CASE STUDY

Portland | Green Streets

Rolling out Green Carpets

Legacy infrastructure can cause problems when a city grows and becomes more dense. The US city of Portland in Oregon uses street and roof greening to help overcome the challenge of legacy drainage systems to better manage stormwater.

The Challenge

The city of Portland, Oregon in the United States is known for being eco-friendly. But in 1991, it faced a lawsuit from a local environmental advocacy group for polluting the Willamette River, which passes through the city.

Since the late 19th century, raw sewage and industrial outflows had fed directly into the river. More importantly, the city had a combined sewage and stormwater system: both were carried in the same pipes that would overflow during heavy rainfall. As Portland grew, more new streets, rooftops and other hard surfaces increased the amount of runoff: even as little as one-tenth of an inch (2.54 millimetres) of rainfall could trigger an overflow.

Despite sewer improvements, about six million gallons of overflows still occurred each year by 1990, enough to fill nine Olympic swimming pools. The city's plan to control these combined sewer overflows included projects to divert stormwater from sewers, expanding sewage pipeline and treatment capacity, and innovative green solutions to manage stormwater such as bioswales and green roofs.

In 1993, it began what is called the Big Pipe project: massive underground pipes and other diversion measures to handle storm runoffs into the Columbia Slough and Willamette River. But while the US$1.4 billion project alleviated overflows, "hard" sewer infrastructure alone would not solve the problem completely.

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Flooding at south end of Willamette Park, Portland, in 1996.

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The Solution

In addition to its hard infrastructure measures, Portland also promoted sustainable stormwater management: slowing and treating stormwater with carefully selected and placed plantings, street landscaping, and green roofs. Such green infrastructure helped to mitigate the amount of runoff into the sewerage system. In Portland, these projects were designed to address the region's rainfall patterns of small, frequent storms.

In 2001, the city formed a Sustainable Infrastructure Committee to investigate these alternatives, to limit the impact of development projects on water quality. The same year, Portland implemented a policy requiring new city facilities and city-funded projects to be constructed according to LEED (Leadership in Energy and Environmental Design) green building principles and practices. It also installed and funded ecoroofs—vegetated roof systems with shallow soils and drought-tolerant plants. These low-maintenance roofs slow stormwater runoff, insulate buildings and improve urban air quality; data shared by the city in 2010 found three sample ecoroofs slowed peak flows by 85 to 100% during the most intense downpours.

In 2003, Portland installed the first of two pilot projects in its Green Streets programme. The landscaped curb extensions captured and treated stormwater, and also beautified the neighbourhood. Flow tests conducted by the city ensured water would run through the curb extensions, and found that they reduced peak flow from a 25-year storm event by 88%—enough retention to protect local basements from flooding—and reduced total runoff to the combined sewer system by 85%.

01 This green street project narrows the road and incorporates a zebra crossing to calm traffic next to an elementary school.

02 A traffic island is transformed into a small park space containing a rain garden.

03 Ecoroofs at the South Waterfront. Ecoroofs are so named, rather than the conventional "green roofs", to highlight that they still serve their purpose in the dry season when they are barely green.

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Following the pilot schemes' success, Portland adopted a city-wide Green Streets Policy in 2007, requiring all city-funded development infrastructure projects to manage stormwater runoff through the incorporation of green street facilities.

Portland's green street initiative included four different strategies. One, modifying an existing planting strip to allow stormwater in and add plantings that absorb and filter water. Two, creating curb extensions where plantings replaced street parking, which helped to shorten pedestrian crossings while increasing permeable surfaces. A third was to use street planters made from concrete boxes, whenever surface planting was not feasible. A final strategy was to identify unused urban spaces that can be transformed into small parks.

All of Portland's projects to divert stormwater runoff, whether "hard" pipe infrastructure or green streets, were paid for largely by development fees and rate increases in utility customers' water and sewer bills.

Meanwhile, the city also offered discounts and incentives for planting trees, installing ecoroofs, and disconnecting home downspouts so that rain fell onto homeowners' lawns rather than into the streets.

In some cases, there were public concerns. These included the loss of parking spaces, the need for private property owners to maintain plantings on their property, the impact on aesthetics, and ensuring that changes to streetscape were safe for street users.

To alleviate concerns, the city's Bureau of Environmental Services worked with key stakeholders. In commercial areas, it minimised parking loss by building planters behind the curb with a step-out zone to accommodate adjacent parking; property owners could select from a list of appropriate plants, which provided a sense of ownership; and with the city's Bureau of Transportation, it made sure designs were safe. For example, pedestrian crossings were often incorporated into green street facilities to improve safety, especially where children travelled to and from school.

