

Urban Water Solutions Initiative

Suggestions for NJDEP Guidance Regarding Green Infrastructure

Stakeholders involved with the Urban Water Solutions Work Group have noted a desire for clarification regarding the evaluation and inclusion of green infrastructure (GI) in Long Term Control Plans (LTCP) for sewer systems with CSOs. The basic questions are what level of analysis is sufficient for LTCP purposes, and how decisions should be made regarding inclusion of GI in the LTCP itself. Beyond these basics, municipalities and utilities will need guidance on green infrastructure maintenance, monitoring and adaptive management to ensure that they get full credit for the GI that is actually implemented.

The Urban Water Solutions Initiative's members have evaluated the current permit language and available guidance from USEPA and elsewhere to suggest how NJDEP can improve clarity for the permittees without overly restricting permittee options. The draft of this memorandum was reviewed by the Best Practice committee and Green Infrastructure subcommittee members and offered for review to the Urban Water Solutions Work Group as a whole. It has been revised to reflect comments.

NJDPES CSO Permit Language

The Final NJPDES CSO Permits define Green Infrastructure at Part IV.B.1.b:

“Green Infrastructure” means methods of stormwater management that reduce wet weather/stormwater volume, flow, or changes the characteristics of the flow into combined or separate sanitary or storm sewers, or surface waters, by allowing the stormwater to infiltrate, to be treated by vegetation or by soils; or to be stored for reuse. Green infrastructure includes, but is not limited to, pervious paving, bioretention basins, vegetated swales, and cisterns.

The associated Fact Sheet notes:

“Green infrastructure which allows for stormwater management close to its source, providing both water quality treatment and some volume control. The volume that is retained onsite and kept out of the sewer system can help delay expensive gray infrastructure maintenance and upgrades. Some examples of green infrastructure measures include, but are not limited to, pervious pavements, street bump-outs, rain gardens, and tree trenches.”

Part IV.G.4.e provides the requirement to evaluate green infrastructure as part of the LTCP development process. The language is as follows:

“The permittee shall evaluate a range of CSO control alternatives predicted to accomplish the requirements of the CWA. In its evaluation of each potential CSO control alternative, the permittee shall use an NJDEP approved hydrologic, hydraulic and water quality models. The permittee shall utilize the models to simulate the existing conditions and conditions as they are expected to exist after construction and operation of the chosen alternative(s). The permittee shall evaluate the practical and technical feasibility of the proposed CSO control alternative(s), and water quality benefits of constructing and implementing various remedial controls and combination of such controls and activities which shall include, but not be limited to the controls below:

- i. **Green infrastructure.**
- ii. Increased storage capacity in the collection system.

- iii. STP expansion and/or storage at the plant (an evaluation of the capacity of the unit processes must be conducted at the STP resulting in a determination of whether there is any additional treatment and conveyance capacity within the STP). Based upon this information, the permittee shall determine (modeling may be used) the amount of CSO discharge reduction that would be achieved by utilizing this additional treatment capacity while maintaining compliance with all permit limits
- iv. I/I reduction to meet the definition of non-excessive infiltration and non-excessive inflow as defined in N.J.A.C. 7:14A-1.2 in the entire collection system that conveys flows to the treatment works to free up storage capacity or conveyance in the sewer system and/or treatment capacity at the STP, and feasibility of implementing in the entire system or portions thereof.
- v. Sewer separation.
- vi. Treatment of the CSO discharge.
- vii. CSO related bypass of the secondary treatment portion of the STP in accordance with N.J.A.C. 7:14A-11.12 Appendix C, II C.7.”

Results of the Part IV.G.4.e evaluation are then subject to evaluation regarding costs and performance in Part IV.G.5.a, as follows:

“The permittee shall submit in accordance with the submittal requirements at Sections D.3.a. and D.3.b.v., the cost/performance considerations that demonstrate the relationships among proposed control alternatives that correspond to those required in accordance with Section G.4. This shall include an analysis to determine where the increment of pollution reduction achieved in the receiving water diminishes compared to the increased costs. If the permittee chooses to pursue the ‘Presumption Approach’ of ‘no more than an average of four discharge events per year’, the permittee is not required to conduct this analysis for the other number of events (i.e. 0, 7, 10, 20). This analysis, often known as ‘knee of the curve’, shall be among the considerations used to help guide selection of controls.”

