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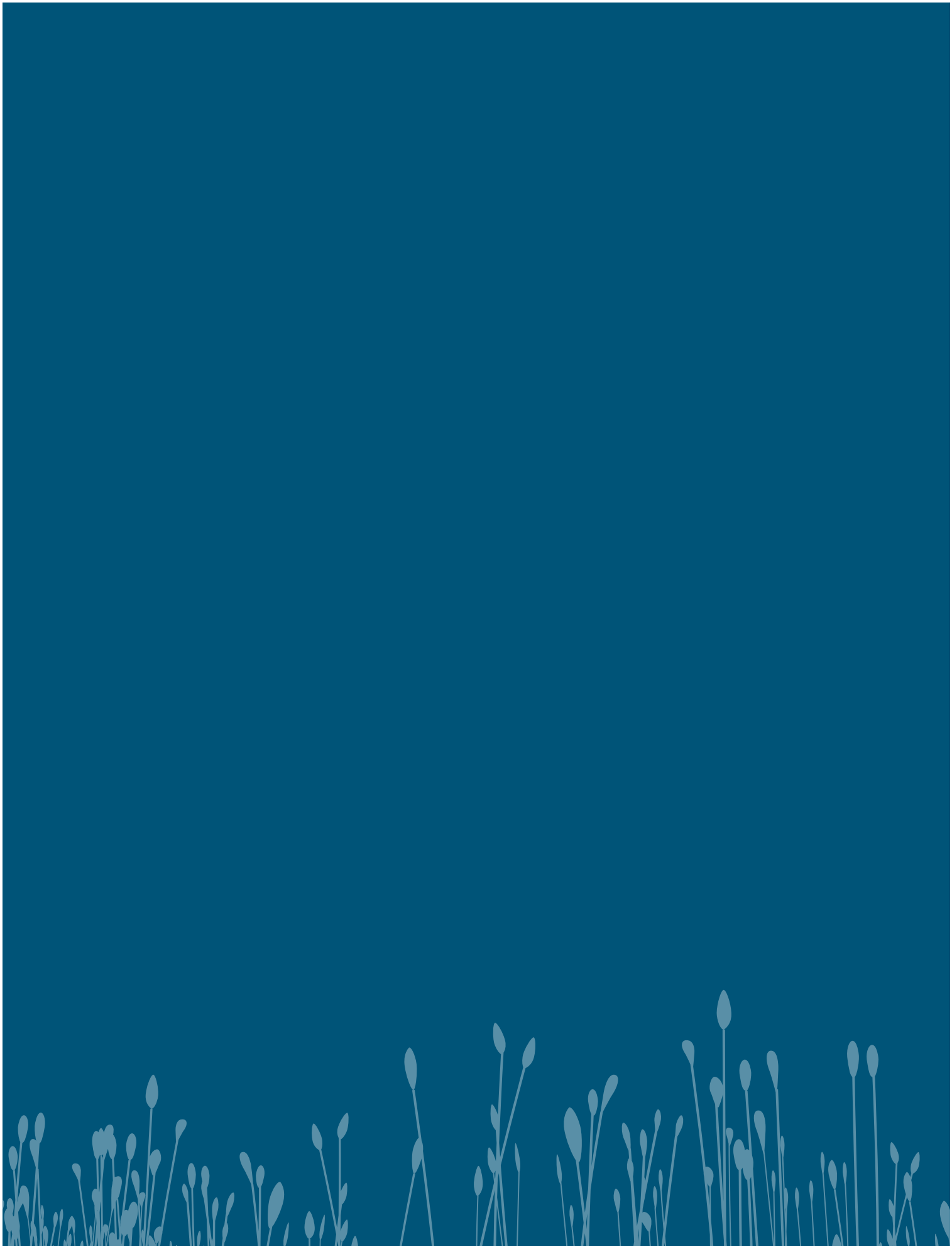
Green Infrastructure Case Studies:

Municipal Policies for Managing Stormwater with Green Infrastructure

CASE STUDIES

EPA Office of Wetlands, Oceans and Watersheds



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Executive Summary

This report presents the common trends in how 12 local governments developed and implemented stormwater policies to support green infrastructure. The local policies examined in this paper include interagency cooperation, enforcement and management issues and integration with state and federal regulations. While a strong motivation for these policies and programs is innovation in stormwater management, many communities are moving past the era of single objective spending and investing in runoff reduction and stormwater management strategies that have multiple benefits. Green infrastructure approaches have a range of benefits for the social, environmental and economic conditions of a community (see Table 1). Not only do these case studies include success stories for building a comprehensive green infrastructure program, but they also provide insight into the barriers and failures these communities experienced while trying to create a stormwater management system that includes more green infrastructure approaches.

The following chapters provide descriptions of the most common and influential green infrastructure policies, a brief background on how each approach works and examples from relevant case studies about results, barriers and processes for implementation. Many of the policies work in tandem and fit within a context of several other green infrastructure policies and programs. The greenest cities in terms of stormwater management use a wide range of policies and a number of approaches that focus on both public and private properties.

This report originally focused on local stormwater regulations alone, but further investigation revealed that the real presence of green infrastructure in a community was due to many other programs and policies that can be adopted by a wide range of communities.

BACKGROUND

Many communities in the United States, ranging in size, population and geographic location, are looking for ways to assure that the quality of their rivers, streams, lakes and estuaries is protected from the impacts of development and urbanization. This case study report describes a dozen cities and counties that are using green infrastructure approaches to reduce imperviousness and preserve natural open space throughout a watershed and at the neighborhood scale, as well as adding green infrastructure practices at the site level. Not all of the communities in this study are using green infrastructure at all three scales, but they are mixing and matching a common set of policies and programs to protect water resources and add value to their communities at the same time.

Traditional development practices cover large areas of the ground with impervious surfaces such as roads, driveways and buildings. Once such development occurs, rainwater cannot infiltrate into the ground, but rather runs offsite at levels that are much higher than would naturally occur. The collective force of such rainwater scours streams, erodes stream banks and thereby causes large quantities of sediment

and other entrained pollutants to enter waterbodies each time it rains.

In addition to the problems caused by stormwater and nonpoint source runoff, many older cities (including many of the largest cities in the United States), have combined sewage and stormwater pipes which periodically and in some cases frequently overflow due to precipitation events. In the late 20th century, most cities that attempted to reduce sewer overflows did so by separating combined sewers, expanding treatment capacity or storage within the sewer system, or by replacing broken or decaying pipes. However, these practices can be enormously expensive and take decades to implement. Moreover, piped stormwater and combined sewer overflows (CSOs) may also, in some cases, have the adverse effects of upsetting the hydrological balance by moving water out of the watershed, thus bypassing local streams and ground water. Many of these events also have adverse impacts and costs on source water for municipal drinking water utilities.

Table 1: Green Infrastructure Benefits by Type

Benefit	Type
Environmental	• Increase carbon sequestration • Improve air quality • Additional recreational space • Efficient land use • Improve human health • Flood protection • Drinking water source protection • Replenish groundwater • Improve watershed health • Protect or restore wildlife habitat • Reduce sewer overflow events • Restore impaired waters • Meet regulatory requirements for receiving waters
Economic	• Reduce hard infrastructure construction costs • Maintain aging infrastructure • Increase land values • Encourage economic development • Reduce energy consumption and costs • Increase life cycle cost savings
Social	• Establish urban greenways • Provide pedestrian and bicycle access • Create attractive streetscapes and rooftops that enhance livability and urban green space • Educate the public about their role in stormwater management • Urban heat island mitigation

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. Linkages between sites and between practices within one site ensure that stormwater is slowed, infiltrated where possible and managed with consideration for natural hydrologic processes. Comprehensive stormwater management with green infrastructure must consider:

- How to protect and preserve existing natural resources,
- Where to direct development in the community, and
- How to develop on individual sites.

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 reduction 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. Site-level green infrastructure is also referred to as low-impact development or LID, and can include rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes

Figure 1: *Communities across the United States from (clockwise from top left) Olympia, Philadelphia, Seattle and Lenexa, are using a range of policies to add new green infrastructure.*

and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation. For more information on specific green infrastructure practices and how they function, visit **http://www.epa.gov/greeninfrastructure**.

These processes represent a new approach to stormwater management that is not only sustainable and environmentally friendly, but cost-effective as well. Municipalities are realizing that green infrastructure can be a solution to the many and increasing water-related challenges facing municipalities, including flood control, combined sewer overflows, Clean Water Act requirements and basic asset management of publicly owned treatment works. Communities need new solutions and strategies to ensure that they can continue to grow while maintaining and improving their water resources.

This report is meant to serve as a policy guide for municipalities that understand the value of green infrastructure and hope to create local policies and programs to allow, require and encourage green infrastructure where appropriate. Although this report originally focused on municipalities with innovative stormwater regulations, it quickly expanded to examine the range of policy types that result in green infrastructure throughout a community (see Figure 1). The paper includes three main chapters that are intended to provide the most valuable lessons learned from the 12 case studies about how to implement a local green infrastructure program. The first chapter, Common Drivers and Regulatory Framework, explains what motivates the case study communities to set up local green infrastructure policies and programs. The second chapter presents a Menu of Local Green Infrastructure Policies. This menu describes the nine policy types common to most or all of the municipalities in the case study, including examples about how the policies have been implemented. The next chapter, Policy Implementation, provides guidance on how the policies can complement one another, how to overcome barriers and how to adapt different policies to local needs and priorities. Finally, 12 two-page case studies

provide specific information about each municipality and the green infrastructure program as it was developed in the local context.

CASE STUDIES

The 12 cases analyzed in this study represent a broad cross-section of the country in terms of hydrologic regime, population and demographics, government structure and geographic and political climate. But there are common trends in how local governments developed and implemented new stormwater policies, including interagency cooperation, enforcement and management issues and overlap with state and federal regulations. While a strong motivation for these policies and programs is innovation in stormwater management, many communities are moving past the era of single objective spending and investing in strategies that have multiple benefits. Green infrastructure approaches have a range of benefits for the social, environmental and economic conditions of a community (see Table 1). These cases include success stories for building a comprehensive green infrastructure program, but they also provide insight into the barriers and failures experienced while trying to create a stormwater management system that includes more green infrastructure approaches.

12 Green Infrastructure Case Studies

- Alachua County, Florida
- Philadelphia, Pennsylvania
- Portland, Oregon
- Seattle, Washington
- San Jose, California
- Santa Monica, California
- Stafford County, Virginia
- Wilsonville, Oregon
- Olympia, Washington
- Chicago, Illinois
- Emeryville, California
- Lenexa, Kansas

Common Policies Used in 12 Green Infrastructure Cases:

- Stormwater Regulation
- Review and Revise Local Codes
- Demonstration and Pilot Projects
- Capital and Transportation Projects
- Education and Outreach
- Stormwater Fees
- Stormwater Fee Discounts
- Other Incentives

The most common trend in successful case studies is the presence of many different policies and programs. Communities such as Chicago, Illinois, Alachua County in Florida, Philadelphia, Pennsylvania, and Lenexa, Kansas, not only passed a new stormwater ordinance for new development; they also devised new funding systems for capital projects, provided incentives for redevelopment and retrofit projects and developed public education and outreach programs. Many of the successes came within the context of larger "green plans" and other comprehensive plans that supported or were supported by green infrastructure policies. In addition, watershed planning for larger jurisdictions and sewershed plans for urban communities helped decision makers prioritize, monitor and validate public investments for green infrastructure.

A total of eight common policies and programs appeared throughout the selected cases and are presented above as a menu of policy options that other jurisdictions should consider when looking for ways to add more green infrastructure in their own communities. Because these policies were implemented in diverse situations and communities, they are applicable for a range of local contexts. Not every community will be able to use all eight policy approaches, but most can choose some combination of the policies in the menu based on their existing programs and level of expertise.

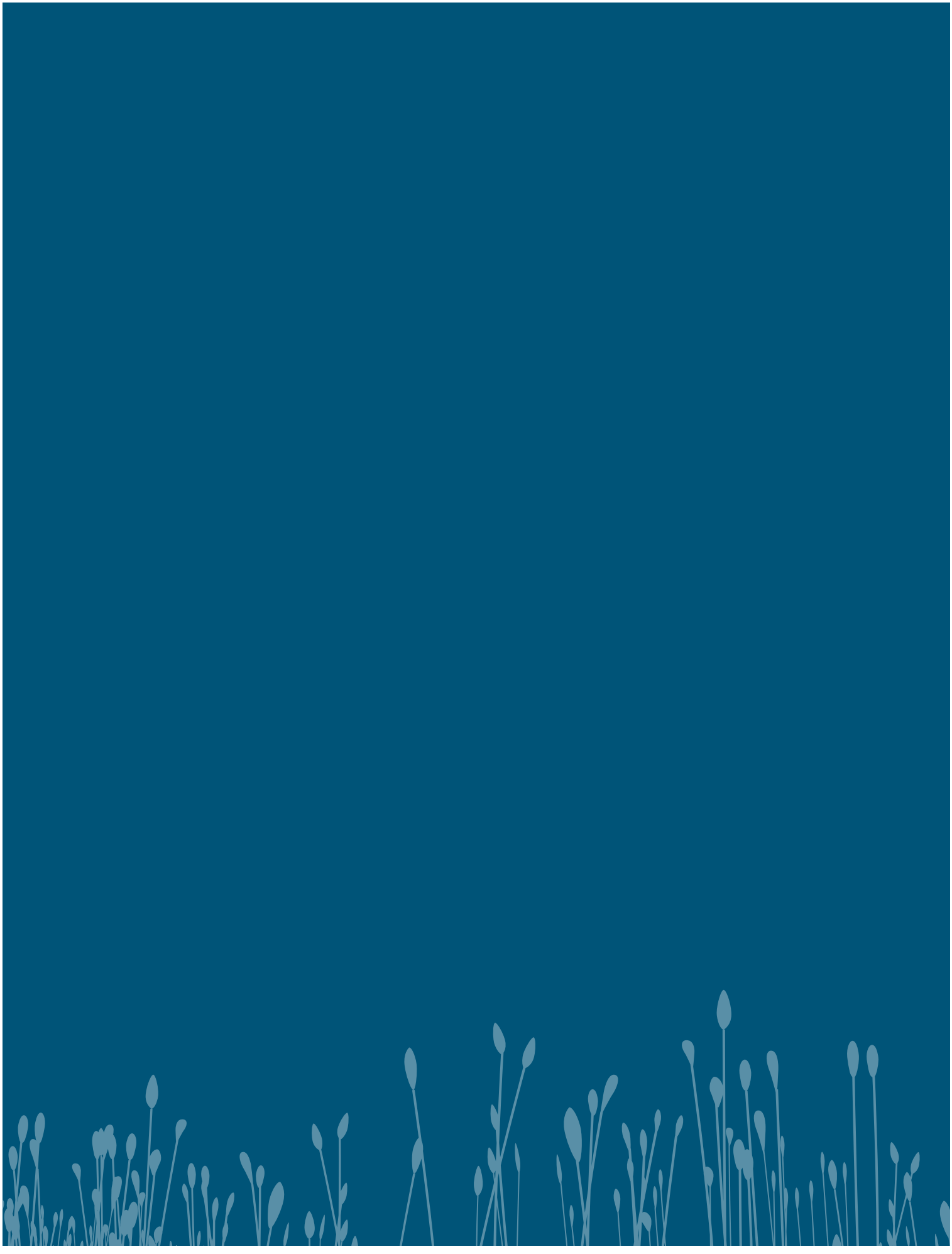
Table 2 lists the 12 communities and which of the common policies they used. The policies are organized into two categories: public sector policies and private sector policies. The

public sector policies and programs can be set up internally by government agencies. Private sector policies are those that apply to private development and private property owners, including commercial and residential properties.

The following chapters include descriptions of the most common and influential green infrastructure policies, a brief background on how each approach works and examples from relevant cases about results, barriers and processes for implementation. No single policy or program will be a panacea for the challenge of how to integrate green infrastructure into the local landscape. Many of the policies work in tandem and fit within a context of several other complementary policies and programs. The greenest cities in terms of stormwater management use a wide range of policies and a number of approaches that focus on both public and private sectors.

Table 2: Case Studies and Common Policy Approaches

City	Public					Private			
	Demonstration projects	Street retrofits	Capital projects	Local code review	Education & outreach	Stormwater regulation	Stormwater fee	Fee-based incentives	Other incentives
Alachua County, FL	X		X			X			
Philadelphia, PA	X	X	X	X	X	X	X	X	
Portland, OR	X	X	X	X	X	X	X	X	X
Seattle, WA	X	X	X	X	X	X	X	X	X
San Jose, CA	X	X		X		X			
Santa Monica, CA		X	X	X	X	X	X		X
Stafford County, VA	X			X		X			
Wilsonville, OR	X	X	X	X		X			
Olympia, WA	X	X		X	X	X	X		
Chicago, IL	X	X	X	X	X	X			X
Emeryville, CA	X	X		X		X	X		
Lenexa, KS	X	X	X		X	X	X		
Total	**11**	**10**	**8**	**10**	**7**	**12**	**7**	**3**	**4**



1 Common Drivers and Regulatory Framework

Green infrastructure policies can achieve multiple municipal goals at the same time as meeting Federal Clean Water Act requirements, making them useful and efficient policy options for local decision makers. The communities in these case studies are not motivated to build green infrastructure programs by Federal regulations alone. Although they may identify overlaps with Clean Water Act requirements, these local governments are making investments in green infrastructure because of many other community, economic and environmental benefits.

Local Agencies Can Use Green Infrastructure to Achieve Goals:

- Planning
- Transportation
- Economic Development
- Housing
- Parks and Recreation
- Water
- Health and Human Services
- Public Works

Green infrastructure is associated with a variety of environmental, economic and human health benefits, many of which go hand-in-hand. Green infrastructure benefits are included in Table 1 of the Introduction. Most municipalities in this case study report provide examples of how green infrastructure can meet overlapping goals and achieve widespread political and public support that translates into more sustainable programs and policies. This chapter outlines the multiple benefits of green infrastructure and explains the ways that communities are using them as motivation for their local green infrastructure policies and programs.

CSO and MS4 Requirements

Federal Clean Water Act requirements, such as the Combined Sewer Overflow (CSO) Control Policy and National Pollutant Discharge Elimination System (NPDES) permit program, must ultimately be implemented at the local level. Many municipalities see major inconsistencies between EPA guidance for using green infrastructure to manage wet weather flows and enforcement of requirements that call for more conventional practices. Cities argue that EPA is promoting innovative solutions without changing the standards and measures for complying with water quality standards.

Furthermore, local governments find it difficult to confidently reallocate funds for green infrastructure projects without better guidance and more confidence that the regulatory standards will eventually support their investments. Investments in publicly owned treatment works are largely compliance driven, which provides little freedom for local

policy makers to implement watershed-based or decentralized green infrastructure solutions that may not yet have the data necessary to demonstrate performance and receive regulatory credit (both because of the amount of time needed for these practices to show long-term performance, as well as limitations in common data collection methods). Through the Green Infrastructure Action Strategy, EPA and its partners seek to address research gaps, develop protocols to quantify benefits and collect more empirical data. Ideally, this effort will provide more regulatory predictability and support for explicit inclusion of green infrastructure into permits, enforcement orders and long-term control plans (LTCPs).[1]

Older cities are looking for solutions to their CSO problems that are affordable and meet the requirements of EPA's CSO Control Policy. A few cities, such as Philadelphia, have found effective means for meeting these compliance needs and altering LTCPs to include green infrastructure.[2] EPA's Office of Enforcement and Compliance Assurance (OECA) is currently working on guidance for implementing green infrastructure as part of a LTCP.[3]

NPDES regulations require development and implementation of a municipal separate storm sewer system (MS4) program to address post-construction runoff from newly developed and redeveloped areas. Some cities, such as Lenexa, Kansas,[4] and San Jose, California,[5] are incorporating green infrastructure

Figure 2: *Lake Lenexa in Kansas is part of 240 acres purchased by the City of Lenexa to protect open space and natural resources, serve as a public park and educational area, and provide large-scale green infrastructure for NPDES permit compliance.*

into local stormwater codes as part of NPDES requirements (see Figure 2). Updated state permits are starting to more directly address the links between imperviousness, runoff and water quality, from the larger land use scales down to specific site designs. EPA is now developing guidance for state permit writers that will expand the requirements for using green infrastructure to meet MS4 permit requirements.[6] As state permits incorporate more explicit language about using green infrastructure, more municipalities will start to adopt local programs knowing they can receive regulatory credit towards NPDES permit requirements.

EPA recognizes that increased coordination among National Program offices, Regional EPA offices and OECA would be beneficial and help avoid inconsistent policies, permits, enforcement orders and LTCPs. Although EPA recognizes the inconsistencies between innovative local policies and national Clean Water Act requirements, the current state of the regulatory environment may continue, at least in the short term, to make it difficult for cities to count their investments toward green infrastructure as meeting Federal stormwater and CSO requirements. However, EPA recently announced plans to initiate national rulemaking to establish a program to reduce stormwater discharges from new development and redevelopment and make other regulatory improvements to strengthen its stormwater program.[7] The municipalities in this case study

[1] See EPA's Green Infrastructure Web site for "Regulatory Integration" guidance and examples of LTCPs and NPDES permit language for states and municipalities: **http://cfpub.epa.gov/npdes/greeninfrastructure/regulators.cfm**

[2] Philadelphia Water Department's CSO Long Term Control Plan Update: **http://www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan**

[3] One of the potential issues that may arise in the use of green infrastructure in treatment of wastewater flows is the development of performance expectations and determination of compliance. Work is ongoing on tools to quantify performance of different types of controls. The Office of Water and EPA New England work referenced above may be of use.

In wet weather enforcement actions, a growing number of Supplemental Environmental Projects (SEPs) have involved the use of green infrastructure techniques to mitigate environmental damage. To date, green infrastructure SEPs have been used in settlements with the following municipalities:

- The Board of Water and Sewer Commissioners of the City of Mobile, Alabama
- The Board of County Commissioners of Hamilton, Ohio and the City of Cincinnati
- The District of Columbia Water and Sewer Authority and the District of Columbia
- The Washington Suburban Sanitary Commission, Maryland
- Sanitation District No.1 of Northern Kentucky
- Lexington-Fayette Urban County Government, Kentucky

[4] Lenexa, Kansas's Rain to Recreation policies: **http://www.raintorecreation.org/policies.html**

[5] San Jose, California's urban runoff regulations: **http://www.sanjoseca.gov/planning/stormwater/how_regulated.asp**

[6] **http://www.epa.gov/npdes/pubs/gi_memo_enforce.pdf**

[7] More information on Proposed National Rulemaking to Strengthen the Stormwater Program: **http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm**

report have found opportunities to combine multiple program objectives, but many have made separate allocations of staff time and funding to move forward green infrastructure strategies without regulatory support or credit.

Asset Management

City and county governments have limited financial resources to allocate to the many competing demands under local control. Municipalities are responsible for implementing and enforcing expensive Clean Water Act requirements, while also trying to pay for a large number of other programs, both environmental and non-environmental. EPA estimated in the 2004 Clean Watersheds Needs Survey that nationwide capital investments for controlling stormwater and wastewater pollution over a 20-year period will be $202.5 billion, including $54.8 billion for combined sewer overflow corrections and $9 billion for stormwater management. With decreased funding from the Federal government to pay for operations and maintenance of existing public stormwater systems as well as costs associated with implementing LTCPs, local governments and citizens must identify and select the most cost-effective solutions to meet regulatory requirements.

In light of these predicted costs for stormwater, wastewater and combined sewer systems, using green infrastructure as a form of asset management is a major driver behind the shift towards establishing a hybrid system of gray, piped infrastructure and green, vegetated infrastructure. By using green infrastructure to divert flow from sewer systems, gray infrastructure costs can be reduced, i.e. operations and maintenance costs can be decreased and future systems can be smaller.

