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Green roofs retain stormwater on site while providing
many other benefits such as heat island mitigation.

# General Accountability Considerations for Green Infrastructure

This factsheet is the first in a series of six on integrating green infrastructure concepts into permitting, enforcement, and water quality standards actions.

The area of impervious cover managed with green infrastructure is a common implementation metric.

## Introduction

Accountability considerations are important in all actions involving permits or enforcement orders, regardless of the approaches used to achieve and maintain compliance with established standards. Different accountability mechanisms may be appropriate for permits and enforcement actions with green infrastructure components, however, because green infrastructure approaches function differently from more traditional grey infrastructure approaches.

This fact sheet discusses six accountability mechanisms that may be applied to permits or enforcement actions that include green infrastructure. Permitting and enforcement authorities can work with regulated entities to determine the mix of accountability mechanisms most appropriate for specific situations.

## 1) Terminology and Articulating Standards

Terms such as "green infrastructure," "low impact development (LID)," and "conservation design" can apply to a wide array of designs that achieve a wide range of outcomes. For example, design manuals may apply the label "LID" or "green infrastructure" to retention, extended detention, and/or extended filtration devices, even though the outcomes associated with these devices are quite different. Because conceptual terms such as "LID" and "green infrastructure" may be applied to a range of practices resulting in a range of environmental outcomes, these terms in and of themselves are inadequate in articulating standards. For example, a standard requiring permittees to "implement LID practices at new development sites in your jurisdiction" would be a difficult standard to implement and enforce. A more effective approach would be to define the standard as the desired result and allow for various green infrastructure or green-grey combinations to achieve this result. For example, a requirement that would be less ambiguous and easier to implement and enforce might read as follows:

"The permittee must implement and enforce via ordinance and/or other enforceable mechanism(s) the following requirement for new and redevelopment: Site design standards for all new and redevelopment that require, in combination or alone, management measures that keep and manage on site the first one inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. This first one inch of rainfall must be 100% managed with no discharge to surface waters."

In certain contexts, standards based on environmental outcomes may be supplemented with standards based on implementation goals. This is especially important where a long-term schedule of compliance is included. In such cases, enforceable medium- and long-term targets can be expressed in terms of environmental outcomes (e.g., number of CSO overflows), while enforceable interim targets can be defined in terms of implementation goals related to the desired environmental outcome (e.g., number of acres retrofitted to retain a certain volume of stormwater). Water quality improvements on the sewershed scale may not be measurable until a certain amount of green infrastructure has been installed; therefore, the inclusion of interim targets is essential to evaluate progress over time and allow for adaptive management as needed.



Stormwater wetlands can effectively absorb stormwater while also providing natural habitat for wildlife. *Photo courtesy of Philadelphia Water Department*

## 2) Metrics and Performance Evaluation

Quantifiable metrics are an essential part of a permit or compliance order regardless of the types of practices that will be implemented to meet performance requirements and protect water quality. The need for such metrics is no different for green infrastructure than for grey infrastructure control measures, but the actual metrics that may work best for green infrastructure measures may vary.

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Metrics are standard measures to assess performance relative to a specific goal. Metrics and indicators are used for all types of technologies to gauge implementation and effectiveness. Tracking and reporting based on metrics is appropriate for most permits and enforcement actions. It may be advisable in many situations to have metrics that gauge both implementation and effectiveness. See Box 1 for examples of both implementation and effectiveness metrics.

In addition to metrics based on stormwater volumes, it may be necessary to establish metrics based on pollutant loadings. For example, meeting a waste load allocation (WLA) established in a total maximum daily load (TMDL)

Many cities have implementation targets for urban tree canopy. Trees in the urban environment provide many environmental benefits, including stormwater management, air quality management, and urban heat island mitigation.

### Box 1

**Implementation metrics might include:**

- Number, square footage, and capacity of green roofs in place
- Number and capacity of rain gardens and other infiltration practices
- Acreage of impervious surfaces in the service area where rainwater drains to a green infrastructure control measure
- Gallons kept out of the sewer system during 2- or 10-year storm events through the use of green infrastructure
- Reductions to Effective Impervious Area (EIA)
- Quantification of flow volume reductions, e.g., flows into or from the sewer system in various size storm events, on an annual basis, or in a typical year

**Effectiveness (receiving water response) metrics might include:**

- Pre- and post-implementation water resources monitoring and assessment
- Assessment of erosion rates in receiving waters
- Attainment of water quality standards for specific pollutants
- Percent stormwater volume capture in combined sewer area
- Percent reduction in CSO volume as a result of green infrastructure

requires specific reductions in pollutant loads. Note that continuous flow monitoring is generally advisable for monitoring wet weather discharges. Grab samples will, in many cases, vary depending on at what point in the storm cycle the sample was collected, and may not be representative of the pollutant concentrations in the stormwater throughout the duration of the storm event.

