Upgrade Your Infrastructure

Green Infrastructure Portfolio Standard

A Guide to the Green Infrastructure Portfolio Standard And Building Stormwater Retrofits

A JOINT EFFORT BY

American Rivers
The Center for Neighborhood Technology
The Great Lakes and St. Lawrence Cities Initiative

CONTENTS

HISTORY AND ACKNOWLEDGEMENTS

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Introduction

Despite an estimated $10 billion in Great Lakes and St. Lawrence local government investment in wastewater infrastructure annually, there still exists a growing infrastructure investment deficit in both the United States and Canada.[1] The American Society of Civil Engineers' 2009 Infrastructure Report Card estimates that in the U.S. alone, the additional investment in wastewater infrastructure needed over the next 20 years in the eight Great Lakes states is $72 billion, or about $3.6 billion per year, with more than half of this needed to eliminate overflows from combined sewer systems.[2] Such significant investment needs coupled with infrastructure that is overdue for replacement and repair in many communities, requires affordable solutions that meet many objectives at once. Green infrastructure is just such a solution.

STORMWATER IN WASHINGTON, DC | Photo by Lynette Batt

Green infrastructure is an approach to water management that uses natural systems—or engineered systems that mimic natural processes—to reduce water pollution and flooding, enhance overall environmental quality and provide utility services.[3] Unlike conventional stormwater management ("gray infrastructure"), which uses curbs, gutters and underground piping to convey water away from developed landscapes, green infrastructure relies heavily on water infiltration, evapotranspiration and collection to capture raindrops where they fall. Natural systems, such as plants and soils, as well as cisterns and rain barrels, provide these functions to manage rainwater onsite. As a result, green infrastructure is a more cost effective means of maintaining healthy waters, providing multiple environmental benefits and supporting sustainable communities. By weaving natural processes into the built environment, green infrastructure provides stormwater treatment, as well as flood mitigation, air quality management, energy savings, landscape enhancement, increased property values, and other benefits to communities.

[1] *Local Investment in the Great Lakes and St. Lawrence.* Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative. (2008) Retrieved from www.glslcities.org

[2] *Report Card for American's Infrastructure.* American Society of Civil Engineers (2009). Retrieved from http://www.infrastructurereportcard.org

[3] http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm

Green Infrastructure Portfolio Standard

The Green Infrastructure Portfolio Standard (GIPS) is an adaptation to stormwater management of the "renewable energy portfolio standards" adopted by over 30 U.S. states. The goal of renewable energy portfolio standards is to gradually but deliberately increase the use of electricity from renewable sources over twenty or thirty years. In the case of the GIPS, an urban municipality with a significant amount of impervious surface gradually scales up the use of green infrastructure, increasing the volume of stormwater runoff and pollutants retained on-site and reducing the amount flowing into the stormwater sewer system and surface waters. By doing so, the GIPS approach not only advances the water quality objectives of the Clean Water Act, but it is also a useful tool for community-scale green infrastructure planning and prioritization over a period of decades.

The overall objective of the GIPS approach is a steady reduction in the volume and pollutant load of the stormwater runoff in an urban (developed or "built out") drainage area. Ideally, the municipality should set annual goals that are small enough to be achievable, but large and consistent enough over a number of years to ensure significant continued progress.

In Renewable Energy Portfolio Standard (RPS) programs, on which the GIPS is modeled, the annual goal is typically set by law as a recurring 1% increase in renewable energy as a portion of the total kilowatt hours of energy sold to customers, usually continuing for periods of 25 years or more. Below is a chart showing the annual requirements for the Illinois renewable energy portfolio standard.

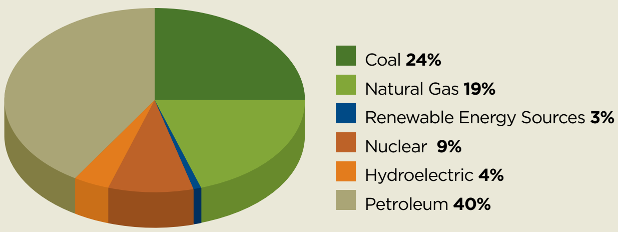
Electric utilities have the ability to plan for the production or purchase of specific quantities of energy, and measuring the quantity of electricity delivered can be easily calculated. Therefore, setting a goal prospectively of an annual 1% increase in renewable energy seems reasonable. It also helps that electricity is delivered over wires at a rate that is easily measured.

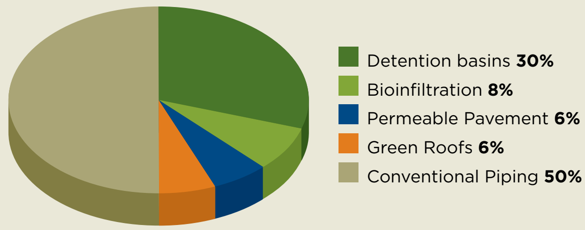
In contrast, in the field of stormwater management, we are much further from being able to measure the quantity of stormwater retention service "delivered" by a particular green infrastructure feature. While the concept of standardized volume reduction rates for individual green infrastructure techniques is something being discussed, for the purpose of this project we must rely on design estimates. More is said about this in the section on setting annual goals, but this limitation does not preclude us from utilizing the general concept an RPS provides — setting and achieving long term and annual goals that are to be attained at a measured but steady pace.

Illinois Renewable Energy Portfolio Standard Schedule

Energy Year	Overall Standard (% of Retail Electric Sales to come from Renewables)
2009	2%
2010	4%
2011	5%
2012	6%
2013	7%
—	—
2024	22%
2025	23.5%
2026	25%

Renewable Energy Portfolio Standard (RPS)





Applying the same concept to stormwater, we are trying to gradually increase the role green infrastructure plays in a municipality's stormwater management portfolio.

Why would your municipality consider a GIPS?

User Friendly Introduction to Green Infrastructure

There are a number of reasons a municipality might consider using the GIPS approach. Using GIPS as a planning tool allows a municipality to analyze the various infrastructure projects planned in a particular area and determine which projects might be best suited to incorporate green infrastructure elements. Green infrastructure can be incorporated into a select group of these projects and avoided in situations where it is less cost-effective. In addition, these green infrastructure projects would be built over the course of several years, spreading out the cost. This approach can be more budget-friendly and culturally easier to adopt in a municipality that has less experience with green infrastructure.

