Appendix D – Funding Subcommittee

Subcommittee Responsibility
The Funding Subcommittee was formed to evaluate and address the following:

- Estimate the cost of meeting the stormwater-related needs identified by the Needs Subcommittee, including the costs of implementing new legislation identified by the Regulatory Authority Subcommittee, if applicable.
- Identify existing funding sources to meet the stormwater-related needs identified by the Needs Subcommittee.
- If sufficient funding does not exist, identify opportunities for new funding sources to meet the stormwater-related needs identified by the Needs Subcommittee.
- To propose marketing approaches to promote funding sources/mechanisms.
- To research funding mechanisms used by other states and municipalities of other states for stormwater management programs and activities.
- Identify potential new and sustainable funding sources and mechanisms to implement recommendations.

Subcommittee Members and Participants:
Robert Roseen, UNH Stormwater Center;
Michael Trainque, American Council of Engineering Companies in New Hampshire
Rep. David Borden, New Hampshire House of Representatives;
Eber Currier, New Hampshire Farm Bureau;
Dave Danielson, NH Association of Regional Planning Commissions;

Subcommittee Findings and Recommendations

Subcommittee work products are listed below and included in this appendix:

D1. Funding Subcommittee Report
D2. 2008 New Hampshire Clean Water Needs Survey
D3. NHDES Extrapolated Stormwater Costs from the 2008 Clean Water Needs Survey
D4. Stormwater Utility Discussion and Examples
D5. Low Impact Development Case Studies

D1 – Funding Subcommittee Report

FUNDING SUBCOMMITEE FINAL REPORT

INTRODUCTION

The Funding Subcommittee was formed to evaluate and address the following:

- Estimate the cost of meeting the stormwater-related needs identified by the Needs Subcommittee, including the costs of implementing new legislation identified by the Regulatory Authority Subcommittee, if applicable.
- Identify existing funding sources to meet the stormwater-related needs identified by the Needs Subcommittee.
- If sufficient funding does not exist, identify opportunities for new funding sources to meet the stormwater-related needs identified by the Needs Subcommittee.
- To propose marketing approaches to promote funding sources/mechanisms.
- To research funding mechanisms used by other states and municipalities of other states for stormwater management programs and activities.
- Identify potential new and sustainable funding sources and mechanisms to implement recommendations.

FINDINGS AND RECOMMENDATIONS

- The Subcommittee has a consensus opinion that funding by means of stormwater utilities, rather than strict regulation (i.e. a statewide permit program) is the preferred approach to implementing stormwater management plans as it provides a consistent dedicated source of funding as well as incentives and flexibility. In its absence, requirements by regulation and/or permitting would be needed.
- Utilize stormwater utilities as a means of providing the revenues, as well as the incentives, needed to facilitate implementation of stormwater management programs statewide. The goal is to have the entire State of New Hampshire covered under any of the following at the discretion of individual communities: (1) a municipal stormwater utility; (2) a regional stormwater utility; (3) a statewide stormwater utility.
- Since it is not practical to start with a statewide stormwater utility initially, this would be implemented in a phased approach starting with the most impaired waters and a municipal separate storm sewer system (MS4) and expanding from there. The NPDES permit(s) issued under the EPA Stormwater Phase II Rule for the MS4 defines the required stormwater program (specific actions) and provides the incentive for taking action. A stormwater utility could then provide the needed revenues to implement the requirements of the NPDES permit as well as financial incentives for individual property owners that are proactive in implementing BMP's on their property.

