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Enhancing the Urban Environment Through Green Infrastructure

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Summary

This Article is adapted from Chapter Seven of John R. Nolon, *Protecting the Environment Through Land Use Law: Standing Ground*, published by ELI Press. The book describes how localities are responding to new challenges, including the imperative that they adapt to and help mitigate climate change and create sustainable neighborhoods. This Article follows the steady advance in the use of green infrastructure in recent years, and details its value as a strategy for adapting to climate change, bettering air quality, lowering heat stress, creating greater biodiversity, conserving energy, providing ecological services, sequestering carbon, preserving and expanding habitats, enhancing aesthetics, increasing property values, and improving the livability of neighborhoods.

I. The Advent of Green Infrastructure

A. Definition

When viewed from 10,000 feet, a community's gray infrastructure is clearly visible. For vehicular circulation to properly function, streets, roads, and highways have to connect, and provide places for parking, serving the built environment efficiently. These linked areas of impervious surfaces are readily observable. An aerial view shows the connected transportation whole and it is obvious that these facilities have been carefully planned. Not so with "green infrastructure." In fact, green spaces are seriously impaired by gray infrastructure, interrupting a community's capacity to convey water, provide paths for species to move among their habitats, provide shaded streetscapes and buildings, and create natural places for people to walk and bike, rather than drive. From the air, they often appear as dysfunctional fragments. Green infrastructure planning strives to connect the natural assets of the community much in the same way that planners design a locality's gray infrastructure.

Green infrastructure planning strives to connect the natural assets of the community much in the same way that engineers design a locality's gray infrastructure. From left to right, images show existing, conventional, and preferred development and their effects on green connectivity. RPA.

Planners concerned with green infrastructure calculate the current green space coverage and connectivity and figure out methods of increasing it to a healthy percentage of the surface area of the community, so that an adequate percentage of the land is sheltered and shaded, with its soils held intact and its ability to absorb and retain water preserved, if not enhanced. Under the urban tree canopy and between intense zones of green, they labor to connect streams and channels, provide paths for people and species, direct and control the flow of water, and provide places along the way for rest and play.

The elements of green infrastructure include green roofs, planters, rainwater harvesting, street trees, preserved open space on building sites, natural vegetated corridors and swales, permeable paved areas accented with green features, xeriscaping, private gardens and public parks, detention basins, bio-retention ponds and rain gardens, green building facades, and greened medians and edges along

streets, paths, and rail lines. Parking lots can be greened by adding trees and using permeable surfaces that allow infiltration and permit vegetative growth. When seen from the air, the community with robust green infrastructure now appears more connected naturally and, in an ideal circumstance, the green and the gray are complementary. This is a difficult task in most places because of the fragmentation that the built environment has already wrought on urban green space.

Some define green infrastructure more narrowly as an approach to stormwater management; it is often measured by its ability to prevent the devastating effects of flooding on property and riparian landscapes. The U.S. Environmental Protection Agency (EPA) is particularly keen on using green infrastructure techniques to manage stormwater as a method of guiding and encouraging communities to comply with stormwater management regulations mandated by Phases I and II of its Clean Water Act. For this purpose, land use laws and building codes are reformed to ensure that buildings have disconnected downspouts; are equipped with rainwater harvesting devices; and that sites are required to use permeable pavement, bioswales, planter boxes, and rain gardens. Site plan and subdivision regulations are amended to include a variety of low impact development (LID) features, the most ambitious of which attempt to retain pre-development hydrological conditions on the site. A new rating system, Sustainable Sites, has been created for developers and communities to use to review the degree to which natural site features are retained or restored during development. Other programs incorporating key elements of green infrastructure include: LEED-ND, Smart Codes, Complete Streets, and the New York Climate Smart Communities Certification Program, to name a few.

In one sense, *Standing Ground* is all about green infrastructure: balancing conservation and development. When local land use law is used to protect a ridgeline, a stand of trees, or a watershed, wetland, or view-shed, it is preserving that patch of green infrastructure. When an overlay district is used to protect a critical environmental area, that area's natural features are protected. What the architects of green infrastructure, in its broadest sense, do is use these land use techniques in an integrated fashion; they plan the entire community so that its natural functions are connected, healthy, and serve to create healthy and livable neighborhoods.

B. *Benefits and Purpose*

The broad view of green infrastructure sees it as a strategy for adapting to climate change, bettering air quality, lowering heat stress, creating greater biodiversity, conserving energy, providing ecological services, sequestering carbon, preserving and expanding habitats, enhancing aesthetics, increasing property values, and improving the livability of neighborhoods. Green infrastructure—with tree canopies covering a third or more of the space at the neighborhood level, green roofs, and pocket parks or other small patches of green open space—lessens urban temperatures (the "heat island effect") and sequesters CO_2.

Green infrastructure can bring economic benefits to property owners and municipalities. These include increased property values, greater retail business and sales, higher rents, lower energy costs and water bills, less damage from floods, and increased job satisfaction and health for employees. Green jobs associated with the greening of landscapes, buildings, and infrastructure can provide employment often in walking distance—or a short bus ride away—from the homes of residents in lower income neighborhoods. On the municipal side, these benefits to building and business owners translate into more property and sales tax revenue, reduced joblessness, and a more robust local economy.

In recent years, EPA's green infrastructure emphasis has broadened from its initial focus on stormwater management. In its 2014 Green Infrastructure Technical Assistance Program, which provides help to localities, EPA describes its efforts to help communities across the country interested in implementing green infrastructure broadly: to protect water quality, provide ecosystem services, increase resiliency to climate change, create economic opportunities, and support a high quality of life.

C. *The Emergence of a New Urban Planning Initiative*

All of these elements of green infrastructure, and much more, can be built into the local land use planning and capital budget process. The local comprehensive plan can be supplemented by the addition of a green infrastructure component that grows out of this planning process, and then zoning and land use regulations can be amended to implement the green infrastructure component's vision. Landscaping requirements, along with erosion and sediment controls, can be added to subdivision and site plan regulations.

Cities can begin green infrastructure planning for the future at the same time that they plan for and implement their plans for building and development to accommodate anticipated increases in population. The affected neighbors, citizens, taxpayers, businesses, landowners, and developers can be assembled and engaged in a process of defining what green infrastructure elements are needed and who is to pay for them. They can consider whether developers are going to be required or incentivized to provide on-site green elements, to pay impact fees, to become certified under LEED-ND, or to at least earn many of its green infrastructure points.

Developers can be required to include green features in, on, and around their buildings. They can also be required to pull development back from floodplains and to leave room on their sites for open space. They can pay impact fees where they cause the destruction of vegetated areas and the proceeds can be used to supplement the

Examples of Projects Assisted Through EPA's Technical Assistance Program:

- Assessment of the water quality and other environmental benefits associated with green infrastructure scenarios;
- Development of conceptual designs or design guidance that identifies an appropriate suite of green infrastructure practices for a particular site or context (e.g. complete streets);
- Development of a parks or open space plan that incorporates green infrastructure into public spaces to provide recreational amenities, stormwater management, and other ecosystem services;
- Development of a long-term green infrastructure plan that incorporates stormwater management goals into capital improvement projects and other municipal projects;
- Evaluation of opportunities to use green infrastructure to address multiple wet-weather requirements within an integrated planning framework;
- Evaluation of opportunities to use green infrastructure to advance climate change adaptation or mitigation or community resiliency (e.g., flood management); and
- Assessment of opportunities to use innovative sources of funding (such as utility programs, offsite mitigation programs, or public-private partnerships) to support green infrastructure implementation.

Source: U.S. EPA, Green Infrastructure Technical Assistance Program: 2014 Request for Letters of Interest 2, *available at* http://water.epa.gov/infrastructure/greeninfrastructure/upload/RLI-2014-Version-4.pdf..

local green infrastructure budget. Local and state capital budgets can support street trees, medians, parks, the greening of publicly owned buildings and sites, and open space preservation.

This Article follows the steady advance in the use of green infrastructure in recent years, including descriptions of programs, tools, and techniques, and instructive municipal case studies that provide hope and guidance for future progress. The Article tells the story of the emergence of a new urban planning initiative, one properly suited to the perturbations of our time.

