S.W.I.M. Coalition

Stormwater Infrastructure Matters: utilizing stormwater as a resource, not a waste!

Testimony submitted on behalf of
The Stormwater Infrastructure Matters (S.W.I.M.) Coalition
NYC DEP Public Hearing on Proposed Amendments to Chapter 31 of Title 15 of the Rules Governing House/Site Connections to the Sewer System
October 31, 2011

Thank you for the opportunity to offer the following comments on behalf of the Stormwater Infrastructure Matters Coalition (S.W.I.M.) Coalition, a coalition of more than 70 organizations, including community and environmental groups, architects, engineers, boaters and scientists, that are dedicated to ensuring swimmable waters around New York City through natural, sustainable stormwater management practices - Green Infrastructure - in our neighborhoods.

Our Coalition championed the New York City Council's efforts to pass Local Law 5 of 2008, which required development of the city's first Sustainable Stormwater Management Plan, completed that same year. Today, we are actively engaged with NYC DEP concerning the agency's refinement and implementation of the approaches outlined in its 2010 Green Infrastructure Plan. We represent our broad membership on the NYC DEP Green Infrastructure Steering Committee.

The Draft Stormwater Performance Standard and associated guidelines that are before us today represent an important step forward in controlling stormwater upland on future developments and major renovations. Our concerns are focused on the degree to which this draft rule will incentivize actual Green Infrastructure (GI) over basic stormwater detention. As this draft rule represents one of the central goals of the 2010 Green Infrastructure Plan, we expect it to directly incentivize GI.

We appreciate the revisions made on the draft rule in response to feedback from members of the GI Steering Committee including the SWIM Coalition. However, our fundamental concern still remains: what we see in the draft rule is essentially a stormwater detention standard. The core issue here is that the standard is based on a runoff rate reduction rather than a volume reduction. To achieve a rate reduction, developers will be required to build detection tanks or rooftop detention systems. GI that utilizes retention and infiltration techniques are subject to review by DEP for credit towards meeting the rate reduction, making GI practices "extra" above and beyond what is required. The fact that GI practices require an additional review is a disincentive for GI. Standards that are based instead on a volume reduction (such as the NY State Stormwater Design Manual and Philadelphia's stormwater regulations) provide a more direct incentive for GI.

According to the US EPA, "Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspire, and/or recycle stormwater runoff" and "can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits."

While basic detention and delayed release can be valuable in terms of CSO control, DEP has not shown it to be as effective as retention (such as with GI) that keeps runoff entirely out of the sewer; in fact, in the 2010 Green Infrastructure Plan, DEP assumed it would be less effective on a per-acre basis. Basing a stormwater rule on a rate reduction rather than volume reduction favors detention over true GI, limiting how developers and neighborhoods can reap the multiple benefits just mentioned. It is our hope that the NYC DEP takes a second look at the basic premise of this draft rule, and opt for the creation of a stormwater rule that directly incentivizes Green Infrastructure.

November 18, 2011

Charles Shamoon, Esq.
NYC DEP, Office of Legal Affairs
59-17 Junction Blvd., 19th Floor
Flushing, NY 11373

Re: NYC DEP's Proposed Amendments to Chapter 31 of Title 15 of the Rules Governing House/Site Connections to the Sewer System (a.k.a. "NYC Stormwater Rule")

Dear Mr. Shamoon,

On behalf of the undersigned members of the New York City Department of Environmental Protection's Green Infrastructure Steering Committee, we are submitting these comments on the proposed NYC Stormwater Rule. DEP convened the Committee pursuant to the NYC Green Infrastructure Plan. It is comprised of representatives selected by DEP from the private sector, nonprofit organizations, and educational institutions. While we have varied perspectives, we all support the content of this letter and share a common goal of widespread implementation of green infrastructure to cost-effectively reduce combined sewer overflows (CSOs), clean up local waterways, and improve the health and livability of New York City neighborhoods. Many of our organizations will be submitting their own comments individually as well.

We applaud the tremendous strides the Bloomberg Administration has taken over the last several years, with the support and encouragement of New York State, to advance the use of green infrastructure as a core strategy for CSO control. All of the members of the Committee agree that an approach that maximizes the use of green infrastructure represents a cost-effective and environmentally-preferable approach to traditional stormwater management, and a significant departure from DEP's past approach. We consider the city's Green Infrastructure Plan, which gave rise to the proposed Rule, to be an important step towards bringing New York City in line with the stormwater management practices of other leading cities.

In the Green Infrastructure Plan, DEP proposed targets for implementing, on both public and private property, decentralized stormwater management approaches that retain runoff -- through infiltration, evapotranspiration, or rainwater harvesting -- or delay its release into the sewer system.[1] The former set of approaches comprise what U.S. EPA, NYS DEC, and others refer to as "green infrastructure," because they rely on soils (or other lightweight growth media), vegetation, and other techniques that mimic the way nature handles stormwater, treating it as a resource rather than a waste. The Green Infrastructure Plan recognizes that these "retention" methods are more effective at reducing CSOs and, by creating more urban green space and reducing potable water demand, yield a wide range of sustainability benefits. Therefore, we strongly encourage DEP to implement its CSO and stormwater management programs in a way that maximizes the use of these approaches.

---

[1] The Green Infrastructure Plan's citywide targets are now proposed to be incorporated into a consent order with the state; today we also submitted to the state Department of Environmental Conservation a comment letter on the proposed consent order.

DEP's draft stormwater performance standard and accompanying technical guidelines (the proposed "Rule") will be a critical component of the success of the Green Infrastructure Plan, which relies on the application of a new performance standard to redevelopment projects to realize most of the CSO reductions attributed to green infrastructure. Therefore, it is critical that the Rule itself be structured to promote the use of retention methods wherever feasible.

We are concerned that, in numerous respects, the proposed Rule does not fully embody the visionary goals of the proposed CSO Order and the Green Infrastructure Plan. We urge the city to improve upon the current draft. Most significantly:

> 1. The proposed Rule is primarily oriented towards stormwater detention and delayed release, rather than stormwater retention, even though the Green Infrastructure Plan states that detention is only 60% as effective as retention. We encourage NYC DEP to revise the proposed Rule so that it directly drives the use of green infrastructure -- including not only infiltration, but also evapotranspiration and rainwater harvesting -- as the principal means of compliance wherever feasible. Even where infiltration may not be feasible, methods such as green roofs and analogous lined bioretention facilities at the ground level can effectively reduce runoff volumes by retaining runoff in the pore space of the soil for subsequent evapostranspiration, and that rainwater harvesting techniques can also be applied.
>
> 2. The proposed Rule remains very vague about what green infrastructure designs will be sufficient to achieve a given amount of "credit" toward compliance with the performance standard, and does not give sufficient credit for the full functionality of green infrastructure techniques. (For example, the current draft of the Technical Guidelines assumes 70% of rainfall will run off from a green roof, which is not consistent with current research or experience, but rather significantly understates the effectiveness of a green roof.)

These two issues lead us to be concerned that developers will often find a "gray" approach, based on detention and delayed release, to be the path of least resistance for permit approval, and that investments in green infrastructure may not be duly rewarded towards achieving compliance with the DEP's performance standard.

In light of these concerns, we urge DEP to improve the proposed Rule to ensure that it maximizes the use of retention methods wherever feasible.

Thank you for considering these comments, and for all of DEP's work to advance green infrastructure. We look forward to continuing to engage with DEP as the city moves ahead with implementation of its exciting green infrastructure initiatives.

Sincerely,

Kevin Bone
Center for Sustainable Design - Cooper Union

Michael Brotchner
Sustainable South Bronx

Susannah Drake
dland studio

Stuart Gaffin
Center for Climate Systems Research – Columbia

Andrew Lavallee
AECOM Design + Planning

Dwaine Lee
The Horticultural Society of New York

Lawrence Levine
Natural Resources Defense Council

Lenny Librizzi
GrowNYC

Philip Musegaas
Riverkeeper

Jason Schwartz
City Parks Foundation

Shino Tanikawa
NYC Soil and Water Conservation District

Herschel Weiss
Ashokan Water Services

Kate Zidar
S.W.I.M. Coalition

cc: Commissioner Carter Strickland, NYC DEP
David Bragdon, Director, NYC Mayor's Office of Long-Term Planning and Sustainability

Sustainable Yards

Charles Shamoon, Esq.
New York City Department of Environmental Protection, Office of Legal Affairs
59-17 Junction Boulevard, 19th Floor,
Flushing, NY 11373

Re: Proposed Amendments to Chapter 31 of Title 15 of
the Rules Governing House/Site Connections to the Sewer System

November 29, 2011

New York City and DEP should be applauded for showing leadership in confronting the issue of combined sewer overflows head-on in the Green Infrastructure Plan. However, Sustainable Yards, a SWIM coalition member, is concerned that the new rules explicitly *excludes* improvement in stormwater runoff of small lots. Arbitrarily setting the runoff threshold at .25cfs or 5000sf sends the wrong message to the thousands of small property owners who could adopt low-tech, affordable low impact development strategies, cumulatively significantly reducing the number of CSOs—efforts that would contribute to the City's goal to convert 10% of the CSO into pervious surfaces.

Together with CUNY Institute for Sustainable Cities, I undertook a study to quantify the amount of residential yardspace in New York City, mapping the 52,000 acres of residential yardspace—over ¼ of the city's landmass. Because much of this residential open space is hidden from street view, Sustainable Yards investigated the environmental benefits of just 1 rowhouse block— about .9 acre of contiguous open space which is 35% permeable, reducing runoff by about 658 gallons per inch of rain (the measured infiltration rates of sample existing garden spaces was 4"+/hour). These rowhouses and apartment buildings are also characterized by flat roofs—ideal for green roofs or rainwater collection. By focusing on restricting flow to the exclusion of volume retention, DEP forgoes the opportunity to encourage property owners, large and small, to install affordable green infrastructure rather than perceive the new regulations as just an extra layer of bureaucracy.

Sustainable Yards and Urban Field Station/NYC Parks & Recreation jointly quantified the environmental benefits of the 96 trees that are on the block – the 49 located behind the rowhouses enhancing species diversity to complement the 47 street trees. Using I-Tree Streets computer modeling we calculated that about 70,000 gallons of rain annually is intercepted by the trees alone (not including the adjacent permeable surfaces). The study block is fairly typical of the thousands of other rowhouse blocks throughout the city—conveying overlooked but significant cumulative stormwater benefit. While lack of funds have not allowed us to determine how many blocks in the City are "typical rowhouse blocks" comprised of open lot space under 5000sf, we know that they are common in every borough, from Brooklyn's Bed Sty to Manhattan's Upper West Side.

Small pockets of open space matter. DEP should require property owners who undertake alterations to embrace low impact development strategies to stop the slow but insistent rate of paving of existing small open spaces. By excluding small pockets of private land area in the new stormwater guidelines, DEP is missing the boat –and an opportunity to engage small property owners to require them to "green the ground" and refrain from installing impermeable surfaces on small spaces—or even incentivize its removal. We can raise the bar above and beyond the current allowable flow requirements for small property owners in ways that do not pose too big a burden on either the city or the property owners themselves—efforts that would reap significant cumulative stormwater, environmental and quality of life benefits to all New Yorkers.

Evan Mason, MA, MSS

40 West 20th Street
New York, NY 10011
(212) 727-2700
Fax (212) 727-1773

November 30, 2011

New York City Department of Environmental Protection
Office of Legal Affairs
Attention: Charles Shamoon, Esq.
59-17 Junction Boulevard
19th Floor, Flushing, NY 11373
CharlesSh@dep.nyc.gov

Julie Stein, Director
Bureau of Environmental Planning and Analysis, 11th Floor
New York City Department of Environmental Protection
59-17 Junction Boulevard
Flushing, NY 11373
JulieS@dep.nyc.gov

Via email and U.S. Mail

RE: Comments on: (i) Proposed Amendments to Chapter 31 of Title 15 of the Rules Governing House/Site Connections to the Sewer System; and (ii) Draft *Guidelines for the Design and Construction of Stormwater Management Systems*

Dear Mr. Shamoon and Ms. Stein,

On behalf of NRDC and its 1.2 million members and online activists, including over 16,000 members in New York City, please accept the following comments on the Department of Environmental Protections ("DEP's") above-referenced proposed amendment to DEP regulations to establish a new stormwater performance standard for connections to the combined sewer system ("Draft Rule") and the related *Draft Guidelines for the Design and Construction of Stormwater Management Systems* ("*Draft Guidelines*"). Of necessity, we address both documents in a single set of comments, since the Draft Guidelines are essential to understanding the practical effect of the Draft Rule.

These comments have been informed by extensive consultation with Dr. Robert Traver, of Villanova University, a nationally recognized stormwater expert. Dr. Traver co-authored the seminal 2009 National Research Council report recommending that stormwater regulatory programs be re-oriented to promote practices that harvest, infiltrate, and evapotranspirate stormwater to prevent it from being discharged.[1] At NRDC's request, he has prepared a written review of the Draft Rule and *Draft Guidelines* (hereinafter, "Traver Memo"), which is attached hereto and incorporated-by-reference as part of NRDC's comments.[2]

We note at the outset that New York City has made great strides in recent years using green infrastructure techniques in projects built or funded by the city. DEP demonstration projects built within the last few years are proving that green infrastructure practices are highly effective at reducing the volume of runoff into the city's sewers, as they have likewise been shown to be in cities around the country. As detailed in NRDC's November 2011 report, *Rooftops to Rivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows*, green infrastructure is a cost-effective tool to reduce combined sewer overflows (CSOs), clean up local waterways, and improve the health and livability of neighborhoods.[3] We strongly support DEP's efforts to increase the use of green infrastructure practices, as an integral element of the city's CSO reduction efforts and its overall long-term sustainability plan.

The Draft Rule and *Draft Guidelines* must play a critical role in the success of the city's CSO efforts, particularly the implementation of the proposed modifications to the city's CSO consent order with the state Department of Environmental Conservation. The proposed order would, for the first time, formally incorporate green infrastructure into the city's Clean Water Act compliance efforts. The proposed order, and the *NYC Green Infrastructure Plan* on which its green infrastructure provisions are based, rely on the application of a new stormwater performance standard for development and redevelopment projects to realize most of the CSO reductions anticipated from green infrastructure.[4] Accordingly, as many commentors on the proposed consent order emphasized -- including a majority of the members of DEP's Green Infrastructure Steering Committee -- it is critical that the Draft Rule and *Draft Guidelines* be structured to maximize the use of volume reduction (*i.e.*, retention) methods wherever feasible, for projects on private as well as public property.[5]

NRDC and others have raised concerns with DEP throughout the development of the Draft Rule and *Draft Guidelines* -- including through DEP's Green Infrastructure Steering Committee,[6] comments on a "peer review draft" of the Draft Guidelines,[7] and various other

---

[1] National Research Council, *Urban Stormwater Management in the United States* (2009) (recommending that stormwater regulatory programs be re-oriented to promote practices that harvest, infiltrate, and evapotranspirate stormwater to prevent it from being discharged). <www.nap.edu/catalog.php?record_id=12465>

[2] A summary version of Dr. Traver's curriculum vitae is also attached.

