Managing Stormwater Runoff:

A Green Infrastructure Approach

by Lynn Richards

Increasingly, communities are looking for ways to maximize the opportunities and benefits associated with growth while minimizing and managing its negative environmental impacts, especially of stormwater runoff.

In many places, however, stormwater management is still primarily addressed at the site development level using "end-of-pipe" practices, such as detention ponds, or conveyance systems, such as sewer systems or culverts. These practices, however, fail to address cumulative water quality impacts from the excessive amounts of impervious cover associated with land development.

While conventional stormwater approaches work to drain each site, the continued spread of development in many areas has resulted in too much water, carrying too much pollution, running into drains and receiving water bodies. This can reduce water quality, especially at drain outlets, and lead to a dramatic drop in the refill rate of aquifers and streams.[1]

Bioswales

THE CITY OF NORTH CHARLESTON

Bioswales are linear, vegetated depressions where runoff is slowed and managed through infiltration and uptake by native plants, including grasses, shrubs, and trees. Bioswales typically use amended soils and bioretention media underground so that these landscape features function beyond simple conveyance by infiltrating, retaining, and treating stormwater runoff. Swales can be used to reduce the impervious surfaces in parking lots or along the edge of streets, sidewalks, and residential or commercial lots.

Bioswales are an integral part of Oak Terrace Preserve, a 55-acre sustainable redevelopment project in North Charleston, South Carolina. When completed, it will include some 300 single-family homes and 74 town homes. The project is being implemented through a public-private partnership with the City of North Charleston as owner and the Noisette Company, LLC providing turnkey development management. The project employs an innovative stormwater management system, an extensive tree preservation program, and mandatory sustainable home building certification.

Photos: completed bioswale and one under construction in North Charleston.

Today, the practice of stormwater management is evolving beyond engineered approaches applied at the site level to a multi-scale approach that looks at managing stormwater through more natural techniques. These "green infrastructure" approaches can be better for the environment *and* cost-effective. Green infrastructure strategies reduce and manage stormwater through *infiltration* (water soaking into the ground), *capture and reuse* (water being stored in a rain barrel or cistern for later use in watering plants or flushing toilets), and *evapotranspiration* (water being used by trees and plants).

A comprehensive green infrastructure approach to stormwater management seeks to:

- *Preserve* and enhance natural features, such as undisturbed forests, meadows, wetlands, regional and neighborhood greenways, trails, and other natural areas.
- *Recycle* land by directing new development to already degraded land, such as parking lots, vacant buildings, and abandoned malls.
- *Reduce* land consumption and development footprint by using land more efficiently.
- *Reuse* stormwater by directing it back into the ground through infiltration, evapotranspiration, or through capture and reuse techniques.

While traditional approaches to stormwater management have focused at site-level techniques, green infrastructure takes into account the wide range of

1 One study has reported that the 20 regions in the country that developed the most land over the period 1982 to 1997 now lose between 300 and 690 billion gallons of water annually that would otherwise have filtered through the earth and been captured as groundwater. "Paving Our Way to Water Shortages: How Sprawl Aggravates the Effects of Drought" (American Rivers, NRDC, and Smart Growth America, 2002). Available at: www.smartgrowthamerica.org/DroughtSprawlReport09.pdf .

U.S. EPA

In addition to managing runoff from the parking lot, this bioswale provides an attractive landscaping feature appreciated by pedestrians.

development-related issues at the regional, neighborhood, *and* site-level that affect impervious cover and stormwater runoff.

Where We Choose to Grow

Decisions about where and how our towns, cities, and regions grow are the first, and perhaps most important, development decisions related to water quality. Using land more efficiently reduces and better manages stormwater runoff by reducing total impervious area. The single most effective strategy for efficient land use is redeveloping already degraded sites such as abandoned shopping centers or underutilized parking lots rather than paving greenfield sites.