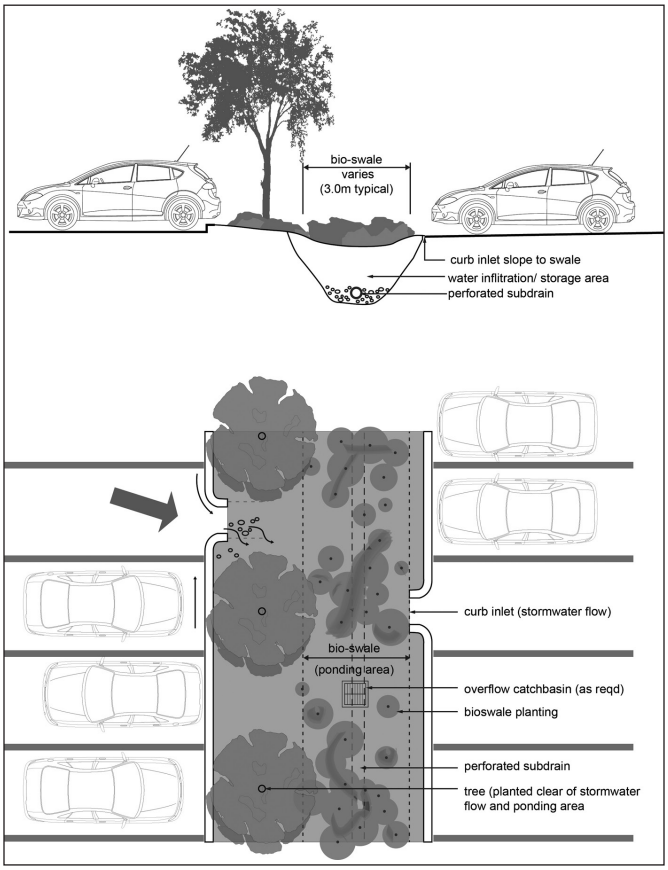
II. Initiatives That Emphasize Green Infrastructure

A. *Low Impact Development*

Low impact development (LID) is one of a number of initiatives that incorporate some aspect of green infrastructure into the land development process. LID, like many of the initiatives discussed in this Article, focuses on individual site development and mitigates the adverse impact of site-specific development on the environment, principally with respect to flooding. LID brings an emphasis on conservation to the development process, one project at a time.

As landscape architects and site planners developed more and more techniques to implement LID projects, the limits of traditional land use regulation were exposed. This was particularly true with the regulation of impervious surface coverage: green infrastructure's archenemy. Impervious coverage includes all building footprints, driveways, roads, streets, parking, and other improvements such as swimming pools and tennis courts that zoning permits. Impervious cover prevents water infiltration on-site and speeds up the flow of stormwater off-site, worsening flooding conditions downstream. Zoning standards were generally limited to specifying the permitted size of the lot, various setback requirements, and maximum lot coverage requirements.

The principal zoning technique that limits impervious coverage is the maximum lot coverage requirement. In a single-family zone, for example, zoning might limit hardscape development to 40% of the site. On a half-acre parcel, a 40% maximum coverage requirement allows approximately 8,000 square feet of hardscape. This much impervious coverage fundamentally changes the flow and



Low impact development best practices include saving trees on the site, enhancing surface permeability, and including on-site infrastructure elements that reduce runoff and filter stormwater, such as bioswales. RPA.

EPA Report on Green Infrastructure and LID

Green infrastructure at the site scale, also known as low impact development, is a strategy for managing stormwater where it falls, allowing soils and vegetation to absorb and filter the water, which reduces many of development's impacts on water quality. Examples of green infrastructure techniques include:

- **Infiltration techniques**, such as permeable pavements, disconnected downspouts, and rain gardens—they are engineered structures or landscape features designed to capture and infiltrate stormwater, reduce runoff volume, and treat or clean runoff.
- **Evapotranspiration practices**, such as green roofs, bioswales, trees, and other vegetation—they can reduce stormwater runoff volumes by returning water to the atmosphere through evaporation of surface water or through transpiration from plant leaves. Trees and shrubs can also filter air pollutants and improve air quality.
- **Capture and reuse practices**, such as rain barrels and cisterns—they capture stormwater for non-potable household uses, irrigation, or gradual infiltration.

. . . The benefits of green infrastructure are not just ecological. Green infrastructure can also make an area more attractive for residents and visitors and increase recreation space. In addition, a review of the literature on the effect of green infrastructure on human health found that epidemiological, experimental, and survey data suggest that there is considerable potential for green infrastructure to improve the health and well-being of urban residents, likely due to physiological, emotional, and cognitive changes.

Source: U.S. EPA, Our Built & Natural Environments.: A Technical Review of the Interactions Between Land Use, Transportaion, & Environmental Quality 112-13 (2013) [hereinafter EPA Built Environment Report], *available at* http://www.epa.gov/smartgrowth/pdf/b-and-n/b-and-n-EPA-231K13001.pdf.

speed of stormwater and adds pollutants that are contained in the hardscape improvements and accumulate on the impervious surfaces. Following storms, this mixture of stormwater and pollutants ends up in downstream surface waters, adding toxic elements such as copper, lead, and zinc as sediment. Gradually, some rudimentary lower impact development standards found their way into local land development regulations. Standards were added to zoning or site plan and subdivision regulations that lessened erosion and sedimentation, or that prevented site disturbance on slopes. In order to truly limit the impact of development, however, more needed to be done.

Slowly, local land use regulations were amended to include a long menu of techniques that became known as LID. These include saving trees on the site, restricting building on designated sensitive areas, orienting roads properly, and enhancing the effectiveness of on-site wastewater treatment systems using, for example, sand filters. These structural techniques were complemented with nonstructural strategies that rely on using soil and vegetation to infiltrate, evapotranspirate, and harvest stormwater runoff and reduce flows to drainage collection systems. These include disconnecting rain gutters from stormwater drains and sewage pipes; harvesting or retaining rainwater onsite; and using green roofs, porous pavement, swales, and rain gardens.

B. Sustainable Sites Initiative (SITES™)

Many green building rating systems focus primarily on the structures the mselves, leaving gaps in the overall picture of the sustainability of the development as a whole. To address this issue, the Sustainable Sites Initiative (SITES™) was created to "promote sustainable land development and management practices that can apply to sites with and without buildings."[1] The seeds of the program were planted in 2005, when the Sustainable Design and Development Professional Practice Network of the American Society of Landscape Architects (ASLA) and the Lady Bird Johnson Wildflower Center at the University of Texas collaborated to host a Sustainable Sites Summit in Austin, Texas. The following year, the U.S. Botanical Garden (USBG) joined the initiative as a third major partner. In 2009, the first version of the SITES rating system was released: the 2009 Guidelines and Performance Benchmarks.

Places Encompassed by the SITES™ Initiative

Open spaces: local, state, and national parks, conservation easements, buffer zones, and transportation rights-of-way

Sites with buildings: industrial, retail, and office parks, military complexes, airports, botanical gardens, streetscapes and plazas, residential and commercial developments, and private campuses

Source: The Sustainable Sites Initiative, *Why Sustainable Sites?*, http://www.sustainablesites.org/why/ (last visited June 11, 2014).

1. The Sustainable Sites Initiative, *About Us,* http://www.sustainablesites.org/about/ (last visited June 11, 2014). As *Standing Ground* was going to press, the new version of Sustainable Sites was released, along with significant updates to the SITES website. Though the material from this section refers to the first version of SITES as well as portions of the website that are no longer live online, the general principles and focus of the SITES rating system remain the same. Information on the updated Sustainable Sites v2 may be accessed at http://www.sustainablesites.org/.

SITES™ Areas of Focus

Hydrology
- Protect and restore existing hydrologic functions
- Manage and clean water on-site
- Design stormwater features to be accessible to site users
- Design the site to minimize or eliminate use of potable water for irrigation

Soils
- Preserve and protect healthy soils
- Use plant trimmings as compost to nourish soils
- Improve health of degraded soils

Vegetation
- Protect and use existing vegetation
- Use vegetation that promotes a regional identity and a sense of place
- Use vegetation to lower energy consumption
- Manage landscapes effectively to reduce potential damage

Materials
- Use existing materials
- Purchase local and sustainably produced plants and materials
- Consider the full life cycle of materials
- Work towards zero net waste
- Consider the urban heat island effect
- Reduce air pollution

Human Health & Well-Being
- Make the site user-friendly
- Focus on natural views
- Educate site users and keep culture and history alive
- Provide spaces for mental restoration, social interaction, and physical activity

Source: The Sustainable Sites Initiative, *Why Sustainable Sites?*, http://www.sustainablesites.org/why/ (last visited June 11, 2014).

Numerous pilot projects were undertaken using these guidelines and a comment period closing in 2013 paved the way for the updated version of SITES (v2). Looking forward, "[t]he USGBC anticipates incorporating these guidelines and performance benchmarks into future iterations of the LEED® Green Building Rating System," which would broaden the focus of the certification system from just the building to a holistic view of the entire development.[2]

SITES provides planners, developers, lawyers and other stakeholders with a toolbox of best management practices and land use techniques that can be implemented to ensure that site development is sustainable. The "central message" of the initiative is that any landscape, no matter its location, scale, or surrounding environment, "holds the potential to both improve and to regenerate the natural benefits and services provided by ecosystems in their undeveloped state."[3]

1. The SITES Rating System: Green Infrastructure Elements

The rating system is designed to move sequentially through all steps required in constructing a sustainable site, from site selection and design to maintenance and monitoring.[4] In the Site Design—Water section, there are three main foci that relate directly to green infrastructure. First, emphasis is placed on reducing the amount of water needed to sustain the site, using techniques such as xeriscaping. This also links with the second area of concern: more efficient means of using this water, such as high efficiency equipment (e.g., drip irrigation) and landscaping to attain minimal runoff. The third step is ensuring that as little potable water as possible is used, by employing tactics such as recycling graywater and wastewater and capturing rainwater on-site.