[3] The report is available at www.nrdc..org/rooftops.

[4] The *NYC Green Infrastructure Plan* (p. 139) anticipates that if 10% of impervious area citywide were targeted for GI retrofits over the next 20 years, over 80% of the necessary acres would comprise "on-site development" (*i.e.*, not in the public right of way), and 54% of the acres would come from private on-site development, through the application of DEP's intended stormwater management rule.

[5] *See* Letter of 11/18/11 from 13 members of the DEP Green Infrastructure Steering Committee to G. Kline, NYSDEC.

[6] *See*, *e.g.*, DEP Green Infrastructure Steering Committee, "Sept. 8, 2011 -- Agenda and summary minutes," available at http://www.nyc.gov/html/dep/pdf/green_infrastructure/green_infra_steering_committee_agenda_and_minutes_090811.pdf..

informal communications -- that the fundamental approach DEP had been pursuing for this rulemaking did not represent a "green infrastructure" approach to managing runoff on private property and at new city buildings. Unfortunately, this is still the case in the official public review versions of the Draft Rule and *Draft Guidelines* (notwithstanding some improvements around the edges, as compared to earlier versions that had been circulated informally).

The performance standard in the Draft Rule amounts to a distributed gray infrastructure approach, whereby developers would build decentralized, on-site storage capacity to capture runoff for delayed release into the city's sewer system. This "detention" approach would likely yield some CSO reductions (although DEP has yet to present any CSO modeling of the effects of on-site detention). But, as described in our detailed comments below, it would be less effective at reducing CSOs than a performance standard based on volume reduction. Further, the proposed approach would constitute a huge missed opportunity to literally "green" the city. Some aspects of the proposal may even have the unintended consequence of discouraging the widespread adoption of green infrastructure practices. As compared to a greener alternative, the proposed rule is likely to result in unnecessary costs for the city, DEP ratepayers, and property owners, because it fails to take full advantage of the cost-effective CSO reduction potential of using green infrastructure on private property.

We recognize that DEP has included in the Draft Rule and *Draft Guidelines* certain opportunities for developers to use infiltration and rainwater harvesting practices to obtain credit towards compliance with the proposed, detention-based performance standard. This is a step in the right direction, although it falls well short of an approach that prioritizes volume reduction, such as the standards now in place in many state and local jurisdictions (as well as for new federal facilities), which require the retention (*i.e.*, without discharge) of a certain amount of runoff, using any available combination of infiltration, evapotranspiration, and rainwater harvesting, wherever feasible. Further, as detailed below and in Dr. Traver's review, even the provisions for the optional use of green infrastructure, which DEP proposes, would still under-value the effectiveness of green infrastructure in ways that are likely to discourage many developers from choosing a green approach to compliance with DEP regulations.

In sum, NRDC is very concerned that the Draft Rule and *Draft Guidelines* do not require -- nor even create effective incentives for the voluntary use of -- current best practices for urban stormwater management. As a result, they fall short of their potential to contribute to necessary water quality improvements in our waterways and to literally "greening" the urban landscape of New York City.

We offer our detailed technical comments below. We respectfully request that DEP revise its proposed approach and issue a performance standard (and accompanying technical guidance) that supports a world-class green infrastructure program and makes good on PlaNYC's vision of a greener, greater New York City.

Despite the shortcomings of the current proposal, NRDC is hopeful that we can work with DEP and the Bloomberg Administration to design and implement a revised rule that could

---

[7] *See, e.g.*, Letter of 8/8/11 from L. Levine, NRDC, to J. Stein, DEP, re: "Comments on July 2011 Draft of the *Guidelines for the Design and Construction of Stormwater Management Systems*."

become a national model of sustainability. We would welcome the opportunity to discuss our concerns with you, and would be happy to arrange a time for Dr. Traver to speak directly with technical staff at DEP.

Detailed Comments

1. The Draft Rule and Guidelines should be revised to establish a performance standard based primarily on volume reduction, rather than on limiting the rate of release.

The fundamental shortcoming of the Draft Rule and *Draft Guidelines* is that they are based on a maximum release rate (0.25 cfs/ac.), rather than on a requirement to reduce runoff volume. By DEP's own accounting, to reduce CSOs, volume reduction is more effective, on a gallon-for-gallon basis, than detention and slow release. (*See, e.g.*, NYC Green Infrastructure Plan, p. 21, estimating that detention is 60% less effective than infiltration.) Volume reduction is also superior in many other respects, including: improved pollutant mass load reduction (by keeping polluted runoff entirely out of the combined sewer system); non-water quality benefits such as air pollutant and heat island reduction and carbon sequestration, which are associated with vegetated green infrastructure; and relative ease of inspection and maintenance, as compared to underground detention systems. (*See* Traver Memo, p. 7) In many places, the Draft Guidelines expressly acknowledge these benefits of a green infrastructure approach based on volume reduction principles.

Infiltration, evaportranspiration, and harvesting practices, known collectively as "green infrastructure," are the optimal methods for urban stormwater management because they reduce the volume of runoff (and the pollution it carries) into the sewer system, while providing a range of additional, non-water quality benefits to our communities. This has been recognized by countless studies and codified in regulatory standards in many U.S. jurisdictions.[8] The *Draft Guidelines* explicitly describe the benefits of genuine green infrastructure and, in particular, vegetated source control practices. The document (p. 5) identifies "green infrastructure" as "a type of source control that moderates or reverses the effects of development by mimicking hydrologic processes of infiltration, evapotranspiration, and reuse." The introductory section of the document affirmatively states (p. 6; emphasis added) that "rain gardens and vegetated swales are *encouraged* in the design and construction of onsite source controls to provide stormwater retention through infiltration, vegetative uptake and evapotranspiration processes. The addition of vegetation provides other benefits for property owners and the surrounding neighborhoods, such as reducing the urban heat island effect, improving air quality, saving energy, increasing property value and mitigating climate change." Nonetheless, the operative provisions of the Draft Rule and *Draft Guidelines* do not prioritize the use of these approaches.

A performance standard based on limiting the volume of runoff, such as exists in many U.S. cities and states, as well as for federal buildings,[9] would promote the widespread use of these true "green infrastructure" approaches.

---

[8] See generally, NRDC, *Rooftops to Rivers II: Green Strategies for Controlling Stormwater and Combined Sewer Overflows* (Nov. 2011), available at www.nrdc..org/rooftops.

[9] *See* examples at note 11, below. *See also, e.g.,*:

Therefore, DEP should revise the Draft Rule to require the retention of the first inch of runoff, through any combination of infiltration, evapotranspiration, and rainwater harvesting, wherever feasible. In cases where it is infeasible to retain all or part of the first inch of runoff (*i.e.*, due to site-specific constraints), an alternative, detention-based standard should be applied to whatever portion of the inch is not retained. (*See* Traver Memo, p. 8 (recommendation #2.a))

Previously, DEP has offered several reasons for not adopting this approach. While each one raises reasonable concerns, none of them -- alone or in combination -- is sufficient reason not to adopt a retention standard as the default approach in New York City. Specifically:

- DEP has argued that infiltration is infeasible in many places because of high water tables, steep slopes, shallow bedrock, non-porous soils, or high density development. It is true that each of these factors must be taken into consideration when determining the extent to which infiltration is feasible at any given location. However, none of these is a reason not to adopt a retention standard because <u>not all retention (*i.e.*, volume reduction) practices are based on infiltration</u>. As noted above, "green infrastructure" includes infiltration, evapotranspiration, and rainwater harvesting techniques. The latter two methods may often be suitable even where infiltration is not. (*See, e.g.*, Traver Memo, pp. 6-7)

- DEP has suggested that its experience with the failure of dry-wells indicates that infiltration systems are prone to failure. However, with respect to vegetated green infrastructure systems, this is simply an invalid comparison. As explained in Dr. Traver's memo (pp. 7-8), "experience with vegetated sites demonstrates that they are robust, and incorporate factors that maintain infiltration pathways to include freeze thaw, soil geomorphology and plant growth, with significant evapotranspiration losses. Note that none of these factors is present in dry well systems; therefore, any local experience with failure of dry-well systems in New York City should not be taken as an indication that vegetated infiltration systems are prone to failure." Moreover, maintenance is important for both gray and green infrastructure; indeed, it may be even more important, in some respects, for gray. (*See* Traver Memo, pp. 7-8 & Appendix B)

- DEP has suggested that a retention standard, with an "infeasibility" exception, would lead to a situation where 'the exception swallows the rule' because of the constraints mentioned above, such that DEP would be over-burdened with applications seeking to invoke the exception. First, as noted above, the constraints

---

- EPA compendium of state standards: http://www.epa.gov/npdes/pubs/sw_state_summary_standards.pdf
- Philadelphia performance standard http://www.phillyriverinfo.org/programs/subprogrammain.aspx?Id=StormwaterManual

Notably, EPA explains that the requirement for federal facilities to reduce the volume of runoff "is intended to address the *inadequacies of the historical detention approach* to managing stormwater and promote more sustainable practices…." USEPA, *Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects Under Section 438 of the Energy Independence and Security Act* (December 4, 2009), p. 3, available at www.epa.gov/owow/nps/lid/section438/.

are less severe than DEP suggests, because non-infiltration methods will be feasible in many instances where infiltration is not. Second, there are ways for DEP to minimize the administrative burden of handling requests for exceptions, such as (i) clearly defining the steps that must be followed to make a showing of infeasibility (such as in Philadelphia's stormwater manual[10]); and (ii) identifying areas of the city where infiltration is presumptively infeasible due to geologic or hydrologic conditions and exempting projects in these areas from performing any site-specific assessment of the feasibility of infiltration.

2. DEP should revise the Draft Rule to impose more environmentally protective requirements for relatively smaller sites, on par with larger sites.

The Draft Rule has the effect of subjecting smaller sites to less stringent requirements, but it is not at all clear that this is warranted. This leads to anomalous results, such as a scenario where the runoff for an individual one-acre impervious development project would be limited to 0.25 cfs of discharge into the combined sewer system but, if the impervious acre were divided evenly among four separate development projects, the summed runoff would be allowed to discharge at a rate of 1.0 cfs for the same amount of impervious surface (*i.e.*, 0.25 cubic feet per second from *each* of the four quarter-acre lots). This effect could substantially undercut the effectiveness of the rule at reducing CSOs. (*See* Traver Memo, pp. 1-3)

DEP should revise the Draft Rule to treat smaller sites (*e.g.*, from 5,000 s.f. to 1 acre) comparably to larger sites (*e.g.*, by defining any maximum release rate on a cfs-per-acre basis).

At a minimum, DEP should analyze, on a system-wide scale, whether the relaxed standards for smaller development sites is consistent with meeting CSO reduction goals, and revise the standard as needed to maximize CSO reductions. (*See* Traver Memo, p. 8, recommendation #1) Given that NYC anticipates over 20 billion gallons of CSO would remain even after implementing the capital projects specified in its proposed CSO consent order, additional CSO reduction from a more comprehensive stormwater rule will unquestionably be of value.

3. DEP should revise the Draft Rule to apply more expansively to projects classified as "alterations."

Initially, we note that there is a discrepancy between the rule for alterations, as it appears in the Draft Rule, and the rule as it is described in the *Draft Guidelines*. The Draft Rule (§ 31-03(a)) states that a maximum release rate applies to "alterations that increase impervious surfaces on a lot by more than 20 percent." However, according to the *Draft Guidelines* (p. 2), the maximum release rate applies to alterations that "increase impervious surfaces or building footprints on lots by more than 20% of existing impervious surfaces." We assume for purposes of these comments that the language in the Draft Rule is controlling, so we address our comments to that language.

---

[10] http://www.phillyriverinfo.org/programs/subprogrammain.aspx?Id=StormwaterManual

The basis for the 20 percent threshold in the Draft Rule has not been explained anywhere, to our knowledge. As the proposed rule is currently written, a lot that includes one acre of impervious space would be allowed to further develop 0.19 previously pervious acres on the same lot, without addressing the increased combined sewer loading. Also, as the proposed rule is currently written, unless a "new building" is being built, any size redevelopment project would be able to replace any amount of existing impervious area with new impervious area, without being subject to the new standard. (*See* Traver Memo, p. 3)

The effect of the 20% threshold is unknown without examining anticipated development patterns. Moreover, even for "alterations" where the rule does apply, it is difficult to understand whether the proposed standard is expected to maintain the current level of service or is to reduce the current volume / occurrence of CSO; since no runoff from existing impervious surface is targeted, it is questionable whether the proposed rule will reduce the current impact at all from these sites. (*See* Traver Memo, p. 3)

DEP should revise the Draft Rule to apply to "alterations" that replace one impervious surface with another (as do the stormwater performance standards in some other jurisdictions, such as Philadelphia[11]). DEP should also revise the Draft Rule to establish some threshold for alterations beyond which the new performance standard will be applied to the entire lot, not only to the portion of the lot undergoing alterations. DEP should also analyze whether 20% is the optimal threshold, and vet that analysis through public review.

At a minimum, DEP should analyze, on a system-wide scale, whether the 20% threshold for applying the performance standard to "alterations" and the lack of coverage for existing impervious surfaces is consistent with meeting CSO reduction goals, and then revise the standard as needed to maximize CSO reductions. (*See* Traver Memo, pp. 3, 8 (recommendation #1)) Given that NYC anticipates over 20 billion gallons of CSO would remain even after implementing the capital projects specified in its proposed CSO consent order, additional CSO reduction from a more comprehensive stormwater rule will unquestionably be of value.

4. If DEP adopts an approach that provides developers with an <u>option</u> to use volume reduction methods, rather than a <u>requirement</u> to do so wherever feasible, the Draft Rule and *Draft Guidelines* (as well as other city regulations, if necessary) should be revised to ensure the option is a meaningful one that ensures adequate credit for the volume-reducing functions of green infrastructure.