By redeveloping an underused site that is already paved, the net increase in runoff from development would likely be zero – or it might even decrease, depending on the on-site infiltration practices used. Indeed, if improved on-site infiltration practices are incorporated into redevelopment projects, runoff levels can even decrease.

By directing and concentrating new development in areas specifically targeted for growth, communities can reduce development pressure on undeveloped parcels and protect sensitive natural lands and recharge areas important for maintaining water quality. In addition, if denser development is allowed, less land may need to be converted overall, resulting in less impervious cover than would otherwise be created.

In conjunction with the stormwater benefits just described, a green infrastructure approach supports an interconnected network of open spaces and natural areas (such as forested areas, greenways, floodplains, and wetlands). This will improve water quality by increasing infiltration and groundwater recharge, while also providing neighborhoods with access to open space for recreational purposes.

In Our Neighborhoods

Neighborhood-level green infrastructure approaches can include a range of planning and design strategies that seek to integrate the natural and the built environment. These include:

- Incorporating natural landscape features and functions into a neighborhood's street and road network, buildings, and other developed areas;
- Narrowing streets and roads;
- Reducing parking requirements or establishing parking minimums;
- Connecting open space and recreation areas; and
- Co-locating a range of land uses (such as retail, residential, civic, and schools) to minimize impervious cover.

These approaches can dramatically reduce pollution, decrease stormwater runoff volume and temperature, and protect aquatic habitat. At the same time, they can result in more interesting places to walk, ride, drive, or visit.

Just how much difference in stormwater runoff can a more compact development pattern make? That was the question examined during an intensive charrette conducted in the Town of Mount Pleasant, South Carolina, located in the Charleston metro area. Participants at the

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The High Point Redevelopment

The High Point Redevelopment in Seattle, Washington demonstrates the superior environmental performance that can come from integrating stormwater design solutions at several different scales. High Point is a redevelopment project that includes 1,600 mixed-income housing units (that replaced 716 subsidized units) on 120 acres in a West Seattle neighborhood. The site's previous infrastructure directed polluted street, sidewalk, parking area, and building runoff through a series of underground pipes into a creek, damaging the ecosystem and reducing local salmon populations.

- Viewed at a regional scale, High Point redeveloped an underused site rather than creating new impervious cover across a previously undisturbed greenfield site.
- The development also increased the site's density, allowing the space to accommodate more people without consuming additional land.
- The project's site design reduced stormwater runoff. In place of curbs and gutters, swales and check dams were constructed. These wide, landscaped swales slow, filter, and direct runoff into a detention pond that doubles as a park area.
- Parking areas in the project were built using pervious gravel cover, and sidewalks with porous pavement.

Together, these features create a comprehensive system to manage and reduce stormwater runoff from all 120 acres of the site.

BILL HOLMSTROM, AICP

High Point received a National Award for Smart Growth Achievement in 2007 from the EPA. For more about the development, go to: www.terrain.org/articles/22/wells.htm charrette included town and county officials and planners, private sector engineers, and researchers from the J.W. Jones Ecological Research Center, among others. Their task was to assess the water quality impacts of two very different development alternatives for a 583-acre site.

Complex water quality models were used to examine the potential water quality related impacts of two site designs. The conventional development design included large lots, wide roads, and separation of land uses. The compact, mixed-use design incorporated higher densities, mixed uses, and narrower roads. In each scenario, the overall number of homes and the square feet of commercial and retail space were held constant.

The results found that the conventional design consumed eight times more open space and generated 43 percent more runoff and three to four times more sediment, nitrogen, and phosphorous than the alternative design.[2]

Besides looking at broader development patterns as described so far, a green infrastructure approach also includes site-specific practices aimed at maintaining natural hydrologic functions by absorbing and infiltrating precipitation where it falls. This allows for local infiltration, groundwater recharge, and filtering of pollutants. It also decreases the amount of stormwater that enters the sewer system, thereby reducing the risk of overflows that impact streams and other outfalls through scouring and the addition of nutrients and pollutants.

