PORTLAND, OREGON

A CASE STUDY OF HOW GREEN INFRASTRUCTURE IS HELPING MANAGE URBAN STORMWATER CHALLENGES

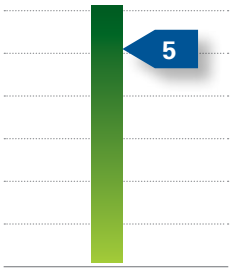
TYPES OF GREEN INFRASTRUCTURE USED: Green roofs, rain barrels/cisterns, rain gardens, permeable pavement, infiltration trenches or vaults, vegetated swales, street trees, planter boxes, green streets

Portland has made a very strong community commitment to green infrastructure. Through a combination of requirements and voluntary measures the city has initiated, green infrastructure is a central component of the community's program for reducing stormwater runoff and its efforts to address overflows from the parts of the city covered by the combined sewer system. In particular, a runoff retention standard with a priority for green infrastructure implementation is in place and applies to new and redevelopment projects involving as little as 500 square feet of impervious area. Portland also has a requirement to develop a retrofit plan for existing impervious areas, and has programs designed to replace city-owned impervious areas along streets and on municipal building roofs. Its 2011 Public Facilities Plan specifies particular intersections for green infrastructure installation—more than 2,200 facilities for green infrastructure are targeted.

The city has an impressive array of incentives for private parties to implement green infrastructure, including its "treebate" program, development area bonuses and grant programs for ecoroofs, and the ability to reduce applicable stormwater fees by implementing green infrastructure practices. The city is working in a number of ways to facilitate green infrastructure. For instance, the city reviews local codes to identify and work to remove barriers to green infrastructure, conducts training programs for a variety of stakeholders whenever it updates its stormwater manual, and sponsors green-roof workshops to educate those working in the local markeplace: designers, suppliers, and contractors. Finally, there are sewer and stormwater fees paid by ratepayers and developers that help supply funding to keep these programs running.

A key to the success of Portland's program has been its willingness to experiment with green infrastructure initiatives, adapt its programs based on implementation experience, and explore solutions that are tailored to the needs of particular watersheds in the city.

PORTLAND, OREGON



Total Criteria Score
Out of a possible 6

EMERALD CITY CRITERIA*

- ☐ Long-term Green Infrastructure (GI) Plan?
- ☑ Existing requirement to use GI to reduce some portion of the existing impervious surfaces?
- ☑ Incentives for private-party actions?
- ☑ Retention Standard?
- ☑ Guidance or other affirmative assistance to accomplish GI within City?
- ☑ Dedicated funding source for GI?

BACKGROUND

For years, Portland, Oregon, has been a leader in green infrastructure, actively promoting innovative stormwater management through various educational, funding, and incentive programs. The city promotes a wide range of green infrastructure technologies, including green roofs (or "ecoroofs"), permeable pavements, infiltration planters, rain gardens, street trees, landscaping requirements, and sustainable street design ("green streets"). One reason the city has remained at the leading edge of the green infrastructure movement is its focus on monitoring the effectiveness of decentralized stormwater management technologies. This has enabled city departments to further refine technologies

The City of Portland is taking a holistic approach toward improving the health of the local watershed with the Brooklyn Creek Basin Program. The program introduces the first prototype for "green" main streets in the country, manages more than 1 million gallons of stormwater runoff, and creates 126 jobs during construction.

and give department employees the confidence to evaluate the effectiveness and promote the use of stormwater designs before they are put into place.