The following recommendations are offered to improve how DEP's proposal addresses green infrastructure <u>if</u> DEP preserves the basic approach of setting a detention-based standard, rather than adopting recommendation #1 above, which calls for a standard that requires volume reduction wherever feasible. Please note that we strongly recommend the volume reduction approach, for all of the reasons stated above.

---

[11] Philadelphia Water Dept. Regulations, Section 600.1(q) (defining covered redevelopment projects to include those where existing impervious surface is replaced with new impervious surface) (available at http://www.phillyriverinfo.org/WICLibrary/StormwaterRegulations.pdf).

a. The Draft Rule should be revised to state that the required stormwater detention volume "will be reduced" when a developer uses properly-designed systems that rely on infiltration and harvesting.

As proposed, the Draft Rule states that DEP "will consider requests" to reduce the required storage volume on that basis. As written, the Draft Rule creates far too much uncertainty as to whether DEP will approve green infrastructure-based approaches. There is no need to create this uncertainty. It may make a gray approach -- based on detention and delayed release -- the "path of least resistance" for applicants, discouraging the use of green infrastructure. (*See* Traver Memo, p. 6)

b. The Draft Rule and *Draft Guidelines* should be revised to state that the required stormwater detention volume will also be reduced when a developer uses properly-designed systems that rely on evapotranspiration to reduce runoff volume.

The Draft Rule makes no mention of evapotranspiration, despite the fact that it is recognized as one of three effective mechanisms for runoff volume reduction, along with infiltration and harvesting. The *Draft Guidelines* do, in effect, give credit for evapotranspiration for green roofs, by recognizing the void space in the growing medium and sub-layers of a green roof (where water is temporarily stored and ultimately evapotranspired, rather than released into the sewer system) as storage capacity that counts towards meeting the performance standard. (See pp. 29-30.) However, no such credit is provided for systems other than green roofs.

As explained in the Traver Memo (pp. 6-7), other vegetated green infrastructure at ground level -- such as a lined rain garden -- can work in the same way as green roofs, even in locations where infiltration is infeasible. The Draft Rule and *Draft Guidelines* should be revised to provide credit for such green infrastructure techniques. (*See* Traver Memo, p. 8, recommendation #2.b.) This basic approach -- providing regulatory credit for all feasible green infrastructure methods, not just infiltration -- is used in many Clean Water Act permits for municipal separate storm sewer systems (MS4s) and state and local regulations around the country,[12] as well as in the New York State Department of Environmental Conservation's Stormwater Design Manual.

---

[12] For example, see:

- Pittsburgh city ordinance (http://library.municode.com/index.aspx?clientId=13525&stateId=38&stateName=Pennsylvania (in left-side menu, click through to Pittsburgh Zoning Code, Title 10, Chapter 1003)
- Washington, D.C. MS4 Permit http://www.epa.gov/reg3wapd/pdf/pdf_npdes/Wastewater/DC/DCMS4permit2011.pdf
- Montgomery County, MD local ordinance http://www.amlegal.com/nxt/gateway.dll/Maryland/montgom/partiilocallawsordinancesresolutionsetc/chapter19erosionsedimentcontrolandstormw?fn=altmain-nf.htm$f=templates$3.0#LPTOC2
- Aurora Illinois, Kane County ordinance http://www.co.kane.il.us/kcstorm/ordinance/adoptord.pdf

c. The Draft Rule and Draft Guidelines should be revised to provide an <u>alternative performance standard</u>, which is not based on release rates or the Rational Method, but rather is based expressly on volume reduction, for applicants that choose to use volume reduction methods at sites where such methods are feasible.

As detailed in the Traver Memo: (i) on a per-gallon basis, detention and slow release is less effective at reducing CSOs than volume reduction; and (ii) the Rational Method (on which the calculations in the *Draft Guidelines* are based) is not an appropriate hydrologic for volume reduction approaches. The combination of these two factors means that the Draft Rule and *Draft Guidelines* under-value the effectiveness of green infrastructure techniques at meeting DEP's CSO reduction objectives. By adopting a performance standard that does not account for the better performance of green as compared to gray, DEP would be artificially increasing the cost to property owners of using green infrastructure to achieve compliance.[13] (*See, e.g.*, Traver Memo at pp. 4-5) This discourages investment in green infrastructure, relative to the incentives that would exist if green infrastructure were appropriately valued in DEP's regulatory scheme (*i.e.*, if a property owner could (or were required to) achieve compliance by meeting a DEP performance standard based expressly on volume reduction). Even worse, developers facing new costs of complying with DEP's rule could entirely divert dollars that would have been spent on green space (*i.e.*, if green infrastructure were adequately rewarded under DEP's rules) into building subsurface storage tanks and rooftop detention instead.

To rectify this situation, DEP should revise the Draft Rule to establish a one-inch retention standard as an alternative performance standard, for those wishing to use volume reduction techniques to achieve compliance.[14] (*See* Traver Memo, p. 8 (recommendation #2.a)) Likewise, DEP should modify the Draft Guidelines to establish hydrologic design parameters for volume reduction systems based upon such a retention standard. (*See* Traver Memo, p. 8 (recommendation #2.c))

- West Virginia MS4 General Permit (http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/permits/Documents/WV%20MS4%202009%20General%20Permit.pdf)
- Federal facilities performance standard www.epa.gov/owow/nps/lid/section438

See also NRDC, *Rooftops to Rivers II* (Nov. 2011), at pp. 32, 37 (available at http://www.nrdc.org/rooftops).

[13] Alternatively, if a green infrastructure installation cannot be sized to entirely meet DEP's proposed standard in a given project (*e.g.*, due to site constraints), the developer would have to invest in both green and gray, if there is a desire to use gray -- but this may be less cost-effective than for the developer than simply sizing a gray system to manage 100% of the required storage volume. The result, again, is to discourage the use of green infrastructure -- even though, if DEP adopted a compliance standard based expressly on a volume reduction approach, that same project may be able to size a green infrastructure system to capture 100% of the volume required to be managed under such a standard.

[14] Again, as explained above (see comment #1), our ultimate recommendation is that such a standard be adopted as mandatory, wherever feasible, not merely as an alternative.

5. DEP should demonstrate the extent of CSO reductions that would result from the proposed approach and revise it as necessary to achieve CSO reduction goals.

DEP has not presented any modeling or other analysis to quantify the benefits for reducing CSOs of its proposed detention-based approach. It seems very likely there will be some benefit, for some storms. However, DEP has not presented any analysis of whether (and for what size and intensity of storms) the sewage treatment plants have capacity to receive and treat the delayed flow into the system, either under present or future hydraulic conditions in any given sewershed.

The *NYC Green Infrastructure Plan* stated that DEP would perform additional modeling of how the system would respond to widespread use of detention and delayed release practices.[15] This modeling is important not only to demonstrate whether an approach based on a maximum release rate would contribute significantly to CSO reduction, but also to determine what particular release rate and sizing requirements would obtain the optimal benefit.

In sum, DEP should analyze whether the proposed stormwater release rate is consistent with meeting CSO reduction goals. If the goals are not met, the proposed maximum release rate require revision.[16] (*See* Traver Memo., p. 8, recommendation #1) Given that NYC anticipates over 20 billion gallons of CSO would remain even after implementing the capital projects specified in its proposed CSO consent order, additional CSO reduction from a more comprehensive stormwater rule will unquestionably be of value.

6. DEP should revise the Draft Rule to apply a volume-reduction standard in separately-sewered and direct drainage areas, not only in combined sewer areas.

DEP has narrowed the scope of the Draft Rule from earlier iterations so that it applies only to combined sewer areas. Apparently, this was done in recognition of the fact that detention and slow release provides little or no water quality benefit in non-combined sewer areas. In addition to revising the Draft Rule to establish a retention standard (see comment #1), DEP should revise it so that the retention standard applies in separately-sewered and direct drainage areas, where reducing the volume of polluted runoff would directly reduce pollutant loadings to local waterways.

7. The Draft Rule and *Draft Guidelines* should require appropriate levels of inspection and maintenance, for both green and gray infrastructure.

We support DEP's inclusion of a general maintenance requirement in the Draft Rule. DEP should also ensure that specific inspection and maintenance requirements, for both green and gray infrastructure, are clear and appropriate to the circumstances. For example, green roofs do not need to be inspected after every storm, as is currently recommended in the *Draft Guidelines*, although appropriate inspection and maintenance of green systems is important.

[15] *See, e.g., NYC Green Infrastructure Plan* at 139.

[16] Note that this analysis is relevant even if DEP adopts our recommendation in comment #1, since a volume reduction standard would still include, in cases where full compliance via retention is infeasible, a maximum release rate for the remaining runoff volume.

Moreover, it is important to establish clear requirements (not merely recommendations) for inspection and maintenance of grey systems, which appear to be lacking in the *Draft Guidelines*. (See Traver Memo, pp. 8-9, recommendation #2.d.)

8. DEP should ensure that any unnecessary obstacles to the use of green infrastructure that may are identified and eliminated.

Cities often find that local building, plumbing, zoning, and other codes contain requirements that may no longer serve the purposes originally intended, but which may present barriers to the use of green infrastructure techniques. DEP should commit to a follow-up rulemaking to identify and eliminate any such barriers in its own regulations. DEP should also, through its leadership of the inter-agency Green Infrastructure Task Force and in collaboration with the Mayors's Office of Long Term Planning and Sustainability, secure the commitments of other relevant agencies.[17]

* * * * *

Thank you for your consideration of these comments. NRDC looks forward to further opportunities to discuss these issues with NYCDEP and other City agencies and officials. Please contact me at the number below with any questions.

Sincerely,

Lawrence M. Levine
Senior Attorney
Water Program
(212) 727-4548
llevine@nrdc.org

encl. [Traver memo, with Appendices A & B and Traver c.v.]

cc (via email): C. Strickland
D. Ramia
D. Bragdon (OLTPS)
J. Tierney (NYSDEC)
G. Klein (NYSDEC)
J. Gratz (USEPA)
S. Stephansen (USEPA)

[17] As but one example, we note that NRDC recently called on the Philadelphia Water Department to update that city's plumbing code to reflect current design techniques and available products. For example, the use of HDPE (high density polyethylene) pipe *in lieu* of ductile iron or concrete pipe is appropriate in many locations and could reduce private property construction costs but it currently restricted by Philadelphia's plumbing code.

To: Larry Levine, Senior Attorney NRDC

From: Robert G. Traver, Ph.D., P.E., D.WRE, Professor Civil and Environmental Engineering, Villanova University

Date: 30 November 2011

Subject: Review -NYC proposed stormwater performance standard and *Draft Guidelines for the Design and Construction of Stormwater Management Systems*

The scope of this project has been to review and make recommendations concerning the draft stormwater performance standard and associated *Draft Guidelines for the Design and Construction of Stormwater Management Systems* developed by the New York Department of Environmental Protection (DEP). In addition, the City of New York DEP document *Criteria for Determination of Detention Facility Volume* dated 9/28/2006 was included in the review as it is incorporated by reference into the *Guidelines*.

Fundamentally, the ongoing change to green infrastructure practices across the nation has brought new tools to an old challenge. Green infrastructure (GI) Best Management Practices add distributed volume reduction and water quality treatment components to the detention practices previously employed. Volume reduction directly reduces the volume entering the combined sewer system and thus directly reduces the volume to be treated and reduces the occurrence of overflows that bypass the collection and treatment system. This process is <u>not</u> the same as detention, and thus the challenge is to merge the new technologies with past practices to take full advantage of their attributes in order to create a sustainable systems. Over the last ten years there has been a tremendous leap forward in the engineering profession's understanding of how these GI control measures work based upon field research. While there is much more to be learned as to how to maximize their effectiveness, they have entered the mainstream and are considered engineered practices, joining the past practices of detention.

The *Guidelines for the Design and Construction of Stormwater Management Systems* is understandable and well organized. It is a good foundation for the final document. There are however two basic concerns. The first is in the effectiveness, coverage and applicability of the Stormwater Release Rate Criteria, and the second in the implementation of Green Infrastructure.

<u>Stormwater Release Rate Criteria:</u>

The stormwater release rate is defined as the greater of 0.25 cfs or 10% of the allowable flow. Note that the allowable flow is based upon the 5 year storm though the storm event modeled is the ten year event. At a hypothetical site in Brooklyn for example, the allowable flow as stated in the 9/28/2006 version of *Criteria for Determination of Detention Facility Volume* is Qall = 2.5 x A, where Q is flow in cubic feet per second (cfs) and A is area in acres. Thus, the new stormwater release rate for that site is the greater of 0.25*Area or 0.25 cfs. An example for a ¼, 0.5,1.0, and 2.0 acre impervious sites are shown in Table 1 below.

Table 1- Brooklyn Stormwater Release Rate Example

	Brooklyn Example				
Area (Impervious)	0.25	0.50	1.00	2.00	Acres
Allowable Flow (AF)	0.63	1.25	2.50	5.00	CFS
10% AF	0.06	0.13	0.25	0.50	CFS
Stormwater Release Rate (SRR)	0.25	0.25	0.25	0.50	CFS
"Greater of 0.25 or 10% AF					
SRR/ unit Area	1.00	0.50	0.25	0.25	CFS/AC

What this table shows first is the commendable reduction in release rates. For a new ¼ acre impervious site, the allowable flow is 0.63 cfs, so 10% of that is 0.063 CFS. As 0.25 is greater, that is the value used, not 10% of the Allowable flow. It also shows that when viewed from an impervious area perspective, the smaller sites have a much smaller reduction required compared to the larger site, though both are certainly much more restrictive then the past criteria. This is also shown in Figure 1 below. For areas 1 acre or above the requirements work out to be a simple value of 0.25cfs/acre, but for a .25 acre site the result is 1 cfs/acre. This leads to widely varying results, with potentially significant reductions of effectiveness toward meeting the goals of the program. For example, the runoff for an individual one acre impervious development project would be limited to 0.25 cfs of discharge into the combined sewer system from the site. But, if the impervious acre were divided evenly among four separate development projects, the summed runoff would be allowed to discharge at a rate of 1.0 cfs for the same amount of impervious surface (*i.e.*, 0.25 cubic feet per second from *each* of the four quarter-acre parcel). While still significantly lower than past practices, this is a 400% increase from the single site requirements. This also translates to a smaller over all site requirements for storage that is addressed later in this review. The one acre site would require stormwater management practices sized to capture approximately 1.1 inches, while each of the four properties would only need approximately .65 inches, a 40% reduction in storage requirements (Figure 2).