Techniques such as the use of rain gardens, green streets, bio-swales, and infiltration naturally treat runoff on-site, while helping reduce the amount of impervious cover. See the boxed material in this article for more on these techniques.

RENDERING BY KEVIN ROBERT PERRY, NEVUE NGAN ASSOCIATES

Creating a green street: the rendering shows how a major thoroughfare could be retrofitted to create stormwater management benefits, and a pedestrian buffer.

Engaging on Stormwater Management

What role can planning commissions play in implementing a green infrastructure approach to stormwater management? One important way is by closely examining the community's zoning code, subdivision regulations, and other land development ordinances for provisions that can lead to unnecessary impervious cover. For example:

• *Intensity of Use.* Zoning ordinances typically specify the type of land uses and intensity of those uses that are allowed on any given parcel. A zoning ordinance can dictate single-use, low-density zoning, which spreads development and can create considerable excess impervious surface, or it can facilitate more compact, higher density development, which uses land more efficiently.

• *Incentives.* What policies or incentives can a local government put in place to foster redevelopment? Some municipalities have successfully used density bonuses, infrastructure upgrades, and streamlined permitting as a way to direct redevelopment in specific areas.

• *Street Standards or Road Design Guidelines* dictate the width of roads, turning radii, intersection design, and

Rain Gardens

Rain gardens are small vegetated areas used to temporarily detain, filter, and evapotranspirate stormwater from rooftops, driveways, parking lots, or other impervious areas. Rain gardens are planted with water-tolerant, native plants and can be implemented in a range of settings, from residential yards to commercial parking lots. Rain gardens are considered one of the most low-cost green infrastructure practices because of they are relatively simple to design, construct and maintain.

The City of Burnsville, Minnesota installed an experimental rain garden system and conducted a study comparing two residential areas, one with rain gardens and one without. The watershed retrofitted with rain gardens saw a 90 percent reduction in runoff volumes.

U.S. EPA

As seen in the photo, green infrastructure can also create community art. In Portland, Oregon, a local grocery store directs runoff from its roof to a rain garden via a metal sculpture.

2 More details on the Mount Pleasant, S.C., charrette, led by Dover, Kohl, and Partners, can be found online. Google search: Belle Hall charrette.

Green Streets

Green Streets are those public rights of way that have been built or retrofitted to include landscape areas that increase stormwater infiltration, reduce runoff, and use biofiltration to remove pollutants and slow the rate of runoff. Green streets also replace traditionally impervious surfaces like roadways and sidewalks with pervious materials such as pavers and pervious concrete or asphalt. Portland, Oregon, has set up an excellent green streets program. To learn about it, go to: www.portlandonline.com/BES/index.cfm?c=44407

PHOTO: U.S. EPA; GRAPHIC: CITY OF PORTLAND ENVIRONMENTAL SERVICES

other criteria. Are street and road widths sized appropriately for neighborhood use? Overly wide streets will not only create excess impervious cover, but will also encourage faster vehicle speeds. Can streets accommodate bike lanes? Sidewalks? Reducing vehicle miles traveled will reduce the amount of hydrocarbons washed into streams and reduce air deposition of some water pollutants.

• *Parking Requirements* in many communities set the minimum, not the maximum, number of parking spaces required for retail and office parking and residential housing. Setting minimums can lead to parking lots designed for peak demand periods, creating acres of unused pavement during the rest of the year.

• *Minimum Setback Requirements* can spread development out by leading to longer driveways and larger lots. Establishing maximum setback lines for both residential and retail development will bring buildings closer to the street, reducing impervious cover associated with long driveways, walkways, and parking lots.

• *Site Coverage & Height Limits*, when set too low, can disperse development and push each parcel further from its neighbor. This leads to more streets and roads than might otherwise be needed, increasing total impervious cover. Similarly, limiting height can spread development out if square footage cannot be met by vertical density.