- Use the NHDES 303(d) list as a basis for implementing the stormwater utilities. The program would start with the most impaired waters. Initially, the program would focus on the large developed properties within the watershed. Every 2-3 years another watershed would be brought on line (incorporated into a stormwater utility) based on receiving water impairment level. Thus, a phased approach would be taken.
- Individual municipalities would have three (3) options; (1) establish its own stormwater utility; (2) join with other municipalities in the vicinity to form a regional or watershed-wide stormwater utility consisting of multiple municipalities; or (3) be covered under a statewide stormwater utility. There would be an "opt out" provision whereby a municipality could petition the NHDES to opt out of a stormwater utility for a period of up to ten (10) years based upon certain agreed-upon conditions (such as the community is too small, the community situation, land use, water quality, financial situation, and other agreed-upon criteria to be developed).
- Revenues derived through a stormwater utility could be used to pay for administration of the utility, operation and maintenance (BMP's) costs and capital expenditures provided the costs are specifically related to stormwater activities.
- The newly-created Southeast Watershed Alliance, which encompasses 42 communities in the Great Bay Watershed, should be the starting point for the program. A stormwater utility could be established for an MS4 within the watershed based on the draft NPDES stormwater permit and the associated needs and requirements. A model stormwater utility could be developed and implemented and become the basis for setting up other stormwater utilities across the State, including the Statewide or State-administered Stormwater Utility.
- Details of the stormwater utilities will be have to be worked out but it should be flexible so as to allow for adaptation to different municipalities, different watersheds and different circumstances and needs. The basic billing unit would be an Equivalent Residential Unit (ERU) based on the square footage of impervious area (roof, driveway, walkway, etc.) of a typical single-family home (2,500 - 2,700 sq. ft.).
- The existing legislation in New Hampshire that enables the formation of stormwater utilities needs to be replaced or significantly revised since it does not adequately address all of the requirements pertaining to stormwater utilities. This was discussed by the Commission but left as a follow-up activity (action item) to be completed.
- It is the opinion of this Commission that at some point in the future a circuit rider program should be developed and implemented to specifically focus on stormwater issues. The circuit rider could be funded by the State, by a grant program, by the stormwater utilities or by a combination of funding sources.

CONCEPT: A solid economic plan is necessary, in fact essential, for the successful implementation of new stormwater programs, without which, any new or proposed programs are likely to fail especially under the current economic conditions. Any new stormwater programs will require a consistent, sustainable and dedicated revenue stream in order to be viable and self-supporting. The current economic climate and the persistent lack of adequate funding for water, wastewater and stormwater programs in general leaves very little available funding on both the State and local level.

ASSESSMENT OF NEEDS/COSTS

Several sources of information were considered as part of this evaluation. These sources included, but were not necessarily limited to: the U.S. EPA, the New Hampshire Department of Environmental Services (NHDES), the New Hampshire Department of Transportation (NHDOT), individual municipalities, several quasi-public organizations. Unfortunately, there are no comprehensive sources of cost information and the costs are wide ranging. Furthermore, the programs and Best Management Practices (BMP's) to manage and control stormwater are rapidly evolving making it even more difficult to make an accurate assessment of the true cost of the total stormwater needs. The cost data from several of the sources investigated by the Commission are presented below.

The EPA Clean Watersheds Needs Survey (CWNS) 2008 report to congress indicated that the total reported water quality needs for the nation were estimated to be over $ 298 Billion as of January 1, 2008. The estimated costs related to Stormwater Management Programs were estimated to be $ 42.3 billion or 14.2 % of the total. This includes $ 7.6 billion for conveyance infrastructure; $ 7.4 billion for treatment systems; $ 17.4 billion for green infrastructure; and $ 9.9 billion for general stormwater management. The 2008 EPA report included a State-by-State breakdown of the estimated needs. The breakdown of the estimated costs for stormwater needs for the State of New Hampshire was as follows:

Conveyance Infrastructure:	$ 51 million
Treatment Systems:	$ 10 million
Green Infrastructure:	$ 2 million
General SW Management:	$ 2 million
Total:	$ 65 million

The estimated costs included the costs to plan and implement structural and non-structural measures to control the runoff water resulting from precipitation in National Pollutant Discharge Elimination System (NPDES) Phase I, Phase II, and non-traditional (e.g. universities, prisons, school districts) municipal separate storm sewer systems (MS4), as well as unregulated sources. It should be noted that these costs to address stormwater needs exist, at least in part, as a result of poor land use practices, excessive impervious surfaces, and the subsequent poor runoff management caused by development. An important goal of a NH stormwater management program will be to educate the public and development sector so that future development incorporates Best Management Practices to address stormwater issues before they arise.