Figure 3: *Euclid Park in Santa Monica, California, includes a depressed area with storage underneath, doubling as a public amenity and stormwater structure.*

Cities such as Philadelphia are passing green infrastructure policies as a means for better managing existing infrastructure assets and avoiding future operations and maintenance costs. The Philadelphia Water Department estimates that its new stormwater standard, which requires properties to retain the first inch on site, has reduced CSO inputs by a quarter billion gallons, thereby saving the City $170 million. These savings are derived from the fact that one square mile of impervious cover has been redeveloped under Philadelphia's updated stormwater regulations, and the cost of storing that same volume of stormwater in a CSO tank or tunnel comes to $170 million in capital, not including operations and maintenance costs. After two years of effectively enforced stormwater regulations, the City now estimates that two square miles are using green infrastructure, saving about $340 million in capital.

Lenexa, Kansas, compared three alternative stormwater management approaches and found that on-site detention with green infrastructure costs about 25 percent less than the old approach of retrofitting and reactive solutions.[8] Portland, Oregon, uses infiltration practices to keep millions of gallons of stormwater out of the "Big Pipe" it is constructing. Not only does this reduce current costs for conveyance and treatment, but it will help ensure that the Big Pipe will be able to handle increased inputs as the City develops over time. All three communities consider green infrastructure to be a smart investment of public funds to complement and extend the life of gray infrastructure projects as well. Many communities are starting to employ green infrastructure solutions as a more effective and cost efficient solution for meeting the multiple demands on publicly owned treatment works and stormwater management systems.

Flood Control

Costs and concerns associated with more frequent flood events have driven many communities to pass green infrastructure legislation as a way to mitigate future flooding and better manage runoff from existing development.

[8] Lenexa's cost-savings: **http://www.ci.lenexa.ks.us/Stormwater/lessexpensive.html**

Communities such as Lenexa, Kansas, and Stafford County, Virginia, were hard hit by major floods in 1998 and again in 2004. Both use green infrastructure approaches, such as rain gardens, street swales and other retention methods to provide additional flood protection during peak events. Both communities had public support for these newer natural systems because of the inability of traditional systems to provide adequate flood protection. Larger and older communities, including Chicago and Philadelphia, assume cost savings associated with green infrastructure for flood control and prevention. Chicago's Green Alley Program was started in large part as a response to homeowner complaints about flooding in alleys and adjacent basements.

Figure 4: *The Buffalo Bayou Promenade in Houston, Texas, retrofitted a formerly impervious area and restored this major drainage way as green infrastructure. The Bayou now has improved floodwater conveyance, in addition to providing other community and environmental benefits. Photo courtesy of Tom Fox,* **http://www.asla.org/2009awards/104.html**.

Municipalities of all sizes are concerned about flooding issues related to human safety, property damage and major public costs, especially in light of recent flooding in the Midwest and Gulf Coast regions. Flood damage in the United States averages over $6 billion annually, not including Hurricanes Katrina, Rita and Wilma.[9] These costs can be mitigated through the use of watershed and neighborhood scale green infrastructure planning to protect stream buffers and natural lands adjacent to water bodies that are known to flood during large storm events. Some localities, such as Charlotte-Mecklenburg County in North Carolina and Portland, Oregon, have established land acquisition programs to purchase and protect land in floodplains to provide more predictable flood control.[10] The Milwaukee Metropolitan Sewer District's Greenseams program protects existing open space and develops it as green infrastructure with natural flood storage.[11] The Milwaukee Conservation Plan reports potential cost savings of this green infrastructure approach as compared with conventional flood control alternatives.[12] More and more local governments are anticipating future flood risks and establishing interconnected systems of functional landscapes to protect floodplains and prevent flood damage.

Larger Sustainability Goals

Although Federal and State regulations are part of the impetus driving municipal green infrastructure programs, many of the communities surveyed have larger sustainability plans and efforts that are supported by and provide support to green infrastructure policies. San Jose's Green Vision,[13] Philadelphia's Sustainability Initiatives[14] or Mayor Daley's goal to make Chicago the most environmentally friendly city in the world are all examples of efforts that transcend compliance of the Clean Water Act. Green infrastructure policies can be used to achieve both water-related goals and a host of other community, economic and environmental benefits.

Municipalities with the most well-established green infrastructure programs have identified synergies in mission statements across agencies, from departments of transportation and public works to environmental agencies. Planning departments can use green infrastructure to promote more efficient land use and change local codes to ensure that projects have both environmental and economic benefits. Economic development agencies can use green infrastructure to improve neighborhoods and increase property values. In "shrinking cities" with population losses, such as

[9] Association of State Floodplain Managers white paper on No Adverse Impact: **http://www.floods.org/NoAdverseImpact/NAI_White_Paper.pdf**

[10] Charlotte-Mecklenburg Floodplain Buyout Program: **http://charmeck.org/stormwater/StormWaterProfessionals/Pages/FloodplainAcquisitionProgram.aspx**; Portland's Johnson Creek Land Acquisition Partnership: **http://www.portlandonline.com/Bes/index.cfm?a=214366&c=33212**

[11] Milwaukee's Greenseams program: **http://v3.mmsd.com/Greenseams.aspx**

[12] Milwaukee's Three Watershed Conservation Plan: **http://www.epa.gov/nps/natlstormwater03/26MOLeary.pdf**

[13] San Jose's Green Vision: **http://www.sanjoseca.gov/mayor/goals/environment/GreenVision/GreenVision.asp**

[14] Philadelphia's Sustainability Initiatives: **http://www.phila.gov/green/**

Philadelphia[15] and Buffalo,[16] vacant properties can be used for green infrastructure projects, either as permanent functional landscapes or interim land uses to encourage economic development. Local transportation departments can use green infrastructure in street and transportation right-of-way improvements. Typical practices include bump-outs, streets trees for improving pedestrian environments, sidewalk planters and even narrowing street widths.[17] Parks and recreation departments can also get involved in supporting green infrastructure, especially at the larger scale, by connecting greenways and corridors for habitat improvement and natural resource protection.[18]

The addition of green infrastructure as a basic community amenity is a strong driver as well. Several of the case studies in this report, including Philadelphia, Emeryville, Lenexa and Santa Monica, explicitly list quality of life improvements as a major priority of their local green infrastructure policies, while other cities see them as ancillary benefits. If communities can identify and ensure designs that provide multiple overlapping benefits, green infrastructure policies can be a solution to the increasing challenges facing cities, counties and metropolitan regions.

From Buffalo's Right Sizing Program:

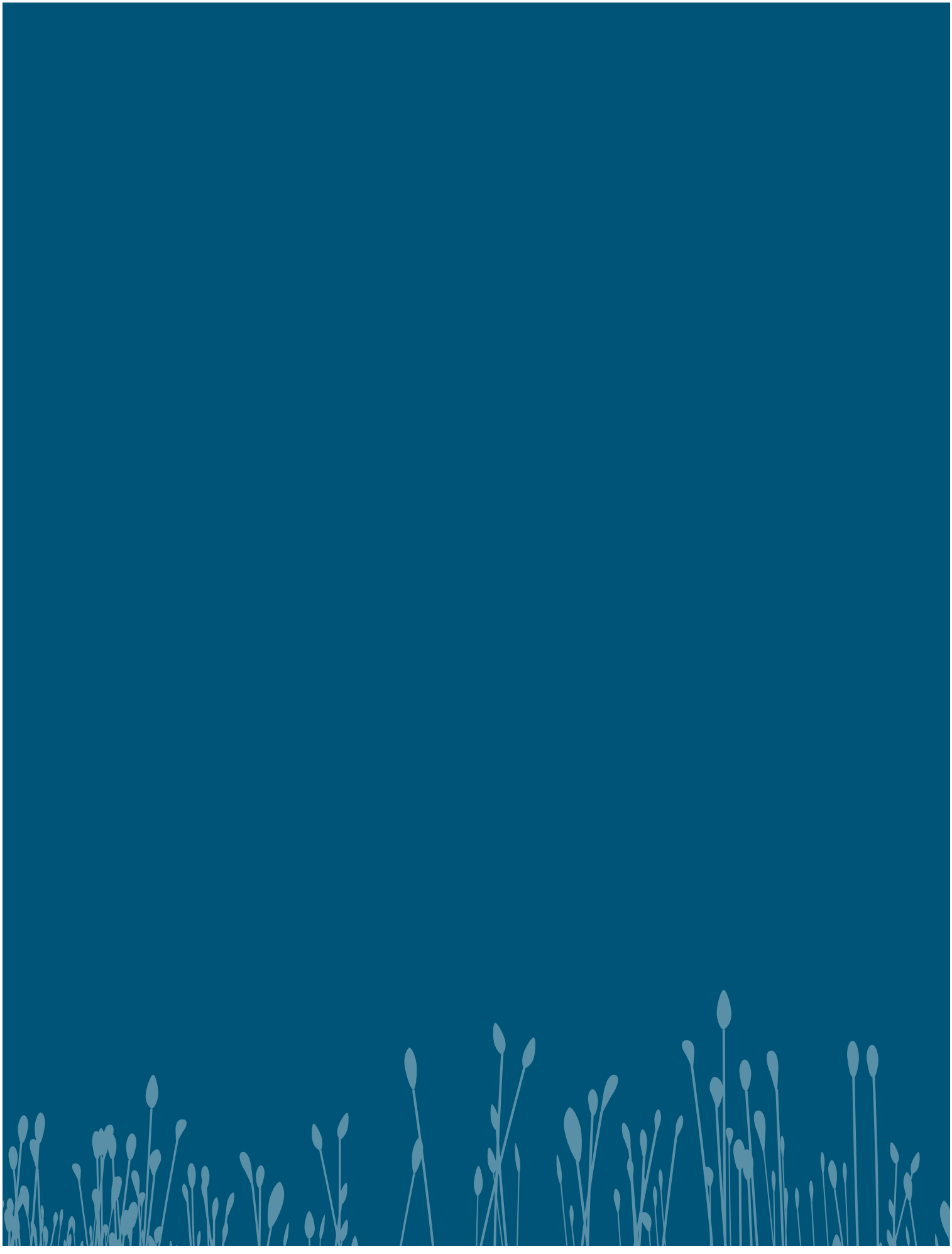
"Given shrinking populations, Buffalo's own land bank will likely contain a specific element addressing 'green infrastructure,' whereby a large percentage of vacant properties will be transformed into open space, trails, community gardens, and parks. A green infrastructure initiative could create value in the habitable properties that remain, and attract investors and residents back to these neighborhoods devastated by decay."

[15] Green Plan Philadelphia: **http://www.greenplanphiladelphia.com/**

[16] Buffalo's Right Sizing, Green Infrastructure and Neighborhood Reinvestment Plans (pages 14-15)

[17] See Portland's Green Streets Program Cross-Bureau Team Report for an example on how to effectively identify agency overlaps: **https://www.sustainableportland.org/shared/cfm/image.cfm?id=153974**

[18] "How Cities Use Parks for Green Infrastructure," By Dr. Mark A. Benedict and Edward T. McMahon, American Planning Association City Parks Forum Briefing Paper, November 2003. **http://www.greeninfrastructure.net/sites/greeninfrastructure.net/files/greeninfrastructure.pdf**



2 Menu of Local Green Infrastructure Policies

This chapter contains descriptions of the major policy approaches that are common to the majority of municipalities in this case study, including examples of how the policies have been applied. The next chapter contains guidance on how the policies should be implemented and adapted to fit local needs.

Stormwater Regulations

New stormwater regulations, whether for new projects or redevelopments, are the single common denominator for all 12 case studies. Each municipality requires new and redevelopment projects to use green infrastructure, if possible, to manage stormwater runoff before leaving the site. EPA's NPDES permit requirements are often the primary driver for these local stormwater codes. However, specific local goals are reflected in the variable types of requirements for on-site management. As seen in Table 3, many of the communities, such as Olympia, Washington, and Lenexa, Kansas, require developers to manage a specific volume of stormwater created by impervious surfaces. At the same time, other municipalities such as Alachua County, Florida, and Chicago, Illinois, require minimization of site disturbances and overall reduction of impervious surfaces.

Although the case study communities show that innovation in local stormwater codes can lead to better water quality outcomes, stormwater regulations cannot address a community's water quality problems alone. Stormwater regulations generally only impact properties seeking new permits, which does not account for most land use types or for properties

Figure 5: *All developers in Emeryville, California, must comply with the City's "Stormwater Guidelines for Green, Dense Redevelopment," which requires green infrastructure, such as this stacked parking lot, throughout a project's planning and operation.*

Figure 6: *Santa Monica, California's stormwater code focuses on protection of beach resources and allows for treatment and release of runoff.*

grandfathered in under older and less environmentally protective requirements (although some cities do choose to leverage political will in favor of regulating existing properties). Philadelphia predicts that only 20 percent of its lands will be managed through land-based controls in the form of stormwater management regulations, and that 20 percent is affected only after the new regulations have been in place for 20 years (see Figure 7). Vacant properties, public lands, streets and waterfront areas will all need to be addressed through other policy approaches.

Stormwater regulations alone cannot address larger land use patterns and development practices. Stafford County, Virginia, has a stringent new stormwater code requiring infiltration and filtration practices but lacks larger land use planning policies to direct growth and encourage higher-density developments.[19] A large percentage of county land is being converted into parking lots and other impervious surfaces. Although 95 percent of new commercial sites in Stafford County are now managing stormwater on site through bioinfiltration, the overall rate of land conversion to impervious surfaces is very high.

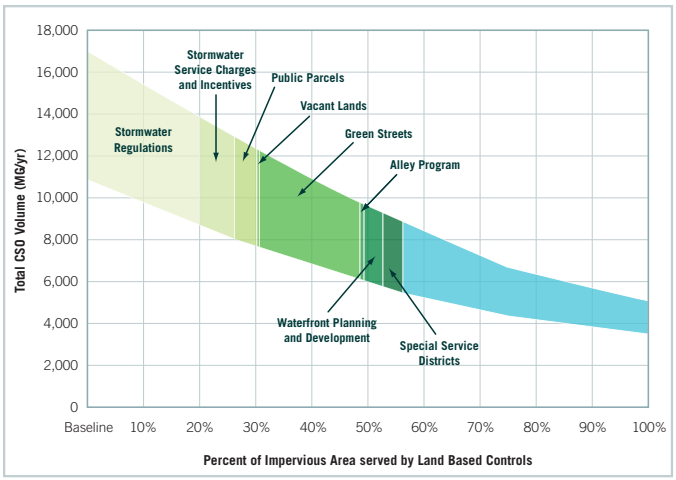


Figure 7: *Philadelphia found that stormwater regulations alone would only reach 20 percent of the impervious surfaces in the City. The City uses a range of policy types, including public land projects and incentives.*

To fully protect water resources, communities need to employ a wide range of land use strategies, based on local factors, including building a range of development densities, incorporating adequate open space, preserving critical ecological and buffer areas and minimizing land disturbance. Lenexa, Kansas, has a comprehensive plan for protecting and creating large-scale green infrastructure within the City's jurisdiction. The City directs development away from sensitive natural lands and then purchases land in priority areas to provide flood mitigation, stream protection, water quality improvements and recreational amenities.[20] The map in Figure 8 shows the many functional green spaces that also serve as public parks and trails for recreation and education. Municipalities must also ensure that local land use policies support higher densities, compact development and a mix of uses, which are methods to better protect water quality—especially at the watershed level. Consuming less land means creating less impervious cover in the watershed.

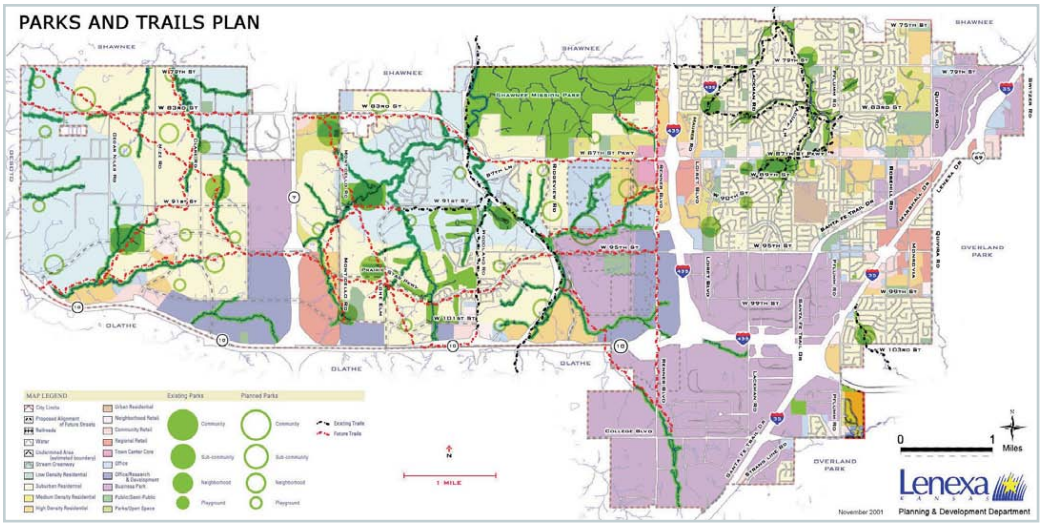


Figure 8: *Watershed scale green infrastructure plan for Lenexa, Kansas.*

[19] Stafford County's stormwater management program: **http://co.stafford.va.us/Departments/Public_Works/Environmental/Index.shtml**

[20] Lenexa's Rain to Recreation Program policies: **http://www.raintorecreation.org/policies.html**

Table 3: Local Stormwater Requirements

	Post-Development to Meet Pre-Development Conditions	**Volume-based Performance Standard**	**Process-based or Menu Approach**
Alachua County, FL	X[21]		
Philadelphia, PA		X[22]	
Portland, OR			X[23]
Seattle, WA	X	X[24]	X
San Jose, CA		X[25]	
Santa Monica, CA		X[26]	
Stafford County, VA	X[27]		
Wilsonville, OR	X[28]		
Olympia, WA		X[29]	
Chicago, IL		X[30]	
Emeryville, CA			X[31]
Lenexa, KS		X[32]	

[21] Alachua County, FL Stormwater Ordinance: **http://growth-management.alachua.fl.us/**

[22] Philadelphia Stormwater Regulation: **http://www.phillyriverinfo.org/Programs/SubprogramMain.aspx?Id=Regulations**

[23] Portland, OR: **http://www.portlandonline.com/shared/cfm/image.cfm?id=93075** & **http://www.portlandonline.com/bes/index.cfm?c=35122**

[24] Seattle, WA: **http://www.seattle.gov/dclu/codes/dr/DR2009-17.pdf**

[25] San Jose, CA: **http://www.sanjoseca.gov/planning/stormwater/Policy_6-29_Memo_Revisions.pdf**

[26] Santa Monica, CA: **http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Urban_Runoff/UR_Worksheet.pdf** & **http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Urban_Runoff/UR_Brochure.pdf**

[27] Stafford County, VA: **http://www.municode.com/resources/gateway.asp?sid=46&pid=11500** (see Chapter 21.5-2)

[28] Wilsonville, OR: **http://www.ci.wilsonville.or.us/Index.aspx?page=91** (see Public Works Standard, Section 3) & **http://ci.wilsonville.or.us/Index.aspx?page=662**

[29] Olympia, WA: **http://olympiawa.gov/city-utilities/storm-and-surface-water/policies-and-regulations.aspx**

[30] Chicago, IL: **http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/StormwaterManagementOrdinance1206.pdf**

[31] Emeryville, CA: **http://www.ci.emeryville.ca.us/index.aspx?nid=335**

[32] Lenexa, KS: **http://www.ci.lenexa.ks.us/LenexaCode/viewXRef.asp?Index=2927**

Table 4: Local Stormwater Requirements

Municipality	Stormwater Regulation
Portland, OR	Mandatory hierarchy for on-site infiltration or other practices to the maximum extent practicable (MEP).
Seattle, WA	All projects > 2000SF new and replaced impervious surfaces are required to compost amend all disturbed pervious areas, and implement green stormwater infrastructure practices to the maximum extent feasible (MEF). For areas with >10,000 SF impervious flow control performance based thresholds must also be demonstrated; For majority of Seattle creeks drainage basins site must achieve predeveloped pasture condition for peak and duration up to the 2-year flood frequency; For CSO and capacity constrained systems peak control target for 2 year and 25 year flood frequency events must be demonstrated. Additional requirements to protect wetlands to maintain hydroperiod.
Olympia, WA	Control 91 percent of runoff volume infiltrated through on-site controls for quality; post-development flow to meet predevelopment rates for quantity.
Santa Monica, CA	0.75-inch reduction of urban runoff from all impermeable surfaces through infiltration or treatment and release.
San Jose, CA	Control either 85 percent of 24-hour storm runoff event (using volume treatment control measures (TCMs)) or 10 percent of the 50-year peak flow rate (using flow TCMs), but must use landscape-based treatment and trees to MEP.
Emeryville, CA	Site design and source control measures, maximize pervious surfaces, and treatment using landscaping. Post-construction quality must meet pre-construction standards, to MEP. Reporting on the amount of impervious surface created/replaced.
Lenexa, KS	Manage 1.37 inches of water quality volume using LID treatment train approach; pay into system for quantity (used to fund regional projects). Natural channels preserved to MEP.
Chicago, IL	Manage 0.5 inch runoff from all impervious surfaces or reduce imperviousness by 15 percent.
Alachua County, FL	Limit the proportion of the area of stormwater facilities to total site area through reduction of impervious surfaces via vertical construction and use of alternative parking surfaces (to MEP); Stormwater management facilities must use site contours and minimize disturbance to existing natural features (to MEF). Anti-degradation requirements for water quality.
Philadelphia, PA	Four areas of focus and associated requirements: channel protection (control one year storm), flood protection (post-development conditions must be equal to pre-development), water quality (infiltrate/manage first 1 inch from all directly connected impervious surfaces), and site design requirements to reduce imperviousness. Redevelopments may be exempt from channel and flood protection.
Stafford County, VA	LID practices must be used to MEP to meet quality and quantity requirements.
Wilsonville, OR	Provide on-site detention and water quality facilities; post-development runoff rates must not exceed pre-development rates; Revising standards now based on pilot neighborhood project using green infrastructure.

Review and Revise Local Codes

Seven of the municipalities studied conducted a thorough review of associated development codes and ordinances to assess consistency with a new or revised stormwater regulation. These cities and counties are finding that a review of other local ordinances is necessary to remove barriers and ensure coordination across all development codes for better water quality outcomes. Local policies, such as landscaping and parking requirements or street design criteria, should complement stormwater standards and make it easier for developers to simultaneously meet multiple requirements. At the same time, if other local policies are written to support water quality goals, they can independently reduce and better manage stormwater runoff.

A comprehensive review process will require interagency coordination and cooperation to both identify and address the potential inconsistencies between different policies and regulatory mechanisms. EPA's Water Quality Scorecard was developed to help local governments identify opportunities to remove barriers, and revise and create codes, ordinances and incentives for improved water quality protection. It guides municipal staff through a review of relevant local codes and ordinances, across multiple municipal departments and at the three scales within the jurisdiction of a local government (municipality, neighborhood and site),[33] to ensure that these codes work together to protect water quality goals. The Water Quality Scorecard can be found at **http://www.epa.gov/smartgrowth/water_scorecard.htm**.

A process of review and coordination, not just for codes, but for interaction among the various departments involved in development permitting, should be done early if not before the new stormwater regulations go into effect. The building and development community may be more willing and able to implement a new stormwater requirement if the process for understanding and installing new practices is transparent, straightforward and in concert with the many other requirements they must meet.

A thorough policy audit can help municipal staff, stormwater managers, planners and other stakeholders better understand where the opportunities and barriers may exist in a municipality's land development regulations, building codes, permitting processes and more. Local regulations that should be reviewed may be controlled and enforced by a number of different local government agencies, including parks and recreation, public works, planning, environmental protection, utilities and transportation.

Chicago's Department of Environment initiated a Green Urban Design process to look at discontinuity of ordinances across eight city agencies and then developed a framework plan to align all development ordinances.[34] One point of discontinuity was with a landscape ordinance requiring prescriptive placement of vegetation rather than prioritizing practices by ecological function, which contradicted the new performance-based stormwater requirements.

Philadelphia has established a Developer Services Committee to streamline its development review process.[35] This partnership effort resulted in a simplified process for permit review, inspection and approval. The success of the new stormwater regulations is contingent upon the fact that the Philadelphia Water Department requires projects to get

Philadelphia Developer Services Committee

- Fire Department
- City Planning Commission
- Philadelphia Industrial Development Corporation
- Department of Licenses & Inspection
- Department of Public Property
- Managing Director's Office
- Streets Department
- Water Department
- PECO Energy
- Philadelphia Gas Works

[33] While the watershed scale is the best scale at which to look regionally at water quality protection strategies, it can be difficult to align policies, incentives and regulations across political boundaries. So for purposes of implementation, the largest scale the scorecard uses is the municipality.