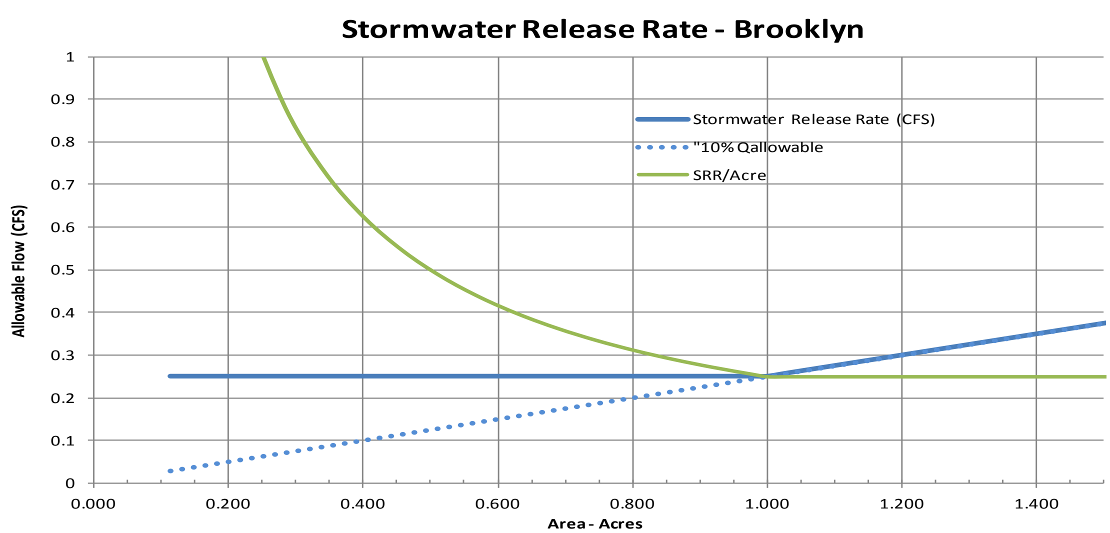


Figure 1- Brooklyn Stormwater Release Rate

It is very hard to understand whether this criterion will meet the desired CSO reduction goal. To answer this question an analysis of expected future development grouped by impervious footprint needs to be merged with the stormwater release rate criteria. The statement on page 3 of the draft that most of the runoff comes from larger buildings is very misleading. The relationship between runoff and impervious area is proportional, and several small buildings will have the same impact as one large one if the total impervious footprint is the same. The statement is made (page 7) that controlling the first inch of runoff from 10 % of the impervious area served by the combined sewer system would greatly reduce CSOs. If any significant proportion of the building permits (by impervious area) are less than an acre -- as it seems they would be in New York City -- the proposed standards should be reviewed and adjusted, as needed, to ensure the goals of the program are met. A spread sheet that was used in this analysis is included as Appendix A.

A similar comment may be made regarding the 20% impervious increase threshold required to trigger required action for redevelopments (also referred to in the *Guidelines* as "alterations"). It is stated on page 3 that proposed redevelopment projects that increase the impervious footprint by less than 20% are exempt from this standard (unless a new sewer connection is proposed), and only the increased impervious area is addressed. The immediate question is what sizes are most redevelopment requests? Does the 20% requirement aid substantially in reducing combined sewer overflows, or does it miss the mark? As the proposed rule is currently written, a parcel that includes one acre of impervious space would be allowed to further develop .19 previously pervious acres on the same parcel, without addressing the increased combined sewer loading. Also, as the proposed rule is currently written, unless a "new building" is being built, any size redevelopment project would be able to replace any amount of existing impervious area with new impervious area, without being subject to the new standard.

Additionally, it is not clear what analysis was done to set these criteria for redevelopment and, therefore, difficult to understand whether the proposed standard -- for projects where it does apply -- is expected to maintain the current level of service or is to reduce the current volume / occurrence of CSO. As no runoff from existing impervious surface is targeted, it is questionable whether this rule will reduce the current impact, without a model study of the impact. If the objective is to reduce the current impact, consideration should be given to extending the requirement to existing impervious surfaces for sites undergoing major alteration.

All of these questions regarding the redevelopment criteria should be addressed through analysis of expected future development patterns to include property size, coupled with the proposed stormwater release rate. The proposed standards should be reviewed to ensure the goals of the program are met.

Green Infrastructure Approach:

The proposed regulatory approach to the implementation of green infrastructure is to treat the volume reduction as a form of volume storage. This is made clear on page 1 with the statement "*The new performance standard is intended to reduce peak discharges to the city's sewer system during rain* *events by requiring greater on-site storage of stormwater runoff and slower release to the sewer system"*. The problem with this approach is it does not recognize or maximize the benefits available through green infrastructure, and may well discourage its use.

Criteria For Determination of Detention Facility Volume (9/28/2006)

These criteria are applied to green infrastructure throughout this document and, as such, is critical to the success of the program. The manual applies the peak flow rational method to develop a required storage volume. The method in essence varies the storm duration, calculating the impervious area peak flow based upon the surface condition and frequency storm intensity for the associated time. The flow rate is extrapolated over the storm minus the allowed release rate. The duration of the storm is varied, for example as the time increases, the intensity decreases, and vice versa. Through calculus, the time that creates the largest storage volume to assure the allowed release rate is met is selected.

The use of the rational method for hydrologic analyses to design stormwater BMPs is no longer supported by most stormwater professionals. The rational method is often used for peak flows for sizing inlets, culverts, etc.) but is rarely used as a hydrologic method that incorporates the volume and rate except for small highly impervious areas. Most current stormwater manuals do not recommend and in fact do not allow this method as it is not a hydrologic method, though arguably it can be useful to estimate runoff from small impervious parking lots, but definitely not for vegetated or storage / volume reduction practices.

As stated earlier, the method as developed in *Criteria For Determination of Detention Facility Volume* (9/28/2006) only considers the storage volume needed to maintain a set peak outflow, assuming a constant outflow. It does not credit the volume reduction approach and, is simply invalid for green infrastructure practices. Using a green roof as an example, the soil mantle void space is used to store the rainfall until it evapotranspires or slowly releases through an underdrain (not all green roofs have underdrains). The first volume of rain is reduced, thereby eliminating the rainfall from the waste stream. Only after the void space is filled would the rational method be valid, and the flow rate from this period would be much less then any release rate. Generally from both published studies (Minnesota) and conversations with green roof experts in New Zealand and Germany, if forced to use the rational method for rate, a "C" coefficient of approximately 0.3 is considered in the ball park. When this method is applied to the NYC criteria as shown in Figure 2 below, only a water storage of 1/3 of an inch over the impervious surface is needed to satisfy the published relationship for larger sites. The authors of the NYC *Guidelines* must have recognized this as they use an artificially `elevated "C" Value of 0.7 to raise the storage requirement to approximately 1.05". The value of rain gardens of 0.2 seems appropriate, but the Guidelines should clarify that 0.2 "C" value for "grassed areas" only applies to lawns or meadows, not grassy overlying compacted urban soils.

A consequence of requiring an artificial rational method approach with inflated "C" Values is that the *Guidelines* undervalues the effectiveness of green roofs and other green infrastructure techniques at meeting the proposed performance standard. This is counter to the statement made on page 21 in the NYC Green infrastructure Plan that detention of one inch is 60% less effective than infiltration (or evapotranspiration / reuse) of this volume. To be equivalent in reducing CSO, green infrastructure practices should be sized smaller than grey to achieve the same result. By not accounting for the improved performance, the cost of using green infrastructure is artificially increased (deeper green roofs, larger bioretention areas, etc.). This is not reflected in the required approach, thus the Green Infrastructure approach is not fully rewarded.

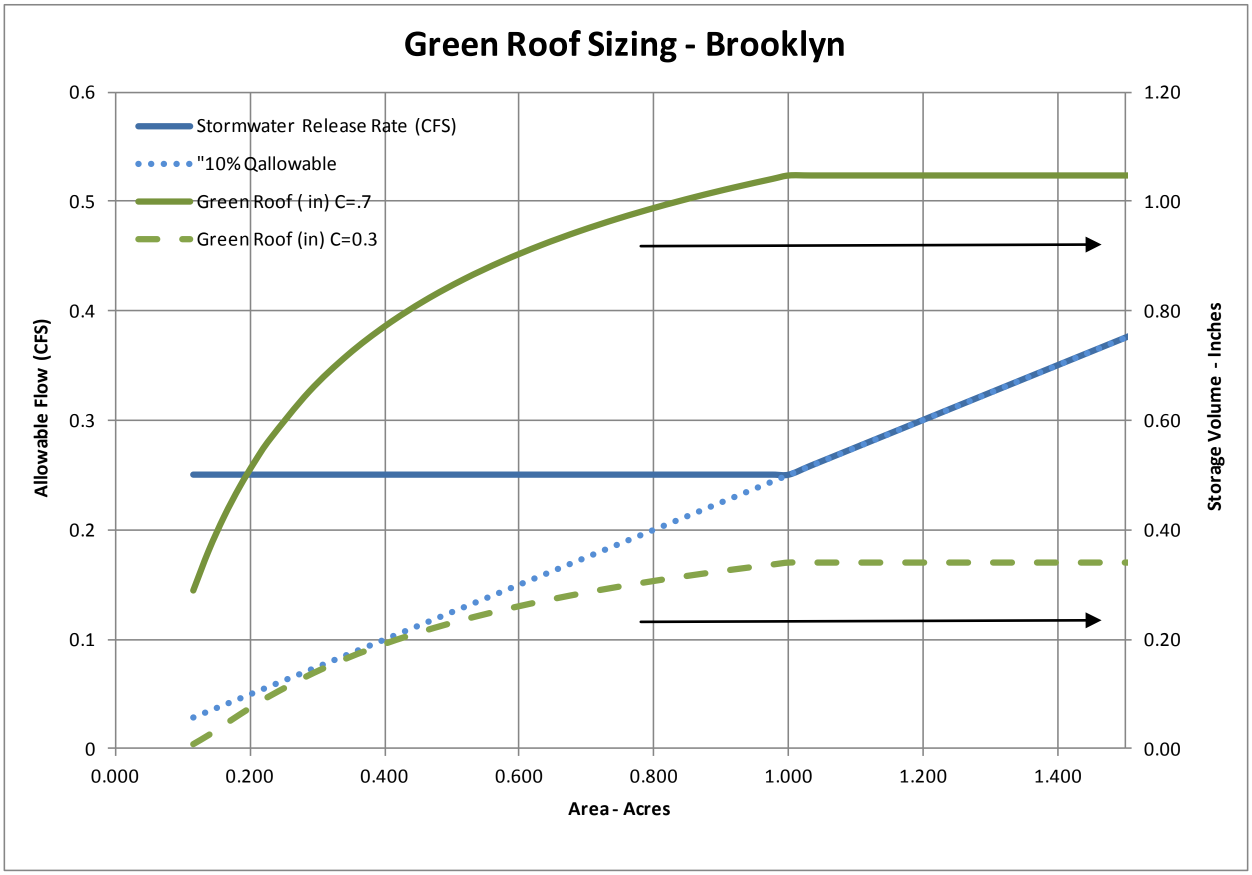


Figure 2- Brooklyn Green Roof Storage Volume - 5 Year Intensity

It clearly seems that it would be much simpler to set a performance standard requiring capture and removal of an inch over the impervious surface for volume reduction techniques (*e.g.*, green roofs, rain gardens, underground infiltration, and possibly rainwater harvesting). It would be essentially be equivalent or superior (for smaller areas) to the proposed stormwater release rate -- even without considering the expected superior performance of green volume reduction systems in regard to CSO reduction. Moreover, this would be more consistent with the statement (page 7) that controlling the first inch of runoff from10 % of the area would greatly reduce CSO volumes, since it appears that statement is derived from the NYC Green Infrastructure Plan, which based its analysis on modeling one inch of infiltration (*i.e.*, volume reduction). Additionally, when one starts with a falsely modified equation, it would not be able to be included in system wide hydrologic modeling, and it is difficult to understand how new knowledge can be included.

Finally, another apparent limitation of the *Criteria* is that the ten-year rainfall intensity relationship (I = 140/(t+15)) is encoded in the derivation. It is not clear when this relationship was developed, but it needs to be evaluated for changes in climate periodically, and the equations revised. Currently the *Criteria* document uses the 5-year six-minute intensity event to set the "Allowable Storm Flow", and then designs the facility for detention using the ten-year event. However, the *Criteria* document states that the 5-year storm should be used to determine the actual storm flow . This document should be revised to include any new performance standard that is adopted, and to ensure that it is based on an appropriate and up-to-date design storm.

Green Infrastructure Disincentives

The concept of slow release is that it will be delayed and move through the sewage treatment plant after the storm event. While the flows would be expected to receive both primary and tertiary treatment, this approach (even if it did reduce CSO volumes as much as a runoff volume reduction approach) is generally not as effective as green infrastructure -- either at reducing pollutant loads or achieving triple bottom-line benefits.

Unfortunately there are several disincentives to the use of green infrastructure throughout this manual. Many appear to be based on caution due to the lack of experience with the practices by the authors, and the overall focus on storage versus volume reduction. For example, for infiltration and reuse systems it states that department will "consider" inclusion of the reductions in the outflow due to infiltration (page 3). If an infiltration or reuse BMP is well designed and meets the criteria as set forth, why is this not an automatic inclusion? On page 3 it states that the applicant needs to conduct soil borings, and perform an insitu or laboratory infiltration trench, and then the department "will consider" approval. The fact that DEP need only consider granting credit towards regulatory compliance creates substantial uncertainty that would be enough to dissuade its use by developers and engineer designers. An option may be to permit a soil scientist to make the determination. Another example is on page one, where the *Guidelines* discuss the reduction of peak discharges through storage. There is no mention of the roles of evapotranspiration or infiltration, or volume reduction. Further, Section 2.6.2 (*Determine Available Storage Volume on Roof*) focuses on blue roofs and omits the void space storage volume of green roofs (although the latter does seem to be acknowledged in Section 2.4.2, on pp. 29-30).)

The draft *Guidelines* are laudable for acknowledging that green infrastructure is not limited to infiltration techniques, since the document also references rainwater harvesting. However, it omits consideration of the third mechanism by which green infrastructure reduces runoff volumes -- evapotranspiration. Importantly, evapotranspiration can be effective even where infiltration is infeasible, and it need not be measured or calculated directly in order to provide appropriate credit towards compliance with a performance standard. Measures such as rain gardens and vegetative systems can provide significant volume reduction in small events through temporary soil storage and evapotransporation, similar to green roofs, even in systems that cannot infiltrate (*e.g.*, lined rain gardens). Unfortunately, the use of lined rain gardens or planters or any non-infiltrative surface green infrastructure practice, with the exception of porous pavements, is simply missing from the *Guidelines*. Combination systems to include those that rely on non-infiltration vegetated features are not included.