> **Pipes alone would have cost US$144 million, but adding green infrastructure projects cuts that to US$81 million.**

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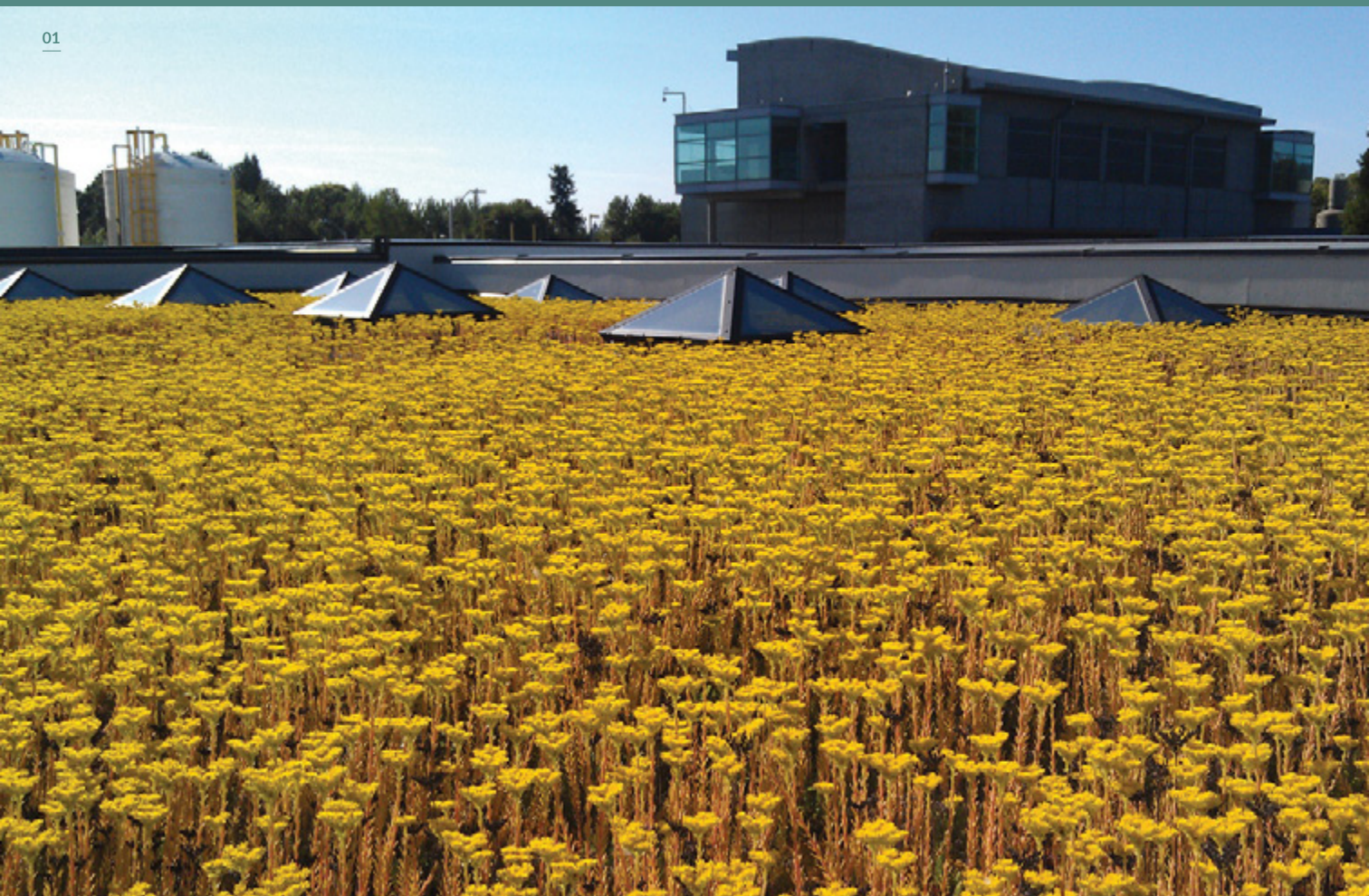

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The Outcome

By the end of 2010, approximately 950 green street facilities had been constructed. Data from the city's 2010 Stormwater Management Facility Monitoring Report showed that infiltration facilities, which included green streets, had tremendous potential to manage stormwater flow rates and flow volumes. Under the US Clean Water Act, the state of Oregon in 1994 had ordered the city to cut its overflows to the Columbia Slough and Willamette River. Today, combined sewer overflows have been cut by 97%, thanks to both pipe-expansion and green infrastructure projects.

Meanwhile, homeowners and local businesses have become involved as well. Since 2009, 1,283 households have received credits to their utility bills for planting trees that help filter and slow stormwater, while 135 people have signed on to be Green Street Stewards who weed, water and pick up trash on green streets. And between 2008 and 2013, the city's ecoroof incentive of US$5 per square foot funded 134 projects and some 362,000 square feet (roughly 5 football fields) of ecoroof.

So far, the green projects have paid off. For example, installing sumps or vegetated infiltration facilities that direct stormwater into the ground cost the city US$145 million, or 10.6% of the total Big Pipe project, but dealt with 15.8% of the water problem.

But green stormwater management complements, instead of replaces, hard infrastructure. For example, the city's new Tabor to the River scheme, which began in 2009 and will take about 15 years to complete, includes both sewer-pipe replacements and green-streets projects. Pipes alone would have cost US$144 million, but adding green infrastructure projects cuts that to US$81 million. What's more, by engaging the community, calming traffic and boosting pedestrian safety, sustainable stormwater management is now contributing to the long-term liveability of the city.

01 The ecoroof on Columbia Boulevard Wastewater Treatment Plant Screening Facility, which is a self-sustaining roof that does not need irrigation.

02 At Mt Tabor Park, the Friends of Mt Tabor Park Weed Warriors volunteers remove invasive vegetation and plant native plants, which helps improve the park's habitat and stormwater management function.