The Site Design—Soil & Vegetation section places emphasis on using natural vegetation well suited to the region, as well as plants that require minimal water.[5] Maintaining a certain amount of biomass on-site helps ensure adequate water absorption, pollution filtration, efficient heating and cooling of buildings, and a reduced urban heat island effect.

2. SITES Case Studies[6]

a. Burbank Water & Power—EcoCampus

The utility company has transformed its Magnolia electric power plant site (located in Burbank, California) into a green campus.[7] It features Lake Street, a green street showcasing stormwater management features such as bioswales, permeable pavement, and five different types of water filtration technologies. Other notable features include green roofs, photovoltaic panels, LED lighting, and salvaged construction materials (such as concrete and gravel). Some local codes and regulatory requirements entered consideration of the project; for example, the project complies with a local landscape ordinance, which mandates the use of drought-tolerant plants. The site faced some unique challenges as it still functions as a working power plant; besides the major constraints imposed by drought, another major issue was the high amount of impervious surface that the plant originally

2. The Sustainable Sites Initiative, *Why Sustainable Sites?,* http://www.sustainablesites.org/why/ (last visited June 11, 2014).

3. *Id.*

4. The Sustainable Sites Initiative, Guidelines & Performance Benchmarks 2009 (2009), *available at* http://www.sustainablesites.org/report/Guidelines%20and%20Performance%20Benchmarks_2009.pdf [hereinafter SITES 2009].

5. *Id.* at Prerequisites 4.1, 4.2, Credits 4.7, 4.8, 4.9.

6. The Sustainable Sites Initiative, *Certified Projects*, http://www.sustainablesites.org/cert_projects/ (last visited June 11, 2014).

7. The Sustainable Sites Initiative, *Burbank Water & Power—EcoCampus*, http://www.sustainablesites.org/cert_projects/show.php?id=42 (last visited June 11, 2014).

had. The project is surrounded by industrial uses and has brought much-needed green space to the area.

b. Cleveland's Public Garden

Created on a grayfield in Cleveland, Ohio, this project includes a visitor center, a mixed woodland broadleaf forest, and a 10-acre garden intended as an educational tool to show visitors the benefits of implementing sustainable land management practices in their own backyard.[8] Features include a low-maintenance lawn, a rain garden, a green roof, native plantings, and on-site food production. The project team collaborated with contractors to ensure sustainable practices, use of recycled materials wherever possible, and use of materials that were locally-sourced and sustainably manufactured. A Sustainable Action Committee will review annually the garden's site maintenance plan to continue to reduce its ecological footprint.

c. Novus International Headquarters Campus

Novus International headquarters is located on a former grayfield at the Missouri Research Park in St. Charles, Missouri.[9] Novus, as a corporation, emphasizes social responsibility and sustainability; it determined to incorporate this ethic into the design of its headquarters. From the outset, all parties engaged in the development of the headquarters bought in to the idea of green site development; early site design integration is credited with making the project successful. The project team collaborated on all aspects of the project, placing most emphasis on the site's hydrological system, native habitat improvement areas, and energy offsets. Novus emphasizes the importance of the improvement to the health and wellbeing of its employees that the site engendered.

d. Scenic Hudson's Long Dock Park

A former 14-acre brownfield in Beacon, New York, was transformed into a park by Scenic Hudson, a large environmental group dedicated to preserving the natural beauty of the Hudson River. The post-industrial area that the park now occupies had been designated a Waterfront Revitalization Zone by the town of Beacon. The project team emphasized citizen input, so that the park would not only serve the function of ecological rehabilitation but would also be tailored to the needs of Beacon residents. The complete park includes remediated wetlands and stormwater management features, as well as paths and a dock suitable for a variety of recreational activities.[10] The most notable SITES strategies used were "the remediation of contaminated soils, the reuse of soils excavated on the site, reuse of found materials (such as large concrete slabs), a planting scheme that is sustainable without irrigation, . . . use of native plant material to create diverse habitation, [and the] prohibition of pressure-treated wood."

e. The Taylor Residence

A 1.69-acre residential home located on a former dairy farm in Kennett Square, Pennsylvania, is the only residential property to achieve certification under the 2009 guidelines.[11] Because the property was once used for agricultural purposes, the owner needed to restore the natural soil and plant conditions of the land. Another challenge was the steep grade of the land, which impacted the design of the stormwater management system. Notable features include native plantings, a drip irrigation system, green roofs, and a stormwater management system. Careful steps were taken to ensure the project complies with PennDOT regulations, the County & Township Sewage Management Code, including the township's Scenic Resources Protection Plan, Steep Slopes Protection Ordinance, Stormwater Management Ordinance, and Subdivision & Land Development Ordinance.

f. Phipps' Center for Sustainable Landscapes

Located in Pittsburgh, Pennsylvania, on the grounds of the Phipps Conservatory and Botanical Gardens, this three-acre former brownfield is now the site of a new 24,350 square-foot research and education building as well as 1.5 acres of new green space.[12] It is the first SITES project to receive a full four-star certification and is also the first project in the world to simultaneously receive LEED Platinum certification, SITES four-star certification, and The Living Building Challenge designation. Utilizing an integrative design process, the project obtained four-star certification through focusing on the SITES strategies of developing on an existing brownfield, on-site stormwater management, use of native plants, responsible sourcing of landscape materials, and sustainable project waste stream management.

C. LEED for Neighborhood Development

The LEED rating system for Neighborhood Development (LEED-ND) advances the U.S. Green Building Council

8. The Sustainable Sites Initiative, *Cleveland's Public Garden: Modeling Sustainability in the Rust Belt*, http://www.sustainablesites.org/cert_projects/show.php?id=31 (last visited June 11, 2014).
9. The Sustainable Sites Initiative, *Novus International Headquarters Campus*, http://www.sustainablesites.org/cert_projects/show.php?id=38 (last visited June 11, 2014).
10. The Sustainable Sites Initiative, *Scenic Hudson's Long Dock Park,* http://www.sustainablesites.org/cert_projects/show.php?id=48 (last visited June 11, 2014).
11. The Sustainable Sites Initiative, *The Taylor Residence,* http://www.sustainablesites.org/cert_projects/show.php?id=43 (last visited June 11, 2014).
12. The Sustainable Sites Initiative, *Phipps' Center For Sustainable Landscapes,* http://www.sustainablesites.org/cert_projects/show.php?id=55 (last visited June 11, 2014).

LEED-ND in Las Vegas, Nevada

The Las Vegas Planning and Development Department completed an audit of the city's zoning code using LEED-ND standards to identify ways the city could incorporate sustainable development into its zoning. The resulting internal report, *Code Audit for barriers (or opportunities) for sustainability in accordance with the Planning Commission/City Council Workshop on Sustainability—Recommendation No. 8*, identified code barriers to sustainability and proposed changes to the code. The recommended changes included adding a policy for adaptive reuse of historic buildings, requiring post-construction best management practices for site plans, allowing greater building heights for green buildings in certain commercial and industrial zones, allowing a more diverse range of building materials and alternative roofing methods, adding greater flexibility in solar panel regulations, and amending parking standards to encourage alternative transportation, reduce impervious surfaces, minimize parking, and require more landscaping.

Source: U.S. Green Bldg. Council & Pace Land Use Law Ctr., Technical Guidance Manual for Sustainable Neighborhoods 9 (2012), *available at* http://www.usgbc.org/resources/technical-guidance-manual-sustainable-neighborhoods.

(USGBC) rating system by focusing on developments and their relationship to their adjacent neighborhoods. The Congress for the New Urbanism (CNU) and the Natural Resources Defense Council (NRDC) collaborated with the USGBC to create LEED-ND, which began its pilot phase in 2007. According to the USGBC, the LEED-ND rating system "encourages smart growth and New Urbanist best practices, promoting the location and design of neighborhoods that reduce vehicle miles traveled and communities where jobs and services are accessible by foot or public transit."[13] It also promotes more efficient energy systems and water use, which are especially important in urban areas where these services are expensive or where the infrastructure is often overtaxed. Though most applicable on the neighborhood scale, there are no size thresholds for projects seeking LEED-ND certification. According to the USGBC, "projects may constitute whole neighborhoods, portions of neighborhoods, or multiple neighborhoods."[14] USGBC does recommend, however, that projects not be smaller than two habitable buildings or larger than about half a square mile.

