

Green Infrastructure Opportunities that Arise During Municipal Operations



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GREEN INFRASTRUCTURE COSTS AND BENEFITS

Local agencies are often tasked with retrofitting a property or installing or replacing stormwater and drainage infrastructure. Overall, green infrastructure has been shown to be more cost-effective when compared with traditional gray infrastructure approaches, and green infrastructure offers numerous ancillary benefits (Figure 2). The visible, above-ground and accessible qualities of green infrastructure, as opposed to gray infrastructure, provide other benefits, including, improving air and water quality, improving quality of life, and offering public education opportunities, as described in Figure 3.

Though green infrastructure can potentially have higher installation costs in redevelopment and retrofit settings, this is not always the case due to the site-specific opportunities and constraints on many infrastructure projects. Since gray infrastructure retrofits can also be costly, green infrastructure can be integrated into already planned infrastructure improvement projects to help mitigate demolition and disposal costs.

From a life cycle perspective, it is important to compare the long-term maintenance and replacement costs associated with green and gray infrastructure. The vegetation characteristic of many green infrastructure practices becomes enhanced as it grows over time, whereas gray infrastructure's engineered materials only deteriorate over the long term. The maintenance required for green infrastructure practices typically does not require heavy equipment, whereas maintaining gray infrastructure's pipes, forebays, basins, and embankments can be more costly.

Green infrastructure can be a cost-effective strategy to help local governments meet regional water quality objectives. Besides green infrastructure's ability to improve water quality and reduce stormwater pollution, green infrastructure reduces the cost of total maximum daily load (TMDL) implementation by reducing pollutant loads associated with stormwater. Green infrastructure can reduce the cost to implement a stormwater management program because the amount of stormwater to be conveyed and treated is reduced.

Green Infrastructure Economics

Several recent publications evaluated the economic benefits associated with green infrastructure:

- **Banking on Green: A Look at How Green Infrastructure Can Save Municipalities Money and Provide Economic Benefits Community-wide:** <http://www.americanrivers.org/assets/pdfs/reports-and-publications/banking-on-green-report.pdf>
- **Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs:** http://water.epa.gov/polwaste/green/upload/lid-gi-programs_report_8-6-13_combined.pdf
- **Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices:** http://water.epa.gov/polwaste/green/costs07_index.cfm
- **The Value of Green Infrastructure: A Guide to Recognizing its Economic, Environmental, and Social Benefits:** <http://www.americanrivers.org/wp-content/uploads/2013/09/Value-of-Green-Infrastructure.pdf?c8031c>.



Green Roofs

- Have a longer lifespan than traditional roofs
- Reduce energy costs
- Buildings with green roofs can command rental premiums
- Vegetation provides habitat for wildlife



Trees

- Intercept and absorb rainfall
- Reduce urban heat island
- Improve habitat and aesthetic value
- Provide shade in summer and block wind in winter, reducing heating and cooling costs
- Reduce greenhouse gases by absorbing CO₂
- Capture urban air pollutants (dust, O₃, CO)



Rain Barrels and Cisterns

- Reduce water consumption and associated costs
- Reduce demand for potable water
- Increase available water supply for other uses
- Can significantly reduce stormwater discharges from roofs



Bioswales and Rain Gardens

- Improve property and neighborhood aesthetics
- Reduce localized flooding
- Promote infiltration and groundwater recharge
- Enhance pedestrian safety when used in traffic calming applications



Permeable Pavements

- Reduce stormwater runoff and standing water
- Promote infiltration and groundwater recharge
- Improve the longevity of infrastructure
- May be easier to maintain than standard pavement



Green Space

- Increase soil porosity
- Reduces stormwater runoff volume
- Reduces peak stormwater flows
- Helps reduce the risk of flooding

Figure 2. Benefits of green infrastructure practices

Improved Air Quality/Climate Change



Urban Heat Island

Green infrastructure practices that include trees and other vegetation can reduce the urban heat island effect, which reduces energy use and the incidence and severity of heat-related illnesses.

Air Quality

Green infrastructure improves air quality by increasing vegetation, specifically trees, that absorb air pollutants, including CO₂, NO₂, O₃, SO₂, and PM₁₀.

Greenhouse Gases

Green infrastructure's ability to sequester carbon in vegetation can help to meet greenhouse gas emission goals by contributing to a carbon sink.

Water Quality and Quantity

Water Conservation

Green infrastructure that incorporates locally adapted or native plants reduce the need for irrigation, which reduces demand for potable and recycled water. Rain barrels and cisterns that capture rainwater also reduce water use.