Helps Offset the Cost of Large Capital Investments

The GIPS approach can also help a municipality avoid some costly upgrades to its traditional gray infrastructure by supplementing it instead with green infrastructure. As municipalities develop over time, the portion of their land surface that is "impervious" to the infiltration of rain gradually increases. This increases the aggregate stormwater runoff that must be managed, requiring larger and larger piping systems and, in some cases, treatment systems to handle flows. Municipalities know all too well the expense of installing, maintaining, repairing, and upgrading these systems. Increasing infiltration and evapotranspiration with green infrastructure in a community increases permeability, thus reducing the amount of stormwater runoff produced and helping to ease the burden on a city's wastewater system and reduce the investment needed to install, maintain, repair or upgrade such systems.

Protects the Community's Valuable Water Resources

Scaling up green infrastructure through an approach like GIPS can help address several other water resource problems as well. For example, as impervious cover increases the natural recharging of the local groundwater decreases. If the area relies on groundwater for its source of drinking water it will find that source gradually disappearing over time. Additionally, without the groundwater to feed them, local streams experience gradually decreasing base flows, which means loss of aquatic habitat and wildlife. When it rains, these surface waters receive sudden, intense flows of polluted stormwater runoff, which erodes stream banks, and increases the sediment and pollutant problems downstream. These conditions result in further loss of aquatic habitat and wildlife and require the municipality to spend scarce funds on stream restoration, sediment removal, and repairs to roads, bridges and culverts from flash flooding.

Practical Approach to Retrofitting Developed Land

Many municipalities have begun to adopt ordinances that require new development to retain and detain more stormwater on site as a "postconstruction" condition. This is helpful, but does not address the majority of the problem. Such rules typically do not apply to the development or redevelopment activities of the municipality itself, which likely owns between 30% and 40% of the impervious surface in an urbanized area, in the form of buildings, streets, alleys, sidewalks and parking lots. Furthermore, the area subject to new development only represents a small fraction of all the land area in an urban municipality, so the practical effect of the new rules is very limited. To address the problems of increased urban stormwater runoff described above, municipalities must also adopt "retrofit" programs that gradually restore the effective permeability of their land surfaces and reduce the volume of runoff entering the sewer piping system. As noted at the outset, in addition to volume control, green infrastructure provides many other benefits to the community, making it a prudent way to invest public funds. Because a retrofit program usually requires more government resources and is more complex than a program aimed at new construction, municipalities may want to consider implementing a process like the Green Infrastructure Portfolio Standard to help make the retrofit effort simpler and more cost effective.

Related Tools

H2OCapture — is a general green infrastructure benefits calculator developed by Natural Resources Defense Council (NRDC) and the Shaw Group, Inc. for Milwaukee Metropolitan Sewerage District. Inputs for online calculator are practice-specific. Calculated benefits include energy use, CO2 reduction, median runoff reduction, Total Suspended Solids (TSS) removed, total capital costs, maintenance costs per year and others. http://www.h2ocapture.com/

SUSTAIN (System for Urban Stormwater Treatment and Analysis INtegration Model) — is a decision support system to facilitate selection and placement of Best Management Practices (BMPs) and Low Impact Development (LID) techniques at strategic locations in urban watersheds. http://www.epa.gov/nrmrl/wswrd/wq/models/sustain/

SLAMM (Source Loading and Management Model) — is a tool for evaluation of nonpoint source pollutant loadings in urban areas using small storm hydrology. This model can calculate the runoff volume and pollutant loading for each source area within each land use from a series of rainfall events. http://www.winslamm.com/winslamm_overview.html

HSPF (Hydrological Simulation Program — FORTRAN) — is a comprehensive package for simulation of watershed hydrology and water quality for both conventional and toxic organic pollutants. http://www.epa.gov/ceampubl/swater/hspf/

Combination with Other Tools

There are several tools available that can be used in conjunction with the GIPS approach that can be useful for municipalities to plan and install green infrastructure features. Such tools include H2OCapture, SUSTAIN model, SLAMM and HSPF. It is important to keep in mind that many of these planning tools carry a heavier price tag than GIPS and often require more staff time and technical expertise to use. At the same time, they may provide some additional benefits to the planning process that a GIPS program alone cannot. It is recommended that a municipality consider these tools along with GIPS prior to making a decision and beginning the planning process.

Documented Scale-up of Green Infrastructure

When considering investing in green infrastructure it is important to consider not just the costs but also the broader benefits of its use. In many cases the installation costs of a green infrastructure practice may actually be less than that of its grey infrastructure counterpart. But even when this isn't the case, there are many other potential monetary benefits from a significant scaling up of green infrastructure. These benefits include increases in property values, increase in development potential, reduction in urban heat island effect, and other societal and economic benefits. Many of these benefits are well described in the American Rivers-CNT joint report "The Value of Green Infrastructure - A Guide to Recognizing Its Economic, Environmental and Social Benefits", found at http://www.cnt.org/repository/gi-values-guide.pdf.

Green Infrastructure Portfolio Standard Planning Process

Leadership is an important factor in the success of the GIPS approach. Securing the commitment to a long-term, incremental increase of green infrastructure in your community from elected officials and upper management will be critical for making any cultural change necessary to ensure success.

Commit to measurable goals

For the GIPS approach to be successful, the municipality or other coordinator must determine what its overall objective is for the program and commit to a process that is carried out over at least 5 to 10 years, and possibly between 10 and 20 years. For example, a reasonable objective could be the reduction in stormwater runoff volume by 20 percent over 15 or 20 years. Another might be the significant reduction or elimination of combined sewer overflows in a particular drainage area. In an arid region, it could be an increase in the harvesting of rainwater for reuse over several years with an ultimate goal measured in gallons per year. These long-term commitments are characteristic of the GIPS approach, which offers several advantages. First, each yearly goal is small, allowing the municipality to incorporate new green infrastructure projects and policies into existing planned projects, programs and other activities without excessive disruption or large annual investments. Second, the incremental approach allows the municipality to plan more steps in future years as it develops and schedules the maintenance, repair and replacement of streets, sidewalks, alleys and parking lots, again allowing for the incorporation of green infrastructure into the future with the least disruption and cost. The gradual, cumulative installation of green infrastructure over the long term will provide a substantial return on the municipality's investment.

Perhaps one of the greatest challenges to making a commitment to the GIPS approach is cultural change. The use of green infrastructure to complement gray infrastructure may be new to many municipalities and the city's codes and ordinances may not readily accommodate such a shift. For this reason, we strongly encourage a top down approach to committing to the GIPS. Leadership and direction from elected officials and agency directors is very important. Through this approach, goals and commitments to GIPS can be incorporated in municipal staff workplans for the year, and staff can prioritize working to develop its codes and ordinances such that they promote the use of green infrastructure where appropriate.