Evaluation Criteria

The CSO permits require that GI be part of the LTCP evaluation, but provide no specific information on what a sufficient evaluation would entail. The Cost Performance Analysis requirement infers that permittees should select the most cost-effective options, but an analysis of this type requires first that the technical evaluation of options be sufficiently thorough to allow for a valid comparison. Therefore, the question of what constitutes a sufficient evaluation of GI must be answered. The NJPDES CSO permit is silent on this issue, but NJDEP has indicated that the USEPA LTCP Evaluation Checklist may be used.

The definition for GI (in the CSO permit) also does not include a critical aspect of GI, where stormwater is retained (e.g., blue roofs) but then flows to the combined sewer after the wet weather event, but rather focuses only on complete removal from the system (e.g., infiltration, treatment by vegetation or soils, storage for reuse). CSO permittees will need to understand whether temporary detention qualifies as GI, as long as CSO volumes are reduced. In addition, it does not address the potential for increased CSOs due to loss of tree canopy, pervious surfaces and other existing GI features within CSO catchment areas.

USEPA LTCP Evaluation Criteria

The USEPA uses a checklist as part of its national approach for LTCP evaluation. The checklist includes two “major questions” that are relevant to GI evaluation, which are essentially replicated within the NJPDES CSO Permit expectations. In both cases, the checklist is quite general to provide ample latitude for local analyses based on relevant conditions.

- “6. Has the permittee considered an appropriate range of control alternatives across the general categories of source controls, collection system controls, storage technologies, treatment technologies, and green infrastructure?”
7. Has the permittee evaluated a range of controls sufficient for a cost/performance comparison in the LTCP, and has a cost/performance curve been developed for controls selected for implementation?”

USEPA. 2014. Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control

USEPA released a technical resource document to assist CSO systems that are interested in considering GI within their LTCPs. GI techniques identified within the document include but are not limited to disconnection of roof drain leaders, rain harvesting, rain gardens, green roofs, infiltration trenches, street planters and porous pavement.

USEPA notes that GI can be incorporated into some of the Nine Minimum Controls, including:

1. Proper operation and regular maintenance programs for the sewer system and the CSOs (where GI essentially becomes part of the sewer system)
2. Maximum use of the collection system for storage (where GI adds flow storage for eventual release to the combined sewer)
4. Maximization of flow to the publicly owned treatment works for treatment (through stormwater retention until after wet weather flows abate)
6. Control of solid and floatable materials in CSOs (through capture of litter and other wastes prior to the stormwater catch basin)

Note that NMC #2 and #4, when used in this manner, seem to extend beyond the definition of GI used in the CSO permit. USEPA notes that “Given the multiple environmental, economic and social benefits associated with green infrastructure, EPA has supported and encouraged the implementation of green infrastructure for stormwater runoff and sewer overflow management to the maximum extent possible.” In some cases, USEPA has allowed GI to be substituted for gray infrastructure after a feasibility study was completed, while in others the LTCP committed to a specific level of CSO reductions through GI, with the option of increasing the GI contribution over time based on further analysis.

This document suggests the following major components of a GI analysis:

1. **Hydrologic and Hydraulic (H&H) models:** These models are used to simulate infrastructure changes for CSO controls. The models are constructed so that individual catchment areas for each CSO can be evaluated. For GI, it is important that dynamic H&H models be capable of simulating the effects of many GI sites, which requires an ability to handle changes in influent flows, not just changes in storage capacity and flow routing within the gray infrastructure system (i.e., after the stormwater is already within the combined sewer). Doing so requires an ability to model stormwater flows across an urban landscape before they enter the sewer system.¹ H&H models require calibration and

¹ USEPA has provided a tool for small systems, *Green LTCP-EZ Template*, available from: http://water.epa.gov/infrastructure/greeninfrastructure/upload/final_green_ltcp_ez_instructions

verification, which in turn requires good monitoring data for precipitation, snowmelt, sewer flows and CSO flows. The ability to subdivide CSO catchment areas into subcatchments will be important for GI evaluations, so that the stormwater capture benefits can be determined at a finer scale. H&H models also can use precipitation data from an extended period (such as a typical year) rather than a single design storm that will not reflect the full range of conditions and CSO events. USEPA notes that “For planning purposes, it is acceptable to employ some level of aggregation and abstraction when modeling the numerous types and locations of green infrastructure controls that comprise a green solution.” This allowance reduces the complexity of modeling for LTCP development, but “this method fails to account for the intricate dynamics between the rates of surface capture, surface infiltration, evapotranspiration, soil percolation, sub-surface storage, and native soil infiltration that characterize the hydrologic behavior of many green infrastructure controls.” More detailed modeling will be needed in the design phase. The H&H modeling is also a critical component of water quality impacts modeling, regarding the pollutant loads from the CSOs.