This omission precludes the use of surface level green structures that are a main component of other cities programs.

It can be argued that green infrastructure should be incentivized in the system to increase the speed of meeting the desired goals. The NYC Green Infrastructure Plan's statement that, for an inch of rainfall, volume reduction is superior to detention would lead to this expectation. There are several additional factors that generally weigh in favor of volume reduction over detention. First, volumes that pass through primary and secondary treatment (*i.e.*, after on-site detention and delayed release into the sewer system) still contribute some pollutants to the waters. Volume reduction keeps the pollutants carried by that volume of runoff entirely out of the system. Second, slow release does not gain additional non-water quality benefits such as air pollutant and heat island reduction and carbon sequestration that are associated with vegetated green infrastructure. Third, it is difficult to determine whether storage/slow release systems are operational. They are usually below ground and out of site. The orifices used are by nature small and can clog. Without an inspection program, there is no certainty as to their operational capacity. Rain gardens, street planters, and in some situations green roofs are more readily visible and accessible (This is discussed further below in the section of this review that addresses maintenance issues.)

Maintenance of Green vs Grey Stormwater Systems

The attention given to Inspection and maintenance of volume reduction systems is laudable, and should be balanced across both green and grey infrastructure. There is a perception that grey systems do not require maintenance. For example on page 45, it states that pretreatment is not required and is a good idea where feasible. On page 48 an observation well is recommended, not mandatory. In contrast, for a green roof it is recommended, on p. 96, that the roof be inspected after every storm.

To investigate this perception that green infrastructure requires more maintenance than grey, and that grey requires little maintenance, a literature review of past maintenance experiences was undertaken (Appendix B). The conclusions of this literature search were that, clearly, BMPs that are not inspected and maintained should not be expected to perform to standard, whether they are grey or green. Sediment and poorly constructed outflows affect both grey and green infrastructure. The Australian studies point this out clearly with grey infrastructure, and bring out the challenges of greatly reducing outflows, and the danger of drowned outlets (which is not mentioned under drawbacks on page 37). The Maryland studies – which surveyed 258 sites – found that close to one half of the sites required maintenance action. Nine of the 47 subsurface infiltration sites (19%) had not drained within several days after a storm event (predominantly infiltration trench rock beds and dry wells), while five of the 31 underground detention sites (16%) had the same issue with ponding. The same study showed that a slightly higher percentage of underground detention facilities needed sediment removal, as compared to subsurface infiltration facilities. Note that this study was early in the implementation of green infrastructure, and does not include green roofs, or rain gardens. Experience with vegetated sites demonstrates that they are robust, and incorporate factors that maintain infiltration pathways to include freeze thaw, soil geomorphology and plant growth, with significant evapotranspiration losses.

Note that none of these factors is present in dry well systems; therefore, any local experience with failure of dry-well systems in New York City should not be taken as an indication that vegetated infiltration systems are prone to failure.

Studies at Villanova and other places referenced in the Appendix clearly define the issue for green infrastructure. Excessive solids when compacted with high depths of water can clog the infiltrating surface. Therefore designs should incorporate protection from this occurrence. One of the chief problems found in the Maryland studies occurred during the period immediately after construction. Grass seeding was the mechanism chosen to reestablish vegetation, and during this period high levels of sediment were allowed to enter the trenches. For vegetated areas, all BMPs need to be protected from such occurrences immediately after construction as illustrated on page 53, bullet 15. A rain garden built in Villanova that was protected immediately after construction has lasted for the past 11 years with no evidence of degradation with only landscape maintenance. Note that rooftop runoff for large buildings with slate roofs has been shown to have only minimal sediments in the runoff.

Recommendations:

My main recommendations are as follows:

1. DEP should analyze whether the guidelines, including the stormwater release rate, the relaxed criteria for smaller development sites, the thresholds for applying the rule to “alterations,” and the lack of coverage for existing impervious surfaces are consistent with meeting CSO reduction goals based upon the climate and development patterns for NYC. If the goals are not met, the coverage and the criteria require revision.

2. The primary Green Infrastructure recommendation is to revise the NYC draft *Guidelines for the Design and Construction of Stormwater Management* Systems so as to include and encourage the use of volume reduction control measures to maximize the reduction in combined sewer overflows.

a) Create volume criteria that are not dependent on the rational method. Currently there are two storage volume equations listed, one for sites with a constant outflow and one for an orifice. Applying the constant outflow equation with the modified green roof “C” factor results in 1.05 inches of water storage in Brooklyn for impervious areas. A one-inch retention standard should be promoted as a third criterion. It is simple, easy to understand, design and review, is based upon the current approach, and more rigorous for areas of less than an acre. A superior approach would be to make the one-inch capture (infiltration, evapotranspiration or reuse) the default compliance requirement, with detention and delayed release implemented only when this standard could not be met. The criteria should reward performance, not provide an artificial advantage for lesser performance.

b) Introduce a section on rain gardens, tree planters, and other surface control measures

c) Revise the hydrologic design parameters for volume reduction systems (*i.e.*, green infrastructure)to be based upon the volume criteria discussed in point “a” above.

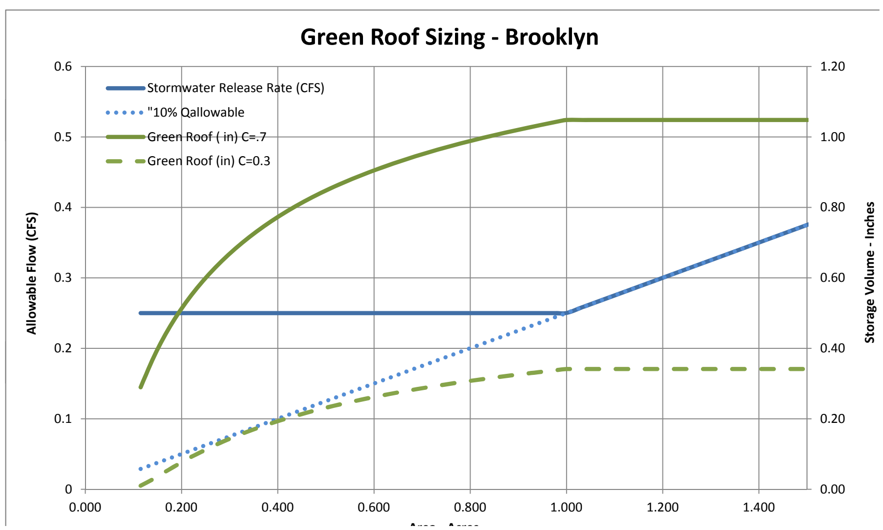
d) Review the manual to ensure the maintenance considerations are balanced for both green and grey infrastructure. For example, green roofs do not need to be inspected after every storm, as is currently recommended, although appropriate inspection and maintenance of green systems is important. Moreover, it is important to establish clear requirements for inspection and maintenance of grey systems, which appear to be lacking in the present draft.

Fundamentally, the document is well written and organized, with good detail. Due to this structure, it would be straight forward to revise this to address the points made previously, and would not require a massive rewrite.

Appendix A

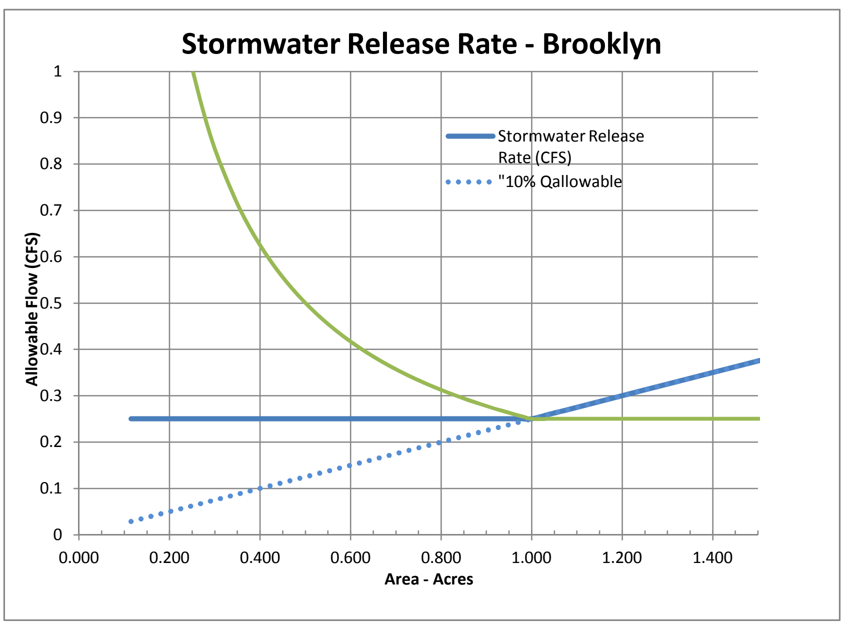
			Brooklyn			Qo				Qo			
			Allowable Outflow			Green Roof C				Green Roof C			
Qo	Area	Area	Criteria	10% Criteria	SRR	0.70	Time	Vol Storage	hes/ Impervious Ar	0.30	Time	Vol Storage	hes/ Impervious Ar
	Sq Ft	Ac	(CFS)	(CFS)	(CFS)	Qo - CFS	Min	Cubic Feet	inches	Qo - CFS	Min	Cubic Feet	inches
Brooklyn	5000	0.115	0.287	0.029	0.25	3.11	10.98	120.55	0.29	7.26	2.01	4.03	0.01
	6000	0.138	0.344	0.034	0.25	2.59	13.46	181.15	0.36	6.05	3.63	13.18	0.03
	7000	0.161	0.402	0.040	0.25	2.22	15.74	247.73	0.42	5.19	5.12	26.25	0.05
	8000	0.184	0.459	0.046	0.25	1.94	17.86	319.04	0.48	4.54	6.51	42.42	0.06
	9000	0.207	0.517	0.052	0.25	1.73	19.86	394.22	0.53	4.03	7.82	61.12	0.08
	10000	0.230	0.574	0.057	0.25	1.56	21.74	472.65	0.57	3.63	9.05	81.94	0.10
	12500	0.287	0.717	0.072	0.25	1.24	26.08	680.01	0.65	2.90	11.89	141.40	0.14
	15000	0.344	0.861	0.086	0.25	1.04	30.00	899.86	0.72	2.42	14.46	209.03	0.17
	17500	0.402	1.004	0.100	0.25	0.89	33.60	1129.17	0.77	2.07	16.82	282.85	0.19
	20000	0.459	1.148	0.115	0.25	0.78	36.96	1365.96	0.82	1.82	19.02	361.57	0.22
	22500	0.517	1.291	0.129	0.25	0.69	40.11	1608.87	0.86	1.61	21.08	444.30	0.24
	25000	0.574	1.435	0.143	0.25	0.62	43.09	1856.90	0.89	1.45	23.03	530.38	0.25
	27500	0.631	1.578	0.158	0.25	0.57	45.93	2109.31	0.92	1.32	24.89	619.32	0.27
	30000	0.689	1.722	0.172	0.25	0.52	48.64	2365.50	0.95	1.21	26.66	710.74	0.28
	32500	0.746	1.865	0.187	0.25	0.48	51.23	2625.01	0.97	1.12	28.36	804.34	0.30
	35000	0.803	2.009	0.201	0.25	0.44	53.74	2887.46	0.99	1.04	30.00	899.86	0.31
	37500	0.861	2.152	0.215	0.25	0.41	56.15	3152.55	1.01	0.97	31.58	997.11	0.32
	40000	0.918	2.296	0.230	0.25	0.39	58.48	3420.02	1.03	0.91	33.10	1095.91	0.33
	42500	0.976	2.439	0.244	0.25	0.37	60.74	3689.64	1.04	0.85	34.59	1196.13	0.34
	43560	1.000	2.500	0.250	0.25	0.36	61.68	3804.57	1.05	0.83	35.20	1239.01	0.34
	45000	1.033	2.583	0.258	0.25826	0.36	61.68	3930.34	1.05	0.83	35.20	1279.97	0.34
	47500	1.090	2.726	0.273	0.27261	0.36	61.68	4148.69	1.05	0.83	35.20	1351.08	0.34
	50000	1.148	2.870	0.287	0.28696	0.36	61.68	4367.04	1.05	0.83	35.20	1422.19	0.34
	52500	1.205	3.013	0.301	0.30131	0.36	61.68	4585.39	1.05	0.83	35.20	1493.30	0.34
	55000	1.263	3.157	0.316	0.31566	0.36	61.68	4803.74	1.05	0.83	35.20	1564.41	0.34
	57500	1.320	3.300	0.330	0.33	0.36	61.68	5022.10	1.05	0.83	35.20	1635.52	0.34
	60000	1.377	3.444	0.344	0.34435	0.36	61.68	5240.45	1.05	0.83	35.20	1706.63	0.34
	62500	1.435	3.587	0.359	0.3587	0.36	61.68	5458.80	1.05	0.83	35.20	1777.74	0.34
	65000	1.492	3.730	0.373	0.37305	0.36	61.68	5677.15	1.05	0.83	35.20	1848.85	0.34
	67500	1.550	3.874	0.387	0.3874	0.36	61.68	5895.50	1.05	0.83	35.20	1919.96	0.34
	70000	1.607	4.017	0.402	0.40174	0.36	61.68	6113.86	1.05	0.83	35.20	1991.07	0.34
	72500	1.664	4.161	0.416	0.41609	0.36	61.68	6332.21	1.05	0.83	35.20	2062.18	0.34
	75000	1.722	4.304	0.430	0.43044	0.36	61.68	6550.56	1.05	0.83	35.20	2133.29	0.34
	77500	1.779	4.448	0.445	0.44479	0.36	61.68	6768.91	1.05	0.83	35.20	2204.39	0.34
	80000	1.837	4.591	0.459	0.45914	0.36	61.68	6987.26	1.05	0.83	35.20	2275.50	0.34
	82500	1.894	4.735	0.473	0.47348	0.36	61.68	7205.62	1.05	0.83	35.20	2346.61	0.34
	85000	1.951	4.878	0.488	0.48783	0.36	61.68	7423.97	1.05	0.83	35.20	2417.72	0.34