The New Hampshire Department of Environmental Services (NHDES) has also compiled cost estimates based on current needs. The 2008 Clean Water Needs Survey compiled the costs related to stormwater management from various municipalities across the State. This included both Municipal Separate Storm Sewer Systems (MS4's) as well as non MS4's. This information is included in *Appendix D2* of the Commission report. The total estimated cost based on that compilation was just over $ 64.6 million.

More recently, Mr. Eric Williams of the NHDES compiled estimated costs, based on the Clean Water Needs Survey, for several urbanized areas and urbanized clusters and then extrapolated this information to determine what the estimated cost would be for urbanized areas and urbanized statewide. This analysis resulted in a total projected capital cost for stormwater needs statewide, including both urbanized areas and urbanized clusters, of just over $ 182.6 million. A copy of this data is included in *Appendix D3* of the Commission report.

The New Hampshire Department of Transportation also provided cost data compiled from the stormwater controls and BMP's that are being incorporated into highway projects statewide. These costs were then extrapolated to a per acre cost. The per acre costs range from less than $ 100/acre to over $ 100,000/acre thus illustrating both the wide range in costs based on BMP's for specific applications and the difficulty in determining with any reasonable accuracy the total estimated costs of the needs. This is further compounded by the fact that new and innovative programs are needed to manage stormwater; a conclusion reached by this Commission and included in the recommendations in this report.

It is the consensus opinion of this Commission, based on our own evaluation of current stormwater needs, the requirements being imposed upon MS4's by the EPA under the Stormwater Phase II Rule, and the evolving nature of stormwater management in general that the true costs of stormwater needs are significantly greater than those estimated in the Clean Water Needs Survey and other sources, perhaps by as much as several orders of magnitude. The true costs to address stormwater needs in New Hampshire are likely to be in excess of $ 500 million and could even approach $ 1.0 billion or more.

THE ECONOMICS OF LOW IMPACT DEVELOPMENT

The economic advantages of Low Impact Development are often not well understood and are deserving of close attention to inform municipal land use decisions. Economic benefits are being realized through the incorporation of LID-based strategies by municipalities, commercial developers, and others. On a national level, substantive economic benefits for commercial development and municipal infrastructure projects – for both construction budgets and project life-cycle costs –are increasingly being observed when using a combination of Gray and Green infrastructure for stormwater management.

While individually, green infrastructure elements may add expense to a project, at the same time, costs savings are often realized on an overall project basis as the need for conventional stormwater infrastructure such as curbing, catch-basins, piping, ponds, and other hydraulic controls are reduced. Of course, cost savings are not observed when compared with no stormwater management, but rather for projects consistent with new state and federal permitting requirements addressing volume and pollutant reduction. Other economic benefits include land development savings from a reduced amount of land disturbance required for a project, reduction in home cooling by 33 to 50 percent from use natural vegetation and reduced pavement area (MacMullan, 2007), and higher property values of 12 to 16 percent. (Mohammed, 2006).

Two particular case studies in New Hampshire for commercial and residential development each had significant savings in contrast to permitting and construction of conventional designs.

Boulder Hills, is an LID condominium community in southern New Hampshire which features the State's first porous asphalt road. The site incorporated porous pavements and rooftop infiltration systems. The benefits of implementing this LID design included local permitting, cost savings and positive exposure for the developers. Although porous asphalt was more costly, cost savings in other areas could be realized including less drainage piping, fewer, reduction of the quantity of erosion control measures, fewer catch basins, elimination of curbing, outlet control structures, and stormwater detention ponds. The LID option resulted in higher costs for roadway and driveway construction however had an 11% reduction in the amount of land that would need to be disturbed. The LID option was calculated to save the developers 6% compared to a conventional design for the total stormwater management costs.