2. **Catchment Area Evaluation:** USEPA emphasizes the need for a good GIS capability so that catchment area evaluations are appropriate to GI evaluation.² For GI, a good understanding is required of soil characteristics (regarding infiltration capacity), topography (generally less than 5% slopes unless modified), water table (which may restrict infiltration) and land use so that GI potential is neither over- nor under-estimated. Factors include roof area (total and per building) by type (flat versus sloped), yard areas, street widths and design, sidewalk widths and design, underground infrastructure that must be protected from enhanced infiltration (i.e., power, water supply lines, telecommunications, subways), vacant lots, parking lots, park lands, etc. Land ownership is also an important factor, as is the pace of redevelopment, which can provide or constrain opportunities for GI. Finally, the nature of the communities should be assessed, as environmental justice issues could provide justification for or constraints upon the use of GI within specific neighborhoods.
3. **Regulatory and Planning Evaluation:** GI opportunities will be enhanced or constrained by current and ongoing planning and regulatory systems. An evaluation is needed of such constraints and opportunities for modification through planning, ordinances, etc.
4. **Partnership Evaluation:** GI opportunities often depend on partnerships between CSO permittees and other entities, both public and private, which may be able to implement GI more cost-effectively than the permittee.
5. **Stormwater Capture Targets:** The LTCP should consider and incorporate reasonable ranges of stormwater capture based on the nature of the catchment areas, the available options and partnerships, cost-effectiveness, etc. Cincinnati determined that “reductions of CSO volume ranged from 39 to 46 percent control of CSO events for a typical rainfall year”, while San Francisco estimated reductions of 14 to 27 percent and Milwaukee estimated reductions of 12 to 38 percent. USEPA notes that the reduction in total CSO flows will not always be the same as the reduction in CSO events per year, another reason for using H&H models.

[withpoecacomments.pdf](#). They also have several H&H models available from: <http://water.epa.gov/infrastructure/greeninfrastructure/upload/EPA-Green-Infrastructure-Supplement-3-061212-1-PJ.pdf>. USEPA states that its new SWMM Version 5.0 “can incorporate a variety of green infrastructure practices explicitly rather than making indirect modifications to reflect the effects of green infrastructure practices.”

² New Jersey is fortunate in having a robust, statewide set of GIS data for many issues relevant to GI, and many counties and municipalities have good local information in GIS. The LTCP process can provide an excellent rationale for further development of local GIS capacity.

6. **Effectiveness and Cost-effectiveness Evaluation:** Not all GI techniques may work in any one area. The planning process should identify relevant GI techniques for the specific catchment areas based on local conditions. Further, achievement of GI for 100 percent of all theoretically feasible areas will not occur, and so the models should incorporate reasonable expectations of coverage,³ “as built” effectiveness, and potential changes (both positive and negative) in effectiveness over time as GI systems age. GI techniques also will have varying cost-effectiveness depending on local conditions and the CSO reduction targets. USEPA notes that the Northeast Ohio Regional Sewer District (NEORS) evaluated potential GI opportunities against a specific CSO reduction target to determine which opportunities would achieve the best results at lowest costs.

