inclusion in the study.

The FPDCC manages 68,351 acres of land, over 11% of the total land area of Cook County. We developed the SMP with the intention of protecting the Forest Preserves from off-site impacts from stormwater. We promote the use of green infrastructure through the SMP to restore predevelopment levels of runoff. The implementation of the 3-V's prescribed in the SMP collects, treats, and infiltrates rain where it fall.

We believe the Illinois Green Infrastructure Study will be a more useful report with the inclusion of the SMP. On page 19 of your report, it would be good if the Illinois EPA was encouraged to work with the Forest Preserve Districts in addition to the other officials mentioned.

We trust this information may be useful to you.

Steven M. Bylina
General Superintendent

Cc: Dr. Jack Sheaffer

BAXTER & WOODMAN
Consulting Engineers

June 15, 2010

Ms. Amy Walkenbach
Illinois Environmental Protection Agency
Bureau of Water
Post Office Box 19276
Springfield, Illinois 62794

Subject: Draft Illinois Green Infrastructure Study Report

Dear Ms. Walkenbach:

Thank you for the opportunity to review and comment on the draft Illinois Green Infrastructure Study report dated May 28, 2010. I applaud your efforts, and those of the rest of the project team, to collect and review available information on green infrastructure. The information included in the report will most certainly help shape the future of stormwater management in Illinois.

According to Illinois Public Act 096-0026 (Green Infrastructure for Clean Water Act), the report is supposed to review the latest available scientific research and institutional knowledge to evaluate the following topics:

(a) The nature and extent of urban stormwater impacts on water quality in watersheds in Illinois;
(b) Potential urban storm water management performance standards to address flooding, water pollution, stream erosion, habitat quality, and the effectiveness of green infrastructure practices to achieve such standards;
(c) The prevalence of green infrastructure use in Illinois;
(d) The costs and benefits of green versus grey infrastructure;
(e) Existing and potential new urban storm water management regulatory programs and methods and feasibility of integrating a State program with existing and potential regional and local programs in Illinois;
(f) Findings and recommendations for adopting an urban storm water management regulatory program in Illinois which includes performance standards and encourages the use of green infrastructure to achieve those standards; and
(g) The feasibility and consequences of devoting 20% of the Clean Water State Revolving Fund to green infrastructure, water and energy

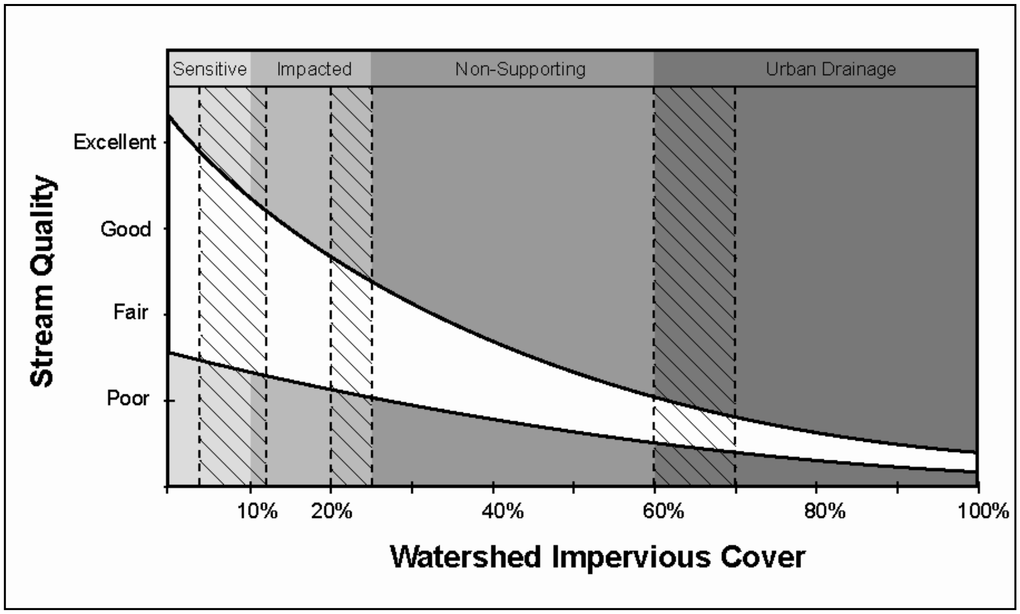
efficiency improvements, and other environmentally innovative activities on a long-term basis.

My comments on the draft report, which are provided below, have been organized according to these topics. I hope that you and the rest of the project team find them useful in your efforts to finalize the report.

Nature and Extent of Stormwater Impacts in Illinois
As evidence of the nature and extent of stormwater impacts in Illinois, the report cites the Center for Watershed Protection's Impervious Cover Model (ICM) and the fact that there are 1,218 miles of stream that are already impaired by stormwater runoff in Illinois. While new research routinely confirms and reinforces the relationship between impervious cover and stream quality predicted by the ICM, the ICM does not in itself describe the nature and extent of stormwater impacts. I believe that the report would benefit from a narrative description of the impacts that stormwater runoff can have on streams and other receiving waterbodies. Such a description would be useful in demonstrating to the Illinois General Assembly that stormwater runoff is indeed a problem and that there is a real need for improved stormwater management in the state of Illinois.

As recent research shows, the changes in stormwater quantity and quality resulting from the land development process can have a wide range of negative impacts on streams and other receiving waterbodies, including increased flooding, decreased baseflow, reduced water quality, reduced dissolved oxygen levels, increased primary productivity (e.g., eutrophication, algal blooms), sediment contamination, degradation of habitat, reduced recreational value and a general decline in wildlife abundance and diversity (CWP, 2009). As predicted by the ICM, these impacts begin to become pronounced – and water resources begin to become degraded – when imperviousness reaches roughly about 10 percent within a watershed. The degradation of these important water resources compromises the numerous ecosystem services that they provide, including pollutant removal, flood attenuation, erosion control, groundwater recharge and wildlife habitat.

Given that the report cites the Center for Watershed Protection's ICM, it should be noted that the ICM has recently been refined and reformulated (Schueler et al., 2009). In the update, the model was modified to reflect more recent research on the relationship between impervious cover and various indicators of stream quality. I recommend that report discuss the most recent version of the ICM, instead of the 2003 version that is currently cited in the draft report.



Revised Impervious Cover Model
(Source: Schueler et al., 2009)

Stormwater Management Standards
Traditionally, communities have relied on regulations and engineered stormwater management systems to address the changes in stormwater quantity and quality that result from the land development process. The conventional practice has been to adopt a set of stormwater management standards that requires developers to address increases in stormwater runoff rates, volumes and pollutant loads on individual development sites. These standards have generally included some combination of flood control, water quality, channel protection and groundwater recharge criteria.

The most effective stormwater management standards are those that have been developed to address specific impacts of the land development process. For example, to address the increased pollutant loads that result from the land development process, some communities have developed criteria that require a certain volume of stormwater runoff to be captured and treated – either by detaining that volume for an extended period of time below the primary gravity outlet of the site or by sending that volume through a stormwater management practice that has been shown to significantly reduce pollutant loads. Of course, the most common way to meet such a water quality criteria – and any accompanying flood control criteria – has been to use a stormwater detention pond.

While research generally indicates that detention ponds have flood control and modest pollutant removal capabilities (ASCE, 2007; CWP, 2007), a handful of studies have shown that stormwater ponds are not capable of protecting downstream habitat or stream channel integrity (Galli 1990; Horner and May 1999; Horner et al. 2001; Jones et al. 1996; Maxted 1999; Stribling et al. 2001). Several recent studies have also found that wet ponds can harbor harmful algal species and are capable of releasing excess nutrients and harmful algal blooms into adjacent water resources (Brock, 2006; Drescher, 2005; Lewitus et al., 2003). Other studies have found that wet ponds and wetlands typically provide little, if any, groundwater recharge benefits (Strecker et al., 2004).

As a result of these findings, which suggest that our current pond-dependent approach to stormwater management cannot fully address the negative impacts of the land development process, stormwater managers across the country have explored the implementation of new stormwater standards. As the authors correctly note, our approach to stormwater management has begun to shift to what can be called the “runoff reduction approach” (Hirschman et al., 2008).

The goal of the “runoff reduction approach” is to subject stormwater runoff to the natural hydrologic processes of interception, infiltration, evaporation, soil absorption and transpiration as rainfall travels from the rooftop to the stream. Runoff reduction is achieved as the total stormwater runoff volume discharged from the site is reduced through the use of through small, runoff-reducing green infrastructure practices. Stormwater managers across the country – including managers in New Jersey, Maryland, Virginia, Pennsylvania, Coastal Georgia, the Etowah Watershed in Georgia and Wisconsin – have begun to adopt this approach by developing “runoff reduction,” groundwater recharge, and infiltration criteria, which specify that a certain volume of stormwater runoff must be reduced on a development site through the use of various hydrologic processes.

Picking up on this national trend, the draft report recommends that the Illinois EPA develop and adopt a stormwater volume retention performance standard. This standard could more accurately be called a stormwater runoff reduction standard. Although such a standard has not yet become the “norm” around the country – as the report claims – it is gaining popularity as a standard that addresses not just one or two impacts of the land development process, but a combination of all of them.

Ability of Green Infrastructure to Meet Stormwater Management Standards
Although the report recommends that the Illinois EPA develop and adopt a stormwater runoff reduction standard, in its review of the effectiveness of green infrastructure practices, it does not focus on the ability of these practices to reduce stormwater runoff volumes. Instead, the report focuses on the ability of green infrastructure practices to reduce total suspended solids (TSS) and total nitrogen (TN) concentrations.