> "Implementing GIPS allows quantification of the implementation of Green Infrastructure. When asked by the public or governing boards about progress and impact on water quality this is a tool which answers those questions in a meaningful and long term manner."

Mike Lunn
Environmental Services Manager
City of Grand Rapids

Minimum Resource Needs

GIPS is designed to minimize the costs and other resource obstacles municipalities may face in setting targets for green infrastructure retrofit programs. However, there are still some minimum resource requirements for implementing the GIPS. Some municipalities may have already made investments in simulation models and staff, which could be brought to the GIPS approach. At a minimum, a municipality should have the ability to:

- **Establish a working task force.** This group will meet periodically to identify project target areas, establish runoff reduction goals, select the projects in which green infrastructure can most cost effectively be incorporated, review green infrastructure facility performance, and promote participation in the GIPS approach by residents, institutions and businesses within the community.
- **Quantify baseline runoff volumes for target areas.** This may involve basic mathematical measurement and calculation of anticipated runoff volumes from land coverage, or utilize more complex computer models.
- **Monitor annual progress against established goals.** The task force or its dedicated staff must monitor the cumulative volume reductions from implemented green infrastructure at least annually to evaluate progress against the annual goals.

Establish a task force

It is critical to the GIPS process that all municipal functions with a stake in land and stormwater management are represented in the GIPS task force and participate in decisions related to the type, timing and location of green infrastructure projects. These functions generally include: planning, engineering, public works, stormwater management, community development, private development permitting, streets and alleys, urban forestry, GIS capability, and finance. It can also be very helpful for the task force to include representatives from appropriate community groups that are active in the project areas, including neighborhood or business organizations. After the task force is established it will need to meet periodically throughout each year to identify and plan the implementation of green infrastructure projects and policy initiatives.

With the task force established, it is helpful to have a point person in charge of moving the GIPS approach forward. This person will have the knowledge of existing and future municipal and private projects as well as regional, state, and local funding opportunities. This person will also have the ability to help create and recommend changes to policies, ordinances, and master plans to the city council or governing body.

The biggest challenge municipalities face when establishing a task force is the time commitment. Many of the participants in the task force will be very busy with their responsibilities in their respective departments, which can significantly limit their time. One way of alleviating the need for additional meetings is to add the GIPS as an agenda item on an already established meeting where many, if not all, task force members are already present. Also, not all task force members will need to be engaged on every aspect of the GIPS. By having one person move the process along, other members will be engaged only when and where their expertise is needed on specific projects and activities. This will keep the momentum for the projects moving while not burdening task force members with unnecessary meetings.

List of task force members in Milwaukee, WI

- Sustainability Director Milwaukee
- Sustainability Director Milwaukee County
- Chief Engineer City of Milwaukee
- City Development Director
- Director of Sustainability—Milwaukee Metropolitan Sewerage District
- Director Department of Public Works

Coordinating Existing Plans

Prior to selecting the GIPS project areas, we suggest taking an inventory of the following items and thinking about how these can work together if they aren't already being coordinated.

- GIS land use data and other relevant GIS layer including imperviousness
- Master plans, sustainability plans, and existing policies
- Existing green infrastructure practices implemented
- Schedule of upcoming capital improvement and private development projects

Selecting the GIPS project area(s)

The first task of the GIPS task force is to select an appropriate boundary for the project area within the municipality. Following is a suggested approach.

1. **Select a relevant scale for project area(s).** An important decision on site selection concerns the scope of the GIPS Program. In other words, a project area could be as small as a sewer drainage area of 50 to 100 acres, or it could be as large as the entire municipal footprint. The GIPS programs in Milwaukee and Grand Rapids, on which this guidance is based, focused on drainage areas or "sewer sheds" between 75 and 750 acres in size. The primary reason for this size choice was ensuring our ability to meet strong annual runoff reduction goals; larger project areas require the implementation of additional green infrastructure projects, and resource limitations could become an issue. In other words, to reduce runoff in the project area by about 1%, a certain number of green infrastructure features have to be installed. In larger areas, more or larger projects are necessary. The success of the GIPS program thus far in Milwaukee and Grand Rapids confirms that the sizes of the selected project areas were not too large. It is likely that larger areas are also quite feasible, and Grand Rapids has already added two additional areas to its GIPS. We therefore recommend that a task force consider selecting one or two project areas of between 200 and 1000 acres each, as a starting point. Additional project areas can then be added over time to gradually increase the land area covered by GIPS goals. Alternatively, the original project areas can be expanded to accomplish this, although adding additional project areas, as opposed to expanding the original ones, allows greater flexibility to focus on areas of critical need.

2. **Identify potential project areas.** Task force members should begin by identifying three to five possible project areas. For each of these areas, the task force should attempt to collect the GIS information listed below in item 3.d. With that GIS data consolidated visually on maps, the group can discuss and prioritize important characteristics and select one or two final project areas. More areas can always be added as the task force gains experience with this approach.

3. **Prioritize zones for investment within project areas**. Within each of the final project areas the task force may find it helpful to focus on working areas consisting of either (a) well defined sub-sewer sheds or (b) transit corridors. To ensure project areas offer adequate flexibility in the opportunities for cost effective incorporation of green infrastructure practices, working areas should have a mix-

ture of commercial, industrial and residential property and meet a high percentage of the following criteria:

a. Identifiable water resource issues. The areas selected exhibit one or more community water resource problems such as frequent basement, yard or street flooding, combined sewer overflows, erosion of a local stream bed, or significant pollutant load being discharged into the sewer or an impaired surface water.

b. Clearly defined flow boundaries. The areas are contained within clearly defined sub-sewer sheds or drainage areas, so that the baseline stormwater conditions and changes to them resulting from the implementation of green infrastructure practices can more easily be monitored and measured.

c. Opportunity for redevelopment. The areas or the land immediately adjacent have the potential for significant redevelopment activity over several years, including maintenance repair or replacement of public surfaces as well as private redevelopment or retrofit projects. In other words, the task force is able to foresee a multi-year plan for projects in the area that includes public surface projects and opportunities for outreach to private land owners to undertake green infrastructure projects as part of the GIPS Program. These private projects could include the installation of porous pavement, rain gardens and bioswales or cisterns to collect rain water for reuse. It is likely that the first years will have more public projects than private ones, as municipal projects involving green infrastructure are usually quicker and easier to develop than projects on private property. In addition, public projects serve as a visible, tangible indicator of a municipality's commitment to green infrastructure, encouraging more private partners to join the program over time.