Developers voluntarily apply for LEED-ND certification; they must meet all the rating systems prerequisites and earn a specified number of points for basic certification or to achieve certification at higher—silver, gold, or platinum—levels. LEED-ND points and prerequisites are divided into five categories: Smart Location and Linkage (SLL), Neighborhood Pattern and Design (NPD), Green Infrastructure and Buildings (GIB), Innovation and Design Process (IDP), and Regional Priority Credits (RPC). Within the first three categories (SLL, NPD, and GIB), prerequisites are identified that embody the principles of sustainable development.

The Smart Location and Linkage prerequisites, for example, encourage development within established communities and near public transit. Developments seeking LEED-ND status as new neighborhoods must protect prime farmland, wetlands, and water bodies from development, and avoid floodplains, imperiled species, and ecological communities. In this way the rating system promotes green infrastructure. Under the Green Infrastructure and Buildings category, credits are awarded for water efficient landscaping, minimal site disturbance, stormwater management, habitat and wetland conservation, restoration of damaged natural resources, and heat island reduction.

D. SmartCode

Growing out of the New Urbanist movement and its form-based codes, which emphasize design standards rather than use and density requirements in local land use regulation, SmartCode is a unified development ordinance that emphasizes compact, mixed-use development. It promotes green infrastructure through strategies that preserve open space. SmartCode distinguishes itself by promoting patterns of development through clustering and scaling up

The Columbia Point Master Plan

In response to a proposal for a ten acre development within Columbia Point, the Boston Redevelopment Authority (BRA), the city's planning and economic development agency, initiated a master planning process for Columbia Point to guide this and other development. . . . [The Columbia Point Master Plan's] Land Use and Urban Design chapter presents recommendation principles to provide a mix of residential and commercial uses and "develop a familiar street and block pattern, with attractive streetscapes, active street frontages and buildings that reinforce the scale of the streets and blocks." Additionally, the master plan includes objectives to integrate roof gardens and increase local food sourcing, [and] . . . further aims to reduce dependency on the electrical transmission grid by using on-site renewable energy generation in new development and creating district heating and cooling facilities with cogeneration. Implementation actions to support these objectives include requiring projects larger than one million square feet to study the feasibility of including a centralized, cogeneration district heating and cooling plant and using on-site, renewable energy generation technologies to generate at least five percent of the annual energy consumption.

Source: U.S. Green Bldg. Council & Pace Land Use Law Ctr., Technical Guidance Manual for Sustainable Neighborhoods 9 (2012), *available at* http://www.usgbc.org/resources/technical-guidance-manual-sustainable-neighborhoods.

13. U.S. Green Bldg. Council, FAQ: LEED for Neighborhood Development 1, *available at* http://www.usgbc.org/Docs/Archive/General/Docs6423.pdf.
14. *Id.*

toward the urban core; techniques that preserve natural resources in less dense portions of the community and in neighborhoods removed from the downtown and neighborhood centers.

The Center for Applied Transit Studies (CATS) distributes a model planning and zoning document centered on higher density cores and lower density peripheries, based on environmental analysis. This open-source SmartCode can be calibrated to any locality.[15] Communities adopting the SmartCode use a variety of techniques to create a sustainable settlement pattern, including clustered development, traditional neighborhood development design, and transit-oriented development, where appropriate. This code integrates the scale of planning from the regional level, through the community scale, to the individual lot, and the development's architectural elements. Water quality control is a central concern as in urban infill and hazard mitigation.

The planned development community of Tuxedo Reserve, located in Orange County, New York, adopted a SmartCode for infrastructure initiatives. The master plan provides for a series of compact, low impact hamlets. The site includes features such as bio-filters for stormwater management, preserved open space for the protection of native species' natural habitat and migration routes, and green infrastructure such as "skinny roads" to reduce impervious coverage.[16]

E. Urban Agriculture

The grassroots urban agricultural movement's relationship to green infrastructure is obvious. Local policies and programs that promote urban gardens, larger farmed parcels, composting, plots for small animals, and the like, enlarge the greenprint of the community. Many urban agriculture projects restore life to hard-packed or impervious surfaces on unused urban lots and thus promote infiltration of rainwater, prevent flooding, enhance sequestration, and reduce the heat island effect. For a fuller explanation of urban agriculture and its relationship to green infrastructure and its benefits, see Chapter 8 of *Standing Ground.*

New York Sustainability Plans

A New York City initiative, PlaNYC, is intended to improve all aspects of urban life. One goal is to increase the amount of school gardens from 70 to 150. Another is to find vacant lots that can be utilized to greater effect as urban farms. There are plans to convert former landfills into public parks, including Freshkills Park in Staten Island, which is over 2,200 acres in size.[a]

New Rochelle, New York, created a sustainability plan known as GreeNR.[b] It includes an action plan as well as recommendations in the areas of: energy and climate; resource conservation and waste reduction; ecology, biodiversity, and public health; smart growth and economic prosperity; transportation and mobility; and public participation and awareness. Green infrastructure is used throughout the plan to reduce waste, manage rainwater, improve public health, and increase energy efficiency.

a. PlaNYC, *Natural Systems*, http://www.nyc.gov/html/planyc2030/html/theplan/natural-systems.shtml (last visited June 11, 2014).
b. New Rochelle, N.Y., GreeNR Sustainability Plan, *available at* http://www.newrochelleny.com/DocumentCenter/Home/View/2054.

III. Additional Techniques That Advance Green Infrastructure

Green infrastructure, broadly defined, values natural features that, among other objectives, manage storm water and reduce flooding, as well as conserve water in drought-prone areas. This section contains a checklist of techniques that contribute to the stormwater management in wet states and water conservation in dry ones. All involve strategies that increase a community's green infrastructure.

A. Increasing Tree Canopies

Urban neighborhoods are protected by tree canopies covering streets, sidewalks, private lots, parks, and other private and public lands. Trees on private lots shade residences, workplaces, and shopping areas. These trees are sometimes called urban forests and they constitute a large percentage of a community's green infrastructure, reduce energy consumption, and sequester carbon. Cities and villages can adopt tree canopy objectives in their comprehensive plans and dedicate themselves to increasing the percentage of the community that is shaded. In addition to sequestering carbon and reducing energy use, urban trees provide windbreaks, mitigate urban heat island effects, and make urban environments more comfortable and healthful.

Maximizing urban forests in cities in the United States might increase the sequestering environment by two to three percent.[17] While small, this is still of some importance. Increasing tree cover in urbanized areas would

15. Center for Applied Transect Studies, *SmartCode Central*, http://www.smartcodecentral.org/ (last visited June 11, 2014). *See also* Local Gov't Comm., Form-Based Codes: Implementing Smart Growth, *available at* http://www.lgc.org/freepub/docs/community_design/fact_sheets/form_based_codes.pdf.
16. 22 Lower Hudson Coalition of Conservation Districts, Natural Green Infrastructure: Landscape-scale mapping and Site planning strategies 103, *available at* http://www.lhccd.net/uploads/7/7/6/5/7765286/natural_green_infrastructure_lavalle_franson_small.pdf; Tuxedo Reserve, Orange County, N.Y., SmartCode V9.2, t. 8 (2010), *available at* http://www.co.genesee.ny.us/docs/planning/Smart_Code_Nov2010.pdf; Marc Wouters: Architect & Urbanist, *Tuxedo Reserve*, http://www.mwouters.com/ecology.html (last visited June 11, 2014).
17. Hugh T. Spencer, Climate Change Mitigation Strategies for Kentucky Policy Options for Controlling Greenhouse Gas Emissions Through the Year 2020 AD 111 (1998), *available at* http://epa.gov/statelocalclimate/documents/pdf/ky_2_fin.pdf.

MillionTreesNYC

New York City began an initiative to plant one million new trees throughout the city under its program MillionTreesNYC. The city takes requests from streets and neighborhoods that want new trees, and residents are allowed to request the ability to plant trees on their property as part of the program. Currently over 600,000 trees have been added as a result of the program.

Source: MillionTress NYC, *About MillionTrees NYC*, http://www.milliontreesnyc.org/html/home/home.shtml (last visited June 11, 2014).

greatly increase sequestering capabilities; sequestration by urban trees has increased by 46.3% from 1990-2012, and in 2012 alone, urban trees were responsible for nine percent of net CO_2 flux.[18] While not all localities enjoy the same amount of municipal resources or political will to expend the resources to plant enough trees to offset their CO_2 emissions, promoting biological sequestration through local land use policies is still a viable and real arrow in society's quiver in the fight against climate change. For more information on biological sequestration, see Chapter 6 of *Standing Ground*.

Land use regulations and project approvals can be used to preserve urban trees. The zoning regulations of the town of Wallingford, Connecticut, for example, require "that existing trees . . . be preserved to the maximum extent possible."[19] Under those regulations, trees and landscaping are to be preserved and provided to reduce excessive heat, glare, and accumulation of dust; to provide privacy from noise and visual intrusion; and to prevent the erosion of the soil, excessive runoff of drainage water, and the consequent depletion of the groundwater table and the pollution of water bodies.