As with many cities, part of Portland's motivation to achieve more successful stormwater strategies comes from a history of pollution and a desire to repair local ecosystems. One of Portland's primary ecological concerns is the Willamette River, which has been subjected to considerable industrial and urban pollution. A significant portion of this pollution has come from overflows of the city's combined sewer system. In 2002 Portland experienced 50 overflow events and discharged 2.8 billion gallons of combined overflow into local waterways.[1] In addition, a significant portion of Portland—roughly 22,000 acres—is served by a separate municipal storm sewer system (MS4), which discharges to area waterways.[2]

To alleviate its combined sewer overflow (CSO) problem, Portland has pursued a dual approach: improving upon its public gray infrastructure to add storage capacity to the overloaded sewer system, and pursuing lot- level green infrastructure strategies to manage stormwater. The Big Pipe project, Portland's primary combined sewage control solution, is set to come online in late 2011, slightly ahead of schedule and within its $1.4 billion budget. Already, a combination of infrastructure improvements and private-property stormwater management initiatives has virtually eliminated CSOs to the Columbia Slough, which discharges into the Willamette River, and has eliminated or controlled eight Willamette River CSO outfalls. Upon completion, the number of CSO events is expected to shrink to an average of four every winter and one every third summer.[3] The project is being paid for by Portland residents via sanitary and stormwater utility fees.[4]

Portland's green infrastructure techniques are designed to address the region's rainfall patterns, which are characterized by small, frequent storms. These storms produce the type of runoff events that green infrastructure technologies—such as vegetative infiltration and ecoroofs—are most successful at mitigating. More than half of Portland's land area is impervious, with streets making up 25 percent of impervious surfaces and rooftops representing 40 percent. These surfaces create an opportunity and a need for green infrastructure development.

Accordingly, Portland's stormwater manual requires that new development and redevelopment projects with more than 500 square feet of impervious surface comply with pollution-reduction and flow-control standards, and requires the use of green infrastructure before other measures can be considered.[5] The city launched a Grey to Green Initiative in 2008 to encourage greater investment in green infrastructure and complement the city's conventional pipe investment. In 2008, the city budgeted $50 million in stormwater management fees to invest in green infrastructure over five years; this is expected to add 43 acres of ecoroofs (a term coined to illustrate that, even in the dry season when very little is green, these roofs still perform well), build 920 "green street" components, plant over 80,000 trees in yards and along streets, and buy 419 acres of "high priority natural areas.[6]

Portland encourages sustainable stormwater management through a series of policy initiatives. Its Green Building Policy, for example, requires green building principles to be

incorporated into all newly constructed city facilities and city-funded projects, and requires that all new city-owned buildings have at least 70 percent of their rooftop space covered by ecoroofs.[7] In 2007 the Portland City Council approved a green street resolution, report, and policy to promote and incorporate the use of green street facilities in public and private development.[8] And in 2009, the City Council and the Multnomah County Board approved a Climate Action Plan that calls for a 40 percent reduction in carbon emissions by 2030 and an 80 percent reduction by 2050. The plan, which identifies products and services related to green infrastructure as one of its guiding visions, calls for the city to implement, by 2012, an outreach campaign to educate residents about the benefits of trees and green infrastructure. Also by 2012, the city must evaluate both green and gray alternatives for public infrastructure projects. In addition, the Climate Action Plan calls for the city to increase its tree canopy from 26 percent to 33 percent by 2030.[9]

STORMWATER RETENTION AND GREEN INFRASTRUCTURE REQUIREMENTS

As noted earlier, a portion of Portland is served by a separate sewer system, which is covered by a discharge permit under the Clean Water Act. The Oregon Department of Environmental Quality issued a new permit for the system in January 2011; it contains important requirements that foster green infrastructure in the city.

Beginning in 2014, the stormwater system is required to have a post-construction program ensuring, among other things, that new and redevelopment projects with 500 square feet or more of impervious area "[i]ncorporate site-specific management practices that target natural surface or predevelopment hydrologic functions as much as practicable."[10] Along those lines, projects are supposed to prioritize green infrastructure. In addition, the permit contains a performance-based site retention standard: projects must be designed to "[c]apture and treat 80 percent of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity." Consistent with these requirements, the permit holder must also review existing barriers to minimize runoff and impervious area, with specific attention to green infrastructure, and must also have an enforceable stormwater management manual that provides guidance on implementing the permit mandates.