d. Available data. The areas have existing GIS data associated with them, with characteristics that are relevant to this project. For example,

i. Parcel Boundaries
ii. Building Footprint Boundaries
iii. Land Use
iv. Water Quality Data
v. Flooding Data
vi. Sewer Overflow Data
vii. Sewer Catchment Areas and Piping Configuration
viii. Current Green Infrastructure Database
ix. Tree Inventory or Canopy
x. Capital Improvement Projects Planned
xi. Demographic Data
xii. Pervious / Impervious Surface Data Layer
xiii. Ortho Imagery
xiv. Satellite Imagery

4. Local Priorities. Municipal staff should include in their consideration of potential project and work areas any other priorities for land use planning or economic development that might be associated with the implementation of green infrastructure practices. It must be kept in mind that these practices can provide numerous community benefits such as increased wildlife habitat and recreational space (pocket parks), reduced heat island effect and improved aesthetics (e.g. trees and green roofs), and improved safety for walking and biking (e.g. porous pavement and bioswales). Such projects may be contained in master plans or comprehensive development plans.

5. Community Engagement. The task force should identify and engage with community and business groups in or near the project areas that are knowledgeable and supportive of green infrastructure practices or otherwise have expressed an interest in working with city staff on local land use issues. Ideally, each of those groups has a representative on the task force. Alternatively, the municipal staff involves them in consideration of the potential project areas outside the task force meetings and shares their input with the task force.

Project Area Selection: Grand Rapids, Michigan

In the Grand Rapids, Michigan project, the city staff presented the project team with three potential project areas, each about 1/2-mile square. GIS information was provided by the city on each area, and though the information did not include sewer pipes, it did include information on the location of planned development projects. CNT prepared GIS maps with that information and also performed a preliminary green infrastructure opportunity analysis on a residential neighborhood within one of the identified project areas.

In a task force meeting, the city provided its own GIS maps and descriptions of a project area within which are two very well defined work areas where the city is attempting to solve a combined sewer overflow problem. The maps showed the sewer pipes and locations of combined sewer overflows, and locations of pipe retrofit projects that had been agreed to pursuant to a consent decree with the Michigan Department of Environmental Quality (MDEQ).

City staff also focused on a third work area within the project area involving a street resurfacing project that (a) has state funding, (b) coincides with a central business corridor, (c) is immediately adjacent to the combined sewer overflow areas to be remediated, and (d) a neighborhood group would like to enhance with more vegetation.

With all this information presented visually, the task force was able to brainstorm effectively. The group quickly settled on the project area described above with the three well-defined work areas within it. The comprehensive set of information, along with the meeting of other city objectives and the specific locations of the work areas within the larger project target area greatly assisted the task force in its selection of these three areas. The combination of interests met all seven of our suggested criteria and added the objectives of complying with an enforcement action and satisfying the desires of a community organization.

This result demonstrated the importance to project area selection of having (a) all the relevant information about the criteria and priorities of the city, preferably in the form of GIS maps and (b) participants with adequate knowledge of pending projects and innovative design alternatives, as well as the authority and enthusiasm for implementing them.

Calculating the baseline

Once a project area has been selected, the task force will need to calculate or estimate its baseline condition. One possible baseline condition is the amount of stormwater currently running off impervious surfaces in the project area. We used this approach in our pilots because calculating runoff volume is fairly easy to do, and provides an opportunity for easy measurement of the impacts of individual green infrastructure projects. By calculating a volume reduction baseline, the community can create real stormwater reduction goals that it can work toward. Several stormwater modeling programs can also be utilized for calculating such a baseline. Taking the approach developed in the pilots, we recommend the task force calculate the baseline runoff volume using a modified version of the Rational Formula[4]. Essentially, the runoff volume is calculated using the simple equation:

$$Q = C * I * A$$

Where **Q** is the runoff volume (gallons or cubic feet); **C** is the runoff coefficient (a higher number represents a more impervious surface); **I** is the rainfall intensity (we used a 1-inch rainfall, of unspecified duration); and **A** is the area (acres).

This method does not take into account such other variables as antecedent moisture conditions, duration of the rain event and time of concentration. While more accuracy could be useful, we believe that municipalities are better

[4] Mays, Larry W., *Stormwater Collection Systems Design Handbook*, McGraw Hill, 2001, Chapter 4 and Table 6.12.