Greenland Meadows is a retail shopping center built in 2008 in coastal New Hampshire that features the largest porous asphalt installation in the Northeast. The development is located on a 56-acre parcel and includes a Lowe's Home Improvement, Target, and a future supermarket, paved parking areas consisting of porous asphalt and non-porous pavements, landscaping areas, a large gravel wetland, as well as other advanced stormwater management. Despite many challenges, substantial savings of 26 percent of the cost for stormwater management was achieved in comparison with the original conventional design by the use of LID systems and the avoidance of some costly conventional strategies.

STATEWIDE STORMWATER PERMIT PROGRAM

General

One option to address the environmental goals of a stormwater program and raise revenue to meet these goals is a statewide stormwater discharge permit. The NHDES would take a permit-by-rule approach to issue permits, which could potentially be issued to every homeowner, business and government entity in the state. The permit system and fees generated could be linked to local or regional stormwater utilities which are addressed in the next part of this section.

A statewide permit program would establish statewide requirements for mitigating potential adverse impacts to water quality from stormwater and implementation of BMP's to control stormwater from developed areas. These requirements could be met through a local program enacted by towns such as site plan and zoning regulations, stormwater ordinances, low impact development (LID) ordinances and similar measures. If the town failed to act, the town would be subject to the statewide requirements. This logic would similarly apply to stormwater utilities, in that a town could opt out of a statewide or regional program if they enacted stormwater regulations in their community.

Defining Impervious Cover

Pursuant to implementation of a permit program, each permittee would be assessed a fee based on the impervious cover of their property. While it is not yet defined how imperviousness would be determined, the goal would be to assess the fee using a standardized approach to quantifying the impervious cover that is contributing to stormwater runoff off-site, typically

called 'effective impervious cover' or 'connected impervious cover'. One approach taken by municipalities that have implemented stormwater utilities is to establish an "Equivalent Residential Unit" based on the average impervious cover on a typical residential lot.

For maximum environmental improvement under a new stormwater law, gravel roads and parking areas would be included if they are hydrologically connected to surface waters. Similarly, lawns in the immediate shoreland zone can be a significant source of stormwater, depending on the slope of the land, which can convey constituents that are detrimental to water quality. The Center for Watershed Protection reports that turf can comprise up to half of the vegetated area in suburban areas (Schueler, 1995a). These lawns receive high inputs of fertilizers, pesticides, herbicides, and irrigation, but their surface soils are highly compacted and these pollutants become runoff in anything larger than small rainfall events. Nitrogen is much more mobile from a lawn than from a forest, in large part because lawns are fertilized, and residential forests are not. Therefore, lawns within 50 feet of surface waters in properties subject to the CSPA that are directly connected to surface waters without an intervening buffer strip would be considered impervious for purposes of assessing a stormwater fee. Note: hydrologically disconnecting a lawn to avoid the stormwater fee would be one of the simplest tasks for landowners under a stormwater law, and could result in significant environmental and aesthetic improvement to impaired water bodies.

Implicit in the definition of stormwater is that BMPs can be used to disconnect existing impervious cover by infiltrating runoff before it goes off-site. This is how landowners can reduce or eliminate their stormwater fee, and *therefore a stormwater fee system will reduce both new and existing environmental degradation.*

Drawbacks to Statewide Permit

There are several potential drawbacks to a statewide program, be it either a permit system or a stormwater utility. The first is the scale of the effort needed to assess imperviousness on properties statewide. For example, who will do this assessment, and who will be responsible for responding to landowners who implement BMPs to reduce their fee? The second is the logistical problem of, and compliance with, collection of a fee that would presumably be done by the NHDES or a statewide agency to be determined. At the local or even county level, such a fee could be collected as part of property billing. At the state level, it is unclear how the fee would be collected. Third, the NHDES would presumably establish a new program to administer the fees collected and to allocate fees to priority remediation projects. Such centralization probably makes sense for efficiency, but may make the program unpopular compared to one run at a more local scale. In New Hampshire, the municipalities typically are averse to state or federally imposed requirements and programs and generally prefer to have the flexibility and autonomy of local control to meet regulatory requirements.