USEPA has also published two fact sheets related to GI.⁴ The factsheet on Green Infrastructure Permitting and Enforcement Series: Combined Sewer Overflows, suggests that an LTCP should incorporate the following information regarding the use of green infrastructure:

- The planned (and quantified) level of green infrastructure implementation (what will be installed where, e.g., number of infiltration practices to be installed and associated sizes/capacity);
- Key implementation steps (actions);
- Sequencing (ensure green and grey elements fit together; also in many cases it may work well to start in upstream areas and work toward downstream areas);
- Schedule;
- Methods and milestones for tracking and reporting on green infrastructure implementation (are the green infrastructure practices going in as planned and scheduled);
- Requirements to assure appropriate operation and management (O&M) of the green infrastructure;
- Methods for monitoring the performance and effects of green infrastructure implementation (e.g., are individual practices working as planned, are collections of practices in a sewershed keeping flows out of the sewer system as projected);

Provisions for adaptive management/corrective actions if green infrastructure performance (at the site scale and/ or the sewershed scale) does not meet expectations Recommendations

Based on the information provided above, the Urban Water Solutions Initiative recommends the following steps for effective green infrastructure evaluations to meet NJDEP and USEPA requirements:

1. NJDEP should provide guidance that the description of GI outcomes in its definition (“allowing the stormwater to infiltrate, to be treated by vegetation or by soils; or to be stored for reuse”) are not exclusive, and that additional measures such as protection of existing GI features, detention methods that discharge to combined sewers, and other GI techniques are considered applicable to the GI evaluation requirement. GI methods of both avoiding future increases and reducing existing levels of CSOs should be included.

³ USEPA suggests creation of a “green infrastructure treatability” table addressing this issue for each CSO catchment area or sub-area.

⁴ USEPA, Green Infrastructure Permitting and Enforcement Series: Combined Sewer Overflows, <http://water.epa.gov/infrastructure/greeninfrastructure/upload/EPA-Green-Infrastructure-Factsheet-2-061212-PJ.pdf>; USEPA, General Accountability Considerations for Green Infrastructure, <http://water.epa.gov/infrastructure/greeninfrastructure/upload/EPA-Green-Infrastructure-Factsheet-1-061212-PJ-2.pdf>.

2. NJDEP should add guidance on Green Infrastructure and its use in LTCPs to the CSO web site at www.nj.gov/dep/dwq/cso-guidance.htm, specifically including USEPA's 2014 technical resource, Greening CSO Plans: Planning and Modeling Green Infrastructure for Combined Sewer Overflow (CSO) Control, and web site, <http://water.epa.gov/infrastructure/greeninfrastructure/index.cfm>. The guidance would include design, modeling of GI in sequence and parallel within CSO subcatchment areas, identification of feasible volume reduction targets, construction, operation and maintenance, assessment of GI effectiveness, and adaptive management.
3. NJDEP and USEPA should cosponsor a training workshop (with hands-on exercises to the extent feasible) on H&H modeling for GI evaluations. Primary target audiences would be the consultants and staff of CSO permittees, involved county and municipal planners and engineers with GIS capabilities, and perhaps stakeholder groups with GIS capabilities.⁵
4. NJDEP should make clear that a quality Green Infrastructure Evaluation should include the following general components, though the results will vary by permittee and even by subcatchment area:
 - a. **System Model:** A dynamic H&H model capable of evaluating aggregate GI benefits (for communities with simple combined sewer systems) and disaggregate, dispersed GI implementation (for all other communities) through an iterative evaluation process that allows identification of the optimum combination of green and gray infrastructure.
 - b. **Physical Characterization:** A GIS-based characterization of each sewer subcatchment area regarding soils (NRCS Soil Survey, SSURGO), impervious surfaces (NJDEP 2012 Land Use/Land Cover at a minimum), topography (LiDAR data if available, otherwise USGS 10-meter DEM), road widths and design function (NJDOT, MPO, county or municipal data), roof types (LiDAR data if available, otherwise inferred from NJDEP 2012 Land Use/Land Cover), and vacant lots and land ownership (MODIV tax assessment data). Also underground infrastructure and sidewalk data where available (otherwise these data will be assessed during the design phase).
 - c. **Community Characterization:** Identification of existing and potential partnerships for GI implementation and O&M; existing and potential environmental justice issues; regulatory opportunities and constraints; planning opportunities and constraints; capital project planning with potential for GI, including transportation, streetscapes, parking lots and parks; and redevelopment trends, plans and approvals. Evaluation of how these factors affect the potential for GI.
 - d. **Stormwater Capture Evaluation:** Using the H&H model, the physical characterization and the community characterization, evaluate the potential for stormwater capture through GI as a set of scenarios based on how much of the theoretically available capture is actualized through GI projects, regarding both public and private properties. Select the most viable scenario or scenarios for further evaluation.
 - e. **Cost Evaluation that Accounts for Private Investment:** Since many GI opportunities exist on private land, and many CSO communities anticipate substantial private redevelopment activity in the coming years, some GI and stormwater management costs will be borne by private interests. The LTCP should not assume that all GI costs must be borne by the permittee. Regulations that require on-site retention of runoff in redevelopment projects