Green Infrastructure Performance: TSS and TN Removal
The methodology used to evaluate the effectiveness of green infrastructure practices with respect to water quality – in terms of percent reduction in pollutant concentrations – is out-of-date and leads to erroneous conclusions about practice performance. Experts in the field of stormwater management have, for some time, been moving away from percent concentration reduction as way of characterizing the effectiveness of stormwater management practices. There are a number of reasons for this, including:

- Percent concentration reduction is primarily a function of influent quality. In almost all of the studies of stormwater management practice performance that I have reviewed, practices receiving more polluted runoff provide greater percent concentration reductions. In other words, percent concentration reduction is often more reflective of how dirty the influent water is than how well the stormwater management practice is actually performing.
- Significant variations in percent concentration reduction may occur within stormwater management practices that consistently provide good effluent quality. These variations in percent concentration reduction – which are due to variations in things like influent quality, antecedent conditions, storm intensity – have very little relationship to the actual quality of the effluent being produced.
- Methods used to calculate percent concentration reduction can vary from study to study. It is not always clear whether percent concentration reductions are being calculated using event mean influent and effluent concentrations, event median influent and effluent concentrations or some other data.
- Percent concentration reduction calculations also sometimes miss the measurement of how much runoff is actually being treated by the stormwater management practice. I have seen studies in which a high percent concentration reduction was being reported based on the runoff being conveyed through the stormwater management practice. However, a

significant amount of the runoff was bypassing the practice altogether, which meant that the overall effectiveness of the practice was significantly less than what was being reported.

Given the shortcomings associated with the methodology, the results, as presented in the draft report, do not adequately document the potential of green infrastructure practices to provide TSS and TN removal. At the very least, the results need to be amended with the event mean influent and effluent concentrations that were used to calculate the percent reductions in pollutant concentrations. If available, the influent and effluent volumes associated with each monitored storm event should also be provided

Most important to this report is the fact that the methodology does not account for the reductions in stormwater runoff volumes and pollutant loads that are provided by green infrastructure practices. Since the report recommends the creation of a statewide stormwater runoff reduction standard, the report should more accurately characterize the effectiveness of green infrastructure practices by considering both volume reduction and pollutant load reduction.

Green Infrastructure Performance: Stormwater Runoff Volume Reduction
Part of the reason for the report's focus on TSS and TN removal is that the authors found very few studies that document the ability of various green infrastructure practices to reduce stormwater runoff rates and volumes. In fact, the authors reviewed only 24 studies – six bioretention studies, twelve permeable pavement studies and six green roof studies – before concluding that green infrastructure practices are capable of significantly reducing stormwater runoff volumes. While I believe that green infrastructure practices are capable of significantly reducing stormwater runoff volumes, I don't believe that a review of only 24 studies – representing just three types of green infrastructure practices – is sufficient to support the recommendation that the Illinois EPA develop and adopt a statewide stormwater runoff reduction standard. There are, however, other studies that could be reviewed to help substantiate this recommendation.

Other studies have shown that, in addition to bioretention areas, permeable pavement and green roofs, green infrastructure practices such as downspout disconnection, rainwater harvesting, grass channels, dry swales, soil amendments and infiltration practices can significantly reduce stormwater runoff volumes (Hirschman et al., 2008). I recommend that the authors review these other studies to: (1) document the runoff reduction capabilities of other green infrastructure practices besides bioretention areas, permeable pavement and green roofs; and (2) further substantiate the recommendation that the Illinois EPA develop and adopt a statewide stormwater runoff reduction standard.

Green Infrastructure Performance: Stormwater Runoff Rate Reduction
The simplified "percent rate reduction" methodology used to evaluate the ability of green infrastructure practices to reduce peak flow rates can lead to erroneous conclusions about practice performance. Since percent rate reduction is primarily a function of the characteristics of the contributing drainage area and storm event being managed, it is difficult to evaluate the effectiveness of a green infrastructure practice over a wide range of storm events using the methodology outlined in the report. For example, a small green infrastructure practice (e.g., rain garden) treating runoff from a small contributing drainage area (e.g., rooftop) will likely be able to significantly reduce the stormwater runoff rates associated with small, low-intensity storm events of limited duration. Conversely, a green infrastructure practice (e.g., bioretention area) treating runoff from a large impervious drainage area (e.g., parking lot) will likely be unable to reduce the stormwater runoff rates associated with large, high-intensity storm events. In other words, green infrastructure practices can be expected to reduce the runoff rates associated with small, frequent storm events, but not the runoff rates associated with larger, more rare storm events, such as the 100-year, 24-hour storm event. That is one of the reasons why stormwater detention ponds – and not small green infrastructure practices – are most commonly used to meet the flood control criteria that have been established across the US.
The report makes no mention of the dependence of percent flow rate reduction upon storm event and contributing drainage area characteristics. Instead, the report generally characterizes the runoff rate reduction provided by green infrastructure practices as somewhere between 52 and 70 percent. At the very least, the results should be amended with the influent and effluent flow rates that were used to calculate the percent flow rate reductions. If available, the characteristics (i.e., duration, intensity, total rainfall) associated with each monitored storm event should also be provided.

Prevalence of Green Infrastructure in Illinois
Appendix II provides a brief overview of some of the green infrastructure practices that have been implemented in northeastern Illinois.

Costs and Benefits of Green Infrastructure
As evidence of the cost-effectiveness of green infrastructure practices, the report cites the US EPA's *Reducing Stormwater Costs Through LID Strategies and Practices* (US EPA, 2007) and Table 3, which shows the unit costs, over a 30-year

life cycle, for six different types of green infrastructure practices. Table 3 includes unit cost data from three sources: (1) cost data from practices constructed and maintained by the Center for Neighborhood Technology; (2) cost data reported by the Capitol Region Watershed District; and (3) cost estimates provided by the Center for Neighborhood Technology's National Green Values Calculator.

Although Table 3 provides valuable cost data that can be used to estimate the life cycle unit costs associated with six green infrastructure practices, it does not provide any information on how these unit costs compare with those for more conventional stormwater management practices, such as stormwater detention ponds. Other studies have found that construction costs for wet ponds, dry ponds, and stormwater wetlands typically range from about $1.00 to $3.00 per cubic foot of stormwater runoff treated (Schueler et al., 2007). Assuming a permanent pool depth of one foot, this equates to a per square foot construction cost of about $1.00 to $3.00 per square foot. To allow for a comparison of the construction and maintenance costs associated with green and gray infrastructure practices, I recommend that the typical unit costs associated with conventional stormwater management practices, such as ponds and wetlands, also be provided in Table 3.

Such a comparison will show that the construction and maintenance costs associated with conventional practices are less than those associated with green infrastructure practices. However, as the US EPA's *Reducing Stormwater Costs Through LID Strategies and Practices* (US EPA, 2007) study illustrates, and the report goes on to discuss, the cost savings associated with the use of green infrastructure is a result of the "avoided cost" of the conventional stormwater infrastructure (e.g., pipes, ponds) that no longer needs to be put into the ground. As the authors point out, these cost savings can only be realized if green infrastructure practices can be used to help meet the applicable stormwater management standards – including any flood control criteria. If they cannot be used to satisfy these criteria, there are no "avoided costs" and no cost savings, since conventional stormwater practices and pipes must then be installed.

Stormwater Management Regulatory Program

As I understand it, the report recommends that the Illinois EPA administer the new statewide stormwater runoff reduction standard by relying on the county stormwater management agencies, soil and water conservation districts and drainage districts to develop appropriate rules and regulations to ensure local compliance with the standard. If the Illinois EPA chooses to administer the program in this way, I encourage them to provide much more technical and financial support than they have provided while administering the MS4 permit program. In my opinion, too much of the burden associated with the MS4 permit program has been passed from the US EPA, through the Illinois EPA, to the counties and permit holders.

In order for a new statewide stormwater management regulatory program to be successful, the Illinois EPA will need to view itself not just as a regulator, but as a full partner in the implementation of the program. It will need to embrace the concept of governance – recognizing that regulations are only one of the inputs to the public decision making process – by providing much more guidance, training and, ideally, a dedicated funding source to assist the counties, soil and water conservation districts, drainage districts and regulated communities in implementing the new statewide standard.

If I understand the report correctly, the new stormwater runoff reduction standard would not only be applied to new development and redevelopment sites, but also to existing development sites. Through its administration of the program, the Illinois EPA would work with regulated communities to establish long-term goals that would annually increase the amount of existing development that is subject to the new stormwater runoff reduction standard. As the report describes it, the idea would be to develop a "green infrastructure portfolio standard," whereby, over time, a larger portion of the existing impervious cover within a community would be subject to the stormwater runoff reduction standard. The amount of existing development that is subject to the standard would increase annually until a target percentage is reached at some target date.

Although the financial burden of meeting the standards on new development and redevelopment sites would fall to the development community, since the cost to construct stormwater retrofits can be 4 times greater than the cost to construct stormwater practices at new development sites (Schueler et al., 2007), I don't know how the effort to retrofit existing development sites would be funded. Although the report recommends that the Illinois EPA make CWSRF funds available for this purpose, communities will be hard pressed to find the resources necessary to retrofit significant amounts of existing impervious cover.