Portland's permit also requires the MS4 to create a "stormwater quality retrofit strategy" to achieve water quality goals via retrofit projects. In particular, the plan must make progress toward any relevant cleanup plan for the receiving waterbody, describe efforts to implement retrofits, and identify priority areas for retrofit projects.[11]

DOWNSPOUT DISCONNECTIONS TO PRIVATE PROPERTY RETROFITS

Portland recently wrapped up its nearly 20-year Downspout Disconnection Program, which provided free work or incentives to disconnect downspouts from its combined sewer system in targeted locations. The city is now focusing on designing and constructing stormwater management facilities on private property in areas with localized stormwater management problems. In total, the city disconnected more than 56,000 downspouts from over 26,000 properties within its CSO area from 1993 to mid-2011, allowing more than 1.2 billion gallons of stormwater to infiltrate into the ground annually.[12,13] The Downspout Disconnection Program started out with a two-year pilot to provide Portland's Bureau of Environmental Services (BES) time to identify and address safety concerns and/or discrepancies with local building and plumbing codes, building setbacks, and right-of-way setbacks; to evaluate slopes, soils, and the amount of area necessary to allow water to infiltrate; and to define targeted residential areas that would benefit from such a system-wide approach. According to the BES, those two years were essential to ensure that the program identified and addressed safety concerns and target areas where downspout disconnections were an effective method of stormwater management.[14]

Now, as the city shifts its focus from strict system-wide CSO concerns to more localized issues, such as basement flooding resulting from stormwater that exceeds local line capacity, its implementation strategy is shifting as well. Through the Private Property Retrofits program, BES is now offering a variety of partnership opportunities to manage stormwater on-site, including the design and implementation of multiple permanent solutions (such as rain gardens, stormwater planters, and ecoroofs) on participating private properties. The agency is currently focusing on projects within the Seven Corners stormwater retrofit area.[15]

PORTLAND GREEN STREET PROGRAM

In 2006, *Rooftops to Rivers* reported on two green street pilot projects Portland conducted. The first, installed in 2003, was a vegetated curb extension on N.E. Siskiyou Street that captures stormwater through an attractive landscaped area. The city conducted flow tests to ensure water would be infiltrated in the right-of-way and found that the vegetated curb extensions reduced peak flow from a 25-year storm event (approximately two inches in six hours) by 88 percent—enough retention to protect local basements from flooding—and reduced total runoff to the combined sewer

system by 85 percent. The project took two weeks to install and cost $15,000. Portland also installed curb extensions on S.E. Ankeny Street and street projects at the intersection of S.W. 12th Avenue and S.W. Montgomery Street, and at the intersection of N.E. 131st Avenue and N.E. Fremont Street.

Since that time, the pilot has become a comprehensive, city-wide program with the adoption of a Green Street Policy in 2007, which requires all city-funded development or redevelopment infrastructure projects involving the right-of-way to manage stormwater runoff on-site at both the source and the surface. The use of vegetated practices that improve water quality and infiltration capacity are encouraged, and projects that do not manage stormwater are subject to an off-site project or off-site management fee. Projects that do not trigger the use of the Stormwater Management Manual, such as retrofits or expansions, are required to pay 1 percent of the total construction cost into a fund that supports green street projects that are not otherwise required by the manual.[16]

This policy takes advantage of transportation corridors to capture and treat stormwater runoff, create green space and pedestrian areas, and create attractive streetscapes that enhance neighborhood livability. By the end of 2010, approximately 950 green street facilities had been constructed.[17] Data from the city's 2010 Stormwater Management Facility Monitoring Report show that infiltration facilities, which include green streets, have tremendous potential to manage stormwater flow rates and flow volumes.[18] Besides investments as part of its Grey to Green Initiative, the adopted FY2010-2011 budget also included $20 million in capital improvement expenditures to construct green street facilities along high-priority bicycle boulevards.[19]