• *Landscaping/Tree Preservation* provisions can help reduce runoff by limiting the amount of impervious surface. Are large trees preserved during construction? If not, will they be replaced? Are all landscaping elements also designed to manage stormwater? For example, sidewalk planter boxes can manage stormwater from the road, sidewalk, or rooftop depending on where they are placed. As most new developments have some type of landscaping, it should be designed to serve multiple functions.

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Some Environmental Benefits of Green Infrastructure

• **Reduced and Delayed Stormwater Runoff Volumes.** Green infrastructure reduces stormwater runoff volumes and peak flows by utilizing the natural retention and absorption capabilities of vegetation and soils.

• **Enhanced Groundwater Recharge.** Green infrastructure increases the amount of water that is filtered through the earth and captured as groundwater.

• **Heat Impacts Reduced.** As paved surfaces gather solar radiation, the heat is transferred to runoff, which can significantly increase the temperature of a creek or pond and disrupt aquatic ecosystems. Green infrastructure can reduce these heat impacts.

• **Reduced Sewer Overflow Events.** Green infrastructure limits the frequency of sewer overflow events by reducing runoff volumes and by delaying stormwater discharges.

• **Improved Air Quality.** Trees and other forms of vegetation that manage stormwater runoff can also help to improve air quality, especially in urban areas.

• **Wildlife Habitat and Recreational Space.** Greenways, parks, urban forests, wetlands, and vegetated swales are all forms of green infrastructure that provide increased access to recreational space and wildlife habitat.

W. SENVILLE

This residential development in Lenexa, Kansas makes use of native habitat to manage stormwater quality – part of the city's "Rain to Recreation" stormwater management program. For more on this program: www.raintorecreation.org/

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Better aligning stormwater goals with other community goals can also help stretch local tax dollars. Think of it this way: your public works department could spend $1 million dollars installing a big tank or pipe underground to hold stormwater until it can be released. That money will serve just one community objective: managing stormwater. However, the same $1 million could be spent retrofitting streets to install green features.[3] These features could handle the same amount, or likely more, stormwater, while also creating more attractive – and safer – pedestrian environments.

Summing Up:

A green infrastructure approach to stormwater management can provide benefits for all stakeholders: the municipality has more effective and efficient stormwater management, residents have more attractive neighborhoods, and developers have more choices on how to manage runoff. Moreover, it can change how we think – and plan – for stormwater. With green infrastructure, stormwater is viewed not as a headache, but as an impetus for better, more environmentally-oriented communities. ◆

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Abby Hall, a Policy Analyst with the EPA, also contributed to this article.

3 The city of Portland, Oregon, just completed a study, *From Grey to Green*, which found the city could either spend $83 million dollars installing a wide range of green infrastructure projects throughout the city, or spend $142 million on larger pipes to manage the same amount of stormwater as the green, more natural approaches.

Infiltration

KWORTH30; FLICKR; HTTP://CREATIVECOMMONS.ORG/LICENSES/BY/2.0/DEED.EN

Infiltration refers to any green infrastructure practice that manages stormwater runoff from nearby "hardscapes" while also serving to reduce overall site imperviousness. For example, downspouts are often disconnected from the storm sewer system and directed into infiltration areas to manage roof runoff on site. Infiltration practices help to reduce flooding, replenish groundwater resources, and buffer against droughts. They also add community amenities that can be both functional and visually attractive.

Making Use of Site Plan Review

by Thomas J. DiPietro, Jr.

Site plan review often can provide the best opportunity to makes changes to a project that will help protect water quality. Even if your zoning regulations are good, there are things to look for during site plan review that can make a difference. Here are a few examples:

• *Snow Storage.* During spring snowmelt, everyone has seen the blackened piles of melting snow that contain trash, sediment, and other pollutants. These pollutants will end up in lakes and streams if attention is not paid to snow storage locations. Plowed snow should not be stored in stream buffers or stormwater management facilities.

Instead, it should be stored either in an area that will allow the melted snow to flow into a stormwater treatment facility, or in a grassed area that will allow the snowmelt to infiltrate.