In Santa Monica, California, one of the purposes of the zoning regulation is to protect and enhance the quality of the natural and built environment and to ensure adequate public open space and tree preservation.[20] Development in each of the city's zoning districts is subject to certain environmental standards. These standards include maximum unit density, lot coverage, minimum lot size, setback requirements, and building spacing, as well as a requirement for open space.

EPA, in its 2013 publication *The Built Environment*, cites a 2006 study that found of the roughly 3,035,033 square miles of the contiguous United States, 40,006 square miles were covered by impervious surfaces.[21] For perspective, this is an area almost the size of the state of Kentucky. Many cities in the United States have been losing their tree cover while simultaneously increasing impervious cover, with an average growth of 0.31% of impervious cover per year from the mid-to-late 2000s. Houston, Texas, for example, saw an average increase of 0.26% in impervious cover, while losing 0.60% of its tree canopy cover every year between 2004 and 2009. Between 2001 and 2005, Tacoma, Washington's impervious cover grew on average 0.89% while it lost 0.36% of its tree cover each year. Only 18 cities in the United States actually increased their tree cover and decreased their impervious cover between 2003 and 2009. One of these cities, Syracuse, New York, increased its tree cover on average by 0.17% while reducing cover by 0.09% per year; the cause is thought to be attributed to natural reforestation and limited further human development.

B. Green Roofs and Planters

Additional vegetation around and on buildings can increase green infrastructure. One method of achieving this is for municipalities to facilitate or require green roof installation. Green roofs, sometimes also called ecoroofs, are specially designed rooftop gardens or lawns. As green roofs have become more common, their benefits—improved air and water quality, stormwater retention, urban heat island mitigation, habitat production, improved building efficiency, longer roof life, and even beauty—have begun to become more popular, leading some municipalities to develop incentives and requirements for green roofs apart from general green building and stormwater management requirements.

The green roof regulations of Portland, Oregon, for example, cover slope, waterproofing, drainage, growing medium, and vegetation types. In Los Angeles County, green roofs must be installed and maintained according to the manufacturer/vendor's instructions, vegetation must include "self-sustaining plants" that do not require pesticides or fertilizers, and 90% plant coverage must be achieved within two years. In order to be eligible for Philadelphia's green roof tax credit, an applicant has to submit documents demonstrating the adequacy of the roof's

Green roofs have become more popular as their many benefits—improved air and water quality, stormwater retention, urban heat island mitigation, habitat production, improved building efficiency, longer roof life, and even beauty—have been recognized. From original color photo by 416Style.

18. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions & Sinks 1990-2012 2-18, 2-19 (2014).
19. Wallingford, Conn., Zoning Code §7.2(E) (2011).
20. Santa Monica, Cal., Zoning Ordinance §9.04.02.020(b), (d) (2011).
21. EPA Built Environment Report, *supra* note 2, at 23.

New York State Green Roof Tax Abatement Statute

The New York State Green Roof Tax Abatement Statute provides one-year tax abatement for the construction of a green roof. The abatement is $4.50 per square foot of green roof up to the lesser of either $100,000 or the total tax liability for the building for the tax year in which the abatement is claimed. Notably, this tax abatement is only applicable in cities of one million or more persons; consequently, the abatement applies only to New York City. If the program is successful, the law could eventually be amended to include other cities throughout New York State.

Source: PLANYC, *Green Roof Tax Abatement*, http://www.nyc.gov/html/gbee/html/incentives/roof.shtml (last visited June 11, 2014).

structural components and the existence of safe access to the roof.

Some local governments offer grants and incentives to help offset initial construction costs. Cincinnati, Chicago, and Portland offer grants for green roof construction. New York City and Philadelphia also offer tax credits up to $100,000 for green roof construction, and density bonuses are available in Philadelphia and Portland.[22] In 2009, the Virginia state legislature enacted a law authorizing local governments to grant various incentives to promote green roof construction. The incentives include discounted permit fees, expedited building permit approvals, or reductions in gross receipt taxes. The incentives apply to both solar and vegetative roofs. It is up to Virginia's local governments to enact these incentive programs.[23] In Chicago, the Department of Planning and Development's Green Matrix program provides for the funding of green roof projects, subject to a set of sustainability criteria.[24]

Similar strategies are employed at the local level to encourage property owners to install planters of all sizes around their buildings to achieve green infrastructure benefits. These facilities can be effective in retaining rainwater, cooling exterior spaces, and adding livability features to sidewalks and other impervious surfaces.

C. Xeriscaping Requirements

Xeriscaping is a holistic approach to landscape design that uses planning and design, selection of appropriate indigenous plant species, water-efficient irrigation techniques, and other sustainable practices to make landscaping more sustainable. EPA describes the specific benefits of xeriscaping to include:

> [R]educed water use, decreased energy use (less pumping and treatment required), reduced heating and cooling costs because of carefully placed trees, decreased stormwater and irrigation runoff, fewer yard wastes, increased habitat for plants and animals, and lower labor and maintenance costs.[25]

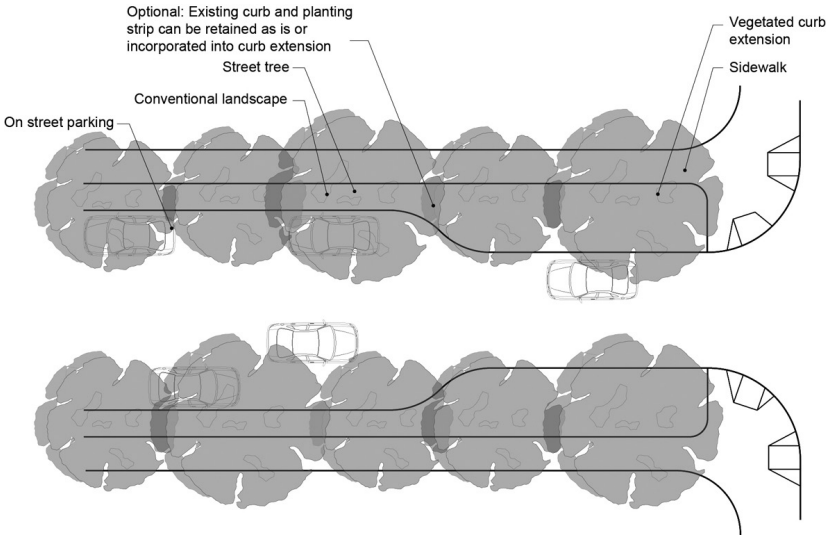
Florida has enacted legislation supporting xeriscape landscaping techniques and directing its municipalities to consider enacting landscaping provisions to conserve water. The law also prohibits covenants that interfere with the use of xeriscaping. Colorado has also prohibited such covenants, and in Texas, local governments are specifically authorized to adopt xeriscaping ordinances. The local governments that have adopted xeriscaping ordinances are located primarily in the South and Southwest. In Florida, they include Hernando County, Sarasota County, and Broward County, and in Texas they include the town of Fairview, and the city of Corinth. Xeriscaping has also caught on in some northeastern cities. Falmouth, Massachusetts, and Westchester County, New York, have enacted measures drawing on xeriscaping principles. The state and local government endorsement of xeriscaping is a step in the right direction for sustainable landscaping procedures.

Two communities on the front range of the Rocky Mountains have adopted aggressive xeriscaping requirements, for the principal purpose of conserving water. Parker, Colorado, requires landscaping that utilizes seven xeriscaping principles: proper planning and design; irrigation systems; use of mulches to reduce evaporation; use of proper soil; grouping of plant materials of similar water needs together (hydrozoning); limiting of turf areas; and appropriate maintenance of the landscape.[26] Aurora, Colorado, adopted a landscape ordinance to ensure that future landscapes will be sustainable during periods of drought. The ordinance limits the use of intensive water grasses, requires the use of xeriscaping and drought-tolerant plant materials, and regulates artificial turf.[27]

D. Green Streets

One practical means for a locality to become more sustainable is through the implementation of a "complete streets" policy, which enhances walkability in urban neighborhoods and can enhance a locality's green infrastructure. Complete streets is a term, now much in vogue, for thoroughfares that allow all users moving by car, truck, transit, bicycle, or foot to travel in a safe and welcoming way.[28] The intent of a complete streets policy is to require safe accommodation of all users of a street and to eliminate barriers to bicycling and walking. Green streets also focus on reducing impervious surfaces and incorporating landscap-

22. Plant Connection, Inc., *Green Roof Legislation, Policies, & Tax Incentives*, http://myplantconnection.com/green-roofs-legislation.php (last visited June 11, 2014).
23. Va. Dep't of Envtl. Quality, *Incentives for Virginians*, http://www.deq.virginia.gov/Programs/PollutionPrevention/VirginiaInformationSourceforEnergy/FinancialIncentives.aspx (last visited June 11, 2014).
24. City of Chicago, *Environment & Sustainability*, http://www.cityofchicago.org/city/en/progs/env.html (last visited June 11, 2014).
25. U.S. EPA, *How To Conserve Water and Use It Effectively*, http://water.epa.gov/polwaste/nps/chap3.cfm (last visited June 11, 2014).
26. PARKER, COLO., PARKER 2035: CHANGES AND CHOICES 12.6.
27. AURORA, COLO., 2009 COMPREHENSIVE PLAN 7 (2009).
28. SmartGrowth America, *National Complete Streets Coalition*, http://www.completestreets.org/ (last visited June 11, 2014).