Devoting CWSRF Funds to Green Infrastructure Projects
The report states that there should be no negative consequences from a long-term policy of setting aside 20 percent of the CWSRF funds for green infrastructure and stormwater management projects. While it is clear that communities need additional funding for green infrastructure and stormwater management projects, setting aside CWSRF funds for these projects means that these funds will no

longer be available for necessary wastewater collection and treatment upgrades and improvements. As the report points out, the CWSRF has historically been able to fund less than 10 percent of the necessary wastewater projects in Illinois. The report does not investigate the potential negative consequences of reducing this percentage even further by devoting 20 percent of the CWSRF funds to green infrastructure and stormwater management projects.

Thank you again for the opportunity to review and comment on the draft Illinois Green Infrastructure Study report dated May 28, 2010. If you have any follow-up questions or if I can provide any additional information, please do not hesitate to call me at (312) 578-0050 or e-mail me at mnovotney@baxterwoodman.com. I look forward to seeing the results of your efforts and those of the rest of the project team.

Very truly yours,

BAXTER & WOODMAN, INC.
CONSULTING ENGINEERS

Michael E Novotney

Michael E. Novotney, PE

H:\Chicago\MEN\Ltr IEPA Green Infrastructure Report.docx

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago
100 East Erie Street Chicago, Illinois 60611-3154 f: 312.751.7926 312.751.7900

Richard Lanyon
Executive Director
richard.lanyon@mwrd.org

June 15, 2010

Ms. Amy Walkenbach
Illinois Environmental Protection Agency
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Walkenbach:

Subject: The Illinois Green Infrastructure Study, A Report to the Illinois Environmental Protection Agency of the criteria in Section 15 of Public Act 96-0026, the Illinois Green Infrastructure for Clean Water Act of 2009, dated May 28, 2010 (Study)

Despite the short turnaround time allotted by the Illinois Environmental Protection Agency (IEPA) for review of a document of this magnitude and length, especially when considering the implications of its recommendations on the local governments of the State of Illinois, the Metropolitan Water Reclamation District of Greater Chicago (District) has reviewed the subject document and identified numerous concerns as discussed below.

We are in agreement that green infrastructure (GI) can supplement conventional or "grey" stormwater practices, provided the objective of GI is to provide water quality benefits whereas the goal of grey infrastructure is to provide quantifiable flood control benefits. GI is not appropriate for addressing large-scale flood events, such as what occurred in Chicago in September 2008. GI simply cannot replace grey infrastructure as insinuated at times in the Study. It is believed GI, when properly designed and maintained, can provide water quality benefits and volume reduction to some degree for small, frequent storm events of 1-2 inches. The desire expressed in the Study is for GI to become "the standard for stormwater management programs statewide" but GI does not perform the same function as conventional infrastructure. The examples provided in the Study focus on volume and pollution reduction, which is reasonable if used in conjunction with conventional stormwater infrastructure to handle the extreme events that lead to flooding.

It is disappointing that, to our knowledge, not one of the authors of the Study is a licensed Professional Engineer in the State of Illinois. The Study makes mention of the common concerns of engineers, which we believe were provided primarily by regulators, regarding GI, but neglects to address those concerns. Rather, the Study marginalizes the concerns by calling them "perceived issues" (Page 13). My staff spent several hours meeting with Chicago Metropolitan Agency for Planning representatives discussing very real issues associated with GI; issues which we are certain were expressed by other engineers, especially regulators, also interviewed. To simply dismiss our concerns by labeling them as "perceived" significantly detracts from the credibility of the Study.

The Study's "aim is to inform policy with science, our sources of data include only compiled peer-reviewed studies" (Page 26), which we essentially interpret to mean the Study is nothing more than a review of existing studies. The Study concedes that "there are substantial gaps in the peer-reviewed data on the effectiveness of many green infrastructure and low impact design strategies" and "filling in these data gaps is essential if we are to clarify our understanding of green infrastructure and inform policy decisions" (Page 101). The Study, despite acknowledging a lack of scientific data to inform policy, concludes in essence that GI is effective and IEPA should require its use regardless by stating "Experience with many types of green infrastructure has shown them to be very effective, even though they have not been subjected to rigorous scientific analysis" (Page 101).

The following points are provided for your consideration:

- Mr. Hal Sprague of the Center for Neighborhood Technology informed the District in March 2009 that he was the principal author of the document that became Public Act 96-0026. His involvement as an author on the Study detracts from its credibility.

- The term "flooding" is a consequence of runoff and should be added to the sentence "Runoff contributes to erosion, combined sewer overflows, sedimentation, and nonpoint-source pollution and threatens human and ecosystem health" on Page 6.

- It is inappropriate to state conventional systems, such as detention ponds, are inadequate to handle current and future stormwater management needs. Detention ponds provide quantifiable flood control benefits, which is probably more of a concern to the common person than water quality benefits and served as the impetus behind the county stormwater management programs established in northeastern Illinois. You will note the term "water quality" is not mentioned in the enabling legislation (Public Act 93-1049) for the District's countywide stormwater management program for Cook County, but terms involving "flood" are used on nine separate occasions.

- The report lacks objectivity as it was authored without true consideration of input from a diverse group of stakeholders. An advisory committee should be established to facilitate input from a broad faction of stakeholders including municipalities, engineers, and federal, state and local agencies.

- The Study references CNT's Green Values Calculator (GVC) as being used to calculate flow rates and determine costs for both GI and grey infrastructure. It is unknown if the GVC has been subjected to appropriate scrutiny by professional engineers. In 2008, CNT stated on their website under Frequently Asked Questions (FAQs) concerning the GVC that they "don't claim that it is accurate" and that one of their reviewers described it as a "mind experiment." The FAQs webpage has been revised to state "Results are not, in this version, meant to substitute for detailed, formal design and engineering assessments." The 2008 and current FAQ pages are attached for your reference. The Study claims, using the GVC, that GI can reduce peak flow rates over 50%. The GVC uses the Technical Release 55 (TR-55) computer model, which was developed by the National

Resource Conservation Service (NRCS), to determine flow rates. The GVC assumes various Curve Numbers (CNs) for various types of GI: Porous Pavement and Green Roofs. To our knowledge, TR-55 has not been revised by NRCS to include CNs for GI. The GVC methodology description states "CNT and others are conducting research to improve the accuracy of the CNs for use with green infrastructure projects." This is yet another assumption being relied upon to tout the benefits of GI even though CNT acknowledges the CNs require further study. It is also important to note that TR-55 is limited to computing runoff for a 24-hour event. TR-55 does not have the capability to perform critical duration analysis or analyze storms of shorter duration than 24-hours, which are the storms believed to be appropriate for GI.

- The Study looked at GI practices separately, and not as potential supplements to conventional stormwater management structures (page 8), however, we did not see any kind of analysis, or anecdotal observations, of how GI installations in NE Illinois performed during the approximate 100-year rain event in September 2008. Such information would help support claims made in the report that GI is at the very least comparable to traditional approaches for stormwater management.

- The Study recommends that landowners causing runoff pay for the "treatment and management of runoff flow and volume needed to protect our urban streams – in the same way that landowners pay for the connection fees and sewage treatment charges for pollution discharged directly into streams by publicly-owned sewage treatment plants" (Page 18). However, unless the authors envision some type of publicly owned stormwater treatment system, collecting fees in this manner is questionable as it is a penalty rather than a cost tied to treatment services provided by the public agency.

Recommendations for phasing in green infrastructure and for implementing a systematic monitoring and reporting program requiring submission of standardized data to the BMP database are reasonable, and should be first steps in any sort of State program promoting GI. This is consistent with the authors' findings that variability is high for all types of green infrastructure due to various factors including climate, design, maintenance, scale, soils, and perennial and seasonal groundwater water table elevation.

Based on the aforementioned concerns, the District strongly advocates a more thorough and objective study prior to consideration of statewide green infrastructure regulation. The District further recommends that The Illinois EPA develop a diverse advisory committee to facilitate stakeholder input. The Study, and any subsequent studies, need broader distribution to facilitate stakeholder input.

Please feel free to contact me if you require further information.

Very truly yours,

R Lanyon

Richard Lanyon
Executive Director

KAK:WSS:JPM
Attachments

- About This Site
- FAQ
- Calculator Methodology
- Contact Us

FAQ

General Questions

How can something like this be accurate?

We don't claim that it is accurate. One of our reviewers described it as a "mind experiment" that should point out a series of opportunities for people interested in sustainable design as well as saving money. Most sites will require planning and engineering, and one of our intentions is that property owners will seek consultants that have experience with green infrastructure and have them do detailed assessments of the opportunities.

Why can't I evaluate new urbanism concepts such as clustered housing, narrow streets and shorter driveways?

You can do that. Simply designate the conventional sizes for street width and driveways on one run, copy the results, and use narrower streets and smaller driveways on another and compare the results. The option of using "Half of lawn replaced by garden with native landscaping" could simulate a development where half the area is left open. The shorter streets common in new urbanism could be simulated by making the lots bigger and putting more rooftop and pavement on each lot to arrive at the same number of homes.

Does the calculator apply to all regions?

We designed the calculator based on the hydrology of the Great Lakes region. The results would be different for other regions with different rainfall patterns. However, the calculator can be used to get a general sense of how green infrastructure might work in other areas.

Can I save my results and come back to them?

Not at this time, however you can print your results for future reference.

Why do you only offer six green options, aren't there other green actions, such as infiltration trenches and rain barrels, that would reduce runoff?

For this first version of the calculator we chose a number of green infrastructure interventions that can be reasonably implemented by a developer or homeowner, used in many locations and at many scales. At the same time, we wanted to keep the calculator simple. If you have research on the stormwater benefits of a green action that we did not include, we would love to hear about it for our future versions.

Why are the green infrastructure options unchangeable? What if I want to install 100 percent native plants, not 50 percent?