• Location of Dumpsters. Keep dumpsters away from streams and storm drains. If dumpsters are left uncovered, rain can collect in them, come into contact with trash, and leak out of holes in the bottom of the container. Dumpsters should always be covered to prevent rainwater from contacting the trash inside.

• *Stream Buffer.* If your town has a stream buffer ordinance, does that mean your stream's water quality is protected? Not necessarily. Landscaping requirements within buffers are often needed to ensure that the buffer provides its intended functions. Existing vegetation should not be cleared during construction and the area should not be converted into lawn. In addition, items can end up within stream buffers that aren't shown on the site plan. Examples include walking paths, picnic tables, compost bins, and dumpsters. It is a good idea to specify that stream buffers are to remain in their natural condition and that modification and clearing is prohibited.

• *Composting.* Compost bins have a habit of ending up near streams, especially in residential areas. Due to their odor and tendency to attract animals, people often place compost piles or bins away from their homes, towards the rear of a property. In some cases, this will result in the compost pile being within the flood plain and only a few yards from the stream. Obviously, this practice should be avoided.

• *Vehicle washing.* In reviewing commercial operations, it is always good to ask where vehicles will be washed and where trucks will be cleaned out. Vehicle washing should never be conducted in the stream buffer or near storm drains.

• *Outdoor Materials Storage.* What kind of materials will be used at the facility and where will they be stored? If materials are not stored under cover, will they pose a contamination risk to stormwater?

Keep in mind the opportunities you have during site plan review to avoid future water quality and runoff problems.

Tom DiPietro is the Stormwater Superintendent for the South Burlington Stormwater Utility. DiPietro has also prepared a quite interesting short article about the formation of his city's stormwater utility district. It's available on our PlannersWeb site: www.plannersweb.com; look for the link to the Stormwater Resources page.

Taking Low Impact Development from Research to Regulations

by John S. Rozum, AICP, and David W. Dickson

As anyone involved in land use knows, a new subdivision rarely garners much emotion, particularly of the positive variety. So it was surprising when while on a tour of the new Glenbrook Green subdivision in 2006 Connecticut's chief environmental official exclaimed, "this subdivision is wicked cool!" The 29-lot Waterford, Connecticut subdivision, also known as the Jordan Cove project, is one of the country's premier applied research sites for a variety of stormwater management and site design approaches often referred to as Low Impact Development (LID). However, making "wicked cool" subdivisions like Jordan Cove commonplace will require a multi-pronged, yet doable, revision of local land use regulations.

A "New" Approach to Stormwater

We know from countless studies that current stormwater management practices are not doing a great job of protecting water quality. Increasingly, communities are recognizing the need to manage stormwater through an integrative, comprehensive approach to land use planning and site design. LID refers to a variety of land use practices, including rain gardens, vegetated swales, pervious pavements, green roofs, and others, that seek to maintain or even improve the pre-development hydrology (i.e., quality and quantity of runoff) of a particular development site. LID practices have been highly touted throughout the country in recent years as one large piece of this puzzle.

Research findings suggest it is worth the hype. The Jordan Cove project (see next page), funded by the EPA through the state's Department of Environmental Protection (DEP), represented a ten-year research effort to gauge the effectiveness of many of these onsite stormwater management techniques in "real world" conditions. The project found that when used in combination these practices can indeed replicate or improve the pre-development hydrology of an area.

> INCREASINGLY, COMMUNITIES ARE RECOGNIZING THE NEED TO MANAGE STORMWATER THROUGH AN INTEGRATIVE, COMPREHENSIVE APPROACH TO LAND USE PLANNING AND SITE DESIGN.

Despite research findings from Jordan Cove and other projects, LID practices are still too often not encouraged. Indeed, many municipalities' regulations actually preclude LID approaches. This is not altogether surprising. Land use and development is a high risk game for both the developers and the communities that regulate them. Mistakes can be costly and, in dire cases, dangerous for the public. In this atmosphere, anything new is viewed, quite rightly, with a healthy dose of skepticism and caution.