Green Roofs Assum 0.700



			Brooklyn			
			Allowable Outflow			
Qo	Area	Area	Criteria	10% Criteria	SRR	SRR/UNIT AREA
	Sq Ft	Ac	(CFS)	(CFS)	(CFS)	CFS/Ac
Brooklyn	5000	0.115	0.287	0.029	0.25	2.18
	6000	0.138	0.344	0.034	0.25	1.82
	7000	0.161	0.402	0.040	0.25	1.56
	8000	0.184	0.459	0.046	0.25	1.36
	9000	0.207	0.517	0.052	0.25	1.21
	10000	0.230	0.574	0.057	0.25	1.09
	12500	0.287	0.717	0.072	0.25	0.87
	15000	0.344	0.861	0.086	0.25	0.73
	17500	0.402	1.004	0.100	0.25	0.62
	20000	0.459	1.148	0.115	0.25	0.54
	22500	0.517	1.291	0.129	0.25	0.48
	25000	0.574	1.435	0.143	0.25	0.44
	27500	0.631	1.578	0.158	0.25	0.40
	30000	0.689	1.722	0.172	0.25	0.36
	32500	0.746	1.865	0.187	0.25	0.34
	35000	0.803	2.009	0.201	0.25	0.31
	37500	0.861	2.152	0.215	0.25	0.29
	40000	0.918	2.296	0.230	0.25	0.27
	42500	0.976	2.439	0.244	0.25	0.26
	43560	1.000	2.500	0.250	0.25	0.25
	45000	1.033	2.583	0.258	0.25826	0.25
	47500	1.090	2.726	0.273	0.27261	0.25
	50000	1.148	2.870	0.287	0.28696	0.25
	52500	1.205	3.013	0.301	0.30131	0.25
	55000	1.263	3.157	0.316	0.31566	0.25
	57500	1.320	3.300	0.330	0.33	0.25
	60000	1.377	3.444	0.344	0.34435	0.25
	62500	1.435	3.587	0.359	0.3587	0.25
	65000	1.492	3.730	0.373	0.37305	0.25
	67500	1.550	3.874	0.387	0.3874	0.25
	70000	1.607	4.017	0.402	0.40174	0.25
	72500	1.664	4.161	0.416	0.41609	0.25
	75000	1.722	4.304	0.430	0.43044	0.25
	77500	1.779	4.448	0.445	0.44479	0.25
	80000	1.837	4.591	0.459	0.45914	0.25
	82500	1.894	4.735	0.473	0.47348	0.25
	85000	1.951	4.878	0.488	0.48783	0.25

Green Roofs Assum 0.700



Appendix B

MAINTENANCE OF STORMWATER INFRASTRUCTURE PRACTICES

Primary Author - Kevin M. Flynn, P.E.

Supervisor: Robert G. Traver, Ph.D., P.E., D.WRE

Villanova University Department of Civil and Environmental Engineering

Prepared for: Natural Resources Defense Council

November 2011

Table of Contents

I. Introduction

Like many older urban areas in the United States, New York City faces challenges associated with a combined sewer system. Urban development, population growth, and aging sanitary infrastructure have pushed these combined sewer systems beyond their capacity causing frequent combined sewage overflows (CSOs) during wet weather. These CSO events result in more than 27 billion gallons of raw sewage and polluted stormwater being discharged in the New York Harbor each year. CSO events can occur as often as 70 times per year at some CSO outfalls throughout New York City (Riverkeeper, 2011).

Tools for combating CSOs consist of both gray and green infrastructure practices. Gray infrastructure tools include wastewater treatment plant improvements, increases in combined sewer storage capacity, and distributed underground extended detention. Green infrastructure tools are more focused on runoff source control, and include both structural and nonstructural stormwater best management practices (BMPs). It is recognized that all CSO reduction practices will require a significant upfront investment, but an aspect possibility being overlooked when considering CSO solutions is the maintenance burden essential to sustain performance and to prevent failure of these practices.

This report focuses specifically on underground stormwater detention systems as a CSO reduction tool. The goal of this report is to explore existing literature that addresses maintenance issues associated with underground systems. Both case studies and published maintenance guidance are examined and summarized. Recommendations are made while addressing comparisons to green infrastructure practices.

II. Gray versus Green Infrastructure

Green infrastructure practices can potentially generate a more valuable array of environmental, economic, and social benefits than traditional stormwater peak flow reduction practices like underground detention systems without infiltration. In contrast to gray infrastructure, green infrastructure practices have the ability to restore natural hydrologic processes that include infiltration and evapo-transpiration. In a combined sewer system, these processes act to remove total stormwater volume, while detention practices simply detain and delay stormwater runoff from reaching a downstream wastewater treatment plant. Vegetated green infrastructure practices also help shade and insulate buildings, block winter winds, and create an evaporative cooling effect. Both reduced energy use at wastewater treatment plants and energy savings from reductions in building heating and cooling result in a decrease in green house gas (GHG) emissions and other pollutant emissions, as well as cost savings at wastewater treatment plants and power plants. Additional green infrastructure benefits not presented by gray infrastructure include recreation opportunities, enhanced community aesthetics, heat stress reduction by evaporative cooling, air quality improvements through plant respiration, and the promotion of community environmental awareness (Flynn, 2011). In effort to place a monetary value on these benefits at a city scale, equivalent gray and green infrastructure CSO plans were evaluated by Raucher (2009) for the City of Philadelphia, Pennsylvania. The results of this study predict the monetary value of environmental and social benefits to be 23 times more for a green infrastructure plan than for an equivalent gray infrastructure plan over a 40 year period (Raucher, 2009).

III. Case Studies

Sydney, Australia

Few detailed maintenance studies have been undertaken for underground stormwater detention systems. The studies that do exist contain more qualitative than quantitative assessments of practice performance and maintenance needs. Most recent studies are focused on infiltration practices and are undertaken in more suburban environments. Perhaps the best example of underground detention facilities without infiltration implemented across an urban area is in Sydney, Australia. Since 1991, municipalities in Sydney have required all redevelopment properties serviced by existing drainage systems to provide on-site stormwater detention (OSD). Due to the ultra-urban development of Sydney and its municipalities, OSD systems in these areas largely consist of underground storage structures without infiltration (O'Loughlin et al., 1995).

OSD policy was originally developed by the Upper Parramatta River Catchment Trust (UPRCT), which was formed in 1989 to control flooding in a 110 square kilometer catchment that spans four municipalities. Since the introduction of OSD regulation, the UPRCT has lead two field studies to evaluate design, construction, and maintenance issues with OSD systems. These field studies qualitatively assess and identify the most commonly encountered problems with Sydney OSD systems. For the first study, over 150 OSD systems built between 1991 and 1994 were inspected (Upper Parramatta River Catchment Trust, 2005). About 90% of these systems were found to have design or construction faults which impaired their efficiency (O'Loughlin et al., 1995). Many systems lacked sufficient storage volume. Drowned outlets, skewed inlets, and unapproved construction materials resulted in unreliable discharge control. Less than half of the 150 OSD systems surveyed had screens to capture sediment and debris. Those systems with screening were often found to have screens that were poorly fabricated, corroding, and too small in relation to the discharge orifice. Odor problems were identified due to decomposing organic matter in unvented underground detention systems. Additionally, the walls of some underground systems were found to be structurally deficient (Upper Parramatta River Catchment Trust, 2005).

The second field study focused on OSD systems built from 1994 to 2004. Although an improvement was observed from the systems constructed prior to this period, further deficiencies were identifies in this second generation of OSD systems. Drowned outlets that retarded discharge were common. Screens were now more widely seen, but improper placement was observed to allow floating debris to bypass and obstruct the discharge orifice. Insufficient and poorly designed conveyance systems allowed for flows to by-pass the storage systems. The most concerning finding with regard to longevity of underground detention systems was the difficulty of access for inspection and maintenance. Common access issues found were heavy concrete lids, jammed grates, inaccessible access points, and deep underground storage structures without safe access (Upper Parramatta River Catchment Trust, 2005). Overall, it was observed that despite improvements in engineering design and construction, underground detention systems cannot perform property without routine maintenance. This is concerning with regard to the performance of the region’s stormwater infrastructure as a whole, as very few underground systems in Sydney receive any maintenance at all (Still and Bewsher, 1995).

Maryland, USA

While the results of the studies by Upper Parramatta River Catchment Trust (2005) show performance and maintenance of underground stormwater facilities without infiltration in urban areas, a study was conducted across the State of Maryland by Lindsey (1992) with an expansive scope that includes both infiltration practices and subsurface practices without infiltration. Lindsey reports on the results of field inspections of 258 stormwater facilities across four Maryland counties. These counties (Baltimore, Carroll, Cecil, and Harford) illustrate different development patterns that range from rural to suburban to urban. Facilities inspected include dry basins, wet basins, vegetated swales, infiltration basins, infiltration trenches, dry wells, and underground detention. Qualitative assessments of all facilities were made based upon these field inspections. Data describing maintenance schedules and the age of the facilities at time of inspection is unknown for this study (Lindsey, 1992). A summary of field inspection results is shown in *Table 1*. Analysis has been undertaken to isolate performance and maintenance needs of subsurface infiltration facilities (infiltration trenches and dry wells) and underground detention facilities without infiltration.

Table 1. Analysis of stormwater facility field inspection results (Lindsey, 1992)

	All Facilities[1]		**Subsurface Infiltration[2]**		**Underground Detention[3]**	
	#	%	#	%	#	%
Facilities inspected	258	100%	47	100%	31	100%
Functioning as designed	164	64%	33	70%	24	77%
Water quantity controlled as designed	182	71%	34	72%	26	84%
Enforcement action needed	71	28%	13	28%	9	29%
Maintenance action needed	177	69%	21	45%	15	48%
Inappropriate water ponding	70	27%	9	19%	5	16%
Clogging of facility	62	24%	13	28%	6	19%
Excessive sediment or debris	122	47%	22	47%	12	39%
Water bypassing facility	25	10%	11	23%	1	3%
Sediment entering facility	141	55%	24	51%	19	61%
Sediment/debris removal needed	125	48%	21	45%	18	58%
Inlet or outlet clogged	48	19%	8	17%	6	19%

Notes:

1. Includes dry basins, wet basins, vegetated swales, infiltration basins, infiltration trenches, dry wells, and underground detention.

2. Includes infiltration trenches and dry wells.

3. Underground detention systems without infiltration.

Analysis shows that maintenance action is needed for almost half (48%) of all underground detention facilities inspected, which is better than the average of all of the inspected facilities.

Despite this designation, enforcement action, which is indicative of more severe maintenance issues, is needed for 29% of the underground facilities inspected. This is worse than the overall average for all of the facilities inspected.

The major maintenance issue for most stormwater management facilities, including underground detention, is the accumulation of sediment and debris. Of the underground detention facilities examined by Lindsey (1992), 61% were found to have sediment entering the facility and 58% were in need of sediment and debris removal. These results are worse than the average of both all inspected facilities and all subsurface infiltration facilities (Lindsey, 1992). These results suggest that underground detention facilities without infiltration may be more susceptible to sediment and debris accumulation. This highlights the need for frequent and scheduled maintenance inspections because accumulation in these practices may not otherwise be observable.

Pennsylvania, USA

Ongoing monitoring and research at the Villanova University Stormwater Research and Demonstration Park has confirmed the importance of proper design, construction, and maintenance for all stormwater BMPs. Publications by Welker et al. (2006), Emerson and Traver (2008), and Emerson et al. (2010) assess performance and maintenance implications of both subsurface and aboveground infiltration BMPs. Site investigations in Maryland by Lindsey (1992) showed that on average approximately half of infiltration BMPs fail due to sediment buildup, improper design, improper location, and lack of maintenance (Lindsey, 1992).

A study was conducted at Villanova University by Emerson et al. (2010) to examine how a subsurface stormwater infiltration trench with an artificially accelerated aging process would perform over time. This practice was significantly undersized and designed to capture stormwater runoff from a busy parking deck, which results in an excessively high loading rate for both stormwater runoff volume and sediment. The practice receives no pretreatment and maintenance access is not provided for the six foot deep stone infiltration bed. Monitoring results over the first three years of operation show a rapid decrease in the subsurface infiltration trench's ability to infiltrate stormwater. This study demonstrates the importance of pre-treatment, proper siting, and adequate maintenance access for subsurface infiltration practices (Emerson et al., 2010).

Other cases have been studied where green infrastructure practices have been found to be resilient despite a lack of maintenance. In a study by Emerson and Traver (2008), two infiltration stormwater BMPs at Villanova University were continuously monitored without significant maintenance of their infiltration surfaces. One practice is a pervious concrete site with a subsurface infiltration basin. The majority of the runoff from this site is received from the roofs four-story dormitory buildings, which discharge directly to the subsurface basin. This subsurface infiltration BMP was monitored over a two year period. The other practice monitored for this study was a bioinfiltration traffic island, which received runoff from a 0.52 hectare watershed with 35% of the drainage area as directly connected impervious. Riprap aprons at inflow points provide pretreatment of all directly connected impervious drainage area. This infiltration BMP was monitored over a 4 year period. Despite no significant maintenance, results show no discernible decline in performance for both practices over the period of record examined (Emerson and Traver, 2008).

Yet another monitoring study at Villanova University by Welker et al. (2006) yielded a similar assessment of subsurface infiltration practices. For this study, an 85 to 100 year old subsurface infiltration pit on the Villanova University Campus was studied. Like the subsurface infiltration practice in the study by Emerson and Traver (2008), this site received the majority of its inflow from the roofs of four-story campus buildings. Despite no known maintenance over the life of the practice, this pits maintained excellent infiltration capacity (Welker et al., 2006). The results of these three studies show that infiltration practices can maintain performance with limited maintenance if they are designed to treat stormwater runoff without high sediment loads, such as roof areas, or designed with proper pre-treatment.

Historic Green Infrastructure

While green infrastructure practices may be a relatively new approach to reduce CSO events, green infrastructure practices have been used for centuries for the conveyance of stormwater runoff, microclimate mitigation, and the enhancement of urban aesthetics. Green roofs have been common in Norway since the Middle Ages. In rural areas, sod roofs were almost universal in the beginning of the 18th century. This green infrastructure practice was used as a means of thermally insulating buildings from the Norwegian climate. Some of these 18th century green roofs are still functioning today as a testament to the potential longevity of this practice. In France, rooftop gardens still thrive at a Benedictine abbey constructed in the 13th century. The use of green roof technology has been well established in Germany since the 1960s. Today, Germany boasts more green roofs than any other nation (Yasinian, 2011). The oldest known green roofs in the United States are located at Rockefeller Center in Midtown Manhattan. These five roof gardens were constructed between 1933 and 1936 (Greenroofs.com, 2011). With their lavish design, they continue to enhance New York City views while reducing stormwater runoff to the combined sewer system.