It may also be appropriate in some cases to have metrics for individual controls, or a sample set of controls. These metrics could be used in combination with system-wide measurements. Metrics for specific controls could include volume reductions or reductions in pollutant loadings. Percent pollutant removal is not a good measure of performance of stormwater controls because it is very dependent on the characteristics of the stormwater entering the practice, and also may not account for the volume reductions achieved through the management practice. Event Mean Concentrations (EMCs) may be appropriate for assessing the performance of a sample set of green infrastructure practices.

It is important to carefully select a set of metrics and incorporate them into evaluation requirements to ensure that desired outcomes are being approached and/or achieved. The ultimate desired outcomes are those centered on environmental protection and improvement, and metrics should be focused on those outcomes. In the shorter term, it may be appropriate to establish interim performance criteria. For example, interim criteria may specify that discharges be reduced by a certain volume or that pollutant loadings be demonstrably reduced. Evaluations may appropriately include field monitoring, modeling, or a combination of methods.

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For many types of metrics, tracking or monitoring data will need to be compared to standards or thresholds (e.g., the number and capacity of green infrastructure measures installed might be compared to the number and capacity planned). Standards or thresholds should be precise enough to allow for such comparisons. There should also be clear expectations for corrective action when observed values and progress do not meet established standards or thresholds. In some contexts, it is perfectly reasonable to

include a period for refinement of methods and thresholds. However, there should also be a clear understanding of the point at which data are considered representative and actionable. It is important that information be relatively unambiguous and interpretable. This will allow for effective compliance monitoring and enforcement, if necessary, of the permit or order provisions. In addition, for long-term compliance schedules, performance data should be fed back into an adaptive management framework so that performance can be continuously improved over time.

An example of language from a CSO enforcement action dealing with metrics and performance evaluation:

"The Sewer District shall develop and submit to EPA a Green Infrastructure Plan. The Plan shall propose a process for locating, designing, constructing, operating, and evaluating a set or sets of green infrastructure control measures to capture a minimum of [XX] million gallons of wet weather flows in a typical year that would otherwise be discharged by the District as CSOs. This [XX] MG volume of capture shall be in addition to the capture per typical year that would be achieved by all of the other grey infrastructure control measures required under the Consent Decree in the absence of the Green Infrastructure control measures. …

The Plan shall describe how the Sewer District will adjust the hydrologic model parameters directly related to the Green Infrastructure control measures (prior to and during model recalibration) as necessary to accommodate changes in model parameterization caused by shifts in runoff hydrology from the Green Infrastructure control measures. The District shall then use the model in two forms (the first encompassing all CSO control measures including the Green Infrastructure control measures proposed, and a second model identical to the first, but without the Green Infrastructure control measures), to simulate the system's typical year performance. The District shall use the difference in performance between the two simulations to gauge compliance with the requirement that Green Infrastructure measures control a minimum additional CSO volume of [XX] MG per typical year."

## 3) Appropriate Schedules

As in other contexts and with other control technologies, it is important to establish schedules that are measurable and realistic. Compliance schedules must conform to Clean Water Act (CWA) requirements and EPA regulations (see 40 CFR § 122.47), as summarized in EPA guidance.

Compliance schedules may include:

- Dates/deadlines for updating ordinances;
- Dates for implementing pilot projects;
- Milestones for broad, systematic installation of green infrastructure measures;
- Benchmarks and/or standards to quantify green infrastructure performance and dates for achieving benchmarks/standards (e.g., implement measures with a cumulative storage capacity of [XX] gallons by [XX] date).

Additional information on the inclusion of compliance schedules in NPDES permits can be found in the Office of Wastewater Management Memo of May 10, 2007: Compliance Schedules for Water Quality-Based Effluent Limitations in NPDES Permits (available at: http://water. epa.gov/lawsregs/guidance/wetlands/upload/ signed-hanlon-memo.pdf). The memo outlines the situations in which it may be appropriate to develop compliance schedules extending beyond a typical 5-year permit term. For more information on compliance schedules with large construction projects and significant expenditures that may require more than one permit cycle, see 40 C.F.R. §§ 122.44 and 122.47, and EPA's CSO policy (found at: http://cfpub.epa.gov/npdes/cso/cpolicy. cfm?program_id=5).

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## 4) Reporting Requirements

When implementing grey infrastructure approaches, permittees will typically report on progress in meeting schedules and milestones, and in many cases will monitor and report on discharge characteristics. The same applies to green infrastructure elements. See examples of reporting activities in Box 2 below.

Along with standard reporting provisions in the permit, administrative order, or judicial order, post-construction monitoring and reporting should be implemented to ensure

the permittee has come into compliance with the CWA and is required for CSO discharges. However, receiving water monitoring and reporting should not wait until after all green infrastructure projects have been constructed. Rather, monitoring and reporting requirements must be sufficient to measure the in-stream benefits of green infrastructure as they begin to accrue and during the life of a long-term implementation plan.