The calculator is meant to give a sense of the stormwater costs and benefits of green infrastructure actions. It is not meant to be a substitute for proper site design. We feel that the simple options make the calculator easier to use.

Why do you ask if this is an existing neighborhood?

The model makes different assumptions for new and existing neighborhoods. In terms of costs, the model assumes that the existing neighborhood is 50 years old, so infrastructure such as sewer pipes will not have capital costs in year one, compared to a new neighborhood where all stormwater infrastructure must be constructed. Moreover, the model assumes that an existing neighborhood does not have room for additional detention basins. Finally, the model assumes that existing neighborhoods have combined stormwater and sanitary sewers, and all of the water is treated, so that there is a financial benefit in terms of reduced treatment cost to reducing the stormwater runoff.

I live in the city, how many blocks are there to an acre?

One city block is the equivalent of 6 acres.

Why can't I change the number of trees on my lot?

If you are using a new development scenario, the calculator assumes that the site starts with zero trees.

How does one go about finding most of these answers?

We have set the defaults for these options at values that are reasonable for the Chicago region.

- **Average slope?**

  A general land slope of either 1 or 3 percent is chosen. The Chicago area is relatively level, so that a default of 1 percent is recommended. If you have specific slope information from a survey of your land you can use that.

- **Soil type?**

  Soil types are characterized from A to D, with A being sandy and well-drained and D being mostly clay and poorly drained. C is the recommended default for the Chicago suburbs. Every soil in the U.S. is assigned one of these four categories using the following table: ftp://ftp.wcc.nrcs.usda.gov/downloads/hydrology_hydraulics/neh630/hydro_soil_groups.pdf

- **Average roof size?**

  Your roof size can be estimated as the square footage of one story of your home and garage.

- **Average number of trees?**

  This is simply the number of trees per lot.

What is "real discount rate?"

The Real Discount Rate is an interest rate used to represent the time value of money in calculations. Higher discount rates will give less weight to future year costs and benefits than lower discount rates. All calculations in this calculator are done on a constant dollar basis, so a Real Discount Rate (one adjusted to remove the impact of inflation) is used. You may want to enter your own rate if your organization has a standard Real Discount Rate for projects. In 2005, the White House Office of Management and Budget recommends a Real Discount Rate of 3.1 percent for projects of 30 years or longer. For more information see http://www.whitehouse.gov/omb/circulars/a094/a094.html

What does changing the life cycle years do?

Changing the life cycle years changes the number of years over which costs and benefits for the site are calculated. Each infrastructure component is assigned a lifespan, so for example, a 100 year life cycle analysis may include the construction cost of the concrete sidewalk and driveway (30 year lifespan) four times. Different life cycle analysis periods are useful for different reasons, for example the 100 year analysis is useful for comparing green infrastructure options to traditional stormwater infrastructure, while the 30 year analysis is useful for considering green infrastructure investments in terms of the average mortgage length.

Will you change the site over time?

Absolutely. This is the first phase of a long-term project. We will make improvements to the site every month and post the changes made. Please use the feedback mechanism to suggest changes, identify new research and give us your ideas.

Original Green Values Calculator

- Calculator
- FAQ
- Methodology
- Feedback
- How can something like this be accurate?
- Why can't I evaluate new urbanism concepts such as clustered housing, narrow streets and shorter driveways?
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  - Soil type?
  - Average roof size?
  - Average number of trees?
- What is "real discount rate?"
- What does changing the life cycle years do?
- Will you change the site over time?

FAQ

General Questions

How can something like this be accurate?

The Green Values Stormwater Toolbox aims to help people evaluate sustainable design opportunities. It is based on extensive research into the long-term costs and effectiveness of green infrastructure approaches. Its results are still approximations based on research-based assumptions of green infrastructure performance, soil types, cost ranges, and other key factors. Results of the calculator are as accurate as our estimates can be, given current research. Results are not, in this version, meant to substitute for detailed, formal design and engineering assessments.

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You can do that. Simply designate the conventional sizes for street width and driveways on one run, copy the results, and use narrower streets and smaller driveways on another and compare the results. The option of using "Half of lawn replaced by garden with native landscaping" could simulate a development where half the area is left open. The shorter streets common in new urbanism could be simulated by making the lots bigger and putting more rooftop and pavement on each lot to arrive at the same number of homes.

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From: Swanson, Robert [mailto:Robert.Swanson@dupageco.org]
Sent: Tuesday, June 15, 2010 5:15 PM
To: Walkenbach, Amy
Subject: Illinois Green Infrastructure Study.

Dear Ms. Walkenbach,
I have attached comments from DuPage County Stormwater Management to this email. Additionally, some typographical errors in the report that should be corrected before the report is submitted to Illinois General Assembly are listed below.

Robert Swanson

Stormwater Management staff noticed several errors during review of the document:

1. Page 7, Table ES-1; Periods missing at the end of paragraphs one, four, and five.
2. Page 9, Figure ES-1; "Infiltration" should be "Bioinfiltration" to match the descriptions in Table ES-1.
3. Page 10, Line 26; The second "and" of the sentence should be "an".
4. Page 12, Line 5; "IEPA issued its first MS4 permit in February 2003," but staff assumes that was the date for the Phase II Permit. A Phase I MS4 must have been issued before that time.
5. Page 14, Table ES-3; Should include word "County" after the mentioned counties.
6. Page 17, Line 4; This sentence is unclear.
7. Page 32, Figure 2A; There should not be a period following "Nitrogen".
8. Page 38, Line 23; DuPage County's Water Quality Improvement grant program has been in existence since 2000; however, examples of funded projects were only provided to the authors for projects for the past three years to serve as examples of the types of projects funded.
9. Page 39, Line 42; "…which can be seen as the building blocks of **a** community scale green infrastructure program**s**."
10. Page 53, Line 7; The backslash should be between the words "and" and "or".
11. Page 53, Line 11; There is no period at the end of the sentence.
12. Page 56, Line 18; The word "developmend" should be "development".
13. Page 59, Line 14; The word "insure" should be changed to "ensure".
14. Page 64, Line 10; There is no period at the end of the sentence.
15. Page 85, Line 28; There is an extra bullet point on this line.
16. Page 92, Line 15; There is no table number for the referenced table, which is Table 10.
17. Page 112, Line 4, Text "Figure 10" should be changed to "Figure 11".
18. Page 112, Figure 10; Should be changed to "Figure 11".

DU PAGE COUNTY
ECONOMIC DEVELOPMENT & PLANNING
Robert J. Schillerstrom, County Board Chairman

BUILDING & ZONING • ECONOMIC DEVELOPMENT • ENVIRONMENTAL CONCERNS • LAND USE • STORMWATER MANAGEMENT
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June 15, 2010

Amy Walkenbach
Illinois Environmental Protection Agency
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Walkenbach:

Thank you for allowing DuPage County Stormwater Management the opportunity to comment on the report *The Illinois Green Infrastructure Study*. While supporting the concept of the expanded use of green infrastructure throughout Illinois watersheds, there are some areas of the report that require comment.

1. **Alternate, more consistent funding sources should be supported besides the CWSRF to financially assist in the permitting, construction, and long-term maintenance of green infrastructure projects.** While the CWSRF has been identified as a possible funding source to promote green infrastructure, the report notes that there has "…not been an outpouring of applications for green project funding from CWSRF." The report continues, "Municipalities have only rarely invested their own money in such projects…first and most important reason for this is the lack of knowledge of the benefits of, and experience working with, green infrastructure…compounded with the policy decision to provide grant funding for only 25% of project costs, a number many municipalities said would not support an application for innovative projects." Another factor that may contribute to the lack of applications, thus, implemented projects, is the uncertain nature of funding. It is difficult to budget for a project years in advance, including completion of the permitting process, if it is not known if or when financial assistance will be available for project construction. Additionally, all costs and development of expertise necessary for continued maintenance of the infrastructure must be financed for years following grant receipt and project construction. The report does sufficiently summarize full cost pricing and the need for a stormwater management fee system, as well as outlining many outstanding maintenance questions in Table 8. A fee system is necessary if "periodic performance monitoring and compliance reporting…to promote long-term reliability and performance" is required from municipalities.

2. **IEPA should support the development of watershed-specific green infrastructure guidance manuals.** Such manuals should include both appropriate practices for that watershed, depending on existing conditions and pollutants of concern for impaired waterways, as well as monitoring and reporting requirements. As noted in the report, "The state should develop guidance to ensure that green infrastructure practices are used appropriately to work

more effectively...Illinois EPA should work with county and local officials, regional stormwater management agencies, soil and water conservation districts, and drainage districts to begin to develop uniform protocols for the green infrastructure compliance monitoring and state-wide guidance for the reporting requirements." Development of watershed-specific guidance manuals will allow local experts to provide input, as it is recognized that "a state-wide one-size fits all will not work" due to varying conditions between watersheds. A watershed approach will allow for the relocation of a green infrastructure project from one property, where it may be required, to a different area of the watershed where it would be more successful or appropriate. Assessing each watershed independently would be beneficial in the adoption of watershed-specific stormwater retention performance standards or volume control requirements, as well as the entire MS4 permitting system.