Infiltration green infrastructure practices have also been around for centuries. Notable are the rain gardens in the City of Isfahan, Iran, which were constructed in the 16^{th} century and are still functioning today. The urban streets of Isfahan are lined with sunken gardens containing dense trees and shrubs. For hundreds of years, these rain gardens have infiltrated and conveyed stormwater and provided climate mitigation through evapo-transpiration and shade. Like green infrastructure practices in urban areas today, these ancient green infrastructure infiltration practices couple environmental function and aesthetic beauty while providing health and social benefits to the citizens of Isfahan. The longevity of these rain gardens may be attributed to the city's dedication to maintain these practices. Routine maintenance keeps the rain gardens free of debris and standing water. This maintenance is necessary to preserve the quality of the precious water resources of Isfahan as these rain gardens drain directly to the City's main canals and the Zayandeh River (Wark, 2011).

More recently, infiltration green infrastructure practices have evolved to adapt to land development patterns shaped by the automobile. This facilitated the invention of porous asphalt pavement in the 1970s. Porous pavements can provide stormwater volume reduction through subsurface infiltration. With proper construction as well as routine and adequate maintenance, these infiltration green infrastructure practices have been observed to be highly effective. Two examples of the longevity of porous asphalt pavement practices with infiltration are the parking lots at the Morris Arboretum of the University of Pennsylvania in Philadelphia and the parking lot at the Siemens Medical Systems Corporate Campus in Malvern, Pennsylvania. Constructed in the early 1980s, both of these practices continue to perform effectively more than 25 years after their installation (Adams, 2003).

IV. Underground Detention Maintenance Guidance and Protocols

Some municipalities offer guidance documents and protocols with respect to maintenance of underground stormwater detention practices. The following section of this report summarizes some of the underground detention maintenance issues, schedules, and protocols from selected municipal manuals and handbooks. Further information on underground stormwater detention system maintenance is available from the Upper Parramatta River Catchment Trust (2005), the Stormwater Services Division of the City of Durham (2008), the Engineering and Public Works Department of Knox County Tennessee (2011), and the Virginia Department of Conservation and Recreation (2009).

Underground detention systems consist of a number of components, each with different potential maintenances issues. Typical underground detention system components include control structures, detention chambers, vaults or pipes, inlets, outfalls, screening, and bypass structures. Control structures may be the most critical component to the stormwater management performance of these systems. A minimum control structure low flow orifice diameter of one (1) inch (25 millimeters) is consistent across all municipal manuals reviewed for this report. Detention control structures are to be fitted with screening or trash racks to prevent orifice blockage, retain trash and debris, and to create static conditions around orifices to achieve predictable discharge rates (Upper Parramatta River Catchment Trust, 2005). The *Knox County Stormwater Management Manual* recommends low flow orifices be protected by a vertical stand pipe with 0.5 inch orifices or slots that are protected by wire cloth and a stone filtering jacket (Engineering and Public Works Department of Knox County Tennessee, 2008).

In addition to proper design and construction practices, underground detention control structures must be routinely maintained to provide the expected stormwater management performance. The most common control structure maintenance issue is blockage by trash, sediment, and debris. This may be addressed with routine inspection and cleaning. To allow for routine maintenance, underground detention systems must be designed with adequate access to their control structures. As per the Upper Parramatta River Catchment Trust's *On-site Stormwater Detention Handbook*, minimum internal dimensions around control structures for maintenance are 600 mm by 600 mm (approximately 2 ft by 2 ft) for structures up to 600 mm (2 ft) deep and 900 mm by 900 mm (approximately 3 ft by 3ft) for structures greater than 600 mm deep (Upper Parramatta River Catchment Trust, 2005).

More severe control structure maintenance issues consist of degraded structural integrity and insufficient debris management. Major structural integrity issues may require complete replacement. Less severe structural issues such as cracks, spalled areas, and rust may be mitigated using typical construction materials such as grouts, bonding agents, sealants, and paints. Insufficient debris management may be a result of environmental factors, improper design, or a combination of issues. This issue can be recognized by standing water for a period of longer than three days, and may require the installation of screening, trash racks, or other pretreatment practices to resolve (Stormwater Services Division, City of Durham, 2008).

Chambers, vaults, or pipes which provide extended detention for underground systems may also build up trash, sediment, and debris without routine cleaning. Accumulation may reduce available stormwater storage volume and thus decrease performance of these detention systems. In addition, debris and standing water due to lack of routine maintenance may promote mosquito breeding in underground structures. Routine maintenance consisting of sediment and debris removal may require specialized pumping equipment for some detention systems. Inspection and maintenance staff could also be required to have confined-space training to satisfy Occupational

Safety and Health Administration (OSHA) safety requirements (Virginia Department of Conservation and Recreation, 2009). Other potential maintenance issues with underground storage components include leaking and misaligned joints, separated joints, and crushed, collapsed, or rusted pipe sections. Progressive infiltration of soil into underground systems may result in cave-ins which could damage utilities as well as aboveground features such as parking and travel surfaces (Stormwater Services Division, City of Durham, 2008).

Inlets, outfalls, screening, and bypass structures are additional critical components to the performance of underground stormwater detention systems that require routine inspection and maintenance. Periodic inspections can identify any blockages, erosion, or structural issues with these system components. Routine maintenance is necessary to keep these components in good working condition. This reinforces the need for adequate maintenance access to all system components. Maintenance will include the removal of trash, sediment, and debris along with mitigation of more significant maintenance issues as they arise.

Because underground stormwater detention systems are likely to be inconspicuous and easily neglected, a maintenance schedule must be established and followed to ensure proper performance and to prevent system failure. One suggested maintenance schedule for underground stormwater detention systems is as follows:

1. Monthly or as needed cleaning and removal of sediment, trash, and debris.
2. Semi-annual inspection of inlet and outlet structures.
3. Annual inspection of sediment accumulation in the facility.
4. As needed inspection after several storm events or an extreme event.

This maintenance schedule is referenced from the *Knox County Stormwater Management Manual* (Engineering and Public Works Department of Knox County Tennessee, 2011). Other municipalities recommend inspection frequency based on land use. For example the Upper Parramatta River Catchment Trust (2005) recommends inspection every six months for residential land uses and inspection every three months for commercial land uses. This illustrates the point that maintenance is a function of the quality of the stormwater flow received by the system. The other integral component to following a proper maintenance schedule is the establishment of maintenance responsibilities and a maintenance budget. While most above-ground green infrastructure practices may be maintained by property owners, residents, or landscaping contractors, many underground systems require commercial cleaning companies with specialized equipment (Upper Parramatta River Catchment Trust, 2005).

V. Summary and Recommendations

The previous sections of this report examine case studies and published maintenance guidance for underground stormwater detention systems. In Sydney, it was observed that improvements in engineering design and construction cannot overcome a lack of routine maintenance (Upper Parramatta River Catchment Trust, 2005). Results of the Maryland case study suggest that underground detention systems without infiltration may be more susceptible to sediment and debris accumulation than aboveground practices (Lindsey, 1992). Studies at Villanova University show the important relationship between runoff quality from contributing drainage areas and the performance of underground infiltration systems. Practices that received building roof runoff without high sediment loads were observed to maintain performance with limited maintenance (Emerson and Traver, 2008). In New York City, only 20 percent of stormwater runoff is from roof areas. The remaining 60 percent is mostly from roads and sidewalks that will yield high sediment loads (Plumb and Seggos, 2008). This indicates that underground stormwater detention systems alone would not be the preferable CSO mitigation tool for New York City. It is recommended that stormwater flows to underground detention systems receive pre-treatment to improve practice performance and lessen maintenance needs.

The review of several municipalities' maintenance guidance and protocol documents demonstrates the range of maintenance issues associated with underground stormwater detention systems and highlights the need for frequent and scheduled maintenance inspections. Accumulation of trash, sediment, and debris is identified as the most common maintenance issue for all underground detention system components. This issue can be addressed with routine inspection and cleaning. One major obstacle to routine maintenance is a lack of access to these underground systems. To allow for routine maintenance, underground detention systems must be designed with adequate access to all system components. This should include access for vehicles and specialized equipment that may be required for system cleaning and repair. Because underground stormwater detention systems are likely to be out of sight and possibly out of mind, providing access alone cannot ensure these systems will receive the maintenance they need. Consequently, a detailed maintenance schedule must be established and followed to preserve system performance and to prevent system failure.

Inspection is just as important as maintenance for both gray and green infrastructure practices. Inspection cost may be as little as 5 to 10 percent of the total inspection plus maintenance cost for these systems. Like underground stormwater detention systems, green infrastructure practices need to be inspected. The frequency of inspection will depend upon the sediment loading and land practices contributing to the practice. Maintenance can be unique between practices, therefore property owners and maintenance contractors must be properly trained and understand the function of these practices (Hunt and Lord, 2005).

Deferred maintenance of both gray and green infrastructure practices can increase cost and negatively affect receiving sewer systems and downstream water bodies. Most maintenance problems are less costly to correct when caught early. The *Virginia Stormwater Management Handbook* separates maintenance into two categories: routine maintenance and structural maintenance. Structural maintenance is typically more costly and requires an enhanced level of expertise than routine maintenance (Virginia Department of Conservation and Recreation, 2009). Typically underground stormwater detention systems will have more components which may require structural maintenance than green infrastructure practices. While both will require routine maintenance, it could be concluded that underground detention will require more frequent structural maintenance compared to green infrastructure, in addition to a similar level of routine maintenance. In some cases, underground stormwater detention maintenance may be a more costly alternative.

VI. References

1. Adams, M. (2003). "Porous Asphalt Pavement with Recharge Beds: 20 Years & Still Working." *Stormwater*. May/June 2003. http://www.stormh2o.com/may-june-2003/pavement-porous-bmps.aspx
2. Emerson, C.H., B.M. Wadzuk, and R.G. Traver (2010). "Hydraulic evolution and total suspended solids capture of an infiltration trench." *Hydrological Processes*. 24, pp. 1008-1014.
3. Emerson, C.H. and R.G. Traver (2008). "Multiyear and Seasonal Variation of Infiltration from Storm-Water Best Management Practices." *Journal of Irrigation and Drainage Engineering*. Vol. 134 (5), pp. 598-605.
4. Emerson, C.H., C. Welty, and R.G. Traver (2005). "Watershed-Scale Evaluation of a System of Storm Water Detention Basins." *Journal of Hydrologic Engineering*. Vol. 10 (3),pp.237-242.
5. Engineering and Public Works, Knox County Tennessee (2008). "Knox County Stormwater Management Manual." Engineering and Public Works, Knox County Tennessee.Knoxville,TN. http://www.knoxcounty.org/stormwater/proposed_stormwater_ordinance.php
6. Flynn, K. M. (2011). "Evaluation Of Green Infrastructure Practices Using Life Cycle Assessment", Thesis, College of Engineering, Villanova University, Villanova PA.
7. Greenroofs.com (2011). "Rockefeller Center Roof Gardens." *Greenroof & Greenwall Projects Database*. Retrieved October 10, 2011 from http://www.greenroofs.com/projects/pview.php?id=666.

8. Hirschman, D., L. Woodworth, and S. Drescher (2009). "Stormwater BMPs in Virginia's James River Basin: An Assessment of Field Conditions & Programs." Final Draft, June 2009. Center for Watershed Protection, Inc. Ellicott City, MD.

9. Hunt, W.F. and W.G. Lord (2005). "Determining Inspection and Maintenance Requirements and Costs for Structural BMPs in North Carolina." Water Resources Research Institute of the University of North Carolina. Report No. SRS-27. Raleigh, NC. http://repository.lib.ncsu.edu/dr/bitstream/1840.4/4119/1/NC-WRRI-SRS-27.pdf

10. Lindsey, G. (1992). "Maintenance of stormwater BMPs in four Maryland counties: A status report." *Journal of Soil and Water Conservation*. Volume 47 (5), pp. 417-422.

11. O'Loughlin, G., S. Beecham, S. Lees, L. Rose, and D. Nicholas (1995). "On-site stormwater detention systems in Sydney." *Water Science and Technology*. Volume 32, Number 1, pp. 169-175. http://www.efn.uncor.edu/departamentos/hidraul/hidrologia/Auxiliar/95-071.pdf

12. Plumb, M. and B. Seggos (2006). "Sustainable Raindrops: Cleaning the New York Harbor by Greening the Urban Landscape." Riverkeeper. Tarrytown, NY. http://www.riverkeeper.org/wp-content/uploads/2009/06/Sustainable-Raindrops-Report-1-8-08.pdf

13. Raucher, R.S. (2009). "A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds." Stratus Consulting, Inc. August 24, 2009. http://www.michigan.gov/documents/dnr/TBL.AssessmentGreenVsTraditionalStormwaterMgt_293337_7.pdf

14. Riverkeeper, Inc. (2011). Combined Sewage Overflows (CSOs). *Riverkeeper Website*. Retrieved September 29, 2011, from http://www.riverkeeper.org/campaigns/stop-polluters/sewage-contamination/cso/.

15. Still, D. and D. Bewsher (1995). "On-Site Stormwater Detention in NSW – Past, Present, and Future." 2nd International Symposium on Urban Stormwater Management, Institution of Engineers, Australia, Melbourne.
http://www.bewsher.com.au/pdf/CNF12P_2.pdf

16. Stormwater Services Division, City of Durham (2008). "Owner's Maintenance Guide for Stormwater BMPs Constructed in the City of Durham." Stormwater Services Division, Department of Public Works, City of Durham. Durham, NC.
http://www.ci.durham.nc.us/departments/works/pdf/doc11_maint_guide.pdf

17. United States Environmental Protection Agency (US EPA) (2007). "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices." US EPA, Nonpoint Source Control Branch. EPA 841-F-07-006. Washington, DC.
http://www.epa.gov/owow/NPS/lid/costs07/documents/reducingstormwatercosts.pdf

18. Upper Parramatta River Catchment Trust (UPRCT) (2005). "On-site Stormwater Detention Handbook." 4th Edition. December 2005. Parramatta, NSW, Australia.
http://www.uprct.nsw.gov.au/osd/2005_4th%20edition/UPRCT%20Handbook%2019Dec05_PDF.pdf

19. Virginia Department of Conservation and Recreation (2009). "Virginia Stormwater Management Handbook." Volume II. Chapter 9 – BMP Inspection and Maintenance. Department of Conservation and Recreation, Division of Soil and Water Conservation, Commonwealth of Virginia. Richmond, VA.

http://www.dcr.virginia.gov/stormwater_management/documents/Volume_II.pdf

20. Wark, Laith (2011). "Rain Gardens of Isfahan." *Verdaus Urban Landscape Architects LLC Website*. Retrieved October 10, 2011 from http://verdaus.com/blog/?p=1084.