Green streets focus on reducing impervious surfaces and incorporating landscaping in sidewalks, medians, and parking lots. Green street infrastructure benefits mobility and ecology while making communities more comfortable and interesting. RPA.

ing in sidewalks, medians, and parking lots. Green street infrastructure benefits mobility and ecology while making communities more comfortable and interesting environments. Green streets mitigate climate change in two ways, by reducing vehicle miles travelled—encouraging people to use sustainable forms of transportation such as biking and walking—and by providing ecosystem services that sequester CO_2, as well as reduce the heat island effect.

Complete streets design elements, such as permeable pavements, vegetated swales, planters, and trees, are also powerful tools for managing stormwater runoff and reducing pollution. Several studies of permeable pavements have found that they can be designed to infiltrate nearly all precipitation, even after extended periods of use. In Renton, Washington, the quality of the stormwater runoff was much improved after being filtered through the permeable pavement (as compared to the runoff from an asphalt parking area). At two study sites in North Carolina, runoff was either completely or very nearly eliminated. Even the runoff that was not eliminated was found to contain much lower levels of pollutants as compared to a traditional asphalt lot.[29]

Seattle's Green Infrastructure

Seattle was the first city in the United States to supplement its hard infrastructure by retrofitting its streets with green infrastructure techniques. Currently, the city has multiple ongoing projects built through the Seattle Public Utilities program. The primary emphasis of the projects is to reduce impervious surface areas and place vegetation in its stead. Most of this infrastructure consists of vegetated swales and rain gardens, as well as cascading pools and small wetland ponds. One such project reduced impervious surfaces by 11% and saw a 98% reduction of stormwater flow from a two-year storm event.

Source: Water Environment Research Foundation, *Seattle, Wash.: Incorporating Water Quality Features Into the Right-of-Way,* http://www.werf.org/liveablecommunities/studies_sea_wa.htm (last visited June 11, 2014).

E. Rainwater Harvesting and On-Site Retention

Many of the above techniques retain stormwater on site and prevent downstream flooding, loss of groundwater resources, and surface water pollution and sedimentation. Increasingly, local governments are requiring that stormwater be retained through disconnecting downspouts, rainwater harvesting, retention, detention, and the use of bio-swales. The Texas Legislature created a Rainwater Harvesting Evaluation Committee in 2005 to report on the possible benefits of rainwater collection and make sug-

Rain gardens collect and filter stormwater. From original color photo by Aaron Volkening.

29. EPA Built Environment Report, *supra* note 2, at 102.

Local Stormwater Retention Initiatives

In 2008, the city of Chicago passed a stormwater ordinance mandating that any building larger than 15,000 square feet or any parking lot larger than 7,500 square feet must detain at least the first half-inch of rain on-site. Alternatively, the building or parking lot may meet the requirements of the ordinance by reducing prior imperviousness of the site by 15%.[a] Street improvement projects now incorporate green infrastructure design elements such as creating discharge patterns that direct stormwater into vegetated swales.[b] In Milwaukee, a public education program resulted in 35% of all downspouts in the target area being disconnected, and an eight percent reduction in impervious cover. This removed 20,500 cubic feet of runoff per one inch of rain from the Milwaukee sewer system.[c]

a. City of Chicago, Stormwater Management Ordinance Manual 35 (2014), *available at* http://www.cityofchicago.org/content/dam/city/depts/water/general/Engineering/SewerConstStormReq/2014StormwaterManual.pdf.
b. The Civic Federation, Managing Urban Stormwater with Green Infrastructure: Case Studies of Five U.S. Local Governments 27 (2007), *available at* http://www.docstoc.com/docs/22941735/Managing-Urban-Stormwater-with-Green-Infrastructure-Case-Studies-of.
c. Milwaukee Metro. Sewerage Dist., Stormwater Runoff Reduction Program: Final Report 10-39, 46 (2007).

gestions for future rainwater collection activities in the state. The committee recommended that municipalities should enact ordinances permitting appropriate rainwater collection systems. Texas law voids restrictive covenants or deed provisions that prevent owners from using rainwater harvesting systems. A number of cities and counties have developed rainwater collection requirements for new construction, including Tucson, Arizona, and Santa Fe County, New Mexico.

F. Green Infrastructure Maintenance: Ensuring Continued Compliance

As localities expand their green infrastructure by imposing standards on new private development proposals, a new challenge is encountered: how to ensure that green improvements are not just in place when the project is completed, but that they are maintained into the future. The environmental gains of these new standards can be lost if, over time, building owners and occupants do not maintain the required green improvements. Pervious surfaces can become clogged, green roofs neglected, on-site vegetation die out, and water and energy conservation fixtures removed and replaced. Slowly, in various parts of the nation, new legal techniques are emerging to accommodate the need for the maintenance of green features and fixtures now required by law. Several initiatives to achieve post-occupancy compliance are described immediately below.

Green City, Clean Waters

In Philadelphia, Pennsylvania, the city's Water Department (PWD) in 2012 launched Green City, Clean Waters, a $2 billion, 25-year program to implement green infrastructure for stormwater management. PWD has forged partnerships with the Pennsylvania Department of Environmental Protection as well as EPA to meet their goals, which include placement of green infrastructure components such as downspout planters, green roofs, porous paving, infiltration trenches, and more, across the city. The city of Philadelphia, through the PWD and the Philadelphia Industrial Development Corporation, has also created a Stormwater Management Incentives Program, which in 2012 awarded seven commercial businesses $3.2 million to create 65.5 greened acres of property. Finally, the PWD has sought to raise community awareness and input mechanisms by giving green infrastructure tours, hosting community events such as festivals and art contests, promoting environmental education programs in local schools, and creating an online community input form, where community members may suggest new locations for green infrastructure projects. Philadelphia's use of green infrastructure has reduced the flow of stormwater into the city's combined sewer system and saved around $170 million since 2006.

Source: Philadelphia Water Dep't, *Green City, Clean Waters, Year in Review: 2011-2012*, http://issuu.com/phillyh2o/docs/green-city-clean-waters-2012-year-in-review?e=6553272/2621487 (last visited June 11, 2014).

1. Require Post-Occupancy Documentation

Municipalities may require the owners of newly developed properties to submit a post occupancy commissioning report at various intervals to show that the project is operating as planned.[30] Some communities require post-occupancy documentation one year and five years after completion. Others require documentation at 18 months and 24 months after completion, as recommended by the International Green Construction Code.[31]

Greenburgh, New York, adopted the Green Building Initiative and Energy Construction Standards.[32] All affected applicants must submit documentation showing compliance with standards, including checklists, worksheets, and other documentation that may be necessary to show compliance with the green building requirements. Applicants must meet with the town's Green Building Compliance Official (GBCO) to discuss proposed green building measures prior to any public hearing regarding the site plan application. Applicants may not obtain a building permit until the GBCO has approved this documentation. The applicant is also required to submit documentation prior to

30. Int'l Code Council, Inc., International Green Construction Code V2.0 193 (2010), *available at* http://www.vpmia.org/pdf/Codes/IGCC-PV2_PDF.pdf.
31. *Id.* at 194 (tbl. 903.1).
32. Greenburgh, N.Y. Code §233.3, 4 *available at* http://ecode360.com/13704907.

the issuance of a certificate of occupancy, verifying that the required green building measures were implemented. After one year of occupancy of the building, additional documentation must be submitted, showing that the building is being operated according to the previously approved efficiency and conservation standards. The same process is again followed in later years.

2. Develop Ordinances With Maintenance Guidelines and Inspections

In water-scarce areas, some municipalities require water-efficient landscapes to be installed in new developments. In order to be effective, some ordinances include the use of maintenance checklists to help residents preserve their water-efficient landscapes. Regular municipal inspections are used to ensure compliance and measure the effectiveness of the landscape post-occupancy.