Expanding on these efforts to take an integrated approach to stormwater management, Portland is planning to implement hundreds of sewer, stormwater, and watershed projects to improve the sewer and stormwater systems in a 1,400-acre section of the southeast quarter of the city. Under the "Tabor to the River" (T2R) program, the city will add more than 500 green street facilities such as vegetated curb extensions and streetside planters, plant approximately 3,500 trees, work with private property owners to install vegetated areas or pervious pavement to capture runoff from disconnected downspouts and parking lots, conduct a comprehensive public involvement and outreach effort, and repair or replace 81,000 feet of sewer pipe.[20] More than 135 green street facilities were completed in 2010 and 2011. The city estimates that resolving flooding and other problems caused by runoff in the region using only conventional infrastructure and pipe solutions would have cost an estimated $144 million, compared with an estimated $86 million price tag using largely green infrastructure which provide the added benefits of enhancing water quality and watershed health.[21,22] Portland's experience with the T2R program has increased the city's confidence in implementing projects that blend watershed health and sewer improvements in other highly urbanized areas of the city.

PORTLAND'S ECOROOFS

The first green roof in Portland was installed in 1996. In 2001 the city created a Green Building Policy requiring that green building principles and practices are incorporated in the construction of new city facilities (LEED® Silver) and city-funded projects (LEED®) to the fullest extent possible. The policy also requires that the city evaluate all future land purchases to reduce environmental impacts through such efforts as on-site stormwater mitigation, vegetation, and habitat restoration. It updated this policy in 2005 to strengthen the ratings to LEED® Gold and Silver for city facilities and city-funded projects, respectively, and to require new city-owned buildings and existing buildings in need of a roof replacement to install a green roof on at least 70 percent of the roof area, with any remaining area covered with Energy Star–rated roofing material.[23]

Green roofs are required only on city-owned buildings, though Portland encourages their installation on private buildings through a number of incentives. In 2006, when the first *Rooftops to Rivers* publication went to print, the city offered developers proposing buildings in Portland's Central City Plan District floor area bonuses if an ecoroof were installed. As a result, a dozen or so developers installed 200,000 square feet of ecoroofs and earned almost 600,000 square feet of additional floor area.[24] Since then, the city launched an Ecoroof Grant Program that offers grants of up to $5 per square foot for ecoroof projects within city limits. To be eligible, the roofs must manage stormwater and have a designated project manager. An internal committee reviews applications twice a year.[25] Since 2006, property owners have received discounts of up to 100 percent of the on-site portion of their stormwater utility fee by installing an ecoroof to retain stormwater (discussed below). In addition, Portland provides education and outreach on the design, installation, and maintenance of ecoroofs. A Portland Ecoroof Handbook was released in 2009, and a do-it-yourself guide for homeowners was released in 2010. As of May 2011, Portland had 288 ecoroofs totaling nearly 14 acres.[26]

One motivation for developing ecoroofs in Portland is concern about reducing peak flows to retain capacity in combined sewers and protect local creeks and streams; accordingly, ecoroofs are a component of Portland's Grey to Green Initiative. The city has continuously monitored

several ecoroofs for runoff over time, and in its most recent Stormwater Management Facility Monitoring Report Summary, issued in 2010, the city included data from three ecoroofs. It was found that all three did an excellent job of reducing peak flows. For the most intensive rain events, reductions of 85 percent to 100 percent were observed, which helps lower the risk of sewer backups. Volume retention was higher in the summer than during the winter months, and varied for individual storm events, depending upon rainfall intensity, duration, and pattern. Of the three ecoroofs studied, the one on the Portland Building had the highest annual and winter retentions. With only a three-inch soil depth, the difference in retention abilities was attributed to the three-inch foam roof insulation sheets on top of the membrane. Overall performance differences among the three ecoroofs were attributed to the soil media used and the irrigation applied, with soil mixed with fine particles appearing to better hold water against gravity. Phosphorus concentrations in the runoff appeared to be decreasing as the ecoroofs became more established but were still high in comparison with the water benchmarks (0.13-0.16 mg/L) established in some Portland watersheds. Zinc and copper levels in the runoff varied greatly, but all concentrations were well below human health guidelines.[27]