[34] Chicago Codes for Green Urban Design: **http://www.cityofchicago.org/content/dam/city/depts/zlup/Sustainable_Development/Publications/Green_Urban_Design/GUD_booklet.pdf**

[35] Philadelphia Developer Services Committee: **http://www.phila.gov/commerce/comm/lvl_2/mbat_dev.htm**

concept approval for water, sewer and stormwater before zoning permits are considered.

Several cities have found that successful integration of green infrastructure systems into new development projects required early site design considerations. Placing stormwater plan approval earlier in the development review process helps to ensure better green infrastructure outcomes in built projects.

Demonstration and Pilot Projects

Demonstration and pilot projects are a common way for communities to introduce green infrastructure into a range of programs and local agency policies. Small projects in locations with fewer physical and political complications provide important testing grounds for the partnerships so often needed for successful development of these programs. Furthermore, pilot projects allow relevant agencies and staff to figure out the logistics of implementing green infrastructure practices, from design, construction and maintenance to basic permitting protocols. A period of trial and error allows for the development and refinement of a better policy or program.

Most cities pilot small-scale projects to work through potential problems with programs intended for citywide application, such as a green streets initiative or standards for capital projects. For instance, Seattle Public Utilities found that the success of its Natural Drainage Systems program was due to several pilot projects that were carefully designed, installed and then monitored for performance before being applied throughout the City.[36]

Although costs for green infrastructure projects initially may be higher than traditional projects, often costs are lowered after a pilot phase.[37] In its first pilot year, Chicago's Green Alley Program cost 150-200 percent more than conventional alley retrofits, but now costs have lowered to nearly match conventional material installation.

Olympia, Washington, provides an example of a pilot phase that went poorly and resulted in a revised program. The City set very strict development standards on the healthiest stream in the jurisdiction, Green Cove Basin, but because they did not entirely agree with or understand the requirements, developers found loopholes in the regulation that resulted in poor neighborhood design and dissatisfaction on the part of homeowners. As a result, Olympia revised its requirements and turned more attention towards street design and on public rights-of-way to improve runoff conditions in this salmon-bearing watershed.[38]

Figure 9: *Villebois is a large neighborhood development in Wilsonville, Oregon, that incorporates decentralized stormwater management features.*

Wilsonville, Oregon, conducted a similar large-scale pilot project with the Villebois neighborhood, a 500-acre project that is seen as a testing ground for a suite of new stormwater regulations and larger development requirements for this fast-growing town (see Figure 9).[39] City officials also intend to apply lessons learned in this private sector project to future capital projects.

Whether demonstrations are meant to test new programs or to serve as tangible evidence of the feasibility and functionality of green infrastructure practices, they are almost always an

[36] For a list of Seattle Public Utilities Natural Drainage System projects: **http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/NaturalDrainageProjects/index.htm**

[37] For more information on pilot projects and costs, see Center for Neighborhood Technology's paper "Managing Urban Stormwater with Green Infrastructure: Case Studies of Five U.S. Local Governments": **http://www.cnt.org/repository/GreenInfrastructureReportCivicFederation%2010-07.pdf**

[38] Olympia development standards for Green Cove Basin: **http://www.ci.olympia.wa.us/en/city-utilities/storm-and-surface-water/streams-and-shorelines/streams-and-shorelines-green-cove-creek-watershed.aspx**; More information on Green Cove as a priority watershed: **http://www.ci.olympia.wa.us/en/city-utilities/storm-and-surface-water/streams-and-shorelines/streams-and-shorelines-green-cove-creek-watershed.aspx**

[39] Villebois Village Master Plan: **http://www.ci.wilsonville.or.us/Index.aspx?page=112**

important first step in a community's effort to establish widespread policies to support green infrastructure approaches.

Capital and Transportation Projects

Taken in total, surface transportation systems, including roadways, railways, sidewalks and alleyways, can be the greatest contributor to total imperviousness in a given community.[40] Local departments of transportation dedicate an equally large portion of funds to repairs, maintenance and improvements to these systems. Eight of the 12 municipalities in this study have realized the value of leveraging these huge funding sources by incorporating green infrastructure practices into standard transportation projects. Green street practices include bioswales, rain gardens and infiltration practices, street trees and porous paving materials, many of which add value to the public space as well as providing better environmental performance.[41] Green streets handle stormwater with vegetated facilities, provide water quality benefits, create attractive streetscapes, improve safety through traffic calming, provide pedestrian and bicycle access and serve as multi-purpose urban greenways.

Municipalities also spend considerable amounts of money planning and building major capital projects, from bridge-building to road retrofits to development and redevelopment of public buildings, parks and other facilities. Several of the case study communities recognized that if even a small percentage of the total funding that goes towards these projects is allocated for green infrastructure designs, large impervious areas can be retrofitted in old projects and entirely avoided in new ones. For example, the City of Seattle established the Sustainable Infrastructure Initiative to evaluate how it spends its more than $650 million annually on capital projects. This interdepartmental initiative will consider sustainable alternatives, such as green infrastructure, to typical retrofits, repairs and new projects. Santa Monica, California, a smaller city, also incorporates green infrastructure into all capital projects, which is much simpler since one staff person can review plans, conduct inspections and ensure that all major projects include on-site stormwater mitigation features.

Figure 10: *Chicago's Green Alley program retrofits existing alleys to include permeable pavers as seen in this residential alley. Photo courtesy of David Leopold.*

Portland's Green Streets program has a formal process to overlay multi-bureau project plans and scheduled capital improvement projects to identify how public and private projects can achieve multiple community and environmental benefits through green infrastructure.[42] Chicago's Green Alley Program (see Figure 10) is an alternative solution to the method of retrofitting over 3,500 acres of alleyways throughout the City.[43] Low traffic volume and the lack of existing infrastructure in Chicago's alleys provided an opportunity to replace existing asphalt and concrete with pervious pavement to allow for infiltration instead of retrofitting with conventional piped infrastructure.

The increased investment necessary to include green infrastructure in these large undertakings is typically a very small percentage of the total project costs. Costs and ease of designing or redesigning streets depends on whether the street is already built, what maintenance or improvements are already planned and whether retrofits are being made to streets, sidewalks or other types of infrastructure or utilities

[40] Clean Water Service's Healthy Streams Plan, 2006 documents 54.5 percent of imperviousness due to roads, parking lots and driveways: **http://www.cleanwaterservices.org/Content/Documents/Healthy%20Streams%20Plan/Healthy%20Streams%20Plan.pdf**; United State Geological Survey report, "Quantifying the Components of Impervious Surfaces," shows that in the study watersheds, roads and parking lots alone account for 52.9 percent of impervious surfaces; For more on this topic, see Tom Schueler's "The Importance of Imperviousness," 1994: **http://yosemite.epa.gov/R10/WATER.NSF/840a5de5d0a8d1418825650f00715a27/159859e0c556f1c988256b7f007525b9/$FILE/The%20Importance%20of%20Imperviousness.pdf**

[41] Find more resources on EPA's Green Streets and Highways page: **http://cfpub.epa.gov/npdes/greeninfrastructure/technology.cfm#greenstreets**

[42] Portland's Green Streets report, resolution and policy: **http://www.portlandonline.com/BES/index.cfm?c=44407**

[43] Chicago's Green Alley program and handbook: **http://egov.cityofchicago.org/city/webportal/portalContentItemAction.do?topChannelName=HomePage&contentOID=536946345&Failed_Reason=Invalid+timestamp,+engine+has+been+restarted&contenTypeName=COC_EDITORIAL&com.broadvision.session.new=Yes&Failed_Page=%2fwebportal%2fportalContentItemAction.do**

10,000 Rain Gardens in metropolitan Kansas City is a successful education and outreach program that engages citizens to manage stormwater on site.

"10,000 Rain Gardens is not a government program.

It is a rallying cry, calling upon the creativity of citizens, corporations, educators, and non-profit organizations to join with government to voluntarily reduce the amount of stormwater runoff that pollutes our waterways. In the past two years, several hundred rain gardens as well as rain barrels and bioswales have been installed and are working to reduce runoff.

These personal efforts combined with commercial-sized green solutions yield a powerful cumulative effect in reducing flooding, erosion and pollutants in our rivers and streams. Working together, we will improve water quality and make a difference now and for the future."

–10,000 Rain Gardens website: **http://www.rainkc.com/index.cfm/fuseaction/home.showpage/pageID/9/index.htm**

For more information, go to **http://www.rainkc.com**

beneath the surface. The use of green infrastructure elements can also decrease overall project costs.[44] For example, green infrastructure designs can be used to reduce the concrete and asphalt needed to pave and curb streets.

Other capital projects include major public investments to acquire lands deemed ecologically sensitive or important for water quality protection. Some communities purchase property to protect it from new development, while others will construct large green infrastructure features to mitigate floods and manage stormwater flows from nearby impervious areas. Lenexa, Kansas's Rain to Recreation[45] program spends tens of millions of public dollars to purchase land in priority areas, which prevents unwanted development while providing long-term community assets. Likewise, Alachua County Forever[46] is a program in Florida where the County acquires, protects and manages environmentally significant lands and water resources. These programs consider large-scale green infrastructure systems that work to improve and protect overall watershed function and minimize imperviousness throughout a community. Capital and transportation projects can have significant impacts at the watershed and neighborhood scales.

Education and Outreach

Education and outreach programs take advantage of built green infrastructure projects to communicate to the general public the value of stormwater as a resource rather than remove it as quickly as possible from the site or city. Using signage, brochures and other outreach materials, municipal agencies can build public understanding of green infrastructure approaches. Education and outreach takes many forms, such as Portland's stormwater cycling tour[47] or Chicago's how-to guide for disconnecting a downspout or installing a rain barrel.[48] Public campaigns, events and publications encourage citizens and property owners to take action to reduce runoff and prevent contributions to stormwater pollution. Olympia, Washington's "Gardening with a Sound Mind"

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[44] Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices: **http://www.epa.gov/owow/nps/lid/costs07/**

[45] Lenexa, Kansas's Rain to Recreation program: **http://www.raintorecreation.org/index.html**

[46] Alachua County's Alachua County Forever program: **http://www.alachuacounty.us/Depts/EPD/LandConservation/Pages/LandConservation.aspx**

[47] Portland Stormwater Cycling Tour: **http://www.portlandonline.com/Bes/index.cfm?a=53568&c=34604**

[48] Chicago's How-to Guide for Managing Stormwater at Home: **http://egov.cityofchicago.org/webportal/COCWebPortal/COC_ATTACH/ManagingStormwater_Home.pdf**

Figure 11: *Examples of educational signage added to public and private property green infrastructure approaches. Images from Philadelphia (top), Portland (middle), and Chicago (bottom).*

urges homeowners to protect the Puget Sound by planting native species and avoiding lawn fertilizers and pesticides.[49] Education programs can be directed toward individual behavior by highlighting how runoff carries pollutants to downstream surface waters.

Other public outreach programs validate public investments and capital projects, whether through educational signage or larger campaigns. Lenexa's Rain to Recreation program includes a free speaker's bureau for schools, community groups, residents, businesses and other professionals.[50] Not only is this type of public education good governance, it helps institutionalize green infrastructure programs for the long-term.

The simplest method of education and outreach is adding signage to any known green infrastructure project, whether on public or private land (see Figure 11). By giving visible markers for these sites along with information about what they are and how they work to protect water quality and improve local environments, people begin to recognize the larger system and cumulative impact of a decentralized system of many practices.

Stormwater Fees

Stormwater fees are used to generate a dedicated revenue stream to address the increasing investment most communities will have to make to control both combined sewer overflows and stormwater runoff. Some municipalities need additional funding for new infrastructure required to meet the demands of growth and development or changing regulatory requirements, while older communities often need extra revenue to repair and maintain existing storm sewer systems. Traditionally, the costs for stormwater management were paid for with general funds collected through taxes, such as a property tax, or through a property's water bill. Stormwater user fees are now being used to direct the costs for stormwater management towards those properties that actually create the most runoff entering the public system.

Unlike familiar water and wastewater utility fees, utility fees for stormwater management are a relatively new concept. Their use arose from the recognition that managing stormwater imparts a fiscal impact on a municipality to manage infrastructure and provide environmental protection. An increasingly common method for calculating a stormwater user fee is an impervious surface based billing system. Because runoff from impervious areas is the primary contributor to the storm sewer system, this system is seen as a more equitable determination for fees than some early methods of calculating charges, such as a meter-based fee, which charges by water consumption. For example, a parking lot may not use potable water on site but discharges significantly more

[49] Olympia's "Gardening with a Sound Mind": **http://www.ci.olympia.wa.us/en/city-utilities/storm-and-surface-water/education-and-action/education-and-action-gardening-with-a-sound-mind.aspx**

[50] Lenexa's Rain to Recreation Speaker's Bureau: **http://www.raintorecreation.org/contact_us.html**

runoff than a residence or business of a similar size. The stormwater fee should reflect the contribution of runoff from a particular site.

Many communities will calculate user fees for commercial, multi-family residential and industrial properties based on total lot size and percentage of imperviousness.[51] These rates are measured through a Geographic Information System (GIS) and orthographic flyover image data that accurately accounts for the stormwater runoff inputs of these large customer parcels. For ease of collection, the stormwater fee is often added to water, sewer or utility bills. Some cities charge the user fee as a monthly or annual tax. In San Jose, California, for instance, the Santa Clara County Tax Collector's Office collects the Storm Sewer Service Charge through the annual property tax roll.

Stormwater Fee Discounts

Stormwater fee discounts and incentives give property owners the option of making site changes that can decrease the amount of their on-site stormwater fee. Discounts often encourage retrofits of existing properties and implementation of green infrastructure in new developments. In Philadelphia, Portland and Seattle, fee discounts and credits provide an opportunity for property owners to reduce the amount they pay by decreasing impervious surfaces or by using green infrastructure techniques that reduce the amount of storm-water runoff. In turn, public infrastructure is less burdened when private property owners manage their own stormwater runoff on site. Discounts also support the fee-for-service system because property owners can reduce the amount they pay by reducing the service received.

Before setting the credit standard or discount, whether for use of specific green infrastructure practices or for a reduction in impervious surfaces, municipalities should set appropriate management goals and determine how to credit private property owners for whatever action is being given an incentive. Table 5 outlines a framework for setting goals and developing mechanisms and processes for implementing fee discounts.

Table 5: Framework for Stormwater Fee Discount Programs

Goal of Discount	Mechanism for Fee Reduction	Process for Implementation
Reduce Imperviousness	• Percent fee reduction • Per-square-foot credit	• Percent reduction in imperviousness • Square feet of pervious surfaces
On-site Management	• Percent fee reduction • Quantity/Quality credits (performance-based)	• List of practices with associated credits • Total area (square feet) managed
On-site Management	• Percent fee reduction • Performance-based quantity reduction	• Percent reduction in imperviousness • Performance-based • Total area (square feet) managed • Practices based on pre-assigned performance values
Use of Specific Practices	• Percent fee reduction • One time credit	• List of practices with associated credits

[51] For more information on stormwater fees, see EPA's Municipal Handbook for Green Infrastructure, Chapter on Funding Options: **http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm** and EPA Region 3's Fact Sheet on Funding for Stormwater Programs: **http://www.epa.gov/npdes/pubs/region3_fact-sheet_funding.pdf**

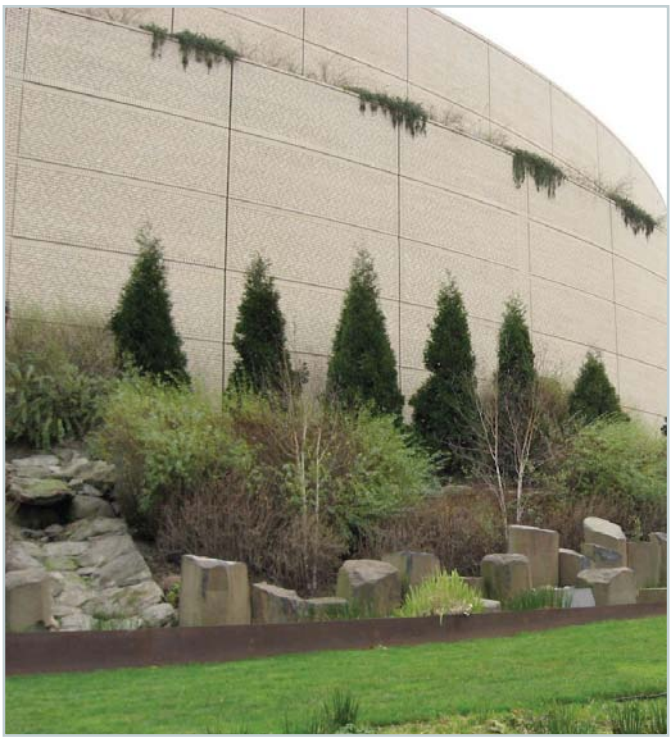

Figure 12: *Oregon Convention Center saves $15,600 per year on its stormwater bill by managing roof runoff in these rain gardens.*

Municipalities using a stormwater fee discount commonly set a maximum percentage for the discount to ensure adequate revenue generation. This discount is primarily given for stormwater quantity reductions and in fewer cases for pollution reduction for water quality purposes. Discounts are also offered for impervious surface reductions, whether for total area or by the square foot. Finally, credits can be based on the implementation of specific practices, such as rain gardens, green roofs or even tree canopy area. Portland, Oregon, gives specific credits for sites with ecoroofs or trees over 15 feet tall (see Figure 12). Credits may vary based on the type of green infrastructure practice and the goals the municipality has for private lands.

Other Incentives

Incentives are a creative tool local governments can use to encourage green infrastructure practices on private property. Incentive mechanisms allow municipalities to act beyond the confines of regulatory authority to improve wet weather management on properties that may not fall under updated stormwater requirements. In these cases, incentives are geared towards private property owners to promote retrofits of existing sites to include green infrastructure practices where they do not already exist. For new development projects, incentives can take advantage of the development processes, such as permitting or other development codes and requirements, to creatively encourage green infrastructure. The four types of local incentive mechanisms include stormwater fee discounts, development incentives, rebates and installation financing and awards and recognition.

TYPES OF LOCAL INCENTIVES FOR GREEN INFRASTRUCTURE

- **Fee Discount**: Requires a stormwater fee that is based on impervious surface area. If property owners can reduce need for service by reducing impervious area, the municipality reduces the fee.
- **Development Incentives**: Offered to developers during the process of applying for development permits. Includes zoning upgrades, expedited permitting, reduced stormwater requirements, etc.
- **Rebates & Installation Financing**: Gives funding, tax credits or reimbursements to property owners who install specific practices. Often focused on practices needed in certain areas or neighborhoods.
- **Awards & Recognition Programs**: Provides marketing opportunities and public outreach for exemplary projects. May include monetary awards.

Development incentives apply to private developers that take initiative in favor of more sustainable site design and green building practices. Incentives tied to stormwater regulations encourage developers to creatively implement on-site management practices to avoid more stringent or more costly stormwater requirements. Chicago's Green Permit Program reviews permits much faster for projects that meet certain Leadership in Energy and Environmental Design

(LEED) criteria.[52] Portland's Ecoroof Floor Area Ratio Bonus increases a building's allowable area in exchange for adding an ecoroof.[53] Portland has seen over $225 million in additional private development through this program, and has added more than 120 ecoroofs to the City.[54] In San Jose, California, 87 percent of all development projects have reduced their total site imperviousness to less than 10,000 square feet to stay under the threshold at which new technology-based water quality requirements go into effect.[55]

Rebates and installation financing programs give money directly to individual homeowners, other property owners and community groups for stormwater-related projects and can help a city or county add green infrastructure projects to the landscape. Examples of rebates and installation financing include paying back property owners that purchase and install rain barrels or trees or disconnect downspouts from combined systems. Seattle's Residential RainWise Program gives residents rain garden and cistern incentives (see Figure 13).[56] Santa Monica, California, gives $160,000 per year in Landscape Grants to property owners that use native landscaping to reduce water consumption and absorb runoff.[57] Chicago's Green Roof Grants helped this former industrial city add over 2.5 million square feet of green roofs across the City. The program grants $5,000 awards to residential and small commercial buildings that meet criteria based on location, visibility and environmental benefit.[58]

Figure 13: *A disconnected downspout in Seattle, Washington.*

Overall, these incentive programs provide awards and savings to developers and individuals who take extra steps to add environmental benefits with greener stormwater management practices. For a list of all known incentive programs from around the country, go to the Incentives Chapter within EPA's Green Infrastructure Municipal Handbook, at **http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm**.

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[52] Chicago's Green Permit Program: **http://egov.cityofchicago.org/webportal/COCWebPortal/COC_EDITORIAL/PermitFeeWaiversGreenPermitProgram_1.pdf**

[53] Portland's Floor Area Ratio Bonus: **http://www.portlandonline.com/shared/cfm/image.cfm?id=53363** (pages 510-32); or see **http://www.portlandonline.com/bps/index.cfm?c=ecbbd&a=bbehci**

[54] Portland BES presentation November 2007: **http://www.portlandonline.com/Bes/index.cfm?a=172761&c=46084** (slide 24)

[55] 87 percent figure based on 300 plans submitted per year with 35-40 reported to the Regional Water Quality Control Board for passing the 10,000 square foot threshold.

[56] Seattle's RainWise Program: **https://rainwise.seattle.gov/systems/water**

[57] Santa Monica Sustainable Landscape Grant Program: **http://www.smgov.net/Departments/OSE/Categories/Landscape/grant_gardens/Sustainable_Landscape_Grant_Program.aspx**

[58] Chicago's Green Roof and Cool Roof Grants Program: **http://www.cityofchicago.org/city/en/depts/bldgs.html**

3 Policy Implementation:
Barriers, Lessons Learned and Realities of Each Policy

Overview

A fully developed municipal program that supports green infrastructure at every scale, including the watershed, neighborhood and site levels, is not created all at once or through a single policy or initiative. Many of the municipalities in this study found that incremental policy adoption and iterative processes led to a fuller and more widespread adoption of green infrastructure approaches. Some policies are easier than others to implement, either because they require less funding, or because they can be incorporated into existing programs or undertaken by supportive municipal offices or agencies. Other policies may be more difficult because of known and unexpected barriers, including:

- Funding
- Lack of political support/leadership
- Resistance to change
- Coordination of multiple stakeholders and partners
- Legislative action
- Conflicting regulations
- Need for technical information and training
- Nascent market
- Misunderstanding about land use issues
- Cost concerns[59]

These items are barriers in the sense that they can add significant time and effort to the process of implementing green infrastructure practices on the ground.

Clearing up misconceptions about green infrastructure may take time and energy, but buy-in from key stakeholders is important for successful policy implementation. Establishing sustainable funding for green infrastructure is another difficult step, but is undoubtedly the cornerstone of long-term and sustainable programs. Lack of political support is another good example of a significant barrier that, if overcome, can help a program flourish. However, personnel may not be able to easily turn the tide of political resistance, and might better invest time and energy in some of the simpler policies that can jump-start a program and provide support for future program expansion. This section describes three steps

[59] Godwin, D.C., Chan, S.A., Burris, F.A. Barriers and Opportunities for Low Impact Development: Case Studies from Three Oregon Communities. **www.nacaa.com/journal/2008/Godwinpaper.pdf**

An Economic Rationale for Integrated Stormwater Management: A Resource for Urban and Rural Land Development in BC. Small Towns Initiative, Landscape Architecture Program, University of British Columbia. **http://www.env.gov.bc.ca/epd/epdpa/mpp/stormwater/urban_rural_land/pdf/43.pdf**

Oregon Environmental Council. Stormwater Solutions: Turning Oregon's Rain Back into a Resource, Chapter 4: Barriers to Overcome. **http://www.oeconline.org/our-work/rivers/stormwater**.

for implementing policies, starting with those that can more quickly and easily result in build-out of green infrastructure.