An example of this approach is the Water-Efficient Landscaping Regulation in Sarasota County, Florida.[33] This regulation requires resourceful landscape planning and installation, water-efficient irrigation, and appropriate maintenance measures to promote the conservation of water. In an attempt to enforce maintenance, the regulations ensure that property owners receive a maintenance checklist.[34] In addition, the local law requires inspections by the code enforcement officer "at reasonable hours of all land uses or activities regulated by Water-Efficient Landscaping Regulations in order to insure compliance with the provisions" included in the Water-Efficient Landscaping Ordinance.[35] The code enforcement officer is responsible for initiating enforcement proceedings. The Board of County Commissioners of Sarasota County is authorized to select special magistrates who can issue citations, assess fines against violators, and hold hearings as provided in the County Code of Ordinances.

Another example is the Water-Efficient Irrigation Ordinance in San Francisco, California.[36] The purpose of this ordinance is to regulate landscape irrigation practices and the use of proper plants, in accordance with California's State Water Conservation in Landscaping Act. Developers must install drainage facilities including, but not limited to, culverts, retention and detention basins, and drainage swales. The ordinance requires irrigation audits for a landscaped area by a certified landscape irrigation auditor, the project applicant, or a public utilities commission water service inspector. An irrigation audit includes inspections, system tests, precipitation rates, and runoff reports. If a site violates the wastewater provision of the ordinance, property owners can be fined.[37]

San Francisco's Green Landscaping Ordinance achieves increased permeability through front yard and parking lot controls and responsible water use through increasing "climate appropriate" plantings and the use of permeable surfaces.[38] Examples of approved permeable surfaces include porous asphalt, in-ground planters, and loosely set paving. The code enforcement team of the planning department helps maintain and improve the quality of San Francisco's neighborhoods by operating programs that ensure compliance with the city's planning code. Code enforcement officials will respond to any complaints regarding code violations. The complaint is logged and assigned to an enforcement planner in charge of the area. If a violation occurs the enforcement planner sends a notice to the property owner. The enforcement planner may conduct a site visit to further investigate the violation.[39]

In addition, the San Francisco Public Utilities Commission is working on a water budget program that provides a report to property owners with dedicated irrigation meters. These reports include information on how property owners can meet their assigned water budget. Sites that go over budget are brought to the attention of enforcement officials, who may issue written warnings. The warning may include information regarding the violation, educate the violator on restrictions, provide resources to assist with compliance, and set a deadline for corrective action. If violations are not corrected, legal remedies can be sought pursuant to San Francisco's Administrative Code.

Grand Traverse County, Michigan, has adopted both a construction and post-construction runoff control ordinance. It requires the preparation of an erosion and stormwater runoff control plan for earth-disturbing activities in order "to effectively reduce accelerated soil erosion and sedimentation during construction and after construction is completed."[40] The ordinance requires property owners to provide stormwater management easements for facility inspections and the maintenance of stormwater runoff infiltration and detention areas and facilities.

3. Create a Commercial Audit Program

Municipalities may implement an irrigation inspection program by adopting ordinances that require mandatory audits and inspections of new irrigation systems. Through such programs, commercial water users are required to submit an audit periodically and must continue to follow audit requirements over time.

33. Sarasota County, Fla., Ordinance No. 2001-081, *available at* https://www.scgov.net/Sustainability/County%20Does/Water%20Efficient%20Landscape%20Ordinance%202001-081.pdf.
34. *Id.* at ch. XXII, art. VI (Landscape Compliance Certification & Checklist), *available at:* http://sarasota.ifas.ufl.edu/Hort/WEL/ord/docs/ordchecklist.htm.
35. *Id.*
36. San Francisco Pub. Utils. Comm'n, *Water Efficient Landscape*, http://www.sfwater.org/index.aspx?page=689 (last visited June 11, 2014).
37. Interview with Julie Ortiz, Water Conservation Manager, San Francisco Public Utilities Commissionn, (Sept. 20, 2013).
38. San Francisco, Cal., Res. No. 18033, *available at*http://www.sfbos.org/ftp/uploadedfiles/bdsupvrs/bosagendas/materials/bag041310_091453.pdf.
39. San Francisco Planning Dep't, *Enforcement*, http://sf-planning.org/index.aspx?page=2202 (last visited June 11, 2014).
40. Grand Traverse County, Soil Erosion, Sedimentation & Stormwater Runoff Control Ordinance, pt. II (2003), *available at* http://www.stormwatercenter.net/Model%20Ordinances/Post%20Construction%20Stormwater%20Management/grand_traverse_county_soil_erosi.htm.

The city of Allen, Texas, implemented an irrigation inspection program through its Land Development Code requiring mandatory audits and inspections of new irrigation systems.[41] Under this ordinance, all irrigation systems are required to comply with the Texas Commission of Environmental Quality's Landscape Irrigation Standards and the city's irrigation standards. Immediately following installation, an irrigation system audit and inspection is required. For new developments, documentation of the audit and inspection must be submitted to the city prior to the issuance of a certificate of occupancy. The commercial account holder must hire a certified auditor and submit an audit every three years thereafter. In addition, all audits must be performed according to the latest edition of the Recommended Audit Guidelines, published by the Irrigation Association. Any person, firm, or corporation who violates any provision of this code is guilty of a misdemeanor and, upon conviction, is subject to a fine of up to $2,000. Each day that a violation exists or continues constitutes a separate offense.

4. Provide Financial Incentives and Disincentives

Municipalities may develop incentive programs that encourage property owners to meet stringent water efficiency standards, such as converting conventional landscapes to xeriscapes. Municipalities may provide penalties for converting back to old landscapes. Through its Water-Wise Landscape Rebate Program, Austin Water pays residents to replace lawn grasses with more drought-resistant native plants. According to Austin Water, the program maintains and enforces itself.[42] The program requires participants to convert automatic irrigation spray heads to drip irrigation. In order to revert to grass, the homeowner would have to reinstall automatic irrigation systems; therefore, the program embodies a natural financial incentive to maintain these new landscaping features rather than converting them at some point in the future. Education is an important element to the maintenance of the program. The education program is designed to remind residents of the frequent droughts and to understand that grass requires a lot of water that could be used for other important functions. In Austin, Texas, it is common to see water-efficient landscapes more frequently than manicured lawns.

5. Offer Stormwater Management Fee Reductions

Municipalities may create stormwater management programs that control runoff from residential properties through a fee and fee reduction approach. Under such programs, customers are charged a stormwater utility cost based on a property's total impervious surface. A reduction in fees is offered to those who employ stormwater control measures. The Northeast Ohio Regional Sewer District uses an individual residential property credit. Customers receive a reduction in annual stormwater management fees if they take measures to reduce stormwater runoff from their property. Credits are earned through the installation and continued use, operation, and maintenance of approved stormwater control measures. Such measures include rain gardens, on-site stormwater storage, pervious pavement, and vegetated filter strips—all green infrastructure measures that aid in groundwater recharge. After three years, recertification is required to continue to receive credits. In addition, maintenance guidelines are provided to help ensure the effectiveness and longevity of each control measure. If ownership of the property changes, a new application must be submitted in order to receive the credit.

6. Administer Property Tax Abatements

Municipalities may provide a property tax abatement to incentivize the maintenance of water-efficient landscapes. Through such programs, residents who install water-efficient landscapes are eligible for a yearly property tax abatement program that requires maintenance and uses municipal inspections. The city of Cincinnati operates a Reinvestment Area Residential Tax Abatement Program that offers a tax abatement for improvements to property that applies to new construction and renovation.[43] The abatement requires an annual exterior inspection for all new and existing tax abatements to ensure that the property is well maintained. Another example is the New York City Green Roof Property Tax Abatement Program.[44] This program requires a maintenance plan that includes semi-annual inspection plans for plant replacement, monthly inspections of drains, and maintenance of green roofs for a minimum of four years.