Non-compliance with a permit program allows for punitive action, however, this is viewed as a disincentive since property owners would only do the bare minimum necessary to comply with permit requirements and it could stifle innovative and creative approaches to stormwater management. It would be necessary to balance punitive measures with meaningful incentives.

One of the most significant hurdles that would have to be overcome for a statewide permit program is the source of resources (especially money) to implement and then administer the program on an ongoing basis.

Phased Implementation

Because of the magnitude and logistics of implementing a program that applies statewide, it is likely that a phased approach to implementation would be necessary. There are several options for such phasing:

1) A stormwater permit system could be initially targeted at watersheds with most significantly impaired waters. However, this would not be consistent with anti-degradation goals because higher quality waters would not be protected until the phased implementation applied to them.
2) The permit system could apply first to larger properties, for example those covered under AoT rules. However, studies in New England have shown that the impacts from individual shoreline house lots can be substantial.
3) The Commission does not support a different fee based on whether the waterbody is on the impaired waters list. Higher fees in one part of the state compared to others will result in public resistance based on perceived unfairness.

Local Incentives

For either a statewide permit system or stormwater utility, the Commission recommends creating incentives for local control. One approach would be to require a fee to be paid to the state, unless a town implemented a program itself in order to retain the revenue generated. A town could establish a town-based local utility or become part of a larger regional utility in order to keep the fee locally. Under a permit system, it is not clear how a town could assume the authority for such a permit.

Dedicated Revenue

For either a statewide or locally-controlled utility, public acceptance will be greater if the funds are allocated for stormwater mitigation, rather than supplementing existing budgets for operations and maintenance. The revenues derived would be managed as an enterprise fund similar to the way sewer and water user fees are managed. The revenue could only be used for stormwater-related activities which could include administration, operation and maintenance (O & M) and capital expenditures with preference being given to stormwater mitigation activities.

Exemptions

Exemptions to the Stormwater permit and/or fee would be granted to agriculture and forestry operations if those operations: (a) have a nutrient management plan in place, or (b) have a regulation buffer strip in place, or (c) already have another permit such as a harvesting permit for logging operations.

State and local governments are not exempt from a permit fee. However they may opt to not pay a fee to themselves.

STORMWATER UTILITIES

A discussion of stormwater utilities is included in *Appendix D4* of the Commission report.

The Statewide Stormwater Utility Concept

Action is needed on a state level for the creation of stormwater utilities, to assist communities at the local level to ensure the successful implementation of new stormwater programs. Without action on the state level any new or proposed programs are likely to fail especially under the current economic conditions. Any new programs will require a consistent dedicated revenue stream in order to be viable and self-supporting. The current economic climate and lack of adequate funding for water, wastewater and stormwater programs in general leaves very little available funding on both the State and local level. Action on the state level eliminates the need to be passed on local level, without which community adoption is very unlikely.

The goal is to have the entire State of New Hampshire covered under a statewide stormwater utility or groups of individual municipal or regional utilities. Individual municipalities would therefore have three options:

(1) Establish its own municipal stormwater utility;
(2) Join with other municipalities in the vicinity to form a regional or watershed-wide stormwater utility consisting of multiple municipalities;
(3) The default position, be covered under a state-administered watershed-based utility.

Following approval of legislation, municipalities would have 12 months to select one of the three options. At the end of 12 months, communities would by default be placed into a state-administered utility or establish a municipal program or join a regional program.

Exemptions could be provided whereby a municipality could petition the NHDES to opt out of a stormwater utility requirement based upon certain pre-determined conditions. Exemptions may be offered for small communities which do not operate a municipal drinking water or wastewater program, and they are not in a watershed listed with impaired waters. The exemption can be rescinded if the conditions change. Properties affected include private, state, and federal, in particular buildings, driveways, and parking lots. It does not include public linear infrastructure.