This three-step approach is based primarily on research within these case studies and is meant to be informative for municipalities trying to prioritize time and resources to launch green infrastructure programs. All of the policies listed are important, but can be initiated in a way that will be simpler, cheaper and faster for getting green infrastructure practices in the ground.

3-STEP POLICY IMPLEMENTATION TO SUPPORT LOCAL GREEN INFRASTRUCTURE

First Step

- Stormwater Regulation
- Code Review

Second Step

- Demonstrations and Pilots
- Education and Outreach
- Incentives

Third Step

- Capital and Transportation Projects
- Stormwater Fee
- Fee Discount

First Step Policies

Every community that is committed to green infrastructure should secure a sustainable local funding source, revise local stormwater regulations to require the use of green infrastructure practices on site and review local codes and ordinances to ensure support of water quality goals.

Securing a sustainable source of funding must be the first step for any municipality trying to set up a comprehensive stormwater program. Municipalities that rely entirely on outside funds in the form of grants and loans will find it difficult to develop many of the other policies and programs. Establishing a stormwater fee is included as a third step because of the time it may take to properly develop an equitable fee system, complete the public comment period and fully implement a new stormwater fee throughout a jurisdiction. However, local funding, whether from stormwater fees or other sources, is a critical element of all other green infrastructure policies and programs.[60]

Stormwater Regulation

All of the municipalities in this case study report have created a new or improved local stormwater ordinance requiring the use of green infrastructure practices to meet quantitative management standards. Revising or creating a local stormwater regulation that explicitly encourages or mandates green infrastructure should be a standard step in the process of setting up a comprehensive green infrastructure program. Table 4 in the previous chapter lists each case study and its specific type of stormwater regulation. Whether the stormwater regulation is performance-based or prescriptive (by requiring the use of particular green infrastructure practices), communities must write stormwater codes with definitive language supporting or requiring the use of practices that infiltrate, reuse and/or evapotranspire runoff, depending on local rainfall data, soil types and other conditions.

Code Review

Local code review must be an early step in the process of truly integrating green infrastructure into all municipal programs, from planning to public works. Local policies, such as landscaping and parking requirements or street design criteria, should complement strong stormwater standards and make it easier for developers to simultaneously meet multiple requirements.

The various regulations, processes and other policies that should be reviewed may be under the control of a number of different local government agencies, including parks and recreation, public works, planning, environmental protection, utilities and transportation. This review process will require interagency coordination and cooperation to both identify and address the potential inconsistencies between different policies. A comprehensive interagency review may be more of an undertaking in a large city with many departments with large staffs that do not regularly communicate or think

[60] For more information on setting up funding for green infrastructure programs, see EPA's Municipal Handbook at **http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm**

about stormwater management. For a smaller jurisdiction, this process may be simpler because fewer departments are involved and internal processes may be easier to change.

EPA has developed a Water Quality Scorecard that provides guidance for communities about how to review all local codes and ordinances, at the municipal, neighborhood and site scales, to ensure that they are mutually supportive of water quality goals. This policy tool can help municipal staff, stormwater managers, planners and other stakeholders better understand where the opportunities and barriers may exist in a municipality's land development regulations and other ordinances from building codes to tree preservation requirements. The Water Quality Scorecard can be found at **http://cfpub.epa.gov/npdes/greeninfrastructure/munichandbook.cfm**.

Second Step Policies

Demonstration and pilot programs and education and outreach programs can set the stage and provide support for larger undertakings, such as instituting a stormwater utility or incorporating green infrastructure in public project design standards.

Demonstration Projects

Demonstration projects are the starting block for almost every one of the communities in this case study. Built projects provide legitimacy to green infrastructure practices that can be challenging to establish simply through research findings, models and examples from other locations. Program staff can easily build internal partnerships to identify locations appropriate for demonstration projects or opportunities to set up pilot programs. Three examples of successful pilot and demonstration programs include:

1 PHILADELPHIA: Philadelphia prioritizes demonstration projects on public property based on priority CSO outfalls and their drainage areas. The Water Department has mapped the City by sewershed, which has supported the process of identifying areas in greatest need of CSO reductions. Demonstration projects are monitored, ideally both before and after green infrastructure improvements, to measure performance and CSO reductions.

2 SEATTLE: Seattle Public Utilities has used demonstration projects to achieve exponential change. Seattle Street Edge Alternatives or SEA Streets helped gain acceptance for Natural Drainage Systems within the Seattle Department of Transportation (SDOT). Monitoring since 2001 on the original 2nd Avenue pilot street shows a 99 percent reduction in stormwater volumes flowing off site.[61] Now SDOT includes swales with any new sidewalk and otherwise reviews each major roadway project on a case-by-case basis for inclusion of green infrastructure.

3 CHICAGO: Chicago's Green Alley Program began as a pilot program in which the Chicago Department of Transportation (CDOT) allowed the program to run as a one year pilot phase to retrofit a small number of alleys with permeable materials. This pilot year allowed CDOT to develop specifications for mixing and installing permeable alley surface material, which has in effect created a new market for manufacturers and installers. Now the Works Progress Administration and other agencies are using these materials and processes to make permeable parking lanes, and CDOT now retrofits all alleys in the City with permeable materials.

Education and Outreach Programs

Education and outreach are common programs in many of the cases because they are relatively easy and inexpensive to implement while building necessary public understanding and support for other green infrastructure policies. Municipalities should develop education programs not only for the general public, but also for residential and commercial property owners and internal municipal staff that might be working on green infrastructure projects.

Public outreach can include placing municipal-sponsored signs on any known green infrastructure projects, including private properties. This brings visibility to the range of green infrastructure projects in a community and should provide simple, straightforward information about how infiltration, reuse and evapotranspiration work to manage runoff on site. Signage is especially valuable for manifesting the cumulative impact of various practices. If people recognize that a home rain garden works in tandem with a neighboring business's green roof, the larger decentralized effort to reduce and manage runoff on site becomes clear.

[61] **http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/NaturalDrainageProjects/StreetEdgeAlternatives/index.htm**

More involved education and outreach programs include trainings and workshops offered to important stakeholder groups such as developers, contractors and municipal maintenance staff and property managers. Classes and seminars that educate the people designing, building and maintaining green infrastructure practices help to build local markets, dispel misconceptions about various practices and train contractors and staff about how green infrastructure systems function.

Decisions to establish education programs are generally less controversial than most other policy options and can be made at the staff or program level. The distribution of materials such as simple explanatory brochures or even more complicated design guides[62] can lead to better understanding by everyone from homeowners to municipal property managers and contractors, which leads to better performance and hopefully greater adoption of green infrastructure practices. Furthermore, education programs create public and political support as people begin to recognize, discuss and inquire about projects.

Incentives

Incentive mechanisms can be easy to implement and afford local decision makers the flexibility and creativity to tailor programs to specific priorities or to particular geographic

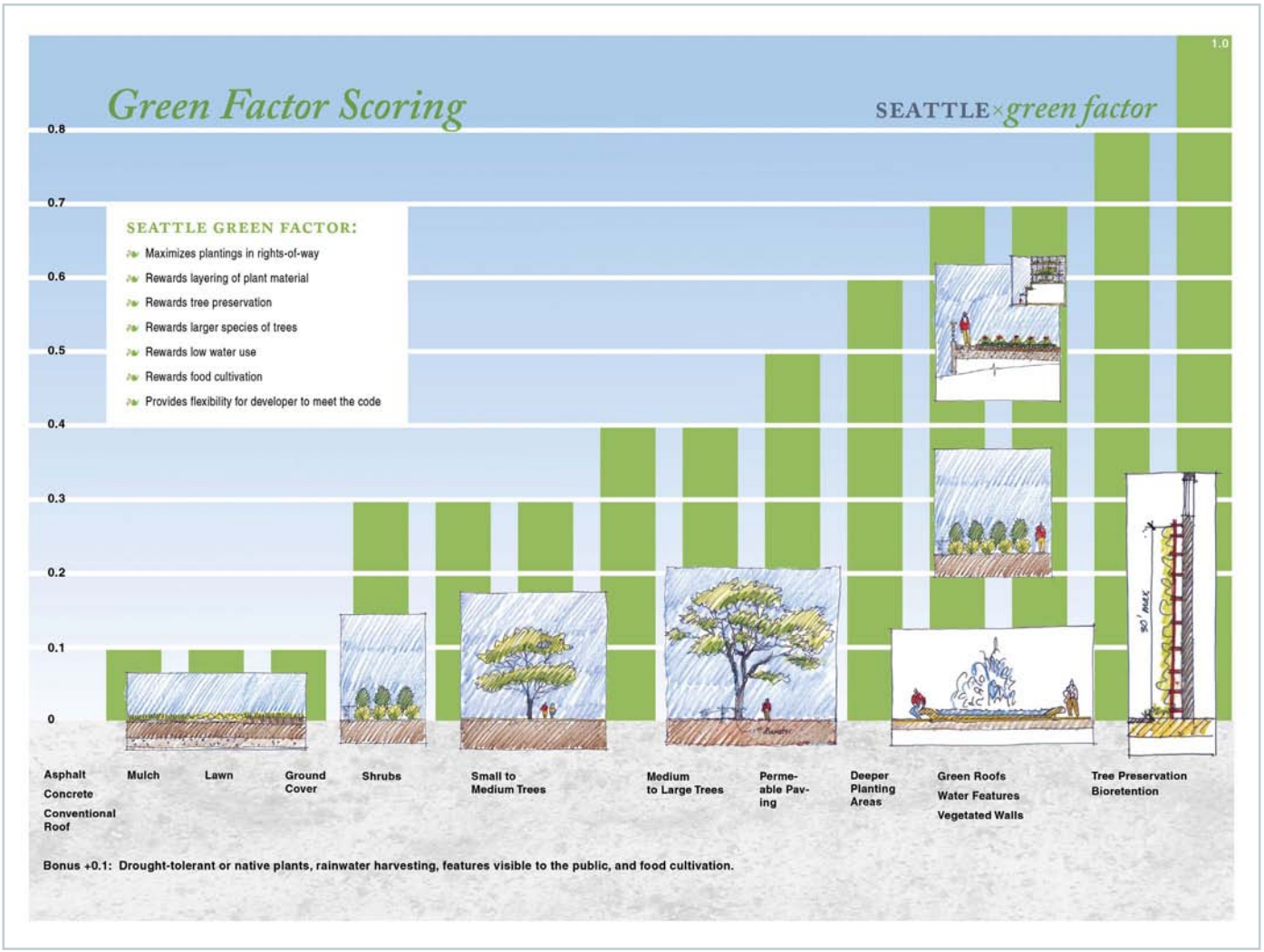


Figure 14: *Seattle's Green Factor requires 30 percent parcel vegetation in business districts. Property owners can use various practices to reach the 30 percent threshold, with bonuses for rainwater harvesting, drought tolerant plants, tree preservation, green roofs and more. Image from the City of Seattle.*

[62] To see examples of education and outreach materials from these case studies and more, go to **www.epa.gov/greeninfrastructure**.

areas in a community. Incentives are voluntary, which creates less resistance from stakeholder groups and allows policy makers to test or pilot programs that may one day develop into mandates or requirements. Seattle's Green Factor is limited to downtown business districts, both because of the economic development potential of improved green space there, and also because it allows the City a defined area to pilot this new program before applying it to other areas and zoning types in Seattle (see Figure 14).[63]

Incentives can be very effective when tied to regulatory programs or to a stormwater fee. Offering property owners a way to decrease regulatory impacts or stormwater fees can serve as effective motivation to decrease on-site imperviousness or add specified green infrastructure practices for managing runoff. However, municipalities should lead by example and incorporate green infrastructure design standards into public works projects at the same time as introducing incentives for the private sector.

Third Step Policies

Capital and Transportation Projects

Municipal governments can create and preserve large areas of green infrastructure by integrating green infrastructure into major capital projects and transportation projects. This may come in the form of design standards for capital and transportation projects, by purchasing sensitive natural areas, or by changing ingrained processes for implementing major public works projects. When local governments lead by example, they send a clear message that the municipality is dedicated to a new form of stormwater management and a new way of approaching development. Furthermore, public projects allow internal city or county staff a chance to learn about green infrastructure, including construction and installation, how to review plans and alter designs and how to operate and maintain the variety of practices that infiltrate, reuse and evapotranspire stormwater. Including green infrastructure in capital and transportation projects is very important for creating a long-term green infrastructure program.

However, changing well-established bureaucratic processes, both for political decision making and for implementation of public works plans, can be both slow and difficult. While incorporating green infrastructure into these projects can retrofit or create large land areas with green infrastructure, these projects may need to come as a lower priority for municipalities hoping to see more immediate impacts.

Stormwater Fee

Municipalities that are serious about setting up effective green infrastructure programs must secure sustainable funding. Stormwater fees can be easier to establish than a local tax because a fee is a charge that municipalities have the authority to leverage for the services they provide, if they have the appropriate enabling legislation. However, a new or revised stormwater fee requires data collection and financing studies to ensure revenue generation and evaluate equity issues. These processes can take time and money, but are necessary elements for developing fair and functional stormwater fees. Furthermore, although stormwater fees do not require direct public approval, they do need political support.

The District of Columbia recently embarked on an effort to increase stormwater fees to meet its EPA MS4 permit requirements. Like some other municipalities, the District of Columbia previously charged for stormwater based on potable water use and is planning to shift to an impervious surface billing system that more accurately reflects the service of managing stormwater runoff created by a site's impervious surfaces. The process has been neither quick nor easy. The District of Columbia Water and Sewer Authority is the entity that bills residents on the District Department of Environment's behalf. This outside coordination has slowed the process, along with concerns about collecting adequate revenues, how to fairly and accurately calculate the charge, how to provide discount programs for low-income residents and even how to represent the charge on bills. Despite political and stakeholder support for the new fee system, the District is still waiting to fully implement its new stormwater fee. The District of Columbia provides just one example that the process can be complicated and cumbersome, but important for cities that want to increase revenues and more accurately and equitably charge property owners for stormwater management costs.

Fee Discount

Stormwater fee discounts are intricately tied to the stormwater fee and often share the same delays and complications. Municipalities want high participation rates in any discount program in order to see green infrastructure retrofits, but there are simultaneous concerns about meeting revenue goals.

[63] Seattle Green Factor: **http://www.seattle.gov/dpd/Permits/GreenFactor/Overview/**

Extensive revenue generation studies can prove difficult to undertake without hiring consultants. Also, significant stakeholder engagement is necessary to the success of an incentive program that will likely impact large-scale development projects and existing commercial and industrial properties.

Portland, Oregon, provides insight into setting up a discount program that takes these concerns into account. The City anticipated the highest level of participation in the first year of its discount program and increased stormwater rates by nearly 20 percent in the first year to make sure they met revenue goals. Although participation rates were only one-third of what the City estimated, they maintained revenue increases and invested excess funds in capital improvements and watershed restoration projects. City staff said in retrospect they would have piloted the discount program in targeted parts of the City to see how it was received by property owners to better estimate participation. A pilot program also would have allowed the City to more easily fix flaws in the program that were much harder to address with a larger citywide program.

Before setting fee discounts, municipalities should first determine the stormwater management goals they wish to achieve (e.g., reduce impervious cover, increase infiltration, increase green roofs). Once these management goals are defined, officials must then decide how to credit private property owners for the action(s). Some cities give a percent discount for level of performance, primarily for stormwater quantity reduction and in fewer cases for pollution reduction. Discounts are also offered for impervious surface reductions, whether for total area or by the square foot. Finally, credits can be based on particular practices, such as rain gardens, green roofs or even tree canopy. This overall process should be thoughtfully developed with input from ratepayers and should build in opportunities for responsive change based on feedback.

4 Conclusion

Integrating Policies

The municipalities in this study illustrate the success of setting up an integrated program that weaves together multiple goals and engages various local agencies. Instead of limiting the scope of stormwater efforts to the regulatory framework outlined in the Clean Water Act, the most innovative municipalities—those with extensive build-out of green infrastructure—use a range of regulatory and non-regulatory mechanisms. Local leadership has helped create programs that move beyond stormwater regulations and take advantage of policies and programs that protect large scale green infrastructure, retrofit existing impervious sites and establish new areas to include green infrastructure practices.

While land use regulations can address many properties and land use types, other approaches such as demonstration projects, incentives, grants and outreach programs increase the amount of green infrastructure through retrofits, stream restoration, watershed projects and changing public perception of stormwater and the infrastructure needed to minimize and manage it. These cities and counties did not always create a clear plan that led to all intended results; many have developed programs over time, filling out gaps with new policies and refining existing policies as they go along. It was also critical that these communities had the initiative to take some first steps and continue to learn as they went along.

Setting Priorities

Whether a community's water-related concerns are primarily with improving water quality, reducing water quantity, restoring natural hydrology, or all of the above, local policy makers need to define local goals and then create policies or programs aimed at these priorities.

Municipalities should also strategize about how to gain benefits where they are most needed and target programs for specific properties and land use types or geographically defined areas. For example, some communities will prioritize combined sewer areas or neighborhoods with the highest percentage of impervious surfaces. Other municipalities may direct policies at specific land uses, like parking lots or vacant properties that combine to form a large block of impervious surface types. Others still may put an emphasis on adding surface vegetation to neighborhoods with less access to public green space. Local priorities, needs and availability of resources should determine the mix of policies most appropriate to achieve these goals.

Innovative communities in this study, and those beyond the ones listed here, are setting green infrastructure priorities based on achieving multiple objectives and choosing approaches that will drive progress in various sectors. For example, cities should consider the non-water benefits of green infrastructure for energy conservation, greenhouse gas emission reductions, public health, community livability, resource recovery (phosphorus and biosolids), reduced infrastructure construction, operation and maintenance costs

and more. Some communities, metropolitan areas and even multi-state regions are starting to link together the site-level and municipal performance of green infrastructure systems to larger regional performance and benefits. For example, Open Space Seattle 2100 is a project that integrates urban planning with watershed planning, uses existing data to calculate long-term future scenarios and outlines a range of benefits from connected green infrastructure systems (see Figure 16).[64] Similarly, Philadelphia's Triple Bottom Line study assesses green infrastructure options for CSO control over 40 years and determines citywide, total present value benefits to range from about $1.9 billion (2009 USD) under the 25 percent green infrastructure option to more than $4.5 billion under the 100 percent green infrastructure option (see Figure 15). Ongoing work and future development may help establish metrics and methodologies for determining the benefits of integrated approaches to resource management and community design and planning.

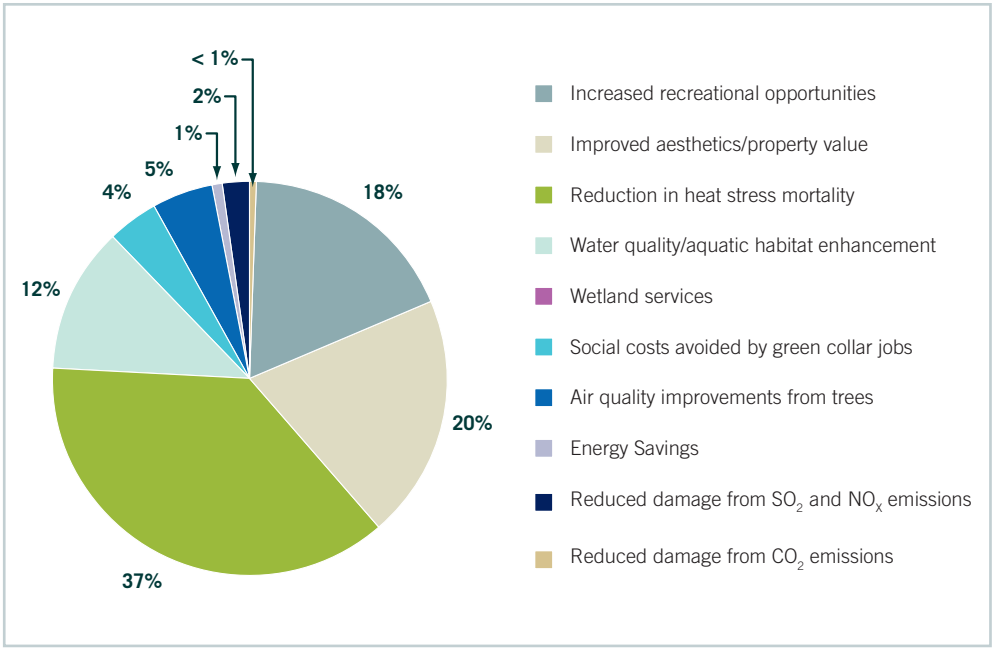


Figure 15: *Citywide net benefits for green infrastructure options. Courtesy of Philadelphia Water Department. http://www.phillywatersheds.org/ltcpu/Vol02_TBL.pdf*

Long-Term Planning and Investment

Communities that take the long-term view invest in hybrid green and gray systems that provide more community and environmental benefits while maintaining existing investments. A systematic approach, often initiated by mapping existing needs and assets, will help to define long-term goals and timelines for achieving them. Moving beyond short-term projects is especially important for investing in vegetated systems that require time to grow and show performance for managing stormwater runoff. At the larger neighborhood and watershed scale, building out different parts of a community with green infrastructure will require time to show cumulative benefits as these areas link together and work as a whole system.

Municipalities should approach the development of a green infrastructure program as an iterative process with many incremental steps. There are a number of policy options available with a range of necessary inputs, including funding, staffing, time, public participation and support from politicians, stakeholder groups and even upstream or downstream jurisdictions. In light of the many potential barriers, municipalities should seek to build programs that are flexible and multifaceted. Flexible programs will be able to respond to changing political climates, public perceptions and new information about the performance and design of green infrastructure systems. By using a diverse set of policies across all three scales, from the watershed to the neighborhood and site, communities can fully integrate green infrastructure into the fabric of the built environment.