IV. A Municipal Case Study: Portland, Oregon[45]

In 1991, prompted by regulatory mandate, Portland's Bureau of Environmental Services (BES) began a 20-year program to reduce its combined sewer overflow (CSO). Green infrastructure played an important role in the development and implementation of the CSO plan. The city promoted four cornerstone projects at the beginning of the CSO reduction process. One of these was a program that incentivized private landowners to disconnect their downspouts and feed stormwater into yards, rain barrels, and

41. Allen, Tex., Land Dev. Code §7.05.06, *available at* http://library.municode.com/index.aspx?clientId=14105&stateId=43&stateName=Texas.
42. Interview with Christopher Charles, Conservation Program Associate, Austin Water (Oct. 8, 2013).
43. Cincinnati Dep't of Cmty. Dev., *Save Money, Live Well! City of Cincinnati Community Reinvestment Area (CRA) Residential Tax Abatement*, http://www.cincinnati-oh.gov/community-development/housing-assistance/residential-property-tax-abatement/ (last visited June 11, 2014).
44. N.Y.C. Dep't of Bldgs., *New York City Green Roof Property Tax Abatement Program*, http://www.nyc.gov/html/dob/html/sustainability/green_roofs.shtml (last visited June 11, 2014). Note that as of April 2014, the program has expired, but there is the expectation that it will be reinstated.
45. This section has been contributed by Marissa Matsler, Urban Studies Ph.D. Candidate, Portland State University.

rain gardens through discounted stormwater and sewer fees. The cornerstone projects reduce the amount of stormwater entering the combined sewer systems by 1.2 billion gallons annually, providing an estimated savings of $300 million in construction costs that would have needed to be spent controlling the CSO problem solely through traditional, grey infrastructure. In the end, the construction of green streets facilities, and other green infrastructure facilities, allowed engineers to reduce the size of new stormwater pipes (the largest public works project undertaken in Portland's history) by about a third.[46]

The city of Portland also instituted the "% for Green" program that provides funding for green infrastructure projects in critical locations around the city. Development projects that do not trigger the city's stormwater manual instead pay a percentage of their project costs into a green "savings account." That money is then spent by BES on high priority public sites, ensuring that green infrastructure projects will be built in locations that otherwise would not be supported by fees. This is an innovative program that seeks to grow the green network within Portland.[47]

Portland has made a point to integrate green infrastructure into a number of different programs within the city, including the comprehensive citywide Watershed Management Plan. Early on in the planning process, BES brought together a group of citizen stakeholders to advise the stormwater management policymaking process. The Bureau attributes much of its success in bringing green infrastructure to the forefront of the program to this, and other, outreach attempts that allowed a genuine integration of information and knowledge from professionals and citizens within the city.[48]

V. Grassroots Strategy

A. *Citizen Engagement*

Successful green infrastructure strategies often rely on the engagement of local stakeholders who have intimate knowledge of local landscapes or expertise in natural resource protection. These stakeholders and environmental advocates can be instrumental in creating an inventory of natural assets and in identifying priorities for creating an interconnected natural landscape. Under state and local law, such individuals can be commissioned by the local legislative body or chief elected official to advise the municipality. They can be appointed to a formal or informal Environmental Advisory Committee (EAC) and tasked with assessing the natural environment, assessing gaps that need to be filled to create a cohesive green infrastructure, and advising local land use boards regarding the protection and enhancement of that infrastructure as those boards review and condition development projects. Some state legislatures have prescribed the means of engaging local stakeholders in this advisory capacity.

Conservation Advisory Boards Authorized by Statute

Under state law in New York, EACs are known as Conservation Advisory Committees (CACs) in most localities. The relevant statute contains a two-step process for local legislatures to follow. The first is to appoint the CAC and commission it to complete a natural resource inventory. The second is to accept that inventory as the official open space index and to re-designate the CAC as a Conservation Board. As a Conservation Board, the advisory group is to be consulted by local land use boards as they review project approvals and to recommend how proposals can be conditioned to protect the natural resources on the official inventory. Both CACs and Conservation Boards in New York are authorized to perform other duties assigned to them by resolution of the local legislative body as long as they are consistent with their general statutory advisory role regarding the development, management, and protection of local natural resources.

The formation of an EAC provides an opportunity for the legislature to appoint local experts in this subject matter to an official advisory body that can assist, guide, and encourage other local bodies in protecting and preserving open areas and natural resources. An effective EAC identifies and collects needed data regarding the community's natural resources, open areas, and, if instructed to do so, historic and scenic assets. Once accepted by the local legislature, an EAC's open-area inventory can be officially adopted by the legislative body and used to guide land use boards in their functions and the local legislature in building out its green infrastructure.

EACs may also assist the community in preparing or amending the comprehensive plan with respect to green infrastructure. EACs can help prioritize the importance of natural areas and advise their legislatures regarding effective strategies for protecting them, including acquisition, cluster development, overlay zoning, and critical environmental area designation.

B. *The Natural Resource Inventory*

Preparing a natural resource inventory (NRI) is a critical function for an EAC to perform. It can serve as a database to be used in local planning and project review, as well as a basis for long-term regulatory and capital planning within a community. The NRI is primarily used to mitigate impacts of development on natural resources. This makes it a useful tool in advising local land use boards on how to enhance the municipality's green infrastructure by

46. PortlandBES, *Portland CSO Program 1991-2011*, YouTube (Dec. 31, 2012) (produced by Tom Frisch), http://www.youtube.com/watch?v=PCM8PICfsCs.
47. City of Portland, Or., % for Green Program Update (2013), *available at* http://www.portlandoregon.gov/bes/article/465399.
48. Water Environment Research Foundation, *Portland, Or.: Building A Nationally Recognized Program Through Innovation & Research*, http://www.werf.org/liveablecommunities/studies_port_or.htm (last visited June 11, 2014).

designating open space set-aside areas, clustering development away from green corridors, and keeping the broad objectives of open space protection in mind as particular decisions are made.

An NRI can be prepared in a variety of ways. The most cost-effective is to engage local volunteers in identifying and describing all remaining open space in the community. Community surveys, workshops, field trips, and data searches can be used to develop a rough map of natural areas for further review. Much of this data is available through regional, state, and federal agencies. There may be agencies or institutions available that will provide Geographical Information System services to the community and create a variety of maps that identify various environmental functions, from stormwater runoff to area-sensitive mammal migration areas. Professionals can then be engaged to fill in gaps in the data and suggest which areas are the most critical for each important environmental function. A process for periodically updating the inventory should be established to reflect any changes in the environmental elements of the area and to assess progress in developing comprehensive green infrastructure.

The process of creating and updating the NRI gives the EAC an opportunity to educate lawmakers and citizens about a variety of pressing environmental issues. This function is strengthened if the EAS is required to prepare and present an annual report of progress and recommendations for effectively meeting environmental concerns in the future.

C. Green Infrastructure Planning in a Dense Urban Community

As part of its long-term urban revitalization plan, the city of Newburgh, New York, consolidated its environmental planning and streamlined its project approval process by combining its Waterfront Advisory Committee and Shade Tree Commission into a Conservation Advisory Council (CAC) and charging it with being an advocate for all of Newburgh's important natural resources. Because Newburgh is a heavily developed city, its existing tree canopy and other natural assets are limited. The city council, in creating its CAC, authorized it to "advise various City agencies on greening the City's infrastructure . . . and . . . study problems and identify the needs of the City of Newburgh in connection with stormwater management, green infrastructure, sustainability and watershed protection."[49]

The Newburgh CAC is taking the novel approach of turning some of the city's gray infrastructure into green infrastructure. It includes components of its gray infrastructure in its "natural resource" inventory. Existing streets, medians, sidewalks, hard-packed underutilized and vacant lots, surface parking, and other impervious areas will be analyzed for their potential contributions to green infrastructure functions, including stormwater management.

In undertaking this experiment, the city is addressing a general problem in developed urban areas in the mid-Hudson River watershed, where overdevelopment and encroachments into floodplains and along water bodies has caused significant stream bank erosion, flooding, and sedimentation threatening the watershed's ecological functions. The damage wrought by this situation is likely to be exacerbated over the coming decades as climate change causes storms of greater intensity, generating larger volumes of rain over shorter periods of time. At the same time, existing stormwater conveyance systems are not up to the task of alleviating even current storm events. Stormwater and untreated sanitary sewage water flows directly into the Hudson River and into tributaries, like the Quassaick Creek in Newburgh, significantly degrading water quality. For neighboring municipalities, such as Highland and Poughkeepsie, which draw their drinking water from the Hudson River, these circumstances have serious human health consequences.

Newburgh's efforts are supported by regional stakeholders who understand that municipalities in the Hudson River watershed can and must reduce the amount of stormwater entering the river. Green infrastructure practices are a tool to reduce and mitigate such conditions. The Newburgh approach will demonstrate how CACs can play a fundamental role in ensuring that development and redevelopment projects integrate green infrastructure techniques to both prevent further degradation of water quality and to remedy a history of poor land use planning.

The city of Newburgh's CAC will play a critical role in advising the city council, planning board, and zoning board of appeals as those bodies make various land use decisions that impact stormwater generation. The CAC is uniquely positioned within the New York State land use system to advise on the development, management, and protection of local natural resources. Its efforts to educate and influence the other entities within the city to enhance surface water quality by reducing stormwater generation will be essential to meeting the water quality goals for both the Hudson River estuary and the Quassaick Creek watershed.

VI. Further Resources

EPA has a green infrastructure website dedicated to the agreement signed between four national groups whose aim is to promote green infrastructure. The agreement promotes the reduction of stormwater pollution, improvement of air quality, as well as mitigation of sewer overflows. The website contains links to other websites that provide additional information about green roofs, rain gardens, and other topics relating to the promotion of green infrastructure: http://cfpub.epa.gov/npdes/greeninfrastructure/technology.cfm.

The latest report from EPA adds to a large body of information that NRDC has provided on the environmental and community benefits of green infrastructure, available at: http://www.nrdc.org/water/pollution/rooftopsii/.

49. Newburgh, N.Y., Local Law No. 2 of 2013.