3. **The report is misleading about the extent to which ILR40 requires private property owners to retrofit their existing development with green infrastructure practices.** While the language of the reissued permit does expand the applicability of stormwater management to developed, private land, the requirements do not suggest establishing requirements to retrofit existing property. As stated in ILR40:

> d. develop and implement a program to minimize the volume of storm water runoff and pollutants from existing privately owned developed property that contributes storm water to the MS4 within the MS4 jurisdictional control. Such program may contain the following elements:
>
> i. source identification- establishment of an inventory of storm water and pollutants discharged to the MS4
> ii. implementation of appropriate BMPs to accomplish the following:
>
> A. education on green infrastructure BMPs
> B. identify a relevant set of BMPs for all departments
> C. evaluation of existing flood control techniques to determine the feasibility of pollution control retrofits
> D. implementation of additional controls for special events expected to generate significant pollution
> E. implementation of appropriate maintenance programs, including maintenance agreements, for structural pollution control devices or systems
> F. management of pesticides and fertilizers
> G. street cleaning in targeted areas

While the report states, "Green infrastructure retrofits are already part of the Illinois MS4 program," obviously, these suggested program components are far from a requirement to retrofit existing developments with green infrastructure components. ILR40 correctly recognizes that the permittee is best suited to identify which programmatic elements will minimize runoff volume and pollutant loads given limited financial resources. Expansion of these requirements to mandate a certain percentage of green infrastructure retrofits on private property requires reevaluation of the methods by which stormwater related costs are currently financed, as administrative, project, and maintenance costs for these requirements will be much greater than costs associated with current permit requirements.

Sincerely,

Robert Swanson
Water Quality Specialist
Stormwater Management, DuPage County

14 June 2010

Illinois EPA
Bureau of Water
P.O. Box 19276
Springfield IL 62794-9276

RE: Public Comments for Green Infrastructure for Clean Water Act Draft - Final Report

Dear Amy Walkenbach,

We have reviewed the Green Infrastructure for Clean Water Act Draft - Final Report and would like to provide the following comment on behalf of The Morton Arboretum Soil Science laboratory and the Illinois Arborist Association.

We feel that a document of this magnitude and importance should not overlook the vital role of trees in green infrastructure. Urban trees and forests are effective and important bioinfiltration systems for handling stormwater. Urban trees and forests intercept rainfall and temporarily store it in the canopy, direct precipitation to the soil through stem and trunk flow, and take up pollutants and stormwater with their roots (Xiao and McPherson 2003; Johnson and Lehmann 2006). The study by Xiao and McPherson (2003) found that individual tree canopies can intercept as much as 79% of a 20-mm, 24-h rainfall event. Furthermore, Bartens et al. (2008) found that urban tree roots increased infiltration rates in compacted urban soils by an average of 153%.

Urban trees are identified as an area of research need on page 101-102 of the draft, but we feel strongly that more attention needs to be directed towards urban trees and forests prior to this section. Additionally, the two references in this discussion appear to be are improperly cited. I suspect, Bartens et al. 2009, should be cited as Bartens et al. 2008, as reported below. Secondly, Van Roon (2005) does not appear to be listed in the References section.

To rectify this problem, we suggest specific identification and emphasis on urban forests and trees and green infrastructure. For, instance in Table 1: Description of Stormwater Infrastructure Practices on page 24, we suggest listing urban forests as a specific example of Bioinfiltration.

Sincerely,

Bryant C. Scharenbroch, Ph.D.

Urban Soil Scientist at The Morton Arboretum
Research Chair of the Illinois Arborist Association
P.O. Box 860; Antioch, IL 60002
Tel: 877-617-8887; Email: iaa@wi.rr.com

References cited:

Bartens, J., S.D. Day, J.R. Harris, J.E. Dove, and T.M. Wynn. 2008. Can urban tree roots improve infiltration through compacted subsoils for stormwater management? J. Environ. Qual. 37:2048–2057.

Johnson, M.S., and J. Lehmann. 2006. Double-funneling of trees: Stemflow and root-induced preferential flow. Ecoscience 13:324–333.

Xiao, Q., and E. McPherson. 2003. Rainfall interception by Santa Monica's municipal urban forest. Urban Ecosyst. 6:291–302.

DRSCW

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Naperville, Illinois 60565
www.DRSCW.org

Phone: 630-768-7427
Fax: 630-428-4599

Amy Burns Walkenbach
Illinois EPA
Acting Manager, Watershed Management Section
Illinois EPA, Bureau of Water
1021 N. Grand Ave. East
Springfield, Illinois 62794-9276

June 15^{th} 2010

Dear Ms. Walkenbach,

Thank you for providing “The Illinois Green Infrastructure Study” for review. Moving away from a sole reliance on “grey” infrastructure promises less expensive construction, a reduction in pollutant and flood abatement costs, and auxiliary benefits such as public amenity and wildlife habitat. In fact, the extensive monitoring and bioassessment work performed by the DuPage River Salt Creek Workgroup (DRSCW) has brought these concerns to the forefront. The primary stressors to aquatic life in our watersheds come from habitat modifications and stormwater inputs. There is a tremendous amount of work that can be undertaken to improve the quality of our local streams by implementing BMPs, enhancing habitat, reducing stream bank erosion, and providing protective riparian areas. The DRSCW is supportive of the incorporation of such concepts into infrastructure development and retrofits.

To that end the DRSCW has a number of comments, while some of these comments are critical of certain aspects of the paper; they should not be interpreted in any way as arguments against the overall concepts outlined by the paper.

The DRSCW suggest modifying the title to “A review of Selected “Green” Infrastructure and state practices for Stormwater Management in Illinois”. Green infrastructure in the paper is quite narrowly defined in terms and storm water quality and volume control. The DRSCW would suggest, as in the IDNR addendum that “green infrastructure” covers more than limited number of stormwater BMPs reviewed in the report and the title should reflect that. Additionally this approach should, begin by maintaining as many of the hydrological and natural functions of the landscape as possible. This was mentioned in the introduction but missing from the rest of the report. The DRSCW would urge that riverine features such as meanders, stream banks and riffle sequences should be added to IDNRs expanded list of features covered by “green infrastructure”. Urban streams in northeastern Illinois have been stripped of these features and this fact undoubtedly makes achieving performance standards more difficult.

Although the report does include an appendix documenting the relationship between wildlife habitat and green infrastructure the discussion was limited to riparian areas (perhaps understandably as filtration was one of the methods focused on in the report), and failed to list any of the benefits riparian vegetation has for aquatic communities. Such relationships have been documented by *Gorman, O. T., and J. R. Karr. 1978. Habitat structure and stream fish communities. Ecology 59:507–515* and others (other references supplied separately).

While the DRSCW fully supports reducing both stormwater pollution and volumes, it would caution against being too prescriptive at the State level. Ideally the State should define the water quality goals but not necessarily the means and methods of reaching those goals. The IEPA should set an expectation through the MS4 permit program that stormwater runoff BMPs should be targeted at TMDL compliance and first flush treatment, and that green infrastructure is a preferred but not absolutely required part of that solution

Pages 10, 17,21, 37 and 99 all make references to the use of the State Water Revolving Fund (SWRF) as a possible tool to fund investment in stormwater green infrastructure. The American Reinvestment and Reinvestment Act (ARRA) earmarks 20% of the State Funds Capitalization grants for such purposes and mandates that some portion of the funds be provided as grants as opposed to loans. To date the Illinois SWRF has been used solely for the funding of waste water management projects providing capital outlays in the form of low interest loans. The expressed purpose was to provide a fund in perpetuity to allow local governments to make the large capital investments needed for replacing and upgrading wastewater infrastructure. Waste water infrastructure is often local government's single largest investment. As such we concur generally with the conclusions set out on page 39 lines 6-12 and again on page 100 lines 5-12.

However the recommendation set out on page 99 (lines 12-20) appear to make the opposite case, suggesting that despite a projected growth in demand for the funding of green infrastructure that "may exceed" the 20% (presumably some of which will be in the form of grants), there would be "no negative consequences" to the SWRF. The DRSCW is concerned about eroding the purchasing power of the SWRF in Illinois, as the report notes on pages 18 and 100 "Historically the SWRF program has funded only about ten percent of the water infrastructure needs of the applicants. Therefore the WSRF *cannot* be relied upon for funding either the sorely needed upgrades to existing conventional waste water and stormwater infrastructure or the green projects " (emphasis ours). The DRSCW concurs with this position. If grants for green infrastructure are to be made available through the SWRF, the DRSCW argues that it is vital that stringent policies be adopted to ensure that the purchasing power of the SRF's funds available to waste water management be maintained at current levels

In the experience of DRSCW members, a large percentage of developments that have incorporated green infrastructure are privately owned and funded. The inclusion of green infrastructure is correctly cited in the report as usually providing significant savings over grey infrastructure alone for initial installation cost and life cycle costs. Green infrastructure is also increasingly required as part of BMP requirements in local ordinances and MS4 permits. As such, a financial incentive for green infrastructure should be unwarranted based simply on economics and any use of public funds, whether through a grant or loan, should be only for public projects. In terms of encouraging local investment in green infrastructure, the DRSCW would also draw attention to the fact funds for such investments already exist in the form of NPDES permit fees paid by NPDES permit holders statewide. Returning these funds to their original purpose of improving state surface water would certainly spur local government investment in such infrastructure.

Table ES-2 shows the savings on three developments under conventional and green construction scenarios. Are the savings projected or realized. If realized, the completion date should be included in the table. Also the cost savings for the life cycle are presumably a net present value. Some of the assumptions such as the discount rate used in calculating the value should be given (as they are for the example on page 40 paragraph 3).