[64] Open Space Seattle 2100: Designing Seattle's Green Network for the next century: **http://open2100.org**

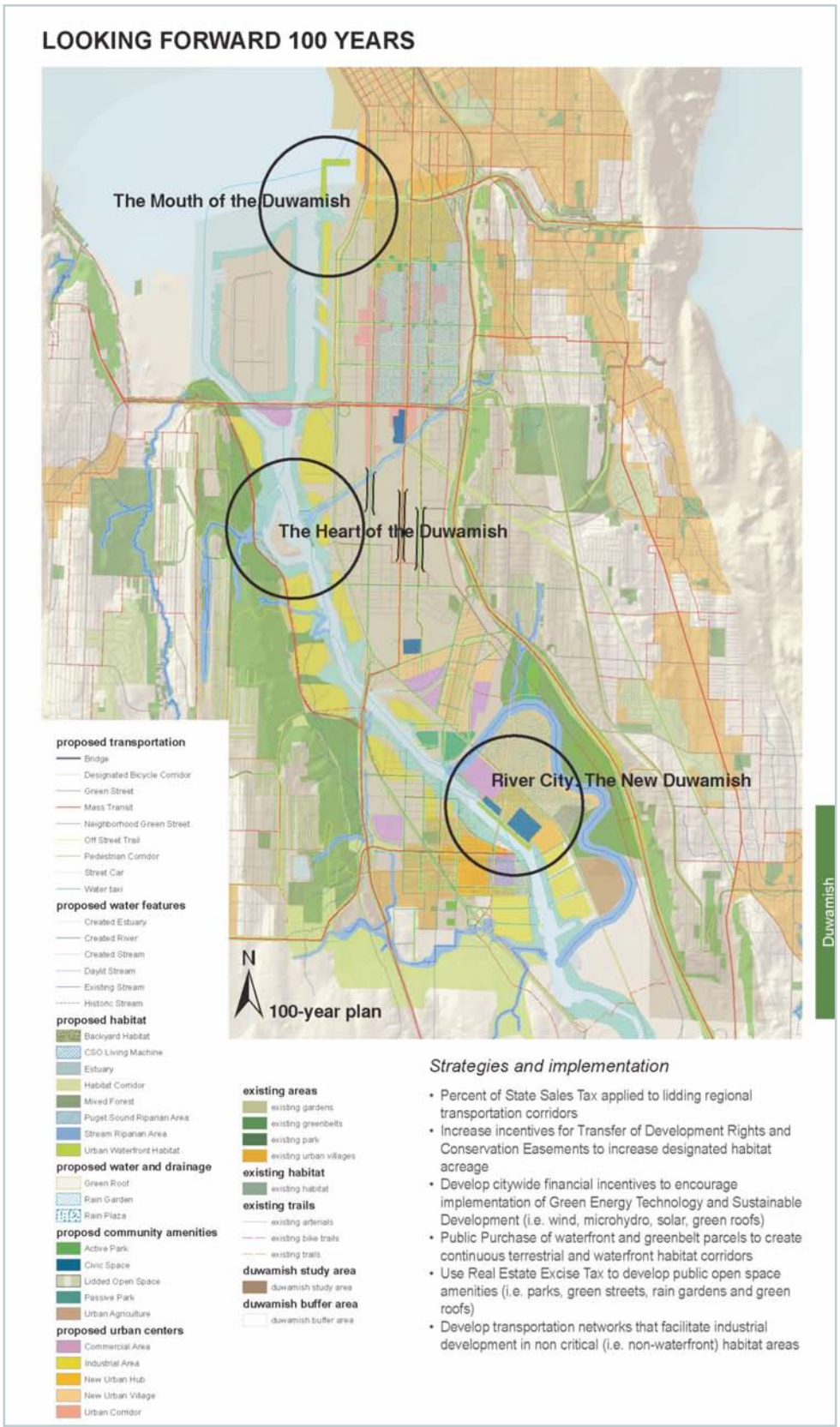
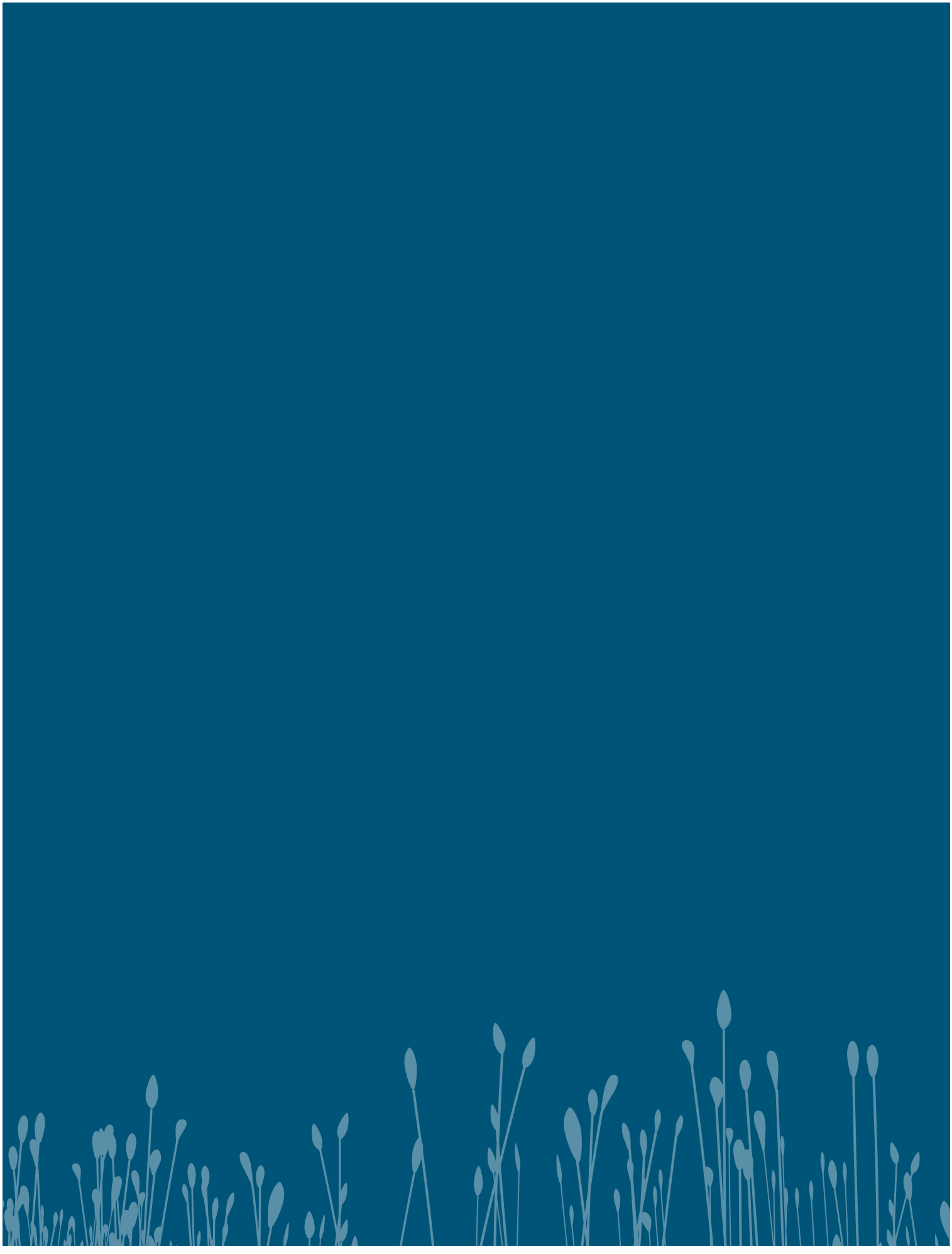


Figure 16: *Open Space Seattle 2100 bases urban planning on watershed units and integrates transportation, water infrastructure, habitat areas and community amenities. Map courtesy of* **http://open2100.org**



Alachua County, Florida

CASE STUDY

Overview

Home to the City of Gainesville and the University of Florida, Alachua County is located in the flat Central Highlands region of north-central Florida. Water is a remarkably visible and important resource for Alachua County. Ample rainfall throughout the year provides water to more than 20 creeks and streams that flow into sinkholes, lakes, marshes and the Santa Fe River. These waterbodies serve as habitat to diverse biota, provide a variety of recreational opportunities, and stimulate economic activity by drawing tourists and residents alike. Some of this surface water also recharges the Floridan aquifer, a vast groundwater reservoir that supplies 90 percent of Florida's drinking water and all of Alachua County's drinking water.

Alachua County is largely rural outside of Gainesville and the University of Florida, and population growth is placing increasing pressure on the County's land and water resources. To preserve these fragile natural resources, Alachua has developed a set of regulatory, land acquisition, and information strategies promoting green infrastructure. Alachua takes a systems approach to green infrastructure, recognizing the interconnections between land, water, habitat and quality of life. The County has drawn broad support for green infrastructure activities by identifying the multiple benefits beyond stormwater management. The County's governance structure promotes collaboration, performance management, and public involvement. This open and responsive structure allows the program to adapt to residents' priorities and promotes continued support.

Drivers

Alachua's green infrastructure program was developed largely in response to development pressures associated with its growing population. Existing development has generated a host of impacts to surface waters, habitat, and recreation, including flooding, stream channel erosion, and poor water quality. Because the County's surface waters are hydrologically connected to its groundwater supply, degraded surface waters could also affect the County's drinking water. As the County's population and development continues to increase, county managers recognize the need to protect the land and water resources for future generations.

Figure 1: *Madera is a neighborhood development on 40 acres that achieves decentralized stormwater management and protects mature trees. The developer, Green Trust LLC, saved $40,000 on stormwater by using existing forested basins instead of building new retention ponds.*

Regulatory Strategies

Adopted in 2005 and 2006, Alachua's Comprehensive Plan and Land Development Code include a comprehensive set of regulations promoting green infrastructure at multiple scales. A series of development requirements promote green infrastructure at the site and neighborhood scales. While developments of 25 units or more are required to cluster units to preserve at least 50 percent of open space, all developments are required to preserve significant natural areas and trees. Developers must maintain 75 foot buffers along streams, 50

percent of "strategic ecosystems" as identified by the County, and 20 percent of existing tree canopy. To reduce impervious cover, the Land Development Code reduces the minimum pavement width standard to 18-22 feet for residential roads, and allows shared parking and pervious materials for spill-overs or parking lanes.

The Comprehensive Plan and Land Development Code also include a set of regulations requiring a comprehensive stormwater management program. To improve the performance of the County's stormwater management system, the County is required to maintain an inventory of stormwater management practices, track maintenance requirements, and schedule maintenance activities in the Capital Improvements Program. The Plan and Code also address funding and administration. The County is required to pursue a dedicated revenue source for its stormwater management program, and the Public Works Department is charged with administering the program.

Land Acquisition Strategies

Alachua's land acquisition strategies complement its regulatory strategies by expanding the County's regional-scale green infrastructure. Alachua's land acquisition strategies enjoy broad support from citizens and landowners. In November 2000, voters overwhelmingly approved the use of $29 million collected through a property tax to create a dedicated fund for land acquisition. The fund, called Alachua County Forever, uses voluntary acquisition tools including sales, donations and dedications of interests in land to conserve open spaces nominated by the public. Voters reaffirmed their commitment to land conservation in 2008 with the passage of the Wild Spaces Public Places referendum. This referendum established a one-half cent sales tax for two years to fund land conservation and recreational improvements.

Information Strategies

Alachua's information strategies include indicators tracking, information sharing, education and outreach, civic engagement, and intergovernmental coordination. By tracking and sharing the success of its regulatory and land acquisition strategies, Alachua promotes confidence in its programs, increases citizen engagement, and assures long-term support of its resource protection efforts.

Implementation

Alachua's development records, built environment, and open space network attest to the success of its policies. From April 2006 to September 2009, developments reviewed and approved by the County protected 31 percent of open space, 67 percent of the tree canopy, 27 percent of upland habitat, 59 percent of strategic ecosystems, and 100 percent of wetlands.

Alachua's Madera subdivision (see Figure 1) provides an illustrative example of the site- and neighborhood-scale green infrastructure practices the County's development regulations can promote. In designing site plans to preserve existing vegetation, the developer not only retained mature trees, but reduced soil compaction. Infiltration was further promoted by native landscaping, narrower streets, and depressed bioretention areas in each cul-de-sac.

On a regional scale, Alachua's land acquisition program has protected an impressive network of open space in the 10 years since its conception. Alachua County Forever has protected over 18,000 acres of land worth over $81 million. Today, Alachua has nature preserves in every quadrant of the County, 90 percent of which are open to the public. These include large, connected properties as well as urban green space.

Alachua County offers an instructive example for other rural counties experiencing steady urbanization. By taking action early to preserve its land and water resources, Alachua has assured continued access to open space, clean water, and diverse ecosystems for generations to come.

Figure 2: *Depot Pond is a former brownfield site that was cleared of contaminated soil and converted into a functional wetland for managing runoff from nearby downtown.*

Chicago, Illinois

Case Study

Overview

A vibrant city on the shores of Lake Michigan, Chicago is one of the nation's innovators in green infrastructure. Chicago's 3 million residents are served by a vast system of water and wastewater infrastructure that includes more than 100 square miles of impervious cover, thousands of miles of water and sewer pipes, a 28-mile canal that reverses the course of the Chicago River, and nearly 100 miles of stormwater storage tunnels. Chicago leaders and residents are creating an integrated system of gray and green infrastructure to better serve their environmental, social and economic objectives. In addition, Chicago's green infrastructure program is one element of a comprehensive environmental agenda addressing green building, transportation, energy and resource management.

Drivers: Aging Infrastructure, Urban Heat Islands, and the Triple Bottom Line

Like many cities that installed sewage collection systems before the 1930s, Chicago has a single piping system to transport both sewage and stormwater runoff. When large storms overwhelm the capacity of Chicago's wastewater treatment plants, untreated waste and stormwater is discharged into the Chicago River, degrading water quality in the Des Plaines River and Lake Michigan. Though Chicago has invested billions of dollars in a "deep tunnel" system to expand capacity during flood events, the City is supplementing this gray infrastructure approach with green infrastructure. Completion of the deep tunnels is not anticipated until 2019, and climate change may overwhelm its capacity. To create a more robust system, Chicago is promoting landscape-based, green infrastructure approaches that infiltrate, evapotranspire or harvest rainwater before it enters the sewer system.

Green infrastructure is also viewed as a cost-effective approach to the extreme summer heat exacerbated by the urban heat island effect. Urban heat islands are caused by the high density of impervious cover in urban areas, which tend to absorb more heat in the day and radiate more heat at night. With 58 percent of its urban area occupied by impervious cover, Chicago experiences a particularly severe urban heat island effect. Green roofs and the urban tree canopy are known to significantly reduce temperatures in urban environments.

The final driver of green infrastructure in Chicago is the City's efforts to advance its triple-bottom-line. Chicago's mayor and other city leaders have consistently maintained that a healthy environment is both consistent with and critical to a robust economy and a richer quality of life. In the comprehensive *Water Agenda* released in 2003, and *Environmental Action Agendas* released in 2005 and 2006, Chicago's leaders have reaffirmed their belief that environmental initiatives can help the City stretch taxpayer funds, help residents save money on energy costs, make the City a great place to live, and contribute to increased property values for Chicago homeowners.

Stormwater Management Ordinance

The Chicago policy that most directly promotes green infrastructure is the recently adopted Stormwater Management Ordinance. As of January 1, 2008, any new development or redevelopment that disturbs 15,000 square feet or more or creates a parking lot of 7,500 square feet or more must detain at least the first half inch of rain on site. Alternatively, the development may reduce the prior imperviousness of the site by 15 percent.

Green Streets Program

In 1989, Mayor Richard Daley announced a Green Streets initiative to expand the city's tree canopy. By increasing public and private tree plantings and improving maintenance and public education, Mayor Daley hoped to increase

the urban canopy by half a million trees by 1992. Though progress was slower than hoped, by 2006, more than 583,000 trees had been planted, raising the proportion of the City shaded by trees to 14.6 percent. These trees not only had the intended effect of improving quality of life and air quality, but also reduced runoff volumes through interception and evapotranspiration.

Green Roof Program

Chicago offers incentives for building green roofs through its Green Roof Grant Program and Green Roof Improvement Fund. In 2005, 2006 and 2007, the Green Roof Grant Program awarded grants of $5,000 to 72 green roof projects on residential or small commercial buildings. In 2007, the Chicago City Council allocated $500,000 to the Green Roof Improvement Fund, and authorized the Department of Planning and Development to award grants of up to $100,000 to green roof projects within the City's Central Loop District. Though neither grant program is active in the present economic environment, the City hopes to resume these programs once the City's budget recovers.

Green Alley Program

The City of Chicago has an estimated 1,900 miles of public alleys paved with 3,500 acres of impervious cover. The Green Alley Program began in 2006 as a series of pilot projects conducted by the Chicago Department of Transportation (CDOT) to test a variety of permeable paving materials to reduce flooding in alleys and increase infiltration of runoff. By the end of 2009, the program became permanent, and CDOT had installed more than 100 green alley designs throughout the City. To share its experience with sustainable infrastructure practices, the City published the *Green Alley Handbook,*[1] which describes best management practices implemented by the program and presents examples from pilot projects.

Figure 1: *Chicago's Green Alley Program retrofits existing alleyways to include permeable pavers like these to infiltrate stormwater runoff. Photo courtesy of David Leopold.*

Sustainable Streetscapes Program

Through the Sustainable Streetscapes Program, CDOT integrates green stormwater infrastructure into street improvement projects throughout the City and tests novel stormwater management techniques. Notable projects include the realignment and grade separation project at 130th Street and Torrence Avenue, the realignment of U.S. Route 41 through the USX Southworks site, and the pilot project planned for Cermak Road. The 130th Street and Torrence Avenue project near the Calumet River will redirect the roadway runoff to discharge into a new treatment pond and vegetated swale rather than directly into the river. Similarly, the realignment of U.S. Route 41 will include permeable pavement, infiltration pipes, and other treatment structures to reduce the volume and pollutant loads of runoff into Lake Michigan and the combined sewer system. Other sustainable streetscape projects completed by CDOT have included permeable pavers, rain gardens, a permeable plaza, and permeable asphalt parking lanes.

[1] Chicago's *Green Alley Handbook*: **http://www.cityofchicago.org/city/en/depts/cdot/provdrs/alley/svcs/green_alleys.html**

Figure 2: *This Chicago building features a green roof, permeable pavers and bioswales, which meet Chicago's stormwater management requirements.*

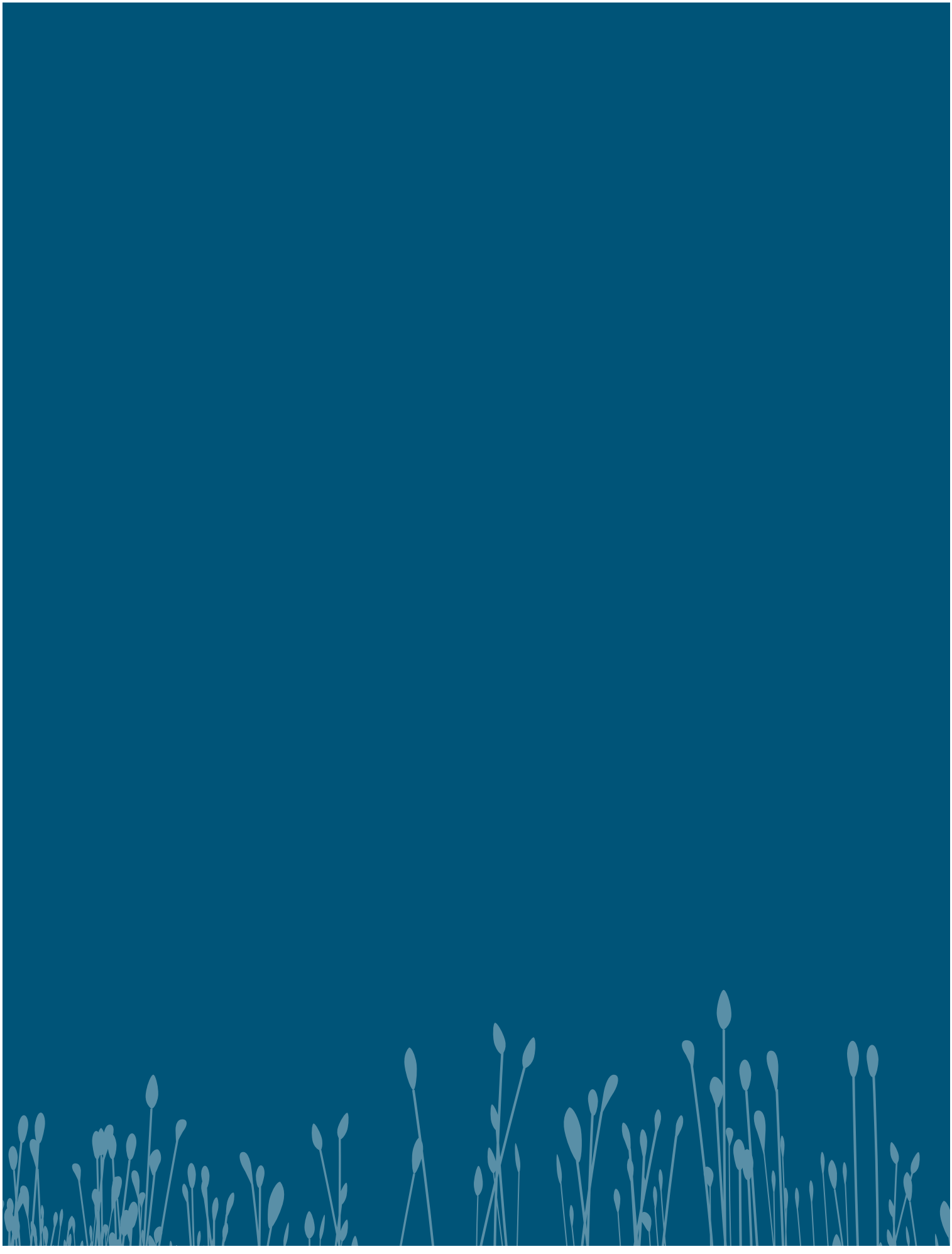
Green Permit Program

Established in 2005, the Department of Buildings' Green Permit Program offers owners and developers an innovative incentive to build green. Qualifying projects may benefit from an expedited permitting process and lower permitting fees. Projects qualifying for Tier I benefits will receive permits in less than 30 business days. Since earlier construction starts generally lead to earlier sales and reduced interest on construction loans, this time savings can translate into significant financial savings. Projects qualifying for the more demanding Tier II benefits may also receive a direct financial benefit in the form of reduced permitting fees of up to $25,000.

Implementation

Chicago's comprehensive green infrastructure program results in highly visible changes in the City's landscape. As of 2010, nearly 600,000 trees had been added to the City's tree canopy, and more than 4 million square feet of green roofs had been installed on 300 buildings. Pilot projects throughout the City are also demonstrating how green infrastructure practices can be integrated into alleys, streets and buildings. These projects not only reduce runoff, but reduce the urban heat island effect, improve air quality, and enhance the pedestrian environment. Data collected from City Hall's green roof indicate that the roof not only reduces stormwater runoff by 50 percent, but significantly reduces energy use and saves the City approximately $5,500 annually on heating and cooling expenses.

Less visible, but perhaps more impressive, are the changes in the way the City and the development community do business. As the City constructs pilot projects to demonstrate green infrastructure practices, developers and associated design, construction and manufacturing industries are becoming more familiar with green infrastructure materials and practices. This familiarity together with the City's various financial incentives has increased the cost-competitiveness of some green infrastructure practices and expanded their adoption among the development community. By integrating green infrastructure into a broader environmental agenda, leading by example, and pursuing an incentive-based approach, Chicago is gradually moving towards more sustainable development and a more robust triple-bottom-line.



Emeryville, California

CASE STUDY

Overview

As Emeryville, California, transitions from a declining industrial city to a vibrant, mixed-use urban center, city managers are promoting environmental and economic sustainability through an innovative set of green infrastructure policies. Emeryville is a former industrial hub located between Oakland and Berkeley on the San Francisco Bay. Industry left the City in the 1960s, and Emeryville struggled with its legacy of contaminated properties until the 1990s, when an aggressive brownfields redevelopment program was initiated. The brownfields program met with great success and attracted thousands of new residents to the 1.2 square mile City, but initial efforts neglected the environmental and social impacts of redevelopment. Emphasizing the "capping" of contaminated soils with parking lots and pavement, initial redevelopment efforts created a largely impervious landscape that impaired water quality, pedestrian access, and quality of life. In 2004, Emeryville received a smart growth grant from EPA to develop sustainable solutions to brownfield redevelopment, and produced a comprehensive set of stormwater policies and guidelines adapted to Emeryville's unique context. Recognizing both the multiple benefits of green infrastructure and the limited supply of developable land, these policies promote the integration of site-scale green infrastructure practices throughout the built environment. Emeryville's experience with green infrastructure illustrates the versatility of the green infrastructure approach, and offers valuable lessons to other cities interested in redevelopment that is both dense and green.

Drivers: Regulation and Limited Developable Land

Emeryville's approach to stormwater management was shaped largely by regulatory requirements associated with the Clean Water Act, and by the City's limited supply of developable land. Beginning August 15, 2006, the National Pollutant Discharge Elimination System stormwater permit issued to Emeryville by the San Francisco Regional Water Quality Control Board required all projects creating 10,000 square feet or more of impervious cover to include post-construction stormwater controls on site. Given the limited supply of developable land in Emeryville and the associated lack of green and pedestrian friendly spaces, city managers chose to address these requirements by expanding the City's green infrastructure network.

Figure 1: *High-density housing with green infrastructure features is necessary in Emeryville to take advantage of the mere 1.2 square miles of developable land in this city.*

Policies

Emeryville requires new developments to manage stormwater with green infrastructure and provides detailed design guidelines tailored to the City's unique context. In 2007, Emeryville introduced a comprehensive set of green infrastructure provisions into its Municipal Code. These provisions promote and require the integration of green infrastructure into stormwater management systems by: 1) minimizing impervious area, and 2) including vegetative stormwater controls. Emeryville's

green infrastructure provisions address the entire life span of stormwater treatment systems—from design to maintenance and inspection. Design provisions require all developers to comply with the City's "Stormwater Guidelines for Green, Dense Redevelopment,"[1] and permitting provisions require developers of lots 10,000 square feet or larger to enter into an operations and maintenance agreement. This system of requirements, guidelines, and permits requires developers to address the design and maintenance of green infrastructure throughout the project's planning and operation.