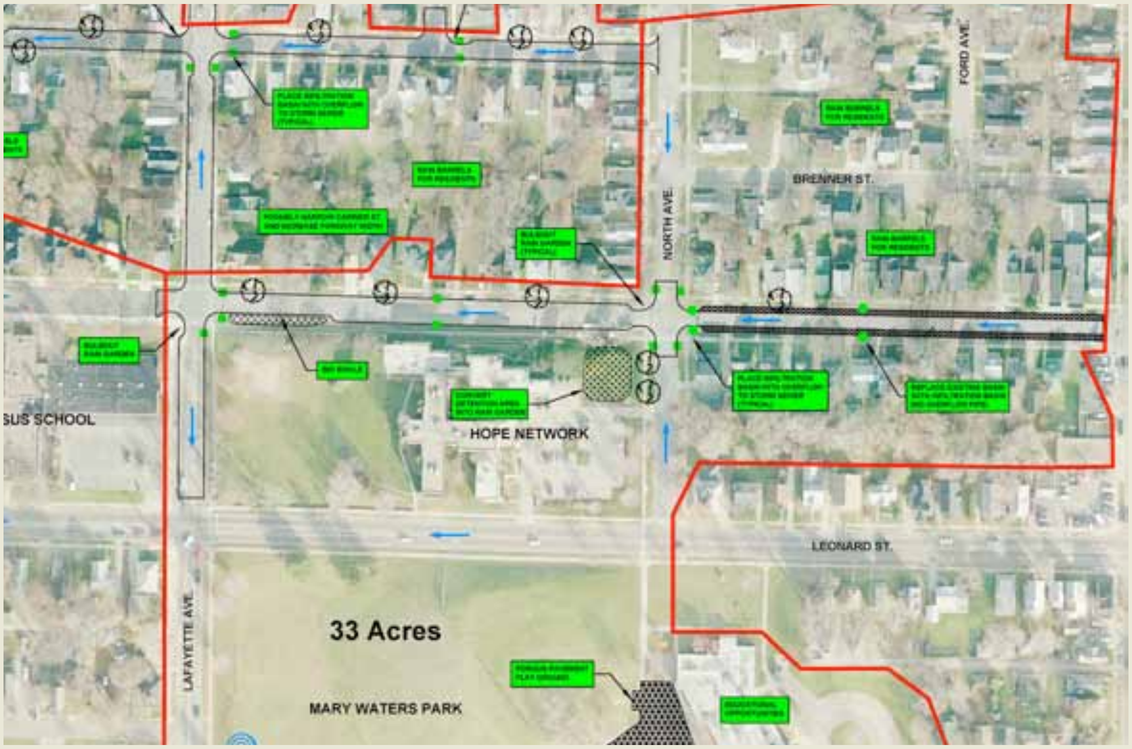


Figure 1 Courtesy City of Grand Rapids

served by using a relatively simple calculation of the baseline so that it matches with similar calculations of the volume retention capacity of proposed green infrastructure projects, and a valuable comparison can be made. A detailed example from the Grand Rapids project is provided in the Appendix.

Identifying and designing green infrastructure features

Identification of retrofit projects for the incorporation of green infrastructure features is the heart of the GIPS approach. The task force must gather information on and review planned construction projects in the GIPS project area, both on public and private land. On public land this will include work on buildings, streets, alleys, sidewalks and parking lots, for example. On private land it will include projects for which private land owners have submitted applications to the municipality for permits. In addition, the task force must be creative in exploring opportunities for new green infrastructure projects that may not yet have been considered, which also may be on either public or private land. On public land this might include roadside or median strip bioswales, parking spaces with porous pavement, green roofs, and cisterns to collect rainwater from the roofs of municipal buildings. It should also involve approaching private land owners with suggestions on the installation of similar green infrastructure features, and possibly offering various forms of incentive, such as sharing installation costs. If the task force can develop a robust list of potential projects, it will be in a position to select only the most cost effective projects, those providing the most benefits for the investment that collectively will retain a substantial volume of runoff.

Figure 1, above, is a representative portion of the Grand Rapids green infrastructure project work area showing the green infrastructure features planned for construction in 2012. There are sections of neighborhood streets with "bulb-out rain gardens" at the corners and infiltration basins, parking lot and street-side bioswales, porous pavement, rain barrels, community gardens and increases in parkway width with additional tree plantings.

Calculation of retention capacity of green infrastructure features

Once a preliminary list of green infrastructure projects or features has been developed, the task force must calculate their runoff retention volume. Table 1, below, shows the data used to estimate the runoff reduction that will be achieved by installing some of the green infrastructure features in the Grand Rapids, Michigan GIPS project. As a practical matter, the runoff reduction is measured in gallons, by comparing the pre-green infrastructure runoff (in gallons) with the post-green infrastructure runoff. Table 1 shows the runoff reduction reached using a combination of drainage area calculations and "C" values.

The first important number in the calculation is the total surface area that will drain to a green infrastructure feature. The next is the fraction of a 1-inch rainfall that will run off from these features, as determined by assigning a C value to this drainage area. For the "Bulb-out Rain Gardens and Infiltration Basins," for example, a reasonable C value is 0.85 (1.0 being a completely impervious surface.) Finally, a C value is selected that represents the runoff from that same drainage area after the green infrastructure features are installed. If, as we believed in this project example, all of the runoff from a 1" rainfall would be accommodated within the features so that there is no stormwater entering the sewer system from the drainage area after the retrofit, the C Value would be zero. However, to be conservative and assume that some runoff will enter the sewer, a C Value of 0.1 was used. The runoff volume reduction is calculated using the difference between the two C values.

Based on these assumptions, the proposed 24 bulb-outs and infiltration basins are expected to reduce the runoff to the sewer system by 1.17% and the bio-swale by another 0.10%, for a total of 1.27% of the baseline for this project area. If the Portfolio Standard has a goal of 1% reduction per year for this project, these planned features would be expected to meet the first year's goal. Note that these projects only represent a portion of all the GI projects the city is planning to implement this year, and the runoff retention capacity of all the projects planned is expected to be larger.

Table 1: Runoff Reduction for Selected Green Infrastructure Features

Sub-area	No. of BMPs	Drainage width	Drainage length	Drainage area	"C" Value	"C" Value	Runoff Reduction	Runoff Reduction
		(feet)	(feet)	(sq. ft.)	existing	with BMP	(gallons)	(% of baseline)
24 Bulb-out or Street infiltration areas along Page and Carrier Streets								
2-12,13,14	24	16	100	1,600	0.85	0.1	17,952	1.17%
Bio-swale along Carrier Street								
2-13	1	16	200	3,200	0.85	0.1	1,496	0.10%
						Project Total	19,448	1.27%

Center for Neighborhood Technology

Establishing annual GIPS goals

As stated in the overview of the GIPS, the overall objective of the GIPS approach is a steady reduction in the volume and pollutant load of the stormwater runoff in an urban (developed or "built out") drainage area. However, there are limitations in our ability to predict stormwater flows that should be taken into consideration when developing annual goals. Because electric utilities have the ability to plan for the production or purchase of specific quantities of energy, and the fact that electricity is delivered over wires at a rate that is easily measured, measuring the quantity of electricity delivered can be easily calculated.

In contrast, in the field of stormwater management, we cannot predict the amount of stormwater runoff that will pass through a particular green infrastructure feature in a given rain event or over the course of a year, because that amount varies tremendously from storm to storm, place to place, and year to year. Also, since each green infrastructure feature is constructed differently, its retention capacity must be estimated prior to installation based on its individual design. Perhaps most importantly, however, as the cities of Grand Rapids and Milwaukee embarked on this process, it was unclear how much retention capacity they would be able to identify in public and private projects within the project area, and the likelihood of that capacity actually being constructed.

Permeable paving blocks being installed in Milwaukee, WI.


PAVEMENT INSTALLATION | Photo by Sean Foltz

With that in mind, the municipality should set annual goals that are small enough to be achievable, but large and consistent enough over a number of years to ensure significant continued progress. In order to make that decision as refined as possible, we decided not to set annual goals until after the cities had completed the process of identifying Year 1 projects.

It is important that the units of measure we use are the same for the retention capacity of the green infrastructure features and the baseline runoff condition. For example, if the baseline condition is established as the volume (in gallons) of runoff per 1-inch rain event, then the retention capacity of each planned green infrastructure feature must also be calculated as the volume (in gallons) of runoff retained per 1-inch rain event.