In addition it is noted that TSS aids in the transport of heavy metals (and indeed others pollutants such as PAHs). It is essential to note that while TSS, metals and PAH concentrations are all highly correlated in storm water washoff, that relationship is a function of TSS particle size with the concentrations of the carried pollutants increasing with increases in the <250 μm fraction of TSS[1]. Obviously in selecting a stormwater management system such considerations are critical and percentage removal of TSS as an indicator of capture of metals and PAHs misleading. Also it has been noted for several years that the size fractions in TSS can make the parameter difficult to measure by traditional means[2].

Page 28 states that percent removal is a common dimensionless measure of effectiveness. While the use of percent removal is common, and probably unavoidable, ultimately the development of site specific performance standards for BMPs will be necessary to measure impact. Several studies have noted that the use of percentage reduction for evaluating BMPs is problematic for a number of reasons including removal rates being sensitive to the concentration of pollutants in the influent.

Page 34- the Semadeni-Davies study referenced found that concentrations of chloride (not elemental chlorine) were higher in discharges from detention ponds during cold weather months in cold climates.

The DRSCW suggests that local watershed organizations be included among the list of organizations and agencies mentioned in the Administration section of the report (pages 16 and 17). While the DRSCW has no regulatory authority, local watershed organizations such as the DRSCW can provide valuable functions in this process, including providing detailed monitoring information to assess current stream conditions, recommend improvement projects and evaluate the effectiveness of BMPs and other projects; provide consistency in watersheds that span multiple counties; assist in the implementation of TMDL report recommendations and help to build consensus among stakeholders.

The following represent our conclusion on how the report met the scope (comments in italics):

(a) The nature and extent of urban storm water impacts on water quality in watersheds in Illinois; *Beyond some analysis based on the Center For Watershed Protection's 2003 study this point was not answered. Data for such an analysis exists in the State's Integrated Report and accompanying data sets as well as in several data sets for urban north eastern areas. Certain aspects of Illinois urban stormwater such as chloride loading will not be improved by the stormwater BMPs evaluated.*

(b) Potential urban storm water management performance standards to address flooding, water pollution, stream erosion, habitat quality, and the effectiveness of green infrastructure practices to achieve such standards. *The review of performance standards in other states was informative and useful. This item was partially fulfilled.*

(c) The prevalence of green infrastructure use in Illinois; *Fulfilled*

(d) The costs and benefits of green versus grey infrastructure; *Partially fulfilled but analysis incomplete.*

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[1] Sim-Lin Lau, Michael K. Stenstrom. *2005. Metals and PAHs adsorbed to street particles* Journal of Water Research 39 (2005) 4083–4092

[2] *USGS Policy (2000), Collection and Use of Total Suspended Solids Data,* November *27,* 2000 Offices of Water Quality and Surface Water Technical Memorandum

(e) Existing and potential new urban storm water management regulatory programs and methods and feasibility of integrating a State program with existing and potential regional and local programs in Illinois; *Partially fulfilled but feasibility not explored*

(f) Findings and recommendations for adopting an urban storm water management regulatory program in Illinois which includes performance standards and encourages the use of green infrastructure to achieve those standards; and *Partially fulfilled but analysis incomplete*

(g) The feasibility and consequences of devoting 20% of the Water Revolving Water Revolving Fund to green infrastructure, water and energy efficiency improvements, and other environmentally innovative activities on a long-term basis." *The report offers two contradictory opinions on this, in arguing for devoting 20% of the WRF to green infrastructure the report does not supply any supporting evidence or analysis. Neither are the merits of including energy efficiency improvements in such a move analyzed.*

It is also noted that the report is somewhat inconsistent in its use of certain terms and is unnecessarily repetitive. The repetitive nature makes the document difficult to read, longer than necessary and open to conflicting interpretations. In summary, the DRSCW is supportive of what is referred to in the report as "Green infrastructure" being included in state and local stormwater management practices, but via performance standards based on water quality goals. There are a number of vital river features that the term as defined in the report ignores, and several benefits from the management practices included that the report also ignores, namely positive impacts on aquatic communities. Without analysis, it is unclear what the proposed change would mean for the SWRF but the DRSCW has strong concerns about grants being made by the fund eroding its purchasing power and future viability. The analysis is limited to some of the site level technical merits of selected practices and does not offer guidance on the equally important issue of where to place them on the landscape.

Yours Sincerely

Kevin Buoy
DRSCW President

The Morton Arboretum
4100 Illinois Route 53
Lisle, IL 60532-1293

June 15, 2010

Amy Walkenbach
Illinois EPA
Bureau of Water
P.O. Box 19276
Springfield IL 62794-9276

Dear Ms. Walkenbach:

Thank you for the opportunity to review and comment on The Illinois Green Infrastructure Study, A Report to the Illinois Environmental Protection Agency.

The Study overlooks an important component of green infrastructure – the urban forest. The trees and forests that surround communities provide measurable, valuable ecosystem services, including storm water management.

This Study is a comprehensive literature review of green infrastructure, yet I feel it falls short of the intent of Public Act 96-0026 which states that Illinois Environmental Protection Agency shall submit to the General Assembly and the Governor a report that reviews the latest available scientific research and institutional knowledge to evaluate and document …green infrastructure.

While the body of research is laudable and credible, the Act also looks towards "environmentally innovative activities" which may not yet have been the subject of peer reviewed research. Moreover, the institutional knowledge, as evidenced by the supplement prepared by IDNR, indicates greater resources available for innovative solutions, like urban forestry.

The future direction of green infrastructure policy in Illinois could benefit by considering the following five points:

1. The broader definitions of green infrastructure include working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations. This would include trees and air.

> *"Green infrastructure is defined as an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations. In our view, green infrastructure is the*

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ecological framework needed for environmental, social and economic sustainability—in short it is our nation's natural life sustaining system.

"Connecting the trees, parks, and other urban green infrastructure at site and neighborhood scales to the surrounding waterways and other regional green infrastructure networks may well become the next great frontier in planning and government services.".

Green Infrastructure: Smart Conservation for the 21st Century. Benedict, Mark and Edward McMahon. Sprawl Watch Clearinghouse Monograph Series

Below **in bold** are references to this broader view of green infrastructure present in Public Act 096-0026, Section 10, yet absent in the report.

"Green infrastructure includes, but is not limited to, methods of using soil and vegetation to promote soil percolation, evapotranspiration, and filtration. Green infrastructure includes ***the preservation and restoration of natural landscape features, such as forests****, floodplains, headwaters, and wetlands. Green infrastructure also includes rain gardens, permeable pavements, green roofs, infiltration planters,* ***trees and tree boxe****s, and rainwater harvesting for non-potable uses, such as toilet flushing and landscape irrigation.*

Section 10,Legisative Finds also describes a number of benefits from the use of green infrastructure including:

(4) ***Cleaner Air****.* ***Trees*** *and vegetation improve air quality by filtering many airborne pollutants, thereby helping to reduce the incidence of respiratory illness.*

(5) ***Increased Energy Efficiency. Trees*** *and other vegetation create shade, reduce the amount of heat absorbing materials, and emit water vapor, which controls surface temperature, thus helping to* ***alleviate the urban heat island effect****.*

(6) ***Mitigation of and Adaptation to Impacts of Climate Change****. Green infrastructure strategies can reduce energy demands and, thus, greenhouse gas emissions by reducing storm water volume and the associated treatment required, reducing the amount of potable water needed, providing thermal insulation and shade for buildings, mitigating the urban heat island effect, and* ***sequestering carbon****.*

*(8) **Community Benefits**. **Trees** and plants improve urban aesthetics and community livability by providing recreational and scenic wildlife areas. Studies show that property values are higher, violence is reduced, and crime is reduced when trees and other vegetation are present.*

*(9) **Health Benefits**. Studies show that people who have access to the open space provided by green infrastructure in their communities get more exercise, live longer, and report better health in general. Exposure to green infrastructure (even through a window) improves mental functioning, reduces stress, and reduces recovery time from surgery.*

The Illinois Green Infrastructure Plan does not address any of the above benefits of green infrastructure. These are benefits handily provided by community trees and forests.

2. Tree canopy is a valuable metric to measure green infrastructure function.

A sophisticated ecosystem service modeling tool, called *i-Tree Eco,* developed by the US Forest Service measures and quantifies these services. A US Forest study published in April, 2010, Assessing Urban Forest Effects and Values: Chicago's Urban Forest (Nowak, Crane, Hoehn, Stevens, Fisher) determined the structure and function of Chicago's urban forest as:

Feature	Measure
• Number of trees	3,585,000
• Tree cover	17.2%
• Pollution removal	888 tons/year ($6.4 million/year)
• Carbon storage	716,000 tons ($14.8 million)
• Carbon sequestration	25,200 tons/year ($521,000/year)
• Building energy reduction	$360,000/year

The Morton Arboretum is collaborating with the US Forest Service to complete an urban forest assessment of the 7-county metropolitan region, called the 2010 Tree Census in the summer of 2010. This study will assess the landscape and measure the ecosystem services of the urban forest across all land use types. The results of this study should inform future green infrastructure policy.

3. Trees are a common, accepted and valued component of urban landscapes. Maximizing tree canopy is simpler than adding new landscape elements like rain gardens and bioswales.

In fact, the planting, preservation and maintenance of urban tree canopy, as a green infrastructure practice is not addressed in the study. Urban forestry is a popular and established green infrastructure practice throughout Illinois, as evidenced by the 183 Illinois communities awarded Tree City USA, the national urban forest stewardship awards programs. Statewide, these communities spend about $82 million, or $12 per capita on average, planting and caring for community trees

A US Forest Service and Western Illinois University study of Illinois mayors and managers in 2002 found 99% of respondents agreeing that trees improve community appearance and 90% also agreed that trees are important for maintaining a healthy community environment and quality of life (Green, Schroeder, Howe.) Increasing tree canopy as a means of providing greater ecosystem services is likely to be widely acceptable and achievable. Trees also readily integrate with other green infrastructure practices such as rain gardens and bioswales.