21. Welker, A.L., M. Gore, and R.G. Traver (2006). "Evaluation of the Long Term Impacts of an Infiltration BMP." Proceedings from the 7th International Conference on Hydroscience and Engineering (ICHE-2006), Sept 10-13. Philadelphia, USA. http://idea.library.drexel.edu/bitstream/1860/1479/1/2007017114.pdf

22. Yasinian, S. (2011). "Investigating the Sustainable Aspects of Green Roofs in Building Construction." *American Journal of Scientific Research*. Issue 25, pp. 46-53. http://www.eurojournals.com/AJSR_25_06.pdf

November 30th 2011

ROBERT G. TRAVER
Department of Civil and Environmental Engineering
Villanova University
Villanova PA, 19085

EXPERIENCE:

Professor	Department of Civil and Environmental Engineering, Villanova University (2008- present)
Director	Villanova Center for the Advancement of Sustainability in Engineering (2009 present)
Director	Villanova Urban Stormwater Partnership (2002- present)
Associate Professor	Department of Civil and Environmental Engineering Villanova University (1995- 2008)
Assistant Professor	Department of Civil and Environmental Engineering Villanova University (1988- 1994)
Assistant Professor	Department of Civil and Environmental Engineering Virginia Military Institute, (1982- 1984)
Project Engineer	Yerkes Associates, Bryn Mawr, PA 1978- 1981

EDUCATION:

Ph.D., Pennsylvania State University, Civil Engineering, 1988
M.C.E., Villanova University, Civil Engineering, 1982
B.S.C.E., Virginia Military Institute, Civil Engineering, 1978

AWARDS & HONORS

Chi Epsilon - Tau Beta Pi - Sigma Xi
2011 President Elect - American Academy of Water Resources Engineers
2008 Chester County Watershed Stewardship Award
2007 Outstanding Civilian Service Medal – US Army Corp of Engineers (Katrina)
2005 Ruth Patrick Education Award – Water Resources Association of the Delaware
2004 Water Resource Engineer of the Year – Philadelphia Section ASCE.

FUNDED RESEARCH:

Funded research from agencies including the USEPA, Cooperative Institute for Coastal and Estuarine Environmental Technologies (a NOAA-supported Center), Pennsylvania Non Point Source Program (319), Pennsylvania Growing Greener and Coastal Zone Programs, and the William Penn Foundation.

PROFESSIONAL ACTIVITIES:

Director - Villanova Center for the Advancement of Sustainability in Engineering, directs multidisciplinary college center to coordinate and integrate interdisciplinary sustainability concepts in research and education.
Director - Villanova Urban Stormwater Partnership –directs public – private partnership working to advance the profession.
Member and Chair - Water Resources Advisory Committee, Pennsylvania Department of Env. Protection.
Associate Editor – Journal of Irrigation and Drainage – ASCE
Board Member – National LID Center

REGISTRATION AND PROFESSIONAL AFFILIATIONS:

Professional Engineer, Commonwealth of Pennsylvania and Virginia

Diplomat and Trustee, American Academy of Water Resources Engineers

MAJOR REPORTS

- *A Review of the Proposed Revisions to the Federal Principles and Guidelines Water Resources Planning Document,* National Research Council, National Academies Press, Washington DC, 2010
- *Urban Stormwater Management in the United States,* National Research Council, National Academies Press, Washington DC, 2008
- *The New Orleans Hurricane Protection System: What Went Wrong and Why – A Report by the American Society of Civil Engineers Hurricane Katrina External Review Panel,* Reston, VA: ASCE, 978-0-7844-0893-3, 2007

RECENT SELECTED PUBLICATIONS

1. Hunt, W.F., Davis, A.P., and Traver, R.G. (2011) "Meeting Hydrologic and Water Quality Goals through Targeted Bioretention Design," Journal Environmental Engineering, ASCE., accepted for publication, October 2011.

2. Davis, A.P., Traver, R.G., Hunt, W.F., Brown, R.A., Lee, R. and Olszewski, J.M. (2011). "Hydrologic Performance of Bioretention Stormwater Control Measures." Journal Hydrologic Eng, ASCE., accepted for publication, June 2011H

3. Horst, M., Welker, A., Traver, R., "Multi Year Performance of a Pervious Concrete Infiltration Basin BMP", ASCE Journal of Irrigation and Drainage, ASCE Posted Ahead of Print Oct 2010.

4. Machusick, M., Traver, R., Welker, A., Traver, R., "Groundwater Mounding At A Stormwater Infiltration Bmp", ASCE Journal of Irrigation and Drainage, ASCE March 2011.

5. Davis, A. Hunt, W. Traver, R, "Improving Urban Stormwater Quality: UCOWR Applying Fundamental Principles, Journal of Contemporary Water Research and Education, Dec. 2010.

6. Wadzuk, B., Rea, M., Woodruff, G., Flynn, K. Traver, R., "Water Quality Performance of a Constructed Stormwater Wetland for All Flow Conditions", AWRA, Volume 46, Issue 2, pages 385–394, April 2010.

7. Emerson, C., Wadzuk, B., Traver, R., "Hydraulic Evolution and Total Suspended Solids Capture of an Infiltration Trench" Hydrologic Processes, Wiley Jan 2010

8. Batroney, T., Wadzuk, B., Traver, R., "A Parking Deck's First Flush" ASCE Journal of Hydrologic Engineering, February 2010

9. Gilbert, R., Traver, R., "Beyond Assessing and onto Managing Risk for Levees," UCOWR Journal of Contemporary Water Research and Education, April 2009

10. Davis, A. Hunt, W. Traver, R., "Bioretention Technology: An Overview of Current Practice and Future Needs." ASCE Journal of Environmental Engineering – ASCE Journal of Environmental Engineering, ASCE March 2009

11. Emerson, C., Traver, R., Multiyear and Seasonal Variation of Infiltration from Storm-Water Best Management Practices, ASCE Journal of Irrigation and Drainage, ASCE Sep\Oct 2008.

REBNY®
REAL ESTATE BOARD OF NEW YORK

November 18, 2011

Julie Stein
Department of Environmental Protection
59-17 Junction Boulevard
Flushing, NY 11373

Dear Ms. Stein,

Thank you for the opportunity to comment on the Department of Environmental Protection's (DEP) Guidelines for the Design and Construction of Stormwater Management Systems ("Guidelines") and stormwater rule. The Real Estate Board of New York and its members support the DEP's goal of reducing the combined sewer overflows (CSO's), and achieving this goal by reducing peak discharges from individual sites. Given the ambitions of this rule, the development of the technical guidelines has been a complex process, and we appreciate the efforts that DEP and the City have made to communicate with us and to incorporate our concerns.

We would like to specifically acknowledge the letter form Deputy Commissioner Angela Licata dated November 10, 2011, which outlined the responses to REBNY's concerns with the Guidelines dated July 2011. The responses within the letter largely addressed some of our most substantial concerns with the proposal – including the rainwater harvesting and greenroofs. We believe the DEP's approach to the rainwater recycling systems now described In Section 2 (page 31) credits the cisterns at a rate for one-for-one with a detention system and will encourage building systems that will not only reduce CSO occurrences, but will also extend our drinking water self-sufficiency and the capacity of our existing waste water treatment facilities. We also appreciate the credits provided to intensive greenroofs, in saturated and unsaturated conditions.

The comments we have on the rule and October 2011 draft are below:

- **Greenroofs**: As discussed above, we appreciate the inclusion of the runoff coefficient of 0.7 for intensive greenroofs as defined by 4" in depth or greater. We encourage DEP to continue advancing the spirit of the Guidelines and in the future consider runoff coefficients below 0.95 (coefficient for "black roofs") for green roofs less than 4" thick, on a case-by case basis when supported by engineering or manufacturer data.

- **Infiltration**: DEP has indicated that it will revise and distribute its Criteria prior to the rule being finalized. We look forward to reviewing those criteria when available and encourage DEP to credit infiltration rates aggressively to encourage green infrastructure as much as possible.

- **Overflow pipes**: We appreciate the coordination between DEP has DOB and would like to thank DEP staff for clarifying the intent to have this issue resolved prior to the rule being finalized. As the goal of the rule is currently structured, we do not see a technical justification or environmental benefit to installing a restrictor plate or reduced-sized orifice on the overflow above the required capture rate. The overflow is utilized to safely convey stormwater during events that exceed the DEP 10-year design storm importantly, however, placing restrictions on the overflow may cause property damage from backups during severe storm events and may conflict with DOB requirements for pipe sizes. Therefore, we strongly suggest removing from DEP Guidelines/Rule/Criteria any requirement for restrictions on overflows, thus leaving the sizing of overflow pipes under the purview of DOB Building Code.

- **Borings**: The DEP letter dated November 10 indicated that our comment that the "design infiltration value shall be the average of the measured readings, up to the limits currently in the Guidelines" was accepted. However, the text on page 124 still indicates 50% effective rate. We request a revision to Item 8, last bullet, to read *"The infiltration rate used in the design of the infiltration practice shall be the average of the measured readings, up to the limits currently in the Guidelines."*

- **Dry wells**: We respect the building code language that discusses how owners are required to connect to sewers when available and should limit drywell use to areas lacking sewers or a being certain distance from sewers. However, drywells in this context would create another tool to comply with the Guidelines, not intended to eliminate site sewer connections. The Guidelines permit and illustrate infiltration chambers, gravel beds, and open-bottom storage tanks – which are functionally equivalent to a drywell. Drywells remain commonplace in the pre-cast manufacturing industry and are a viable system when used in the context of the rest of the Guidelines.

- **Phase in period**: We are requesting that a phase in period apply to this rule, and that the requirements would impact developments 9 months after the effective date of the rule, which will allow buildings currently in design to move forward and not require systems or buildings to be redesigned.

As we acknowledged in previous comments, the costs of operating the City's water and sewer infrastructure are ones that all New Yorkers in some way share, and with the recently reversed trend of double digit increases in water rates over the past several years, the Green Infrastructure Plan's $2.4B in savings over 20 years will continue to provide great relief to residents and businesses. We feel that these programs are critical to maintaining a sustainable and competitive New York City. Thank you for the opportunity to comment, and we look forward to any further discussions regarding these proposals.

Sincerely,

Angela Sung Pinsky
SVP Management Services and Government Affairs

Master Plumbers Council of the City of New York
and the
Subsurface Plumbers Association of the City of New York
104-09 Metropolitan Avenue, Forest Hills NY 11375
Phone: (718) 793-6300 • Fax: (718) 793-6190 • Website: www.nycmpc.org

October 31, 2011

Good morning!

My name is David Balkan and I am here to represent both the Master Plumbers Council and the Subsurface Plumbers Association of New York City.

After a review of the proposed rule changes our Associations have but two comments:

1. Located on Page 14, number 2, ii:
(ii) ***If the Licensed Master Plumber retains a subcontractor, that subcontractor is only authorized to conduct non-plumbing work. All plumbing work must be done by the Licensed Master Plumber or persons under the direct employment and continuing supervision of the Licensed Master Plumber.***

By stating that all plumbing work must be performed by 'the' licensed plumber it seems to eliminate a Licensed Master Plumber from being able to subcontract to another Licensed Master Plumber. We propose that the word 'the' be changed to 'a' Licensed Master Plumber as Licensed Master Plumbers have always been allowed to subcontract out work to other Licensed Plumbers.

2. Located on Page 18, number 1, iv:
(iv) ***Extra heavy cast iron soil pipe (EHCI) on broken stone bedding conforming with A.S.T.M. Class thirty-three (33), size sixty seven (67).***

We would like the wording changed to indicate that broken stone bedding will only be required when unstable or unsuitable soil conditions exist. Trucking in stone when existing ground conditions such as sand exists is an unnecessary step in performing a proper house sewer installation.

Thank you in advance for your time and consideration regarding the above two comments.

Respectfully,
David Balkan
David Balkan
Chairman, Subsurface Committee of the N.Y.C. Master Plumbers Council
Vice President, Subsurface Plumbers Association of N.Y.C.

BOMA NEW YORK

October 31, 2011

Charles Shamoon, Esq.
New York Department of Environmental Protection
Office of Legal Affairs
59-17 Junction Blvd, 19th Floor
Flushing, NY 11373

Dear Mr. Shamoon:

Thank you for allowing us to comment on the proposed amendments to Chapter 31 of Title 15 of the Rules Governing House/Site Connections to the Sewer System. BOMA/NY represents more than 700 owners, property managers and building professionals who either own or manage 400 million square feet of commercial space. We're responsible for the safety of over 3 million tenants, generate more than $1.5 billion in tax revenue and oversee annual budgets of more than $4 billion dollars.

BOMA/NY members have had a long standing commitment to the greening of our City—and we do that *every day* in the buildings we own and manage. Our members have voluntarily pursued and received LEED, Energy Star and IS4001 certification—the gold standards in energy and environmental conservation.

We support the purpose of the amendments to alleviate the number of combined sewer overflow events by reducing the amount of run-off from structures to capture stormwater and help reduce the burden on New York's sewer system. We believe that this is not only a wise way to allocate city resources but is environmentally sustainable.

However, we are concerned about the proposed "Guidelines for the Design and Construction of Stormwater Management Systems". We would like the Department to revise the Guidelines to reflect that not all retention and tank systems in existing buildings are built the same. We ask that the language of the proposed amendment be changed to give building professionals the flexibility to control stormwater flows without adversely impacting the Sewer System. The requirements for overflow pipes, permeability testing, pretreatment of flows entering detention systems, inspection during and after construction need to be crafted in order to allow maximum flexibility without diminishing the impact on stormwater flows.

We believe that by tightening detention requirements, our members would be required to build additional stormwater infrastructure that will not only lead to higher costs being passed along to tenants but will inhibit investments into making existing buildings more energy and water sustainable.

BOMA/NY believes that our professionals are capable of designing, implementing and operating retention systems that meet the Department's sustainability goals while decreasing the chances of combined sewer overflow events in the future.

Once again thank you for giving us the opportunity to comment on the proposed amendment, we look forward to working with the New York City Department of Environmental Protection on this issue.

Sincerely,

Sylvester A. Giustino
Director of Legislative Affairs
BOMA/NY

BUILDING OWNERS AND MANAGERS ASSOCIATION OF GREATER NEW YORK, INC.

11 Penn Plaza, Suite 2201
New York, New York 10001
Telephone (212) 239.3662
Facsimile (212) 268.7441
E-mail info@bomany.com
http://www.bomany.org