⁵ The New York New Jersey Harbor and Estuary Program's forthcoming grant to a New Jersey municipality to assess the capacity for green infrastructure may provide an opportunity for collaboration on providing a training workshop.

can generate a substantial amount of GI implementation, at no cost to the permittee (see, for example, Philadelphia's *Green City, Clean Waters* plan and NYC's *Green Infrastructure Plan*). Further, costs to retrofit existing impervious area with GI can sometimes be lower on private property than public property. Finally, costs will vary based on the financing mechanism used; alternative models may reduce net costs. Accordingly, GI cost and feasibility evaluations should include consideration of: (i) regulations requiring on-site retention of runoff in redevelopment projects (see, for example, Sustainable Jersey's model stormwater ordinance); (ii) the potential for GI project delivery approaches that include public subsidy, incentives, or other pay-for-performance models to fund private property GI retrofits (see, for example, Philadelphia's Greened Acre Retrofit Program); and (iii) alternative financing approaches.

- f. **Cost Evaluation that Accounts for Multi-Agency Public Investment:** GI can be an ancillary part of other public projects, such as parks and street improvements. By implementing GI as part of another project, total GI costs can be reduced. In some cases, the GI will provide a benefit to the other agency, resulting in a decision to incorporate GI using non-permittee funds. The GI cost and feasibility evaluations should assess the potential for these cost savings to ratepayers.
- g. **Evaluation of Benefits:** NJDEP should make clear that its preference for the most cost-effective solution is not based solely on financial costs and benefits, but also includes non-financial and ancillary costs and benefits. The GI cost and feasibility evaluations should assess a wider array of costs and benefits on a lifecycle basis, to ensure that the community is fully informed regarding the appropriate balance of green and gray infrastructure. Of interest will be energy conservation (reducing the heat island effect), community beautification (through additional plantings), air pollution control (through particulate capture by plants), traffic safety improvements (through street treatments that slow traffic and protect pedestrians), economic improvement (through street improvements and community beautification), beneficial alternative stormwater uses (such as for plantings and water sculptures, etc).
- h. **Green:Gray Infrastructure Optimization:** Based on the above evaluations, determine a stormwater capture target for GI that provides optimized CSO reduction benefits to meet CSO permit requirements, incorporating a broad view of costs and benefits. The issue of integrated water management would tie in well here.
- i. **Incorporation of Green Infrastructure into the LTCP Implementation Schedule:** Implementation of GI can begin before LTCP approval, and should be front-loaded within and continue throughout the overall schedule for LTCP implementation. Adaptive management should be directly incorporated into the LTCP, with interim targets for GI implementation and success,⁶ GI commencing as soon as possible, periodic evaluation of progress, and modifications to the plan to ensure successful attainment of GI objectives.⁷

⁶ See, for example, Philadelphia's *Green City, Clean Waters* plan and NYC's *Green Infrastructure Plan*

⁷ See, for example, EPA, *General Accountability Considerations for Green Infrastructure*, <http://water.epa.gov/infrastructure/greeninfrastructure/upload/EPA-Green-Infrastructure-Factsheet-1-061212-PJ-2.pdf> ("[S]tandards based on environmental outcomes may be supplemented with standards based on implementation goals. This is especially important where a long-term schedule of compliance is included. In such cases,...enforceable interim targets can be defined in terms of implementation goals related to the desired environmental outcome (e.g., number of acres retrofitted to retain a certain volume of stormwater)....[T]he

In Conclusion

The Urban Water Solutions Initiative requests and recommends clarification regarding the evaluation and inclusion of green infrastructure (GI) in Long Term Control Plans (LTCP) for sewer systems with CSOs. We have identified a number of ways to accomplish this clarification, consistent with USEPA and NJDEP policy. If you have any questions, please contact Chris Sturm, csturm@njfuture.org, 609-393-0008, x114.

inclusion of interim targets is essential to evaluate progress over time and allow for adaptive management as needed.”