4. Likewise, much is known about the cost effectiveness of urban forestry.

The Midwest Community Tree Guide, Benefits, Costs and Strategic Planning, published by the US Forest Service in 2006 (McPherson, Peper, Maco, Cozad, Xiao) examined all planting and maintenance costs of both public and private trees. And it considered all the environmental service provided by trees over a 40 year period. Large landscape trees had a benefit/ cost ration of 6.5 and large street or park trees had a benefit/cost ratio of 2.67.

5. Since trees add a vertical layer of green to built environments, the environmental function of urban land is enhanced without compromising its original use. i.e. a large tree stretching up and over a suburban yard adds significant leaf surface area above impermeable roofs, driveways and turf to intercept rainfall. More research is needed to understand trees impacts on stormwater management.

The Illinois Green Infrastructure Study acknowledges the need for more research on the impacts of urban forestry on stormwater. However, the scope of the Public Act 096-0026 including benefits; the broader definition of green infrastructure that prevails nationally; and the Public Act's call for innovation and collaboration to solve our state's need for green infrastructure services call for a more comprehensive Green Infrastructure Plan that addresses the role of trees and urban forests.

Sincerely,

Edith Makra
Community Trees Advocate

To: Amy Walkenbach, Bureau of Water IEPA

From: Andrea Cline, The Conservation Foundation

Date: June 14, 2010

Re: Green Infrastructure for Clean Water Plan

The Conservation Foundation has reviewed The Illinois Green Infrastructure Study and offers the following comments:

- Green infrastructure is broader than what is covered in the report. Perhaps the qualifier “for stormwater” should be added to make the scope of the report more clear.
- Funding green infrastructure for stormwater through the State Water Revolving Fund is concerning. Wastewater improvement projects, which the fund was created for, are expensive to maintain and modernize. As indicated on page 39, the SRF does not come close to funding the necessary projects. Therefore it seems illogical to direct funds away from this. It is unclear how the authors came to the conclusion stated on page 99, that there would be no negative consequences for funding green infrastructure in this way.
- It appears that funding energy efficiency improvements through the Water Revolving Fund is out of scope of the program.
- Various studies have concluded that there is a cost savings in implementing green infrastructure over gray infrastructure and therefore a cost incentive program seems unnecessary. Green infrastructure is also required by many municipalities in compliance with NPDES permits.
- The discussion on page 12 regarding NPDES permits leads the reader to believe that only small MS4s are required to get an ILR40 permit. This paragraph could use further clarification.
- The document was quite long and two weeks notice to read and prepare comments is really insufficient.

Robinson
ENGINEERING

Dana E. Ludwig, PE
CFM, CPESC, LEED AP
Direct Line: (815) 412-2702
Email: dludwig@reltd.com

June 15, 2010

Illinois EPA, Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Attn: Amy Walkenbach

RE: Illinois Green Infrastructure Study

Dear Ms. Walkenbach:

On behalf of Robinson Engineering, I read the Draft Illinois Green Infrastructure Study and provide the following additional comments and questions.

Chapter 1: Introduction
No comments or questions at this time.

Chapter 2: Effectiveness
No comments or questions at this time.

Chapter 3: Funding

1. Support through public outreach and education: I support the recommendation that IEPA increase resources and efforts in outreach and education [page 39, lines 2-5]. Has the IEPA considered a Public Service Campaign? There have been several commercial ads (Forest Fires, Crime Prevention, etc.) that reach a large public audience through the use of one of the most popular media type, television.

2. Fee programs and utilities: Has the IEPA collected research or have guidance materials available for communities to implement a fee program? This is another somewhat unpopular or uncommon practice in our client communities, mostly because little is known about it. More support may be garnered by more information and more tools [page 39, lines 16-17].

3. Costs of Green Infrastructure (General and Scenarios): The tables provided have minimal data; perhaps the data should be expanded to support a statewide report [page 41, Table 3 and page 43, Table 4].

4. Costs in Three Development Scenarios: The report should include more project types and sizes. Some counties in Illinois have very large scale developments (100 acres and up to a square mile). There are other areas in Illinois that are currently built out to a high percent impervious that might expect to redevelop with a very similar percent impervious. This table, and the report, do not contemplate those communities.

   This table also does not address the loss of "buildable" land, to which a developer would assign some dollar value. For example, assuming that the new Green Infrastructure Act does not permit (or promote) underground detention systems, a redevelopment project may actually lose building square footage and parking lot acreage in order to accommodate the GI, what value is lost in examples of this scenario?

Chapter 4: Current Practices

5. Will County Regulations: The Volume Control Mechanism applies only to properties upstream of agricultural properties, *not* the entire county [page 52, Table 7 and page 56, lines 32-24]. Please refer to Section 203.5 of the Will County Stormwater Management Ordinance, also known as the "countywide" ordinance: http://willcountylanduse.com/DevReviewDiv/SubEng/SubEngDocs/StormwaterOrd_20100325.pdf.

6. Will County Regulations: The Green Infrastructure Allowance applies only to subdivisions in unincorporated Will County, *not* the entire county [page 52, Table 7 and page 57, lines 14-21]. Please refer to Sections 10-04 and 31-04 of the Will County Subdivision Ordinance: http://willcountylanduse.com/DevReviewDiv/Current/Documents/SubOrd/Subdivision%20Ordinance_20100601.pdf. Please note that the "countywide ordinance" states that "best management practices *may* be required pursuant to the United States Clean Water Act" under Section 202.10: http://willcountylanduse.com/DevReviewDiv/SubEng/SubEngDocs/StormwaterOrd_20100325.pdf.

7. Will County Regulations: The required use of practices listed applies only to croplands, pasturelands, farmsteads and outbuildings associated with agricultural practices, *not* the entire county [page 57, lines 1-13]. Please refer to Section 204 of the Will County Stormwater Management Ordinance: http://willcountylanduse.com/DevReviewDiv/SubEng/SubEngDocs/StormwaterOrd_20100325.pdf.

8. Homer Glen Regulations: The BMP hierarchy and regional detention provision are not unique to Homer Glen [page 59, lines 10-13 and 16-17]. These items were written to be parallel to the Will County Water Resource Ordinance (enforceable within unincorporated Will County since, last updated in 1999). Please refer to Sections 500.0 and 800.0: http://willcountylanduse.com/DevReviewDiv/SubEng/SubEngDocs/waterresourceord_Oct07.pdf.

   However, there are other documents that are noteworthy in the Village of Homer Glen with respect to the Green Infrastructure Act, including the Conservation Design Ordinance and Green Vision Plan: http://www.homerglenil.org/Ordinances/OR06-051ConservationDesign.pdf, http://www.homerglenil.org/Environment/Green%20Vision/04%20Section%203%20Executive%20Summary%20Report.pdf.

9. Clay soils & winter climate: The concern is well defined on page 61 and first part of page 62; however, no detail, explanation or even summary is provided regarding the 57 peer reviewed research articles [page 62, lines 17-19]. How many of these articles covered clayey soils and climates similar as northern Illinois? How many and what kinds of projects were successful? [page 62, lines 26-29]. How was their successfulness measured, as pollutant removal or peak flows? What was observed during freeze and snowmelt saturation conditions? What explanation for success can be provided without infiltration during these conditions? Or what were the levels of infiltration during these conditions? Were storm events documented during freeze and snowmelt in these projects? How was the BMP designed to prevent structural flood damage in consideration of reduced infiltration? What would the cumulative effect on streams and creeks be with the addition of Green Infrastructure during winter saturated snowmelt conditions? What technical support will be given to help overcome these concerns?

   Furthermore, no detailed discussion is provided regarding soil types, either impervious soil types or even pervious soil types with respect to incidents of flooding and flood damage as a result of increased infiltration.

10. Covered Area: Does the IEPA intend to update the Exempt List and issue/reissue Waivers for MS4s after the 2010 Census is complete? How does the Census timeline and Green Infrastructure timeline compare?

[page 91, lines 31-24]. Furthermore, does the "percentage of impervious" apply to the entire community or each site? [page 91, line 24].

11. Assumed Impermeability: It may be simpler to use already defined and understood criteria, such as runoff coefficients or runoff curve numbers rather than use an "assumed permeability" [page 92, Table 10]. This information is readily available for municipalities to provide their initial calculation of areas treated since the "c-value" or "RCN" is already calculated in each stormwater report that the municipalities have on file.

Chapter 5: Recommendations

12. Overall: The recommendations are not well defined. What detail and/or criteria will be defined by the State? Will most of the criteria and administration be determined by each County?

13. Delegation: It appears that the IEPA recommends that counties will manage program. Will the IEPA provide a base document or guidelines to assure consistency?

14. Support information: The report does not mention any future technical guidance for GI, including design, construction, maintenance and inspection criteria. This will be a very important tool for effectiveness as well as willingness for compliance.

15. Target Percentage: Has sample data been collected to assess what portion of communities are currently treated by Green Infrastructure? I would recommend that a range of community types be examined prior to establishing the criteria so that various sizes and locations are taken into consideration.

16. Areas most significantly affecting water quality: The areas impacting water quality the most may be the same communities with the least opportunity for redevelopment (from an economic and market perspective). They may also have high percent impervious without much ability to modify green space. These communities may also be the ones needing the most guidance and tools to comply with the Green Infrastructure Act [page 98, lines 39-40]. What assistance will be available for such communities?