Having completed these two calculations, the task force is in a position to set annual goals. Three factors should be considered:

1. The percentage of the baseline represented by the total aggregate retention capacities of the green infrastructure projects committed to in Year 1;
2. The level of effort, including staff time, funding, participation by private property owners and community groups, that went into obtaining the commitments to complete the Year 1 projects; and
3. The ability of the task force to consistently repeat the runoff volume reduction achieved in Year 1 every year for at least 5 years, and hopefully 10 or 15 years.

With these factors, the task force has a sense of what is achievable given a certain level of effort, and how aggressive it will have to be to meet its overall objectives in establishing the GIPS. Based on this, the task force can set annual goals for volume reduction, or retention, defined as a percentage of the baseline, for at least the next 5 years. The annual goals for the following years can be determined at the end of the first 5 years, after reviewing the level of success in meeting the goals of the first 5 years.

A GIPS city may wish to incorporate some flexibility into the annual goals. For example, if the goal is retention of 1% of the baseline volume per year for 5 years, but an annual goal is missed, the city could allow itself one additional year to make up the difference. Similarly, a city might exceed its goal in a given year, and may want to "bank" the excess and use it as a credit the following year. As long as progress is consistent over a relatively short period, the annual goals are meaningful. As an example, we note that the Oregon renewable energy portfolio standard has 5-year goals of 5% instead of 1-year goals of 1%.

Monitoring Implementation Progress

Once the annual GIPS goal has been established, it is necessary to measure the progress of installed green infrastructure practices toward the annual reduction goals within the target area. Monitoring can be as simple as a cumulative subtraction of the designed volume reductions for each installed green infrastructure practice from the annual target volume reduction goal. However, it is important to specify a tracking method and responsible agent to aggregate and measure annual installations toward the designed reductions.

Green Infrastructure Performance Monitoring

Progress toward meeting a GIPS goal is based upon designed performance, and not actual performance of installed green infrastructure. Obtaining actual retention data through empirical testing is encouraged where practicable, as this will allow a municipality to:

1. Confirm design criteria and intended benefits;
2. Measure additional benefits and adjust performance goals as necessary;
3. Demonstrate value of investment in infrastructure, and may:
4. Help to meet current or future regulatory requirements.

Expanding the Project Range

While implementing green infrastructure and meeting GIPS goals in the chosen project areas will take time, following the above steps will help create a successful GIPS program. However, at some point a municipality will feel comfortable expanding either the boundaries of its project areas, depending on the size of the original program areas, or creating new ones, so as to broaden the implementation of green infrastructure throughout its jurisdiction. There is not a recommended timeline for expanding the program and timing will vary for each municipality. A community should feel comfortable with the GIPS in the first program areas before expanding, but at the same time expansion is encouraged and should be taken into account when determining stormwater reduction goals.

When a decision is made to expand GIPS project areas, there are two means of doing so. The first is to expand the original project areas, or create separate new ones. That choice depends on what is best for each individual municipality and can be decided by the task force. We believe creating new project areas may be preferential, as it allows a community to focus efforts on higher-need areas, areas that create the most stormwater, or areas of varying geology or land use. A community will most likely have several critical need areas, which may or may not be adjacent to each other, and the multiple project area approach provides flexibility in meeting those needs. Repeating the above steps is the recommended way of proceeding with new project areas.


Photo by CNT

Kids planting native shrubs in a bioswale illustrate a basic green infrastructure principle — everyone can help manage water intelligently.

Finding new projects

It will usually be easier for municipal staff to identify future green infrastructure projects in the public right of way than on private land. However, taking on the GIPS approach includes the commitment by municipal staff to engage with private property owners over the years to find opportunities on private land, to incorporate green infrastructure features, such as permeable parking lots or bioswales, either as part of private development projects or as stand alone green infrastructure installations. Many such private retrofit projects are already taking place across the country. An important factor in accelerating the implementation of private projects is the inclusion of community groups as part of the project, and even as members of the task force. These groups often have good working relationships with local residents and can engage with them to identify more private projects. A useful source of relationships in the business community is the local chamber of commerce, and it might be valuable to invite a chamber representative onto the task force. It is well documented that broadening the group of decision makers to include representatives from different community sectors can strengthen support for an approach such as the GIPS and also provide a wider source of ideas for implementing the approach.

Policy Recommendations

Making sure local plans, policies and permits are in alignment with GIPS goals can help make the GIPS and retrofit process easier. This might involve adding green infrastructure components to master plans and sustainability plans that may already include stormwater management or incorporating the GIPS as part of a municipalities MS4 program. Green infrastructure stormwater management is a proven but still emerging technology, and how best to incorporate green infrastructure into an MS4 permit is an ongoing question. It is possible that a GIPS program could help a city meet MS4 requirements if the permit has a focus on utilizing green infrastructure and the GIPS was utilized in a way to ensure that water quality goals are met. However, this is still a new concept and the appropriate use of a GIPS within an MS4 permit has not been determined or tested.

In terms of local planning and zoning, however, there are clear guidelines to ensuring that plans and codes are compatible with a GIPS. Zoning codes and other municipal ordinances will need to be reviewed to identify and remove any impediments to the GIPS approach and to consider adding incentives for the increased use of green infrastructure. Planning and related municipal staffs are typically responsible for such review. Hiring a consultant for a full audit of all policies and plans is another option. Municipalities may also want to codify the GIPS approach in a policy or ordinance, a step which could lead to establishing a permanent funding source for green infrastructure projects.

When reviewing municipal policies and ordinances to advance green infrastructure goals, there are several key areas to address. These include zoning ordinances, development codes, erosion and sediment control ordinances, stormwater management ordinances, parks and open space planning documents, and development related permits. Resources from American Rivers, Center for Watershed Protection, and U.S. EPA are available to help with reviewing codes and ordinances. Below are a few recommendations to help your planning staff get started.

- **Remove barriers to implementing green infrastructure and make quick improvements.** This can be accomplished by reducing or removing parking requirements or setting upper limits, removing or decreasing mandatory road widths or setting maximum widths, removing storm sewer connection requirements or requiring disconnection, and requiring the integration of low impact development practices into existing landscaping requirements.

- **Set performance-based standards.** Set benchmarks for on-site stormwater retention. To ease the review process and create a clear standard, communities often require developers to retain or infiltrate a designated percentage or volume of stormwater runoff on site. Such a uniform standard makes the review process more efficient and predictable for developers, and dramatically reduces the impacts of the project on surface and groundwater.