### Box 2

### Examples of Reporting and Tracking Activities

- Report on policy and administrative accomplishments, e.g., adoption of new ordinances, standards, site plan review procedures, and operation and maintenance protocols. These are short-term elements that would typically be expected to be completed in the first 2–5 years of the program.
- Report on implementation activities and accomplishments (e.g., number of green roofs or number of rain gardens).
- Report on the cumulative storage capacity of and/or cumulative runoff volume managed by installed green infrastructure practices, and/or the extent of the service area where rainwater drains to a green infrastructure control measure.
- Measure and report on flows to, through, or from the sewer system in different-sized rain events to quantify the flows that are kept out of the system by green infrastructure practices.
- Monitor and report on a sampling of green infrastructure practices, where they adhere to standard community designs, to gauge performance.
- Using performance data from a sampling of green infrastructure installations, periodically model and report on annual discharges from the sewer system (e.g., CSO volume or pollutant loadings).
- Track and report on operation and maintenance (O&M) activities for all green infrastructure installations.

## 5) Enforceable Mechanisms for Operations and Maintenance

Operation and maintenance (O&M) are critical to ensure the continuing effectiveness of any suite of controls, including green infrastructure. For green and grey infrastructure components, O&M plans and schedules should be established, and accountability measures should be included to assure that necessary O&M is carried out.

In some cases, the green infrastructure may be located on private property. It is necessary to establish a provision(s) to assure responsibility and accountability for the O&M. This typically includes:

- Requirements in codes and ordinances for private property owners to inspect and maintain practices, with provisions for fines or cost recovery should this not occur;
- Maintenance agreements with similar elements;
- An inspection program, which could include private property owner responsibility for 3rd party inspection with subsequent reporting to the municipality; and/or a municipal inspection program that prioritizes certain practices for periodic inspections;
- Development of a municipally-operated tracking system to document locations and types of practices, the party responsible for their maintenance, maintenance reports, and maintenance needs, as appropriate.

Most green infrastructure programs will also make significant investment in publicly owned and operated systems. In these cases, O&M planning must include:

- The development of protocols and schedules for different types of green infrastructure practices (e.g., the frequency with which curb extension bioretention cells need to be inspected, and their maintenance needs, such as weeding or plant replacement);
- Identification of which municipal department(s) will conduct or oversee O&M;
- Development of a tracking system to ensure all elements of the O&M program are fulfilled and documented;

- Establishment of a reliable source of funding for ongoing O&M.

O&M requirements often vary among sites or projects. Therefore, it is important that the permit or enforcement document make clear what will constitute non-compliance. Maintenance needs may vary notably depending on soils, seasonal or annual climate conditions, land use, and other factors. After initial vegetation establishment, many practices need little or no maintenance to function properly. Alternatively, due to a site-specific event, a given practice may need additional attention to establish or restore proper function.

Example language that could be used in a permit or enforcement action:

"Maintenance. The Sewer District will establish a database to manage information on all green infrastructure practices (e.g., green roofs, rain gardens, constructed wetlands) put in place pursuant to this Order/Consent Decree. The Sewer District will enter into the database GPS coordinates for the practices and as-built information. For each practice, the Sewer District will also identify maintenance activities for the practice and schedules for maintenance. The Sewer District will use the database to schedule/track maintenance activities and assure maintenance is performed. Documentation such as inspection reports or records relating to maintenance conducted shall be maintained in the database or linked to from the database."

## 6) Modification Provisions

Permits and enforcement orders typically include modification provisions to deal with performance issues or unexpected occurrences. Such modification provisions should be included in permits or enforcement orders focused on grey infrastructure solutions, green infrastructure solutions, or a combination. In permits, this may be accomplished through use of the standard NPDES modification provision in 40 CFR 122.62. Enforcement orders also should include an evaluation and revision process. That is, if the compliance requirements are not met, after sufficient compliance testing has been performed and despite performance of the required projects, the government should retain authority under the decree or order to require additional compliance measures.

**Rain gardens can beautify neighborhoods as well as reduce the volume and rate of stormwater discharges.**

## Green Infrastructure Permitting and Enforcement Series

*This series on integrating green infrastructure concepts into permitting, enforcement, and water quality standards actions contains six factsheets plus four supplemental materials that can be found at **http://water.epa.gov/infrastructure/ greeninfrastructure/gi_regulatory.cfm#permittingseries**.*

**Factsheets**
1. Potential Challenges and Accountability Considerations
2. Combined Sewer Overflows
3. Sanitary Sewer Overflows
4. Stormwater
5. Total Maximum Daily Loads
6. Water Quality Standards

**Supplemental Materials**
1. Consent Decrees that Include Green Infrastructure Provisions
2. Consent Decree Language Addressing Green for Grey Substitutions
3. Green Infrastructure Models and Calculators
4. Green Infrastructure in Total Maximum Daily Loads (TMDLs)

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For additional resources on green infrastructure, go to the EPA Green Infrastructure Web page: http://www.epa.gov/greeninfrastructure/.