Emeryville's high water table, dense development patterns, and compacted or contaminated soils pose significant challenges to green infrastructure. Infiltration opportunities are often limited, and infiltration in contaminated soils could pose a risk to groundwater. To promote the installation of green infrastructure systems adapted to the City's unique constraints, Emeryville developed and published the "Stormwater Guidelines for Green, Dense Redevelopment." These guidelines offer developers a range of green infrastructure alternatives grouped into two general strategies: innovative parking solutions to reduce runoff and innovative stormwater controls to manage and treat runoff. The integrated parking strategies included in the guidelines reduce runoff by reducing the number of parking spaces required by the community. These strategies include pricing strategies, transportation demand measures, and parking information and guidance systems.

The innovative stormwater controls include methods to infiltrate, evapotranspire and/or harvest and use stormwater, while adapting to space constraints and preserving groundwater quality. These controls take many forms—from green roofs to permeable pavements—but all follow a few general principles. First, many of the stormwater controls consist of plantings or landscaped areas designed to serve as components of the stormwater treatment system, rather than ornaments. Second, all stormwater controls may be integrated into the urban mosaic of a dense city. Finally, all stormwater controls that infiltrate stormwater include under-drains connected to the sewer system to reduce the risk of groundwater contamination. The guidelines also include a numeric sizing methodology to aid developers in sizing green infrastructure facilities.

Implementation

Though Emeryville's green infrastructure policies are relatively new, implementation has proceeded smoothly, and at least 10 projects have incorporated the guidelines so far. These projects include the GlasHaus development, which planted vegetation on a podium level to capture and treat stormwater, and Green City Lofts, a 62-unit development that reuses stormwater for irrigation on site. Developer resistance is low, and experience to date has demonstrated that additional costs may be minimal. If stormwater treatment measures are addressed early in the planning process, the project can easily integrate space requirements and may even achieve operational savings.

Green infrastructure offers many benefits aside from stormwater treatment. The integration of green infrastructure into streets, parking lots, landscapes and buildings can create more pedestrian friendly spaces, calm traffic, improve air quality, reduce the urban heat island effect, create habitat, and improve energy efficiency. As permeable pavements, native plantings, and other green infrastructure practices become standard features of new construction, Emeryville expects its green infrastructure system to enhance urban livability and sustain its economic renewal.

***Figure 2**: Multi-level or stacked parking behind a business further reduces imperviousness and complies with Emeryville's "Stormwater Guidelines for Green, Dense Redevelopment."*

[1] Emeryville's Stormwater Guidelines for Green, Dense Redevelopment: **http://www.epa.gov/smartgrowth/emeryville.htm**

Lenexa, Kansas

CASE STUDY

Overview

Lenexa, Kansas, is a growing suburb in metropolitan Kansas City that faces increasing pressure from the impacts of new development, including more homes, roads and other impervious surfaces that create more runoff. In an effort to protect local water quality, as well as prevent flooding and improve the quality of life for residents, Lenexa's comprehensive plan, Vision 2020, initiated Rain to Recreation, an innovative and integrated watershed protection program.

Rain to Recreation outlines a number of policies and programs to protect land from future development and introduce new green infrastructure practices that limit imperviousness and manage runoff on site. Since the program began in 2000, it has grown to include both regulatory and non-regulatory approaches as well as major capital projects and land acquisitions. From protection of priority natural resource areas in the watershed, to creation of riparian greenways through application of the stream setback ordinance, down to requiring low-impact development practices on site, Lenexa is investing in green infrastructure at all three scales, including the watershed, neighborhood and site levels.

Regulatory Changes

In 2001, as part of the larger comprehensive plan, Lenexa established an integrated Stormwater and Watershed Management Master Plan that focuses on correcting existing problems in developed areas, building new facilities to minimize runoff and protecting undeveloped lands. In 2004, Lenexa increased its requirements in favor of stormwater management practices that infiltrate, reuse and evapotranspirate runoff by passing a stormwater ordinance and design manual to comply with its new National Pollutant Discharge Elimination System (NPDES) Phase II permit.[1]

Lenexa's updated post-construction stormwater ordinance applies to both new and redevelopment projects and prioritizes water quality by assigning rankings for different stormwater management practices based on their value for water quality performance. Developers are thinking creatively about how to meet the new standards, selecting low-impact development practices that are both functional and aesthetically pleasing for residents and tenants. These natural and functional green infrastructure designs complement neighborhood revitalization plans and gain multiple benefits for the environment and community.

Figure 1: *A constructed 1st order intermittent stream in a neighborhood development slows and infiltrates stormwater runoff, while adding aesthetic value for residents. Plant selection and landscape transition plantings were carefully considered for acceptance.*

[1] To access Lenexa's Phase II NPDES Permit, go to **http://www.raintorecreation.org/idde_program_plan.pdf**

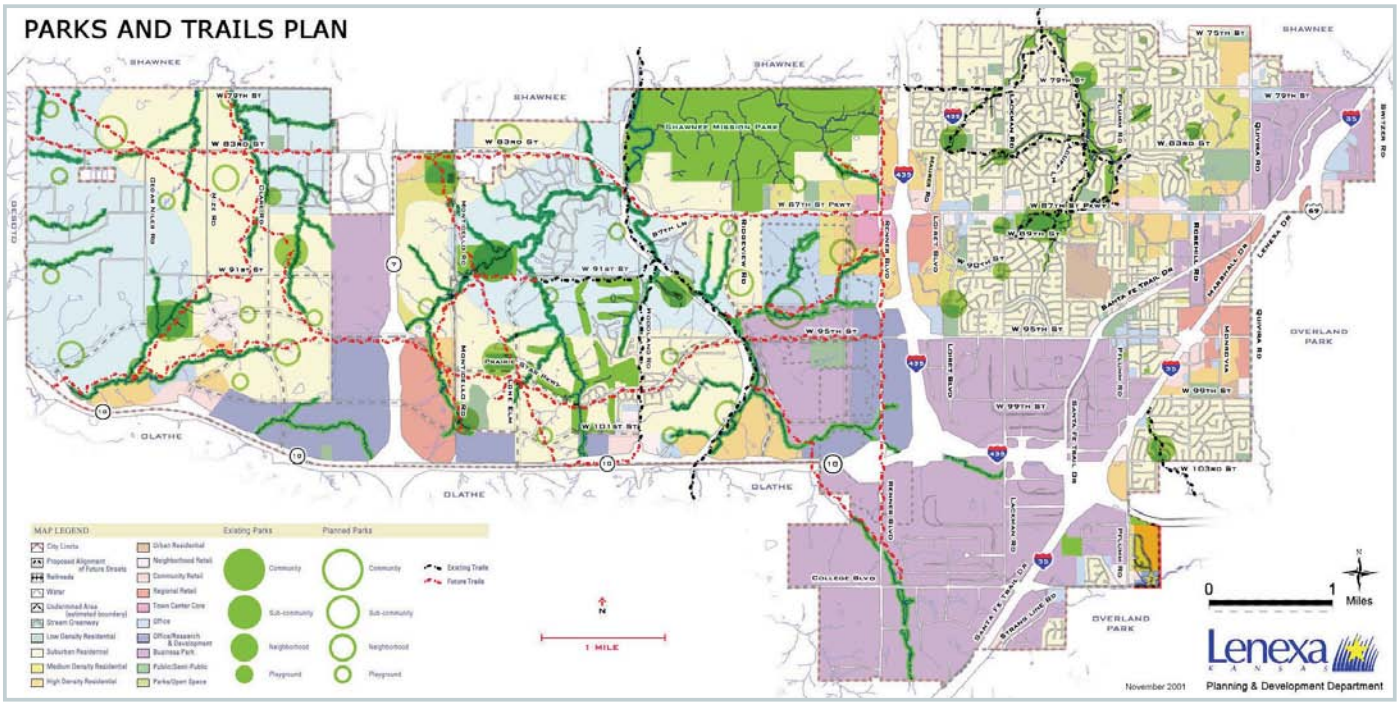


Figure 2: *Lenexa's Parks and Trails Plan outlines existing and future projects to protect and preserve open space, especially right around streams (shown in green as protected by the setback ordinance) and sensitive sub-watersheds.*

Land Acquisition and Restoration Projects

Lenexa is not just motivated by water quality improvements, but is also driven to use green infrastructure practices and plans to address flood concerns, stream erosion and quality of life improvements for local citizens. Water quality and water quantity are addressed through different policy mechanisms. While the new stormwater ordinance deals directly with water quality, water quantity is being minimized through large-scale projects that the City builds on its own.

The City purchases land in priority areas to provide flood mitigation, stream protection, water quality improvement and recreational amenities. For example, Lake of the Prairie and Mize Lake are two projects that restore and stabilize damaged sections of streams, create new wetland areas and include plans to construct large recreational and educational amenities. The largest project in Lenexa is a $26 million project called Lake Lenexa, which includes a 35-acre lake at the center of a nearly 350-acre public park. The comprehensive design for Lake Lenexa includes wetlands, rain gardens, stream restorations, trails and boardwalks, recreational space and art and education areas. The City bought the property to protect the land from potential development and to enhance existing natural resources.

Creative Funding

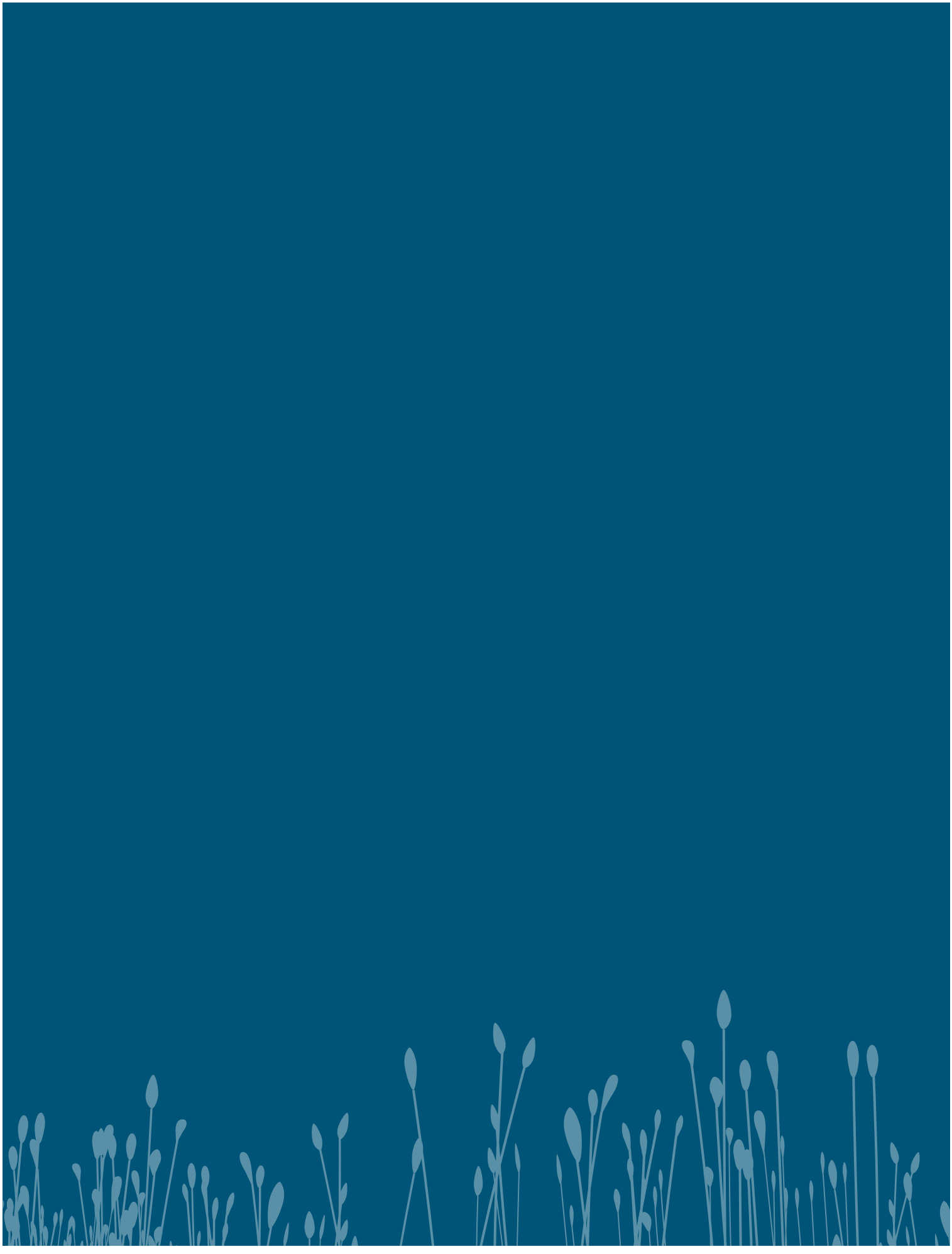
Lenexa uses creative and long-term funding for these major land purchases and projects, as well as for the day-to-day staffing and management of the Rain to Recreation program. In 2000, Lenexa taxpayers voted for a ballot to add a 1/8 cent sales tax to support building stormwater facilities that repair existing infrastructure problems and protect against future flooding events. In addition, Lenexa established a stormwater utility to provide sustainable funding for its new programs. The stormwater utility charge is based on the amount of runoff surface on each parcel of land. Each property is charged $5.50 (in 2008) per equivalent dwelling unit (EDU), which is measured at 2,750 square feet, or about the average runoff surface area of a house with a driveway. Commercial and non-residential properties are charged based upon amount of stormwater runoff generated and rates are calculated by dividing total runoff surface area by the number of square feet in an EDU (2,750) to more closely charge these larger properties by runoff contributions to the public system.

In 2004, the Lenexa City Council adopted the Systems Development Charge to require new developments to pay a one-time fee at the time of the building permit as a means for recovering costs for capital improvement activities. This charge works like a fee-in-lieu mechanism where developers

are paying the City to manage water quantity that is created by the addition of new impervious surfaces.

Continued grants from state and federal sources, such as Clean Water Act Section 319 Nonpoint Source funding for park construction and Surface Transportation Project funding for roadway projects, have assisted with capital and demonstration projects like Lake Lenexa. Other sources of funding also support Lenexa's stormwater program, including Johnson County Stormwater Management Advisory Council funding supported by a 1/10 cent sales tax and basic permitting fees charged to developers. Together, these funding sources ensure long-term watershed protection through the continued creation, operation and maintenance of green infrastructure practices.

Overall, Lenexa wields strong local control to require more rain gardens, bioswales and other forms of green infrastructure in private development projects. At the same time, through the Rain to Recreation program, the City invests heavily in large land preservation and restoration projects that provide key neighborhood and watershed scale green infrastructure.



Olympia, Washington Case Study

Overview

Olympia, Washington, is the capital city of the State of Washington and is located on the Puget Sound, a sensitive estuary in the Pacific Ocean. Olympia's Storm and Surface Water Utility works alongside other city departments, such as Planning and Zoning, and Parks, Arts, and Recreation, and businesses and residents, to promote best available science and local innovation that can help enhance water quality, prevent flooding and protect aquatic ecosystems.

Drivers

Olympia's Storm and Surface Water Plan aims to protect and improve water quality, maintain and prevent further degradation of aquatic habitat and minimize flooding. Olympia is part of the Western Washington Phase II Municipal Stormwater Permit, which requires five counties and 81 cities to manage stormwater before it discharges to surface and groundwater. In addition to regulatory drivers, the citizens and decision makers in Olympia hope to protect salmon populations and aquatic habitat for many species, which are harmed in already degraded urban waterways and threatened in still healthy parts of the watershed.

Policies

Olympia's Storm and Surface Water Plan supports better watershed protection and runoff reduction through a variety of policy and funding mechanisms.

On-site Stormwater Requirements

Olympia's stormwater regulations require that developments infiltrate 91 percent of runoff through on-site management. The City works with developers to offset the addition of new impervious surfaces through effective green infrastructure practices. For example, Figure 1 shows a green roof at Evergreen State University that helped offset new parking spaces on campus.

Figure 1: *A green roof at Evergreen College was built to offset the addition of new impervious surfaces from new parking spaces.*

Environmental Planning and Policy Development

The utility and other city departments are working together to promote better understanding of green infrastructure approaches and to incorporate performance measures and evaluation tools into new policies and programs.

Capital Facilities

The City is developing new stormwater management and restoration projects on public lands around important streams and waterways. Projects include land acquisition, conservation easements and other ecosystem protections and improvements.

Development Review

The utility, along with the Community Planning and Development Department, continue to update local development codes to ensure compliance with stormwater management and water quality requirements, as well as encourage

innovation in the development community. The City is trying to reach out to the development community to promote better site planning, soil and slope protection and inclusion of green infrastructure practices that reduce impervious surfaces and infiltrate runoff.

Code Enforcement and Technical Assistance

The City monitors and evaluates stormwater practices on private properties, as well as provides direct assistance to homeowners and commercial sites to help them more effectively introduce green infrastructure practices that are cost effective.

Storm and Surface Water Utility

Olympia's stormwater rate structure secures annual revenues used for basic system maintenance, expansion and rebuilding of infrastructure to meet state and federal regulations and improve water quality and protect aquatic habitat.

Permeable Streets and Sidewalks

The City of Olympia began using permeable pavement in 1999 and continues to develop new projects and retrofit existing surfaces to reduce runoff through infiltration. Cost and benefit evaluations, maintenance information and technical specifications developed through early demonstration projects have helped the City continue to use permeable materials on trails, sidewalks, streets and bike lanes.

In 2005, the City developed a memorandum describing the rationale for using pervious concrete in the construction of city-funded sidewalks, based on a study showing that it is more cost-effective to construct and maintain pervious sidewalks to meet stormwater storage and treatment requirements than to construct and maintain traditional sidewalks.[1] The study considered both construction and maintenance costs and found that traditional sidewalks totaled $101 per square yard while pervious sidewalks cost only $54 per square yard.

Figure 2: *A medical center in Olympia, Washington, manages runoff from the roof and other impervious areas through small swales and permeable sidewalks.*

Implementation

Olympia continues to evaluate and refine the various policies and programs that support better land use and on-site stormwater management practices. The City employs a range of policies for new developments that add impervious surfaces and for existing sites that can be retrofitted to better manage runoff on site. Past experience with green infrastructure helped the City secure Recovery Act State Revolving Funds in 2009 to develop 10 acres of city-owned park land with green infrastructure. The project will provide enhanced treatment for 840 acre-feet of runoff per year through a water quality treatment wetland, bio-retention ponds, a 5,000 square foot rain garden, a new parking lot with porous pavement and water harvesting and re-use for irrigation. These large scale projects complement requirements for private property owners to better manage runoff on site to protect the Puget Sound and other priority streams in and around Olympia.

[1] Memorandum on Traditional versus Pervious Concrete Sidewalks Construction and Maintenance Cost: **http://olympiawa.gov/~/media/Files/PublicWorks/PDFs/WaterResources/Traditional%20vs%20Pervious%20Concrete%20Sidewalks%20Memo.ashx"**

Philadelphia, Pennsylvania Case Study

Overview

Philadelphia has a sewer collection system that is 60 percent combined sewer and 40 percent municipal separate storm sewer system (MS4) and is working to improve stormwater management through restoration and demonstration efforts, regulations and incentives for the private sector and a revised stormwater billing system. Green infrastructure is an effective approach for Philadelphia, which recognizes the links between land use and water quality and the overlapping economic, environmental and community benefits that can be gained through green infrastructure.

Philadelphia is in the process of completing watershed-wide plans for each stream system in the City, working with neighboring municipalities through watershed partnerships. However, the City also outlines regulatory areas by sewersheds and drainage areas. This allows the City to prioritize and justify new green infrastructure projects based on intended outcomes and for meeting the conditions of their National Pollutant Discharge Elimination System and combined sewer overflow (CSO) requirements.

Philadelphia is trying to institutionalize green infrastructure as standard practice in all development projects as well as capital improvement projects undertaken by city agencies. Citywide policies, such as Green Plan Philadelphia, the Green Roof Tax Credit and the Green Streets program support the widespread creation and preservation of functional green spaces on both publicly and privately owned land. From sewershed demonstrations to stormwater fee discount programs, more and more opportunities exist for landscape architects to be a central part of the planning and design of private and public projects throughout Philadelphia.

Drivers: Asset Management and Smart Investment

The Philadelphia Water Department (PWD) emphasizes the role that green infrastructure can play in extending the service of existing stormwater infrastructure. The City expects to save money on the cost of maintaining pipe networks and treatment plants by removing flow from these systems. PWD plans to increasingly invest in decentralized green infrastructure that minimizes runoff where possible and otherwise manages it at the source. In addition, PWD implements green infrastructure as an acceptable method for meeting Clean Water Act goals. Currently, green infrastructure implementation is in the demonstration phase, in which projects are designed and monitored.

Although permit compliance prioritizes green infrastructure performance for aquatic habitat health and water quality, a core goal of creating more green roofs, rain gardens and street swales is to improve the quality of life for residents and visitors by retrofitting dense urban areas and restoring the state of waterways that have long been destroyed by heavy flows, trash and other impacts of urban runoff. A green infrastructure approach allows Philadelphia to integrate goals for land, water, community and infrastructure, making it a smart investment with multiple benefits.

Impervious-Based Billing

The stormwater billing system is being revised in Philadelphia to create a more equitable fee structure by using a parcel-based system that more closely reflects the costs for managing stormwater from each property. Rates will be set by determining the amount of a property's impervious cover and thereby the amount of runoff a property will generate. As a result, 80 percent of the City's new stormwater fee is based

upon a property's impervious area, with the remaining 20 percent based upon the property's gross area. In this way, stormwater fees will reach non-metered customers such as vacant lots, parking lots and utility right-of-ways that account for significant impervious space (and stormwater runoff) within the City.

Philadelphia offers a stormwater fee discount up to 100 percent of the impervious area charge, gross area charge or both for customers who reduce impervious cover using green infrastructure practices, including rain gardens, infiltration trenches, porous pavements, vegetated swales and green roofs. If a property is retrofitted with any of these features, the PWD will re-calculate that property's stormwater fee based on the 80/20 impervious/gross area formula.

By creating simple financial incentives for developers to reduce site imperviousness, the City is getting the development community to build green infrastructure projects that will help achieve citywide goals for watershed improvements, flood mitigation and community amenities.

Figure 1: *Philadelphia's new impervious-based fee encourages retrofits of large impervious sites, such as the Wissahickon Charter School (above), which now intercepts all parking lot runoff with rain gardens.*

Revised Stormwater Regulations

One of the key features of Philadelphia's updated stormwater regulations is that they encourage urban infill through exemptions for redevelopment projects. Focusing developments in vacant or infill areas helps to reduce the total imperviousness throughout the region. Additionally, on-site stormwater management with vegetated systems will provide a range of benefits beyond just water quality improvements. Implemented in January 2006, these new regulations apply to all developments resulting in earth disturbance of 15,000 square feet or more. Redevelopment projects may be exempt from Channel Protection and Flood Control Requirements if they can reduce directly connected impervious area by at least 20 percent. In effect, most developers now build on infill lots instead of undeveloped, natural areas. Most redevelopment projects reach the 20 percent reduction by any of the approved methods that count as "Disconnecting Your Impervious Area," such as disconnecting downspouts, pavement disconnection, tree canopy increase, impervious cover decrease, green roofs and porous pavements.

The success of the new stormwater regulations are contingent upon the fact that PWD requires projects to get concept approval for water, sewer and stormwater before zoning permits are considered. This early requirement for stormwater design approval results in better decentralized stormwater management systems that work with the natural hydrology of the site.

Implementation

In 2006–2007, the first year of the new stormwater regulations, the City saw over one square mile built out with low-impact development features. These practices, when fully built out, will manage most one-inch storms, reducing CSO inputs by 25 billion gallons, which PWD estimates will save the City $170 million. The success of this program has helped create political and public support for integrating green infrastructure throughout the City.

However, Philadelphia is not relying on stormwater regulations alone to create more green projects. As the figure below shows, stormwater regulations only result in 20 percent of the total land served by land-based controls, and that 20

percent is only reached after the regulations have been in place for 20 years. In effect, Philadelphia's program includes policies and projects that also address public lands, streets, vacant properties and waterfront separation. From financial incentives and assistance for retrofits to internal policies for increased use of green infrastructure practices, Philadelphia is using a range of regulatory and non-regulatory approaches to make economic, environmental and community improvements with green infrastructure.