- **Reduce imperviousness.** Use standards to limit impervious areas by setting foot print caps, provide market incentives for compact or infill development, remove incentives for sprawling greenfield developments, and adopt smart growth and traffic demand management programs. For example, Michigan, Massachusetts and New Jersey have adopted statewide "Fix-it-First" infrastructure policies to address both the rising costs of infrastructure expansion and declining condition of existing urban infrastructure. As a result, developers are more likely to receive permits for infrastructure upgrades in infill areas than for new infrastructure in greenfield areas. In Seattle, Washington developments are not required to provide off-street parking for residential developments near mass-transit stops. This allows developers to create more residential or commercial units while encouraging residents to use the nearby transit system.

- **Develop a downspout disconnection program.** By incentivizing safe disconnection of downspouts across a municipality, many millions of gallons of stormwater can be removed from a combined sewer system each year. It is important that such disconnection programs include instructions to prevent the practice from resulting in increased basement flooding. If they do, they can be a low maintenance option to help keep rainwater out of the storm sewer, move water away from building foundations and allow it to soak into the ground.

- **Create and protect buffers for water resources.** Set minimum floodplain and wetland requirements to protect sensitive areas. For example, prohibit development within the 100-year floodplain and promote parks in floodplain areas. Since there are often strong interests in favor of development in the floodplain, the task force may want to take time to build the case demonstrating the many benefits of floodplain restrictions and providing some of the financial and other problems created by unrestricted construction in flood prone areas.

- **Require green infrastructure designs for municipal projects.** Local ordinances requiring municipal buildings to incorporate green infrastructure practices to the extent practicable can provide examples needed to persuade private developers and landowners to do the same. In addition to the stormwater benefits, many communities have chosen to incorporate these features into municipal projects to reduce energy costs. Portland, Oregon uses their "Green Streets" Program to integrate Low Impact Development into municipal infrastructure projects. The Green Streets Program reduces stormwater pollution from city streets and shows private developers the economic, environmental, and aesthetic benefits of green infrastructure.

- **Establish a stormwater utility and fee system, charging landowners on the basis of effective impervious cover.** This will have several benefits. First, it will ensure that all landowners that contribute to the stormwater runoff of the municipality pay their fair share of the cost of keeping up the stormwater infrastructure necessary to manage that runoff. At the same time, along with their monthly stormwater bill, landowners can be provided information about how they can reduce their bill by installing green infrastructure features or reducing the effective impervious cover on their property. Finally, the fee system creates a dedicated source of revenue which can help the municipality more easily meet its regulatory requirements for stormwater management, rather than relying entirely on a portion of the local tax revenue for this purpose. Establishing grant and other incentive programs will also encourage the implementation of green infrastructure best management practices.

Resources available for ordinance assistance:

Local Water Policy Innovation: A Road Map for Community Based Stormwater Solutions

This American Rivers report argues that local governments are in the best position to manage the water quality impacts of urbanization. The report describes 10 measures that local governments can take to minimize the degradation of water resources. Examples of cities that have implemented these measures are presented throughout the report. **http://www.americanrivers.org/library/reports-publications/local-water-policy-innovation.html**

Center for Watershed Protection's Codes and Ordinance Worksheet

The Codes and Ordinance Worksheet, or COW, is a simple worksheet that you can use to see how the local development rules in your community stack up against the model development principles outlined in the Center for Watershed Protection's Better Site Design Handbook.
http://www.cwp.org/documents/cat_view/81-audits.html

Water Quality Scorecard

This EPA product is a tool that communities can use to collaboratively identify the barriers to green infrastructure in local codes and ordinances. The scorecard guides municipal staff through 230 policies, codes, and incentives that could be adapted to promote sustainable stormwater management. The scorecard also provides extensive references and case studies.
http://www.epa.gov/smartgrowth/water_scorecard.htm

Presentation: The role of codes and ordinances in water quality and stormwater management
http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_webinar_part2.pdf

Presentation: Codes and Ordinance Reviews: Case Studies and Findings
http://water.epa.gov/infrastructure/greeninfrastructure/upload/gi_webinar_part3.pdf

Photo by CNT

Parking lots are a natural location for bioswales. Besides helping in water management, they can help drain impermeable surfaces and reduce the heat island effect of paving.

Conclusion

Effective stormwater management must take advantage of a number of complementary strategies. For example, to limit the increase in impervious surfaces and the runoff from it, municipalities should adopt ordinances requiring that new development and redevelopment practices maintain or reduce the predevelopment runoff volume, preferably through an effective reduction in impervious surface and the use of green infrastructure, which provides multiple community benefits. At the same time, municipalities must try to reduce runoff from already developed areas where little or no redevelopment is planned. This retrofit process can be a challenge, given that modifying existing impermeable surfaces can be expensive, and it may be difficult to entice private landowners to participate in the program. However, the GIPS approach provides a framework for moving slowly but steadily (and with lower costs) toward greater permeability in the urban landscape. This investment should be rewarded by reductions in flooding and sewer overflows and the associated costs. As more communities look to using green infrastructure solutions on a regular basis, the question arises as to where and how to implement these techniques, and how to do so without breaking the bank. One answer, as this guide shows, is the Green Infrastructure Portfolio Standard. With a long term goal in mind, the GIPS gives communities an opportunity to maximize their dollars over the long term, with the inevitable result of cleaner water, drier basements and greener neighborhoods. Utilizing the steps outlined here, any community, with time and consistency, can reach their stormwater reduction goals.

From the Northwest to the Great Lakes, green infrastructure is a proven tool in managing runoff and protecting our rivers and lakes.

In Milwaukee, Green Infrastructure is even being used to protect beaches from road and parking lot runoff.

This rain garden helps a church avoid flooding, yet appears to be a landscaping feature. Churches, schools and other public institutions often welcome green infrastructure as an inexpensive alternative to costly gray water projects.

Appendix: Grand Rapids, Michigan Case Study

The City of Grand Rapids has been promoting the use of green infrastructure for a number of years, which can be seen in the Grand Rapids Sustainability Plan and Green Grand Rapids Master Plan. Green infrastructure projects such as green roofs, rain gardens, pervious pavement parking lots, and rain barrels on public and private properties have been implemented without a structure to systematically calculate the benefits of water volume reduction on overall water quality. The City of Grand Rapids is utilizing the GIPS approach to increase the number of green infrastructure projects and to quantify those benefits on a larger scale.

Below you will see how Center for Neighborhood Technology was able to calculate the baseline conditions in one of the Grand Rapids pilot project areas.