Water Quality and Flood Mitigation

Green infrastructure can decrease the frequency and severity of local flooding by reducing stormwater discharge volumes and rates.

Habitat

Vegetated green infrastructure can provide habitat for wildlife, particularly birds and insects, even at small scales of implementation.

Quality of Life

Public Health

Residents have more recreational opportunities in the presence of large-scale green space in their community, which can improve public health and well-being.

Public Safety

Green streets that include curb bump-outs at pedestrian crossings improve pedestrian safety by slowing traffic and decreasing the distance that pedestrians must travel in the roadway.

Recreational Opportunities

Larger-scale green infrastructure facilities that include public access, such as constructed wetlands, offer recreational opportunities.

Property Aesthetics

Green infrastructure that includes attractive vegetation can improve property aesthetics, which can translate into increased property values.



Educational Opportunities

Public Education

The visible nature of green infrastructure offers enhanced public education opportunities to teach the community about mitigating the adverse environmental impacts of our built environment. Signage is used to inform viewers of the features and functions of the various types of facilities.



Figure 3. Additional green infrastructure benefits

Plan for Maintenance

Maintenance is critical to ensure the longevity and continued effectiveness of green infrastructure practices. Below are ways municipalities can ensure that green infrastructure is maintained over the long term.

Identify Staff Resources for Inspection and Maintenance

A municipality needs to determine if green infrastructure inspections and maintenance can be accomplished with existing staff, if additional staff needs to be hired, if specialized training is needed, or if it would be more cost-effective to hire an experienced contractor. Consider which municipal departments have the equipment and skillsets to inspect and maintain green infrastructure, such as parks or public works. Training may be needed for both municipal staff and contractors who perform inspections and maintenance.

Maintenance Resources

The University of New Hampshire Stormwater Center created **Maintenance Guidelines and Checklists** for pervious pavements, subsurface gravel wetlands, and bioretention and tree box systems, which are available for download at <http://www.unh.edu/unhsc/maintenance>.

The Oregon State University Extension Service hosts the **Field Guide: Maintaining Rain Gardens, Swales, and Stormwater Planters**, which was developed by numerous practitioners to assist contractors and maintenance staff. <http://extension.oregonstate.edu/stormwater/sites/default/files/fieldguide.pdf>.

American Rivers and Green for All's **Staying Green: Strategies to Improve Operations and Maintenance of Green Infrastructure in the Chesapeake Bay Watershed**: <http://greenforall.org/focus/water/staying-green-strategies-to-improve-operations-and-maintenance-of-green-infrastructure-in-thechesapeake-bay-watershed>.

EPA's **The Importance of Operation and Maintenance for the Long-Term Success of Green Infrastructure**: http://water.epa.gov/grants_funding/cwsrf/upload/Green-Infrastructure-OM-Report.pdf.

Identify Maintenance Triggers

It is important to identify common problems that require non-routine maintenance to aid inspectors in the field. Such maintenance triggers include excess sediment accumulation, trash and debris, overgrown vegetation, dead or diseased vegetation, signs of erosion, structural damage, or standing water present more than 72 hours after a rain storm.

Update Standard Operating Procedures

If municipalities have standard operating procedures for routine landscape and infrastructure maintenance, they should be updated to incorporate green infrastructure maintenance triggers and remedial actions. Additionally, if contractors are used to maintain practices, include specific language in contracts that require training of maintenance crews. Maintenance schedules should be set for each type of practice, and a tracking system should be in place to ensure that maintenance is performed as prescribed.

Secure Funding for Maintenance

As with all infrastructure, expenses for green infrastructure maintenance are ongoing. Sources of funding typically pursued for green infrastructure projects, such as state and federal grants and loans, cannot be used for ongoing maintenance. Local funding sources such as tax revenue or utility fees can provide a stable source of funding for maintenance of green infrastructure practices.

Enlist the Help of Volunteers

Some routine maintenance, such as removing trash and weeds from bioretention areas, can be accomplished by partnering with neighborhood organizations, greenway groups, or garden clubs to leverage their funds/volunteers.

Procure Equipment

Municipalities should also consider the equipment needed to maintain green infrastructure and determine if additional equipment is needed. Most of the necessary equipment is typical of general landscape maintenance, as shown below. Note that heavy equipment is discouraged for routine maintenance, because it can cause soil compaction, which reduces the effectiveness of the practices.