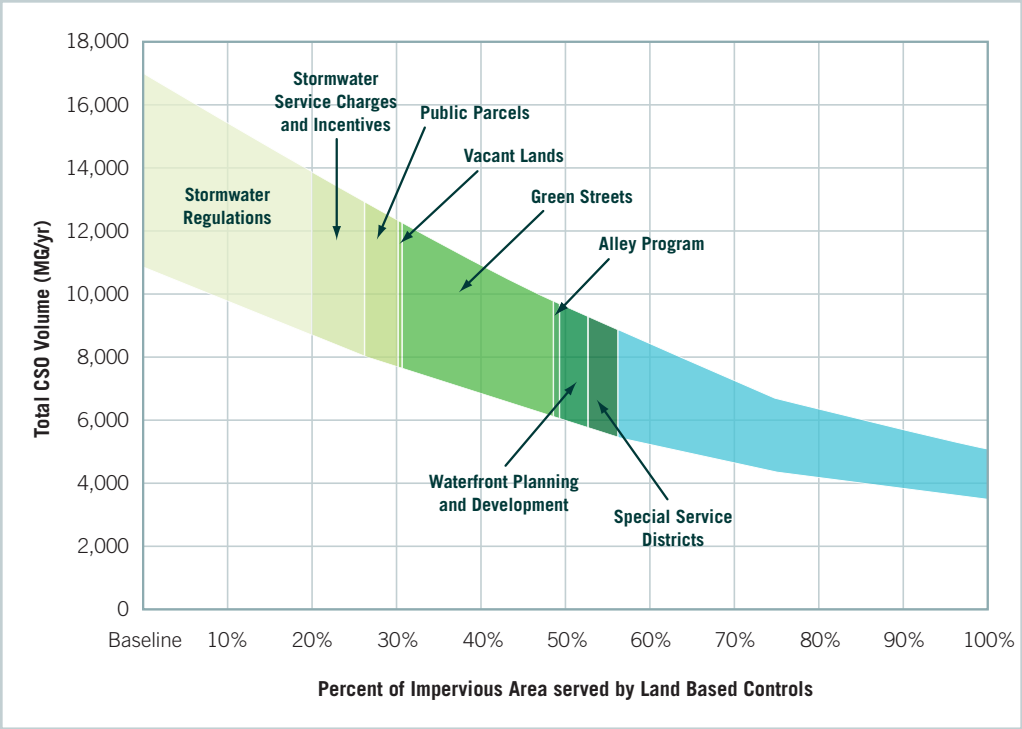
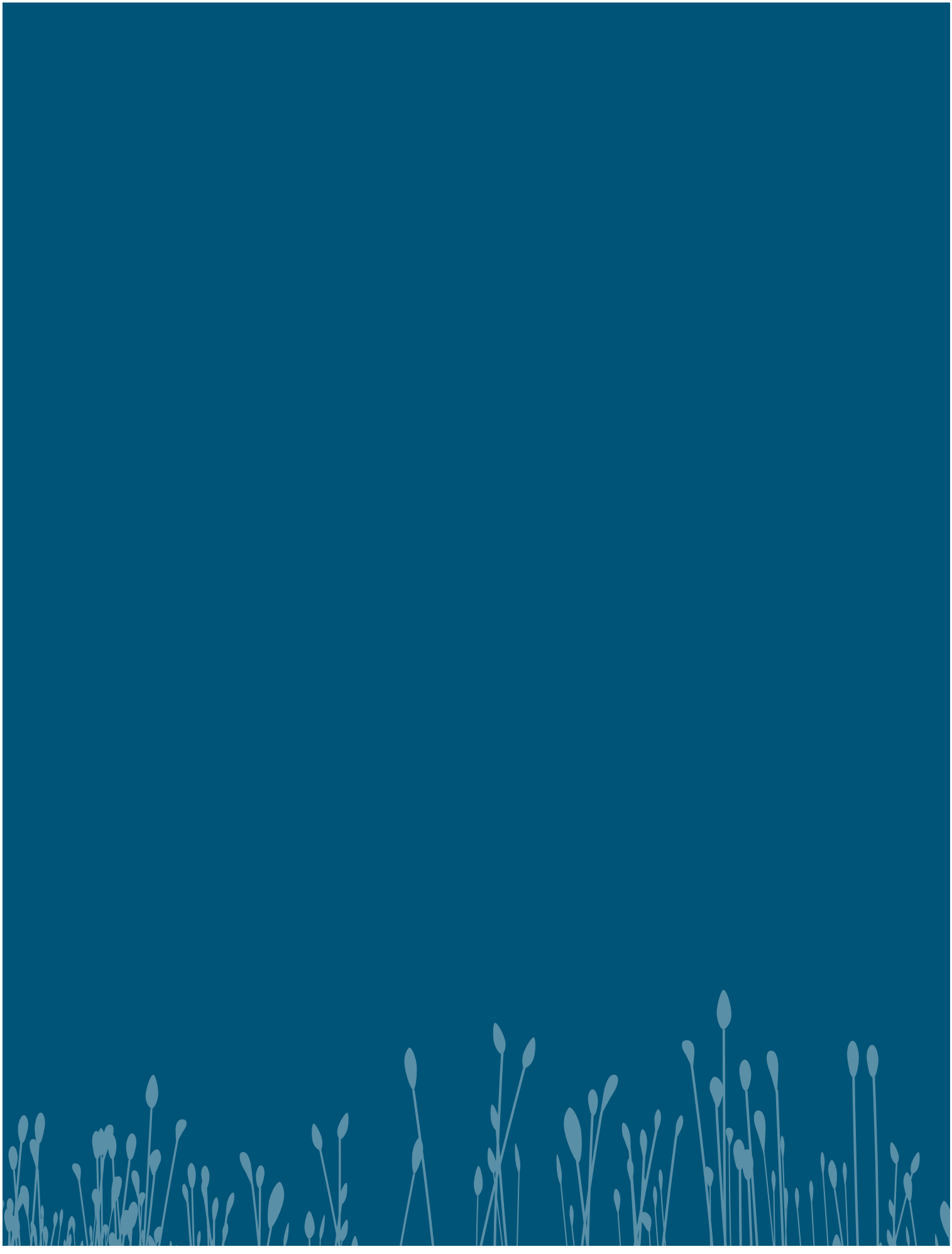


Figure 2: *Philadelphia's approach to converting different land use types to include green infrastructure for managing stormwater. Graph courtesy of Philadelphia Water Department.*



Portland, Oregon

CASE STUDY

Overview

Portland, Oregon, is often cited as the prime example for green stormwater management, and with good reason. Portland has one of the most mature and comprehensive green infrastructure programs in the country, with multiple overlapping policies and programs that have seen several iterations over time to become as well established and successful as they are today. The City has taken the initiative, and to some degree, the risk, necessary to implement a citywide program. In addition to substantial combined sewer overflow (CSO) tunnel costs (total costs to sewer ratepayers is estimated at $1.4 billion), Portland is investing in green infrastructure, in part to offset costs for major gray infrastructure. The City considers its $9 million investment in green infrastructure to save ratepayers $224 million in CSO costs, such as in maintenance and repair costs. But on top of the direct stormwater benefits, Portland sees a number of additional benefits whether for Coho salmon and Steelhead trout or for residents in neighborhoods with Green Streets and Watershed Stewardship Grant projects. The array of policies listed above attest to the fact that Portland considers stormwater a resource to highlight rather than a problem to quickly remove.

Build Out and Practices Used

Technologies as varied as planters, rain gardens, swales, porous paving, rainwater harvesting, green streets and disconnected downspouts are found in abundance and with good representation throughout Portland. These practices are found in a range of settings, including parking lots, apartment buildings, schools, private businesses, government offices and in public spaces like parks and riverside esplanades. Again, the multiplicity of policies, from requiring on-site management for public and private development to incentive-based programs for homeowners and developers, has resulted in innovation in design and function.

Figure 1: *Tanner Springs Park in Portland, Oregon, features a 5,300 square foot pond fed by rainwater captured from the entire park.*

Portland's Downspout Disconnection Program targets homes and small businesses in the combined sewer areas and provides a great opportunity for public education about stormwater and CSOs. This is in addition to the direct benefit of having 56,000 properties with disconnected downspouts, resulting in 1.2 billion gallons of stormwater kept out of the combined sewer system since 1994. Portland's Clean River Rewards, or stormwater charge discount program, has seen over 35,000 participants, including both residential and commercial property owners. These discounts have resulted in $4 million in retroactive credits for properties with low-impact development (LID) already in place at the program's inception and another $1.5 million in discounted fees for newly participating properties.

Portland effectively blends regulations with incentives. Where local codes and ordinances can make a difference, they are employed. But for existing properties or for more immediate results, other programs have been created, including grants, incentives and discounts.

Requiring Green Infrastructure

Portland's current Stormwater Management Code and Manual outline the requirements that apply to all projects within the City of Portland, whether public or private. All projects developing or redeveloping over 500 square feet of impervious surface, or existing properties proposing new stormwater discharges off-site, are required to comply with pollution reduction and flow control requirements. Projects of any size must meet the Destination/Disposal Requirement, which includes a hierarchical system designed to "mimic predeveloped hydrologic conditions by requiring on-site infiltration wherever practicable:"

1. On-site infiltration with a surface infiltration facility.

2. On-site infiltration with a public infiltration sump system, private drywell or soakage trench.

Figure 2: *Portland's first Green Streets project at NE 35th and Siskiyou features curb cuts, bump outs and swales.*

3. Off-site flow to drainageway, river or storm-only pipe system.

4. Off-site flow to a combined sewer pipe system.

Green Streets

Portland's Green Streets Program is a cross-bureau policy adopted by the City Council in 2007 to "incorporate the use of green street facilities in public and private development" to achieve a range of benefits:

- Handles stormwater on site through use of vegetated facilities.
- Provides water quality benefits and replenishes groundwater (if an infiltration facility).
- Creates attractive streetscapes that enhance neighborhood livability by enhancing the pedestrian environment and introducing park-like elements into neighborhoods.
- Meets broader community goals by providing pedestrian and, where appropriate, bicycle access.
- Serves as an urban greenway segment that connects neighborhoods, parks, recreation facilities, schools, main streets and wildlife habitats.

Green Streets are a citywide priority that formalizes the process to "overlay multi-bureau project plans and scheduled Capital Improvement Program (CIP) projects" to identify how LID can be incorporated into plans for new streets and retrofits. By locating the overlap of goals and beneficial outcomes of vegetated stormwater systems in the right-of-way, Green Streets have been institutionalized into citywide policies and funding.

Tours, Signage and Public Outreach

Portland Bureau of Environmental Services has several predesigned walking and cycling tours that encourage residents and tourists to explore the range of ecoroofs, stormwater projects and green streets locations in the City. The signage and descriptions that accompany these facilities engage the public to be more aware and knowledgeable about the role of stormwater in the urban setting. They also provide demonstrations for practitioners and professionals in landscape architecture, engineering and other relevant fields.

Floor Area Bonus for Roof Gardens and Ecoroofs

The Floor Area Bonus for Roof Gardens and Ecoroofs increases a building's allowable area in exchange for adding an ecoroof. This incentive program has produced an estimated $225 million in additional private development at 11 participating sites. The program has stimulated ecoroof developments and added to the more than 120 ecoroofs in the City. This kind of local development incentive stimulates LID designs and practices while also encouraging further market development for green infrastructure.

Community Watershed Stewardship Grants

Community Watershed Stewardship Grants provide technical assistance and financial support and foster partnerships for community-initiated projects to improve watershed health. Projects have included ecoroofs, parking lot swales, habitat restoration and downspout disconnects. Between 1995 and 2005, the program awarded 108 grants in all subwatersheds around the City, engaging more than 27,000 citizens. This widespread community engagement and on-the-ground neighborhood improvements foster a larger support network for green infrastructure policies while also resulting in context-sensitive solutions that are both instigated and maintained by local stakeholders.

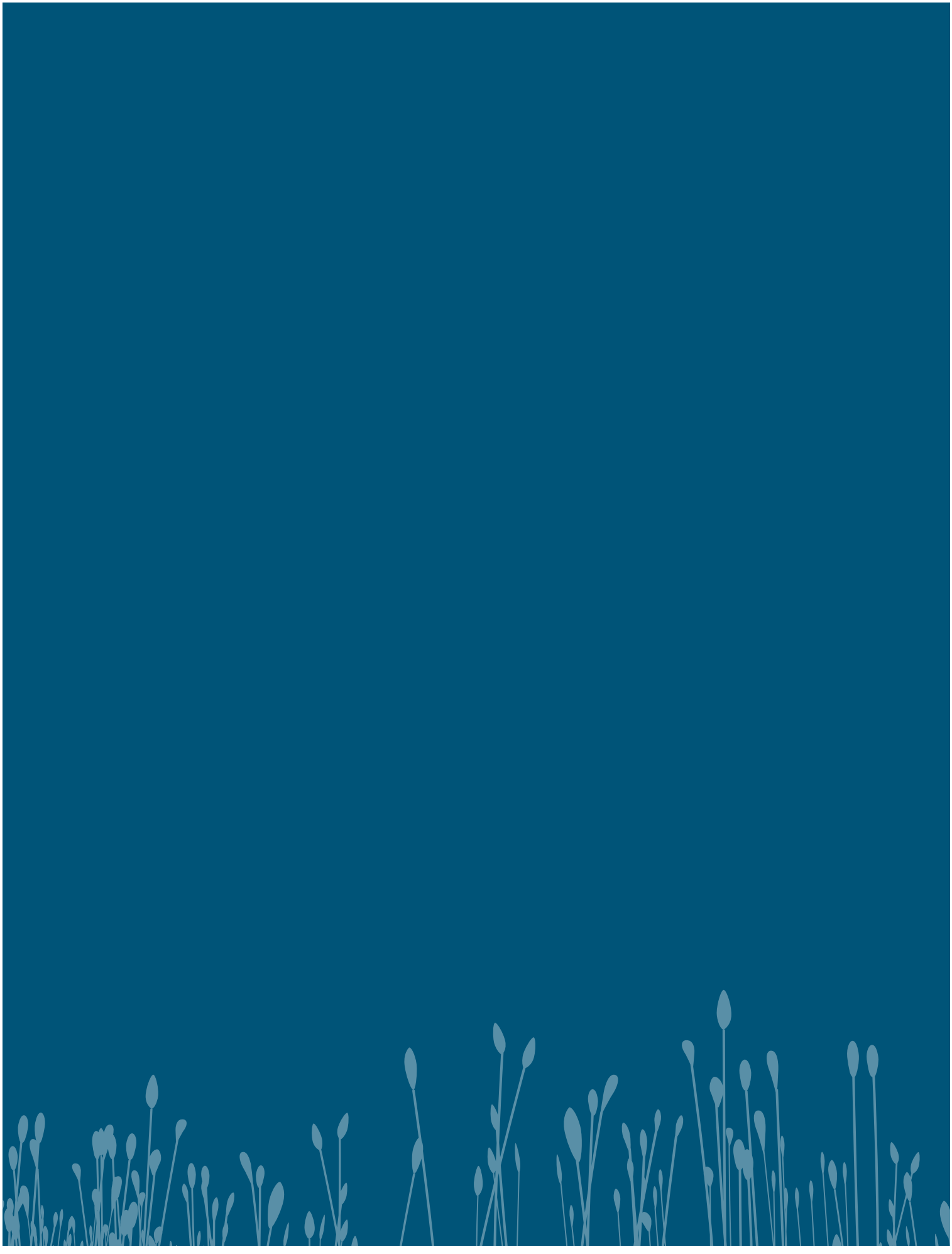
Clean River Rewards

Clean River Rewards discount stormwater user fees up to 100 percent of the on-site stormwater management services and up to 35 percent of the total stormwater bill. Fee reductions are calculated based on the extent and effectiveness of practices to limit flow rate, pollution and disposal. Participation is expected to reach 110,000 of the 176,000 ratepayers in Portland. Since October 2006, 14,000 registrations have been processed.

Implementation

Monitoring and learning from demonstration projects was a key element in the early stages of implementing new policies for managing stormwater with vegetated systems. This iterative process of addressing the requirements for municipal separate storm sewer systems and combined sewer systems, while also demonstrating LID approaches, helped Portland to establish one of the most mature and functional hybrid stormwater systems in the United States.

The learning curve for practitioners, including local engineers and developers as well as internal city staff such as permit reviewers and inspectors, can slow the process of transitioning from a purely piped system to a hybrid system that includes natural drainage elements. However, as Tom Liptan from BES has stated, the winning formula throughout the initial stages of creating new policies was to identify partners and start with small projects that can then evolve into official policy.



San Jose, California

CASE STUDY

Overview

Located south of the San Francisco Bay in the Silicon Valley, San Jose is the third largest city in California and the tenth largest city in the United States. Once a small farming community, San Jose experienced rapid automobile-oriented development from the 1950s–1970s, growing to a population of about 1 million today. San Jose's approach to stormwater management and green infrastructure is driven largely by Federal and State regulations. To comply with the requirements of the Municipal Regional Stormwater Permit issued by California to the City of San Jose and its neighbors, San Jose has developed a comprehensive stormwater program, including early integration of stormwater planning into the development process, quantitative performance standards, and the promotion of vegetation and infiltration-based stormwater controls. San Jose's stormwater program is also unique in its integration with smart growth objectives. As San Jose pursues more compact, transit-oriented development, it has adapted its stormwater program to accommodate and promote smart growth projects.

Regulatory Drivers

The California Regional Water Quality Control Boards (RWQCBs) develop and administer stormwater permits for municipalities in California. The stormwater permit issued by the San Francisco RWQCB to San Jose and 77 of its neighbors is particularly progressive in addressing the source of water quality impairments. The Municipal Regional Stormwater Permit supplements qualitative requirements with quantitative performance standards, which assures development that is protective of water quality, while allowing developers significant flexibility. In San Jose, all new development or redevelopment projects that create 10,000 square feet or more of impervious surface are required to comply with a set of low impact development (LID) requirements, supplemented by more quantitative numeric sizing criteria. The volume-based standard requires the stormwater controls to capture either the 85th percentile 24-hour storm event, or 80 percent of the volume of annual runoff; the flow-based standard requires stormwater controls to treat a certain flow rate. These standards apply to both building and road projects, requiring the management of runoff generated throughout the built environment.

Site Design, Source Control, and Treatment Control

San Jose has built upon the framework provided by Federal and State regulations by adopting policies that require early integration of stormwater planning into the development process, and promotes vegetation and infiltration-based approaches to stormwater management. Recognizing that much of a project's impact on runoff rates and volumes is determined by site design and grading plans, the City of San Jose developed an Urban Runoff Management Policy that requires developers to demonstrate compliance with performance standards early in the planning process. Before development applications are accepted, all new development or redevelopment projects that meet the impervious surface thresholds defined in the Municipal Regional Stormwater Permit must submit a Stormwater Control Plan. Stormwater Control Plans must illustrate how the project will integrate site design, source control measures, and treatment control measures to comply with appropriate performance standards. The San Jose Department of Planning reviews development applications before granting permits, and inspects approved projects during construction to verify compliance.

Developers are encouraged to minimize impervious surface to reduce the generation of stormwater runoff, and to treat any runoff generated with vegetative swales, biofilters or other landscape-based infiltration features. These measures are recommended not only because of their environmental

performance, but also because they are cost-effective and require limited maintenance. The Urban Runoff Management Policy also includes a unique provision to promote tree planting. The policy indicates that new trees planted within 30 feet of impervious surfaces can receive credit as post-construction treatment control measures.

Integration with Smart Growth

The City of San Jose views its green infrastructure and smart growth objectives as complementary. Smart growth policies can advance the water quality objectives of green infrastructure by directing development toward existing buildings and infrastructure and preserving undeveloped land. Similarly, green infrastructure policies can advance the community revitalization objectives of smart growth by increasing the urban tree canopy and vegetation and creating more livable communities. To accommodate the higher density of impervious surfaces in smart growth projects, San Jose provides credit for smart growth projects towards its Urban Runoff Management requirements. At the discretion of city staff, smart growth projects that can treat runoff on site may be designated "water quality benefit projects," and are not required to contribute to regional or off-site treatment.

Figure 1: *Guadalupe River Park in San Jose, California, features green infrastructure systems alongside dense downtown redevelopment. Photo courtesy of Michael Patrick via Flickr: http://www.flickr.com/photos/michaelpatrick/ 2408259482/.*

Implementation

Developers have responded to San Jose's Urban Runoff Management requirements with a variety of innovative stormwater management techniques. Perhaps the most effective element of San Jose's stormwater management policy is the 10,000 square foot threshold for new development and redevelopment. Because projects that create less than 10,000 square feet of impervious surface are exempt from the Urban Runoff Management requirements, developers are finding creative ways to reduce impervious surface, including: narrow streets, shared driveways, vegetated swales and pervious pavement. Planning staff generally review over 300 plans per year, and around 90 percent of these projects are able to reduce their total imperviousness below the 10,000 square foot threshold.

San Jose's stormwater policies are also promoting the expansion of urban green space. Many projects apply for the tree credit, which includes planting new trees and expanding the urban tree canopy. This range of incentives helps to ensure that as San Jose increases density in already developed areas, these neighborhoods are gaining the benefit of green infrastructure practices.

Santa Monica, California Case Study

Overview

The City of Santa Monica, California, is located on the Santa Monica Bay and is surrounded on the other three sides by the City of Los Angeles. Water quality is central to Santa Monica's economy and community because of its beachfront location. With a population of around 87,000 and just over 8 square miles of land, Santa Monica is a very high density city that must manage stormwater runoff from impervious surfaces, as well as dry-weather runoff from car washing, overwatering of landscapes, and other non-wet weather events.

Santa Monica uses various forms of green infrastructure to manage both dry-weather and wet-weather runoff, including pervious pavements, water-wise landscaping, and rainwater harvesting. Santa Monica uses regulations, incentives and public education campaigns to integrate green infrastructure into streets, parks and private properties. Santa Monica's green infrastructure efforts are supported by the Sustainable City Plan, which provides a framework for the use of stormwater management practices that both limit potable water use and manages runoff on site.

Drivers: Beach and Water Quality Protection

As a beach community, Santa Monica more than doubles its population each day as tourists and workers enter the City. Urban runoff is the largest contributor of pollutants entering the beach and nearby waters, and threatens the economic viability and community amenities of this beach-side community. The City's Office of Sustainability and the Environment states that, "a cleaner bay means a healthier marine ecosystem and improved quality of life for residents, and increases Santa Monica's appeal to visitors and businesses."[1]

Figure 1: *This commercial site includes parking lot swales to bioinfiltrate impervious surface runoff.*

In response to regulatory responsibilities, such as EPA's National Pollutant Discharge Elimination System and Total Maximum Daily Loads for trash and bacteria, Santa Monica adopted a Watershed Management Plan in 2006 to protect and improve the water quality of Santa Monica Bay. The plan lays out the following priorities to balance urban land use with ecosystem function:

1. Reduce urban runoff pollution
2. Reduce urban flooding
3. Increase water conservation
4. Increase recreational opportunities and open space
5. Increase wildlife and marine habitat.

Green Infrastructure Policies

Santa Monica meets these watershed management goals with a stormwater management ordinance, stormwater fee, rebate program and capital improvement projects.

[1] **http://www.smgov.net/departments/ose/categories/urbanRunoff.aspx**

Stormwater Management Ordinance

Santa Monica's stormwater ordinance provides water quality guidelines for existing properties and new construction sites to reduce the level of pollutants leaving the site. It requires all newly developed or retrofitted parcels to manage the first 0.75″ of runoff from impermeable surfaces, which accounts for approximately 80 percent of storm events annually.

The City provides waivers for impracticability based on space constraints, soil type or groundwater contamination concerns, but requires developers to pay an appropriate mitigation fee. This in-lieu fee is then used to fund larger city projects to retrofit streets, parks and other sites to better manage urban runoff.

Stormwater Fees

Santa Monica has two stormwater parcel fees, the Stormwater User Fee and the Clean Beaches & Ocean Parcel Tax, that are used to implement the watershed management program and that support compliance with Federal and State Clean Water Act regulations. The fees are paid annually by all property owners and are assessed through property taxes. In 2009 and 2010, the fees together generated around $3.9 million a year.

Rebate Program

Santa Monica offers four rebates for private property owners to encourage rainwater harvesting.