FINANCE STRATEGY

Portland's adopted budget for FY2010-11 for the Bureau of Environmental Services included $1.5 million in capital improvement project funds to support innovative watershed enhancements over five years, with priority given to projects that leverage other funding, demonstrate new technologies, or address multiple goals. Under its Grey to Green initiative, the bureau also intends to invest $48 million over four years in ecoroofs, green street facilities, tree plantings, the protection of high-priority natural areas, and other priorities. It will spend another $20 million in capital improvement project funds for FY 2010-11 through FY2012-13 to construct green street facilities along high-priority bicycle boulevards.[28]

To pay for improved stormwater and wastewater control, Portland's projects have been funded through operating capital; paid directly by ratepayers; debt, which is repaid through public utility fees on developed property; and system development charges, incurred when there is new development or a change in use. Stormwater management utility fees are based on rates per thousand square feet of impervious area. The city established fixed impervious area values for single-family residences and duplexes (2,400 square feet) and for multifamily residential developments with less than five dwelling units (1,000 square feet per unit). All other multifamily residential and nonresidential properties, including industrial and commercial sites, are charged on the basis of measured impervious area.[29] Portland residents pay among the highest combined sanitary and stormwater rates in the country, with average monthly fees increasing from $30 in 2001 to $53 in 2011. Average monthly fees are expected to reach $69 by 2016.[30]

In addition, the city utilizes a Stormwater System Development Charge (SSDC) for new residential structures, ranging from $783 for one- or two-unit residences to $1,243 for a four-family dwelling. For new commercial, industrial, and multifamily residential properties, developers are charged an SSDC of $164 per 1,000 square feet of impervious surface for on-site management; for off-site management the fee is $5.12 per linear foot of frontage and $2.68 per daily vehicle trip.[31] These fees can be lowered, however, by reducing the number of square feet of impervious area by installing vegetation, porous pavement, or other measures.[32] Portland also supports construction of green streets through the One Percent for Green fund, created by the City Council in 2007.[33]

The Clean River Rewards program was implemented in 2006 to offer a stormwater fee discount of up to 100 percent of the on-site portion of the bill, or up to 35 percent of the total stormwater charge, for retaining stormwater on-site through green infrastructure practices. For a single-family home, the discount is based on roof runoff management. Partial credit for residential properties can also be received for tree-planting, installing ecoroofs, and having less than 1,000 square feet of impervious surfaces. For commercial, industrial, and multifamily residential properties, the discount is based on runoff managed from roofs and paved areas. The discount is applied on a sliding scale, depending on how much and how well runoff is managed in terms of flow control, water quality, and disposal location.[34] In estimating the impact that an ecoroof installation could have on the average homeowner's bill, one study found that a homeowner with a 2,000-square-foot house can save $69.30 a year. For commercial and industrial properties with acres of impervious surface area, the credit becomes even more significant.[35]

Looking beyond user fee and SSDC discounts, in 2005 Portland undertook an EPA-funded study to evaluate the feasibility of implementing a credit trading system for stormwater volume controls. While the study determined that developing a stormwater trading program would be cost-prohibitive, it went on to identify several innovative market-based strategies, such as the Ecoroof Grant Program and development density bonuses, that the city could use to better motivate private investment in stormwater

management. Another city-run initiative is the Treebate program, started in 2010 and continuing to 2014 that provides homeowners with a credit of up to $50 on their utility bill for every tree planted. Without much overhead expense, the city persuaded local home and garden centers to publicize the program. In 2010, 1,000 trees were planted.[36]

*EMERALD CITY RATING SYSTEM

Each of the cities profiled in *Rooftops to Rivers II* is a leader in green infrastructure investment—rethinking the design of municipal services and infrastructure. These cities leverage funding in creative ways. They provide tools to residential and commercial land owners to retrofit private properties and realize the multiple benefits provided by green infrastructure. In short, they are changing how cities look and function.

NRDC's Emerald City Rating System identifies six actions cities should undertake to maximize their green infrastructure investment. Our metric does not directly compare one city to another, due to geographical, population, budgetary and other differences. Instead, it identifies the presence or absence of common factors of success that NRDC believes are essential elements of a robust green infrastructure commitment. Only one city profiled, Philadelphia, is undertaking each of the actions identified, although each city is undertaking at least one.

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