The Nonpoint Education for Municipal Officials (NEMO) program and the National NEMO Network have been working with communities across the country to encourage them to wade into these new waters and find ways to bring LID to their community. NEMO was created in the early 1990s at the University of Connecticut to provide local planning commissioners and others with information, education, and assistance on the latest in stormwater and land use research. The success of the program in Connecticut led to the creation of the National NEMO Network, now a coalition of 33 affiliate education programs operating in 31 states.

The primary focus of NEMO educational programs is on the connection between land use and water resources. This, not surprisingly, has led to a focus on better land use planning and site design. NEMO has worked with dozens of communities to ensure their land use plans and regulations allow for LID techniques.

In the following paragraphs are examples of how three very different communities in Connecticut that NEMO has worked with have incorporated the latest in stormwater management research and practices into their land use regulations. As you will see, there isn't a single approach that must be used. Rather, each community needs to assess its abilities and conditions to tailor these practices to its own environment.

Case Studies in Low Impact Development

1. Flexibility in Waterford

Waterford, Connecticut, home of the Jordan Cove Project, is an urban coastal town bisected by two interstate highways. The town, which serves as a regional commercial center, has experienced growing development pressures. The amount of developed land has increased by over 20 percent during the past two decades.

In 1992, NEMO held its very first workshop in Waterford. NEMO staff met with town officials and others to explore the connection between land use and water quality, and the impact better land

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The Jordan Cove Project

The Jordan Cove Project, located in Waterford, Connecticut, was designed to determine water quantity and quality benefits of using pollution prevention best management practices (BMPs) in a residential subdivision. The ten-year monitoring project, begun in 1995, used a "paired watershed" design that compared a pre-existing residential watershed to the new subdivision's watershed. The subdivision consisted of two parts, one built using conventional development and subdivision design practices, the other using a panoply of low impact design techniques.

Above: This aerial view of the Jordan Cove development highlights a variety of low impact development techniques used and evaluated on the site. The other photos show: top right, use of swales; below left, narrow street using porous pavers; and below right, a residential rain garden.

The stormwater runoff volume per unit area from the subdivision after construction was 42 percent less than what ran off the undeveloped site!

For a description of the techniques used at Jordan Cove, visit the project website at http://jordancove.uconn.edu.

Low Impact Development…

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use planning and regulations could have. "NEMO challenged the way we thought about development," explains Town Planner Tom Wagner. "We tended to think of development on a site-by-site basis. NEMO helped us to think more comprehensively on the watershed level."

Soon after the NEMO workshop, the U.S. EPA and Connecticut DEP began looking for a location to host an applied research study of low-impact development practices – what eventually came to be the Jordan Cove project. The team found a site within Waterford and approached the town and the developer to assess interest. With assistance from NEMO, Wagner and the Waterford Planning Commission saw the potential value of the project and helped make it happen.

Still, Connecticut is called "the land of steady habits" for good reason, and there was some hesitation in town at being first to try out a range of LID stormwater practices. The existing subdivision and zoning regulations did not allow several of the LID features that were planned for the site. Instead of changing its regulations to allow what was then unproven technology, the planning and zoning commission used its authority under Connecticut law to grant waivers to allow the Jordan Cove subdivision to proceed.[1]

"The unique nature of this subdivision required significant flexibility and buy in by the commission in order to take the leap," observes Wagner. "The scientific and educational components of the project were, in part, a justification for going beyond the letter, but not the intent, of our current regulations." The planning and zoning commission was able to articulate to the public why Jordan Cove was an important project, and how it met the goals set forth in the town's planning documents.

Many of the key features of the LID portion of the site required the commis-

1 Connecticut General Statutes, Chpt. 126, §8-26.

sion to grant waivers from its subdivision regulations – allowing for reduced road width; the use of porous pavers; elimination of curbs and gutters; the installation of a cul-de-sac with a central bioretention cell; and several other features.