Grand Rapids Baseline Calculation Methodology

The Rational Formula[5] was used by an experienced staff member because it is a widely-used method of estimating peak runoff flow rates from a given rainfall event. The flow rate is calculated using the simple equation:

$$Q = C * I * A$$

Where **Q** is the runoff volume (gallons or cubic feet); **C** is the runoff coefficient (a higher number represents a more impervious surface); **I** is the rainfall intensity (we used a 1-inch rainfall, of unspecified duration); and **A** is the area (acres).

This method does not take into account such other variables as antecedent moisture conditions and time of concentration. While more accuracy could be useful, we believe that municipalities are better served by using a relatively simple calculation of the baseline so that it matches with similar calculations of the volume retention capacity of proposed green infrastructure projects, and a valuable comparison can be made.

In Grand Rapids, the first project area is a sewer shed and was divided into 22 sub-sewer sheds. Each of the sub-basins was visually scanned to estimate its predominant land use and density. Using Table 6.12 from Mays, (Table 2, below)

Table 2: Selected Urban Values of Runoff Coefficient C for Rational Formula

Land Use	C Value
Business	
Downtown areas	0.70-0.95
Neighborhood areas	0.50-0.70
Residential:	
Single family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.25-0.40
Apartment dwelling areas	0.50-0.70
Industrial:	
Light areas	0.50-0.80
Heavy areas	0.50-0.90
Park, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard areas	0.10-0.30
Unimproved areas	0.10-0.30
Streets:	
Asphaltic	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Drives and walks	0.70-0.85
Roofs	0.75-0.95
Lawns	
Sandy soil, flat, 2%	0.05-0.10
Sandy soil, average, 2-7%	0.10-0.15
Sandy soil, steep, 7%	0.15-0.20
Heavy soil, flat, 2%	0.13-0.17
Heavy soil, average, 2-7%	0.18-0.22
Heavy soil, steep, 7%	0.25-0.35
Woodlands	0.05-0.25
From: Mays, Table 6.12	

[5] Mays, Larry W., *Stormwater Collection Systems Design Handbook*, McGraw Hill, 2001, Chapter 4 and Table 6.12.

tempered by years of local experience, a C Value was assigned to each sub-basin (Table 3, below).

Table 3 shows the size of each sub-basin, the estimated C Value for each and the runoff intensity from a 1-inch per hour storm. Runoff estimates from larger storms can be obtained by substituting larger rainfall quantities.

Table 3 also shows the volume of runoff for a 1-inch storm for each sub-basin in both cubic feet and gallons. Since this is just the volume of stormwater that runs off the land, which isn't affected by the intensity of the rainfall nor any time differences, these sub-basin volumes can be added to get an estimate of the total runoff generated. This total volume is used as the baseline for runoff under existing (pre-green infrastructure) conditions.

In the Grand Rapids project, we estimated the reduction in runoff volume to be achieved by the green infrastructure and subtracted that volume reduction from the total runoff for the study area. Accurate calculations of the reductions from individual projects will be available from engineering designs for those projects, but they can also be estimated during the earlier planning stage using a tool such as the Green Values® Calculator.

Table 3: Database for Determining "The Baseline" – Grand Rapids Study Area

Sub-Basin	Area	"C" Value	Runoff Rate for 1in/hr	Runoff Volume for 1 inch	
Number	(acres)		(cfs)	(cu.ft.)	(gallons)
2-1	9.0	0.80	7.20	26,136	195,497
2-2	2-0	0.60	1.20	4,356	32,583
2-3	11.2	0.50	5.60	20,328	152,053
2-4	1.7	0.30	0.51	1,851	13,848
2-5	1.2	0.30	0.36	1,307	9,775
2-6	6.2	0.30	1.86	6,752	50,503
2-7	3.6	0.30	1.08	3,920	29,325
2-8	7.3	0.45	3.29	11,925	89,196
2-9	3.9	0.35	1.37	4,955	37,063
2-10	6.0	0.30	1.80	6,534	48,874
2-11	9.3	0.45	4.19	15,192	113,633
2-12	14.1	0.30	4.23	15,355	114,855
2-13	8.7	0.35	3.05	11,053	82,679
2-14	9.6	0.40	3.84	13,939	104,265
2-15	8.6	0.40	3.44	12,487	93,404
2-16	5.1	0.45	2.30	8,331	62,315
2-17	5.0	0.40	2.00	7,260	54,305
2-18	5.8	0.40	2.32	8,422	62,994
2-19	2.9	0.35	1.02	3,684	27,560
2-20	9.4	0.30	2.82	10,237	76,570
2-21	2.3	0.30	0.69	2,505	18,735
2-22	7.8	0.30	0.69	8,494	63,537
Total Runoff Volume — Baseline					**1,533,568**

American Rivers
Rivers Connect Us®

About American Rivers | www.AmericanRivers.org

American Rivers is the leading organization working to protect and restore the nation's rivers and streams. Rivers connect us to each other, to nature, and to future generations. Since 1973, American Rivers has fought to preserve these connections, helping protect and restore more than 150,000 miles of rivers through advocacy efforts, on-the-ground projects, and the annual release of America's Most Endangered Rivers®.

Headquartered in Washington, DC, American Rivers has offices across the country and more than 100,000 supporters, members, and volunteers nationwide.

CNT
Sustainable Communities
Attainable Results

About The Center For Neighborhood Technology | www.cnt.org

The Center for Neighborhood Technology (CNT) is an award-winning innovations laboratory for urban sustainability. Since 1978, CNT has been working to show urban communities in Chicago and across the country how to develop more sustainably. CNT promotes the better and more efficient use of the undervalued resources and inherent advantages of the built and natural systems that comprise the urban environment. As a creative think-and-do tank, we research, promote, and implement innovative solutions to improve the economy and the environment.

Great Lakes and St. Lawrence Cities Initiative
Alliance des villes des Grands Lacs et du Saint-Laurent

About The Great Lakes and St. Lawrence Cities Initiative | www.glslcities.org

The Great Lakes and St. Lawrence Cities Initiative is a binational coalition of mayors and other local officials that works actively with federal, state, and provincial governments to advance the protection and restoration of the Great Lakes and the St. Lawrence River. With more than 90 member municipalities in Quebec, Ontario and 8 U.S. States, the Cities Initiative represents more than 15 million citizens. The Cities Initiative's mission is to protect, restore and enhance the Great Lakes and St. Lawrence basin and to provide a unified voice to the mayors of its member communities in discussions with other orders of government and other interested organizations.