Thank you for this opportunity to comment. I commend the extensive research by the group and look forward to seeing the final report. If you would like to discuss any of these items, please feel free to contact me.

Very truly yours,

ROBINSON ENGINEERING, LTD.

Dana E. Ludwig

Dana E. Ludwig, PE
CFM, CPESC, LEED AP
Project Engineer

xc: Sean Kelly, PE, CFM - Robinson Engineering, Ltd.

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June 18, 2010

Ms. Amy Walkenbach
Acting Manager, Watershed Management Section
Illinois Environmental Protection Agency
1021 N. Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

Dear Amy:

Thank you for the opportunity to provide some initial comments on the recent Illinois Green Infrastructure Study draft report.

As you are well aware, the Illinois Association of REALTORS® (IAR) has consistently participated in discussions on legislation and regulations on various water issues, including stormwater management, in recognition of the impact of such regulatory proposals on the real estate industry and private property owners. The following dot points highlight some of our concerns after reviewing the draft report:

- A primary concern is funding for the implementation of a green infrastructure program. We are concerned with several references to granting counties expanded legislative authority or requiring local governments to move toward full cost pricing-particularly without reference to any type of voter input. Further, these enhanced county powers could lead to opposition from municipalities or other units of local government. There was also a suggestion for establishment of a "stormwater utility" with an independent budget and significant regulatory powers over private property which would need to be fully debated.

- The IAR has actively sought amendments to the state's Special Service Area law to provide for enhanced disclosure requirements to property owners for the increasing use of back-up (or dormant) Special Service Areas (SSAs). While these assessments appear on property tax bills, they are only tax deductible on federal income tax forms if the assessment is for the repair or maintenance of existing infrastructure. The assessment is NOT tax deductible if it is for new infrastructure. The interest portion of the assessment is tax deductible ONLY IF the taxing body separates the principal from the interest- which is not done in most situations. This draft report anticipates much more aggressive use of SSAs which, as noted above, would add a significant financial burden on already over burdened property taxpayers.

- Maintenance costs and enforcement are significant issues that have not been fully vetted. The cost to private property owners as well as to local governments warrants much more discussion and study. One could argue that the costs of a significant public benefit would be shifted to certain property owners.

- It is unclear how existing developments and existing property owners may be impacted by the application of any new standards. We are also concerned about a potential negative impact on in-fill development.

- We believe that any state or local program be based on incentives to encourage the use of green infrastructure.

- The potential infringement of private property rights warrants *much* more review. Restrictive covenants, easements held in perpetuity, authority to enter upon a private property owner's land, nuisance liens -are concepts that raise a red flag with the IAR.

- We were struck with the statements in the report such as "not based on scientific research"; "not yet been subjected to rigorous scientific analysis"; "little published data to support them"; "more scientific data on the effectiveness of these techniques....would be useful".

- While the report focuses on urbanization we believe that there should be further breakdown of sources of water pollutants, particularly for run-off from agricultural lands.

Thank you again for the opportunity to make some comments on the draft report. I look forward to continuing to work on this issue as it progresses.

Sincerely,

Julie M. Sullivan
Assistant Director Legislative and Political Affairs
Illinois Association of REALTORS®

IAFSM
Illinois Association for Floodplain and Stormwater Management

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June 21, 2010

Illinois Environmental Protection Agency
Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

Attention: Amy Walkenbach

Subject: The Illinois Green Infrastructure Study, a report to the Illinois Environmental Protection Agency, dated May 28, 2010

Dear Ms. Walkenbach:

The Illinois Association for Floodplain and Stormwater Management (IAFSM) represents over 600 stormwater and floodplain managers, engineers, local officials, insurance agents, and state and federal agency staff. IAFSM would like to provide input to the above-referenced study and register our dismay about the short comment-response period allotted following the publication of the draft final report and the limited distribution.

Despite the short response period allotted, our Board received a number of comments and concerns from members regarding the study. Due to the time constraints we recommended that they submit those comments directly to you.

IEPA's report would greatly benefit from integrating comments from professional stormwater managers and engineers. Doing so in a manner that involves interaction with the diverse group of stakeholders of this study would require more than the time remaining prior to the June 30, 2010 submission deadline to the Illinois General Assembly.

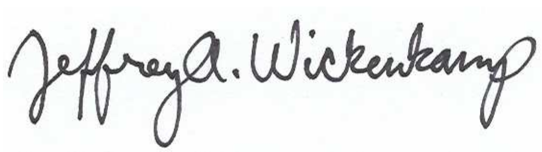
Many of our members have been actively involved in adopting local ordinances and regulations in the past 20 years, and once a draft document was developed as part of those processes there has always been a much longer period of interaction with the stakeholders than that currently allotted for the Illinois Green Infrastructure Study. Given that this document is being proposed as a basis for statewide regulation, we strongly recommend that IEPA extend the submission deadline to provide a proper venue for a comment-response period.

In particular, our members have listed concerns about:

1. The insufficient time allotted for the authors to consider and incorporate the comments on the report, which will diminish its credibility.
2. The methods used for performing cost analysis of green infrastructure.
3. The lack of distinction between uses of green infrastructure for water quality improvement, as opposed to control of flood producing events. It is not clear if the report is suggesting that green infrastructure alone will reduce peak flow rates for large design storm events.

In summary, IAFSM supports the use of green infrastructure for improvement and protection of Illinois's aquatic resources. However, any potential state-wide regulations must be based on a fully vetted process wherein diverse stakeholders participate in the preparation of the recommendations. The current Green Infrastructure Study has not accomplished this objective. We encourage IEPA to delay the submittal of the report to the Illinois General Assembly until such corrective actions can be implemented.

Sincerely,



Jeff Wickenkamp, PE, CFM, D.WRE
IASFM Chair

Submitted by Rob Sulski (Illinois EPA) by email June 24, 2010 10:48 a.m.

Intern Kim Israel and I read through "The Illinois Green Infrastructure Study" and have the following general comments. The study focuses on some, but is silent on or glosses over other of the specific mandates in Section 15 of PA096-0026. With respect to the mandates, the report would benefit by including more discussion as described below:

1. 15 "(a) The nature [e.g. phosphorus, biosides, chlorides and other deicers, lbs. of pollutants, algal blooms, hypoxia, sedimentation, etc.] and extent [e.g. down to and into the Gulf and throughout the waterways] of urban storm water impacts on water quality in watersheds in Illinois ...."
2. 15 "(c) The prevalence of green infrastructure use in Illinois…."
   The report could include statistics on how many 319, SRF and other green projects have been completed or are in progress; how many acres, stream miles, etc. have been installed; how many gallons of rain have been intercepted and allowed to seep versus run off; how many pounds of nutrients and soil have been kept out of waterways …. Also, green gardens and other native deep-rooted, non-turf grass installations are relatively inexpensive storm water fixtures, however, the report generally addresses such practices only in regards to relatively expensive green roofs. There are many more opportunities for green landscapes other than green roofs.
3. 15 "(d) The costs and benefits of green versus grey infrastructure…."
   The report could expand upon costs. For example, what are the costs associated with: lost crop revenue and maintenance associated with stream buffers; installing/maintaining traditional, shallow-rooted, rain-shedding, non-native turf grass versus deep-rooted, rain- and nutrient-absorbing, native grasses and forbs plantings; etc. OpenLands, TNC, and other Chicago Wilderness member organizations could provide cost amounts.
4. 15 "(f) Findings and recommendations for adopting an urban storm water management regulatory program in Illinois which includes performance standards and encourages the use of green infrastructure to achieve those standards…."
   Before one can even consider state mandates, one might undertake a more thorough evaluation of existing state and local regulatory, policy, procedural, etc. obstacles that prevent, impede or delay the installation of green infrastructure and remove or modify such obstacles. The report is deficient in this regard. For example, the permitting processes (IEPA, IDNR, USACE, counties, storm water management agencies, other local necessary to perform work within and along waterways and floodplains in urban areas is complicated and costly to get through and scares the average Jane or Joe away from undertaking and managing many potential projects. IEPA's and local government's requirements for obtaining and annually renewing individual permits for burn managing native systems are in themselves fraught with unnecessary, burdensome conditions and requirements. Another obstacle that comes to mind is weed or aesthetics ordinances that lump native grass and forbs installations into the weed category. Such obstacles are fairly common in local governments' ordinances and homeowner or condo association covenants. None of the very real obstacles listed above are discussed in the report.
   Regarding performance standards (See also comments under 1e below), more consideration needs to be given to longer-term management of green infrastructure installations. For too many years, regulatory agencies, engineers and consultants have concentrated on only the front ends of projects, with little consideration of long-term maintenance – the money is handed out and the recipients take it, construct the projects and runs away. As a result, most green installations have reverted back to dysfunctional, invasive, non-native species mono- or bi-cultures (purple loosestrife and reed canary grass in wet systems, and buckthorn and garlic

mustard in upland systems) that do not function in accordance with the intended green objectives. Restoration ecologists should have a strong voice in evaluating projects. The report is silent in this regard.

e. 15 “(g) The feasibility and consequences of devoting 20% of the Water Revolving Fund to green infrastructure, water and energy efficiency improvements, and other environmentally innovative activities on a long-term basis.”

A substantial portion of revolving fund money will be wasted unless more emphasis is placed on long-term, proper maintenance of green infrastructure. The report could recommend options to ensure long term maintenance is performed, such as requiring that a portion of a loan be held in escarole and released only if maintenance is performed. Loaner/grantor follow-up inspections of projects would be necessary.

Rob