Given the success of Jordan Cove and other water quality projects in town, Waterford is working with NEMO to revise its land use regulations to require the use of LID practices for new development.

2. Addressing Key Issues in East Haddam

Not all towns in Connecticut are as well staffed as Waterford. East Haddam is a rural town with one full-time land use administrator and a half-time zoning/wetlands compliance officer. Because of the work load on both the staff and the land use commissions, the town had not been able to update their comprehensive plan in over ten years and had a long list of needed changes to their regulations.

It was in this climate that the town, in 2003, asked to work with the Connecticut NEMO program. Over a three month period, the NEMO team provided five educational workshops, with topics ranging from basic roles and responsibility of commissions to alternative design standards for stormwater management. A task force of town staff and commission members was formed to draft changes to town regulations.

East Haddam's immediate concern was a perceived inadequacy of its subdivision and zoning regulations. The town planning and zoning commission first addressed the road standards and stormwater management sections of the regulations. Road width requirements for low-volume, local roads were reduced from 32 to 18 feet, and the use of curb-and-gutter drainage was discouraged. In addition, all proposed subdivisions in town would require a stormwater management plan encouraging the use of curbless road design, bioretention, reduced impervious cover, or other features preserving the pre-development hydrology of the site.

East Haddam also implemented new parking regulations allowing for innovative stormwater management practices such as on-site bioretention and landscaping that would both reduce stormwater runoff and provide aesthetic benefits. Parking needs were also lessened through strategies such as shared parking in commercial areas (allowing businesses to share common parking areas rather than install new ones).

3. A Comprehensive Approach in Tolland

Tolland is a town in the northeastern part of Connecticut that has undergone significant change over the past twenty years. Originally a farming community, the completion of an interstate highway connecting Hartford and Boston helped boost residential development in town by a whopping 35 percent from 1985 to 2002. In part because of this development pressure, the town faced growing stormwater management issues.

Director of Planning & Community Development Linda Farmer brought in NEMO staff to present a workshop on water quality impacts and strategies to protect water resources. This led the planning commission to see a need to more closely scrutinize the town's existing land use regulations. "I had a planning commission chair who just got it," notes Farmer. "She understood the problem and the steps that needed to be taken to address these issues. She also wasn't interested in taking a slipshod approach, but wanted to address LID throughout the regulations."

A consultant engineer familiar with LID practices was retained to review the town's subdivision and zoning regulations. Ultimately, this led to several significant changes, including more flexible road width requirements, preservation of open space, and utilization of stormwater management techniques that mimic the pre-development runoff and infiltration relationship. But perhaps the most beneficial step the town took was in adopting a LID design manual for town development applicants. The manual reduces much of the ambiguity that often accompanies a new set of stormwater management rules by providing developers with detailed design standards for integrating LID approaches and principles into their projects.

Summing Up:

While the "perfect" regulation or development code is a laudable goal, small steps can also result in substantial progress toward protecting community resources. That has been our experience in working with municipalities to implement changes to their local land use regulations to better manage stormwater runoff. ◆

John Rozum, AICP, is the director of the Connecticut NEMO program. He regularly delivers workshops and training to Connecticut's 169 towns, assisting them to implement land use practices that protect water resources. Rozum holds a M.S. in Land Use Planning and in Ecology, both from the University of Arizona. He has also served on his town's planning and zoning commission and on the board of directors of the East Haddam Land Trust.

Dave Dickson is the coordinator of the National NEMO Network, a coalition of 32 programs in 30 states educating local officials about natural resource protection. Dickson has both a J.D. and a Masters of Public Administration from the University of Colorado.

NEMO Resources:

The Connecticut NEMO program's website (http://nemo.uconn.edu) has more information about low-impact development practices and research, including a database of LID-friendly regulations and an inventory of LID installations. From there you can also link to the National NEMO Network website and find out if your state has its very own NEMO program.

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