1. The Rain Gutter Downspout Redirect Rebate provides up to $40 per qualified downspout that redirects downspout runoff to permeable and/or landscaped surfaces. All downspouts on a given property can qualify for the $40 rebate, which is meant to cover both labor and material costs.
2. The Rain Barrel Rebate provides property owners $100 per barrel with a capacity of up to 199 gallons and covers costs for design, labor and materials.
3. The Small Cistern Rebate offers up to $250 per cistern with a capacity of 200 to 499 gallons and covers costs for design, labor and materials.
4. The Large Cistern Rebate offers up to $500 per cistern with a capacity of more than 500 gallons and covers costs for design, labor and materials.

Figure 2: *Santa Monica offers rebates for water harvesting and reuse to help reduce the amount of polluted urban runoff that reaches the beach.*

Capital Improvement Projects and Streets

Santa Monica's Watershed Management Plan explicitly calls for interagency partnerships on capital improvement projects undertaken by the Planning and Community Development Department, the Open Space Management Division and the Housing and Redevelopment Division. Because Santa Monica is a relatively small city, incorporating green infrastructure into all capital improvement projects is as simple as working with the urban runoff manager who can review plans, make recommendations and later conduct inspections. The City has retrofitted several existing streets and parking lots to include porous pavement and bioinfiltration areas, such as Bicknell Avenue. This project reduced the overall street width by 16 feet and retrofitted the parking lane with pervious pavers to infiltrate runoff from the street. The redesign also calls for 12-foot wide biofilter swales on either side of the street to further manage roadway runoff.

Seattle, Washington

CASE STUDY

Overview

The City of Seattle, located on the Puget Sound in Washington State, boasts many successful green infrastructure projects and policies, many of which started out as pilot programs and grew to have a much broader application and impact. Seattle's approach includes several internal policies to require green infrastructure in public property standards, such as for street designs and capital project plans. At the same time, Seattle leverages its control of local codes and development policies to encourage and require green infrastructure on private property.

Seattle Public Utilities (SPU) is the local agency responsible for meeting National Pollution Discharge Elimination System permit requirements and it coordinates the City's Natural Drainage System (NDS) approach, which supports the use of green infrastructure at the site level and in terms of larger development planning and design.

SPU has made strategic decisions about using demonstration projects, such as the original 2nd Avenue Street Edge Alternatives (SEA) Street or the Seattle Green Factor,[1] to introduce new policies or methods for implementing green infrastructure. Many of the lessons learned from these earlier and easier projects are now being transferred to the rest of the City, including more challenging and highly urbanized areas.

Drivers: Sensitive Water Bodies and Community Assets

In Seattle, as with most communities around the Puget Sound, the primary motivation for new stormwater management methods lies in protecting aquatic biota and creek channels as well as improving overall water quality. Coho salmon still thrive in many creeks of the Pacific Northwest, but their future health is at risk and has become a high priority for both residents and regulators. SPU takes a demand management approach by investing public resources in areas of the City with the most sensitive sub-basins and creeks, using practices that infiltrate stormwater runoff into soils, which treats water for pollutants and recharges waterbodies slowly through groundwater recharge.

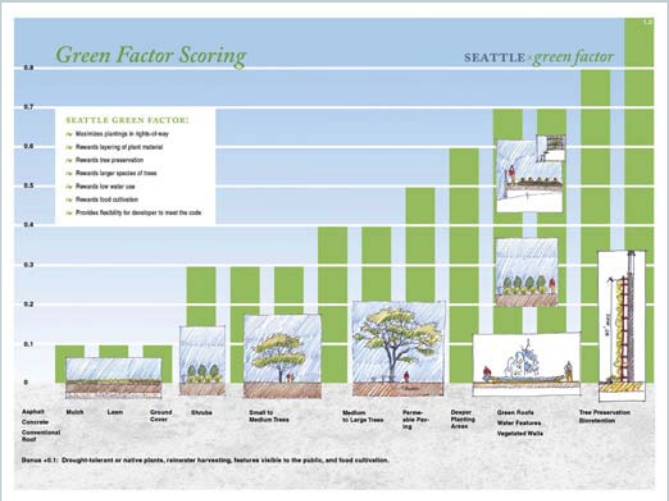


Figure 1: *Seattle Green Factor requires landscaping features with stormwater management benefits.*

Seattle also chooses to use green infrastructure systems, often in the public right-of-way, in areas where surface vegetation not only manages stormwater but also adds visible community amenities. The Seattle Green Factor was originally developed for commercial cores and requires that property owners achieve 30 percent parcel vegetation using a defined set of weighted practices including green roofs, permeable paving and green walls that are highly visible. This weighted system reflects Seattle's emphasis on a range of benefits for the environment and for the community.

[1] Seattle Green Factor: **http://www.seattle.gov/dpd/Permits/GreenFactor/Overview/**

Stormwater Code

In the past five years, SPU has revised the City's Comprehensive Drainage Plan to address flooding and water quality needs through green infrastructure source controls and to establish a long-term schedule of both capital improvement and operating programs. The City of Seattle's existing Stormwater, Grading and Drainage Control Code provides guidance for flow control and water quality treatment using green infrastructure practices.

In the past, Seattle has enjoyed support from the development community because State requirements were so strict that they wanted cheaper ways to meet standards and found that green infrastructure offered cost savings, often through avoided gray infrastructure investments. However, Washington State's Ecology Department has recently updated the state NPDES permit to require the use of practices that manage stormwater on site and limit on-site imperviousness.

1) Redevelopment

Seattle is in the process of revising and updating the Stormwater Codes and Manuals that address new and redevelopments. This update coincides with the new NPDES Phase I permit and requirement by the Washington State Department of Ecology to comply with their statewide manual for developers. The new code will require an analysis of green infrastructure as a first evaluation in site design for all new and redevelopment plans. A fee-in-lieu policy is incorporated into this code revision that will allow developers to pay a fee in place of using detention vaults for flow control. The fee amount is determined through the normal cost evaluation methods for sizing vaults. SPU intends to use income from these fees for specific basin restoration or for salmon-bearing creeks, as well as for incorporating green infrastructure practices into major capital improvement programs.

With assistance from the consulting firm Herrera, SPU has identified key steps to creating new policies and materials for the following areas of stormwater management responsibility:

- Source Control Manual
- Stormwater, Grading and Drainage Control Code
- Flow Control Manual
- Rainwise Incentive Program
- NPDES Phase I imposed by Ecology such as flow control requirements for small site developments and accompanying flow control technical manual.

The High Point redevelopment provides guidelines for future construction of publicly- and privately-funded homes that encourage sustainable design approaches. Using a performance-based approach, the design meets the needs of the client and infrastructure stakeholders, and serves an ecological function. Most importantly, the High Point model challenges beliefs that dense urban design and ecological performance are mutually exclusive. The City stormwater code and the High Point redevelopment project confirm Seattle's environmental commitment for sustainable development to maintain a high quality of life.

2) Roads

Recognizing the contribution that streets make to overall imperviousness, the City of Seattle focuses considerable staff and resources to its NDS Program. The central goals of an NDS as an innovative approach to street design are to protect aquatic organisms, protect creek channels and improve water quality by slowing the flow and reducing the volume of stormwater runoff. By retrofitting and redeveloping public rights-of-way to mimic predevelopment hydrologic processes, projects like SEA Streets and High Point collect runoff from nearby streets, roofs and other impervious surfaces to store and treat it through vegetated systems.

3) Retrofits

Rainwise Incentives Program

Much of Seattle's land area is privately-owned properties that contribute to water quality, flow control and conveyance issues. Runoff from residences and businesses results in degraded watersheds or flooding problems downstream, where SPU invests in capital project solutions. The Rainwise Incentive Program is a customer stewardship program to encourage private property owners to manage stormwater flows on site.[2] Through educational materials and low cost incentives, such as guides, workshops and discounted utility

[2] RainWise Incentive Program: **https://rainwise.seattle.gov/systems/water**

costs, SPU hopes to see customers using on-site management techniques, as listed below, to protect both public infrastructure and the environment:

- Rainwater cistern
- Downspout disconnect
- Rain garden
- Rock-filled trench
- Porous pavement
- Trees
- Compost and mulch.

SPU is also investing in a Roadside Raingarden project and providing residential incentives for rain gardens and cisterns in the Ballard neighborhood.[3]

4) Capital Improvement Program (CIP) Projects

The City of Seattle makes a clear connection between the use of green infrastructure for stormwater management and overall asset and demand management for all SPU sewer and drainage systems. Most major capital projects within the City, even managed by other agencies, include consideration for incorporating low-impact development (LID) and thereby gaining the multiple benefits afforded to SPU's assets, regional environmental quality and quality of life for Seattle residents.

SPU's specific asset management approach enables the utility to meet agreed-upon customer and environmental service levels at the lowest cost, considering full life-cycle costs, by investing in maintaining and replacing its multi-billion dollar infrastructure. Although conventional methods for managing stormwater can be readily calculated for costs, benefits and risks, natural drainage designs with vegetation are still being considered to relieve traditional systems, despite less predictability for cost-benefit analyses.

An example of LID in CIP projects is the Alaska Way Viaduct Project. The Viaduct is an elevated highway retrofit along the waterfront in downtown Seattle. The Washington Department of Transportation (WDOT) is responsible for a new plan to replace the existing highway structure. Despite no current plans for the Viaduct's retrofit, the Seattle Department of Planning and Development (DPD) will be working with WDOT to include low-impact development features as part of this multi-billion dollar capital improvement project. Another major project is the 520 Floating Bridge over Lake Washington, which costs more than $1 billion. Demand Management, which is a component of Asset Management approach, incorporates LID into all these other CIP Projects. Rick Johnson with Seattle DPD is currently working on a document to package how LID can be incorporated into all these bigger projects.

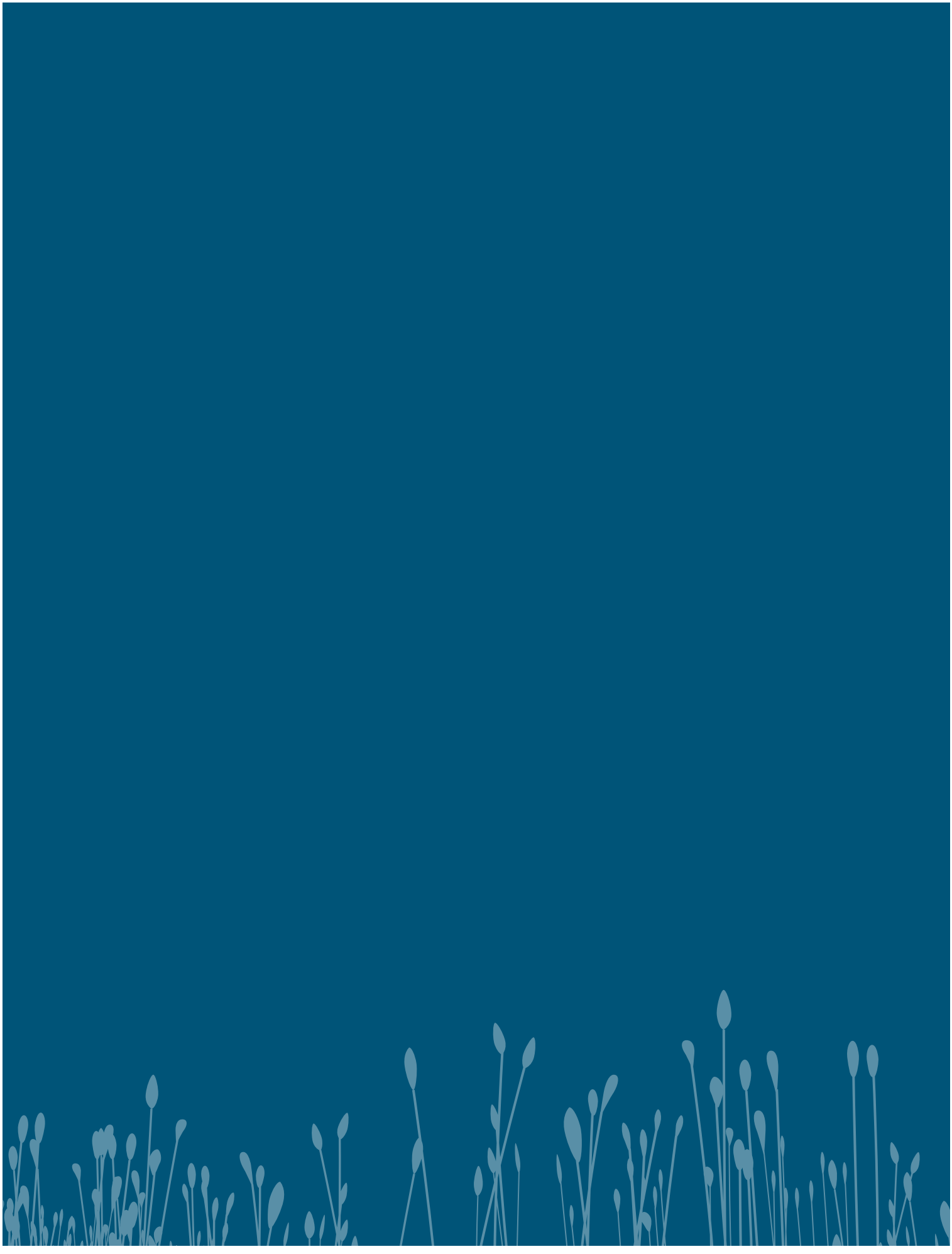
Imlementation

As stated on SPU's Web site, "NDS cost about 10 to 20 percent less than traditional street redevelopment with curb, gutter, catch basins, asphalt, and sidewalks," in large part because SPU was improving "chip and seal" streets that lacked underground infrastructure. For more developed parts of town within the combined sewer area, total costs are not as predictable.

NDS projects include SEA Streets, the Broadview Green Grid Project, 110th Cascade Project, Pinehurst Green Grid Project and High Point Project in West Seattle. The great achievement of these projects was finding a way to implement LID into street rights-of-way and reduce overall imperviousness of roadways. Most of these projects are located in the northern neighborhoods of Seattle, which is much less dense than downtown portions of the City.

The next phase of demonstration and monitoring will be an extensive project to minimize downtown parking spaces and test the application of green infrastructure in an ultra-urban setting with a combination of green roofs, right-of-way application and methods to treat and release stormwater.

[3] Ballard Roadside Raingardens: **http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/Plans/CombinedSewerOverflowReductionPlan/BallardRoadsideRaingardens/index.htm**



Stafford County, Virginia

CASE STUDY

Overview

Stafford County, Virginia, is located in the Metropolitan Washington DC Region and has experienced an estimated 30 percent population increase from 2000 to 2007. This fast-growing County faces the challenge of new residential and commercial development that creates additional runoff from roads, parking lots and roof tops. The Stafford County Public Works Department is responsible for complying with National Pollutant Discharge Elimination System (NPDES) permits. The NPDES first introduced on-site green infrastructure, or low-impact development practices, as an option for meeting stormwater requirements on new developments. After success and experience implementing green infrastructure through voluntary measures, Stafford County then included green infrastructure practices, to the maximum extent practicable, on all new developments. Stafford County does not have complete jurisdiction over local subdivision ordinances or street right-of-way design standards, and is therefore limited in the types of impervious surfaces they can impact through code and ordinance updates. The County focuses instead on areas where it does have authority, such as adding green infrastructure on County-owned land and reaching out to existing property owners and developers to educate them on green infrastructure practices for meeting local stormwater requirements.

Drivers

Stafford County's efforts to incorporate green infrastructure countywide are motivated by a mix of flooding concerns and water quality protection needs. The County is responsible for protecting residential and business properties from flood damage. Past flood events have led to a greater concern with standing water, high water in ditches and on roads and other negative impacts from large amounts of stormwater runoff. This greater awareness of the role and impact of stormwater in a community have helped Stafford County build support for a stormwater management and overall drainage system that encourages the use of natural systems.

In addition, Stafford County's stormwater program is responsible for complying with the Virginia Stormwater Management Regulations and must also meet the requirements of the County's Phase II NPDES permit. The Virginia Department of Conservation and Recreation controls how stormwater is managed on state and federal property, but allows localities, including counties, the option to establish a locally-appropriate stormwater management program for private properties. Although streets and other land uses can contribute large amounts of impervious surfaces, the state controls subdivision ordinances, as well as street runoff and road width requirements. As a result, the County largely focuses on encouraging and requiring private property owners to use natural drainage systems to minimize impervious surfaces and manage runoff.

Figure 1: *Bioretention areas, like the one in this parking lot, are commonly used in Stafford County to meet local stormwater requirements.*

Policies

While many communities similar to Stafford County have only recommended or allowed the use of green infrastructure practices, such as bioretention and permeable pavements, in 2003, Stafford County began requiring on-site approaches that are supported by local development ordinances, management agreements, design and construction guidelines and public outreach and education material. This full set of policy approaches has enabled the County to ensure greater implementation and compliance with the stormwater code.

Stafford County worked with multiple stakeholders in developing its ordinances. County staff worked with a local conservation nonprofit, Friends of Rappahannock, to hold a roundtable on better site design, which resulted in a committee to update the stormwater code. The committee included several state agency representatives, including staff from the Virginia Department of Transportation, local developers, and representatives from Friends of the Rappahannock. This process resulted in a new stormwater ordinance and a design manual that was approved by the County Council in 2003, and included requirements for using low-impact development on private lots, relaxed regulations for curbs and gutters in all new subdivisions and an allowance for low-impact development practices to meet county landscaping requirements. In addition, stormwater management concept plans are now required to be approved much earlier in the larger plan and design process. These actions combine to form a comprehensive set of rules and guidance that private developers and landowners can use to incorporate natural systems to reduce runoff and manage stormwater on site.

Implementation

The County has found that almost 95 percent of developers are using bioretention, including rain gardens, as the primary method of on-site management to meet the stormwater requirements. The widespread use of a single practice may be due to the fact that bioretention design is perceived to be easier to technically justify as meeting impervious surface management requirements than other methods. In addition, it has become the commonly accepted method, and might offer greater assurance of plan approval for developers.

Figure 2: *A rain garden in Stafford County, Virginia, limits runoff that leaves the site and enters nearby streams.*

Homeowners in Stafford County are also retrofitting existing yards with rain gardens. Many houses in Stafford have one to three lots and can more easily design and implement rain gardens to manage runoff from roofs, driveways and sidewalks.

In 2004, Stafford County retrofitted the Stafford County Administration Center parking lot to include bioretention to manage impervious surface runoff. The retrofit added water quality treatment measures and provided an important publicly-funded demonstration for developers and citizens.

Wilsonville, Oregon

CASE STUDY

Overview

Wilsonville, Oregon, is located along the Willamette River at the southern edge of the Portland metropolitan area. The population of Wilsonville is around 17,000 and has experienced rapid growth in the last 10 years. Most of the City of Wilsonville lies within the Portland Metro Urban Growth Boundary,[1] which limits development on farm and forest land and supports efficient use of land, infrastructure and services within existing urban areas.

Wilsonville's land use and stormwater management policies work together to balance increased density of land use with natural resource protection. The City initiated its green infrastructure efforts by working with private development projects to test the construction and performance of green infrastructure practices, along with the feasibility of requiring and enforcing on-site management practices like permeable pavers, ecoroofs and bioswales. Wilsonville built on initial lessons and now incorporates green infrastructure approaches into capital projects and a range of other codes and ordinances that apply to new development projects.

Drivers

Wilsonville's green infrastructure planning and projects came in the context of Portland Metro's long-standing support and outreach about the value of open space preservation, smart growth and green streets for balancing environmental and community development goals. Wilsonville was also motivated largely by a need to update and revise the outdated comprehensive plan, including future urban expansion and stormwater system needs. Furthermore, financial analyses on the costs of new stormwater infrastructure, as well as on meeting state and federal Clean Water Act requirements, set the stage for improved management approaches that would provide multiple benefits across city departments and to the general public.

Green infrastructure projects are prioritized in Wilsonville's Stormwater Master Plan because they can provide multiple benefits for pollutant treatment, flow control, groundwater recharge and landscaping for aesthetic improvements. Local capital investments emphasize projects to restore streams and protect or enhance wetlands and buffer areas. Other capital projects within the Master Plan focus on retrofitting existing impervious surfaces such as streets and parking lots to include vegetated practices that infiltrate runoff on site.

Figure 1: *The City of Wilsonville worked with developers to monitor the performance of new green infrastructure techniques, like this planter box, before establishing development standards for on-site management.*

Pilot Project

When the City began plans in the 1990s to redevelop a nearly 500-acre property into a mixed-use village center called Villebois, city staff recognized that the codes and infrastructure plans created for this large site could be a testing ground

[1] Portland Metro Council: **http://www.metro-region.org/**

for future development code changes that apply citywide. Before the City finalized design requirements for the full development, the pre-project phase required the developer to monitor, test and analyze the effectiveness of site-scale green infrastructure, including porous pavement, bioretention cells and ecoroofs. This testing period also allowed city staff to figure out how well new stormwater management requirements could be integrated with existing city and state development codes. The pilot process resulted in updated stormwater requirements that emphasized decentralized management and that integrated well with transportation, natural resources and parks and open space plans.

Policies

Natural Resource Protection

In 2010, the City adopted an updated Comprehensive Plan that outlines measures to protect natural areas and introduce new green infrastructure elements on development and retrofit sites. The 2010 Plan explicitly prioritizes the need to limit the negative impacts new developments might have on local water quality. The Plan emphasizes measures that improve ground water infiltration, add habitat value and provide other benefits to community aesthetics:

- Natural drainage systems, including streams and creeks, must be preserved as open space to serve as primary elements in the overall urban drainage system. This includes protection against burying current natural drainage systems into underground culverts or pipes.
- Streams, swales and other open drainage systems can be used to meet landscaping and open space requirements for new developments.
- Existing underground drainage ways must be restored or daylighted to surface streams.
- Site development plans must preserve or improve native vegetation in identified riparian zones and landslide-prone areas to mitigate runoff.
- Restoration of vegetation, including the removal of invasive plants, may also be required depending on the type, scale and location of development.

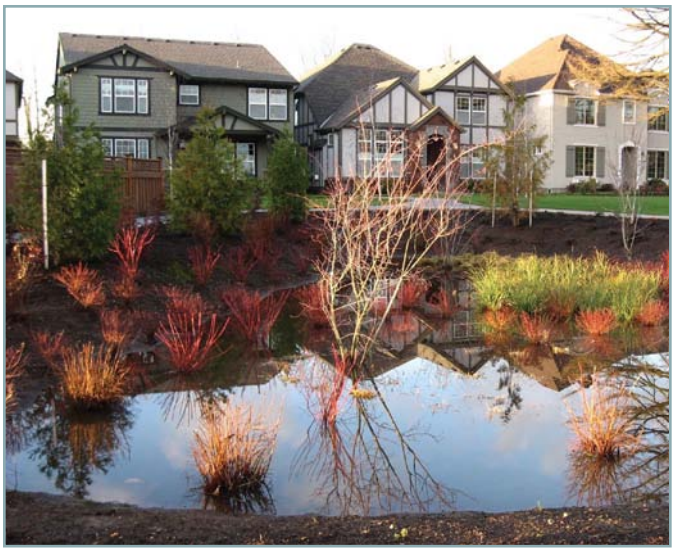


Figure 2: *Decentralized stormwater management features, such as this bioretention area in the Villebois project, collect runoff from rooftops, sidewalks, and yards for infiltration into the ground below.*

Capital Projects

System development charges and user fees are collected to implement the Stormwater Master Plan, which identifies key capital improvement projects that improve stormwater quality and control the volume of runoff. Wilsonville requires developers to pay a stormwater system development fee before being issued a building permit. The revenues from this development charge are used to implement large-scale capital projects, such as stream restorations or green street curb extensions. These capital investments support the overall natural drainage throughout the community.

Implementation

Wilsonville protects functional open space at the community scale and introduces new green infrastructure at the smaller site scale. The City directs development charge revenues toward capital improvement projects that protect healthy waterways and restore degraded streams. At the same time, Wilsonville created development requirements, with the private sector as a key partner, which resulted in regulations that are achievable, transparent and effective at complementing large scale protections with site-level runoff mitigation and management.

Acknowledgements

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