All three programs fees will be based on the usage of an Equivalent Residential Unit (ERU) determined on the average impervious cover on a typical residential lot and combined with tax records. This is commonly in the range of 2,500 to 2,700 ft^2 per ERU. Residential properties are charged a single ERU and commercial properties a multiple of ERUs. Fees are recommended in the range of $2-$6 per ERU per month for residential properties which translates to a range of

$25-$75 per month per acre of impervious area for commercial properties. Impervious cover assessment would be a component of routine municipal property assessment. This would be analogous to determination of square footage for tax records.

Funds generated by the utility SW program would be used solely to fund stormwater related needs and could include staff, planning efforts, equipment, and structural improvements.

Incentives for property owners' fee abatements are based on installation and maintenance of LID BMPS. Complete fee abatement can be achieved with full effective impervious cover reduction. Reductions in the fee may be offered for practices that reduce discharges and treat for water quality. Level and duration of abatement would be based on degree of impervious cover reduction over time. Continued investment in reduction of impervious cover over time would result in continued fee abatement. These fee reductions will serve as an incentive to encourage more innovative and effective stormwater management practices.

A circuit rider for municipal staff assistance may be administered by the regional planning commissions and paid for by the stormwater mitigation fund (described below) if developed. Assistance will be prioritized to communities without dedicated planning staff. It is not expected that significant assistance will be needed and will likely be limited to the initial establishment of the program.

Option 1: Municipal Stormwater Utility w/ Incentives

The first option is for a municipality to develop and operate its own utility program. The utility would be developed based on guidance from DES. Regulatory authority exists in HB 1581 for the creation of a stormwater utility. The utility funds generated would be held locally and used solely for the implementation of the program.

One incentive for adoption of a municipal program is that because it will be administered locally, no funds are sent to the state program. For that reason, a greater amount of funds will be available to the municipality to fund efforts that, in many cases, are already underway, however funded by other sources (e.g. roads, water and wastewater). Reductions in the fee may be offered for practices that reduce discharges and treat for water quality. These fee reductions will serve as an incentive to encourage more innovative and effective stormwater management practices. Incentives should include disconnection of impervious surfaces from storm sewers and other stormwater conveyance, reduction of impervious cover (e.g. pavement removal), installation of vegetated buffers, rain gardens, and other items. A full list would need to be developed.

Option 2: Regional or Watershed-Wide Stormwater Utility Consisting of Multiple Municipalities

This option would involve the establishment of an inter-municipal cooperative agreement, such as a village district, analogous to the process for wastewater management. It could also be developed as a component of a regional watershed entity such as the Southeast Watershed Alliance. Advantages to Option 2 are that a watershed approach allows the flexibility of addressing stormwater management and contaminant loads where they can be most effective, and have the greatest economic benefit. Activities by a municipal utility will typically limit activities to within areas under their jurisdiction. There may however be areas and activities within the watershed where improvements may have greater impact with respect to stormwater improvements and be less costly. Such examples include: reduction of nutrient loads through land use controls (ordinances, site plan review regulations, etc) and planning versus removal by wastewater treatment facilities; and preservation of undeveloped lands versus retrofitting existing development. Stormwater controls and contaminant reduction efforts alike would need to account equally for reduction with similar schedules for implementation.

An inter-municipal agreement would need to be structured such that any activities funded by a municipality that took place elsewhere in the watershed would be credited to all participants. This point is crucial and would need to be addressed at a federal permit level for MS4 communities and a state level for non-MS4 communities.

Fees generated would be distributed both to the Regional or Watershed-Wide Stormwater Utility and municipality. The Regional or Watershed-Wide Stormwater Utility would receive 25% of funds generated to cover program administration, watershed-based retrofits, and other program related activities. 75% of funds generated would remain with the municipality to administer the stormwater utility program and other program related activities.

Option 3: State Administered Watershed Utility.

The third option is the default condition for all municipalities required to implement a stormwater utility. Option 3 similar to Option 2 however administered by the state. Similarly, a municipal-state agreement would need to be structured such that any activities funded by a municipality that took place elsewhere in the watershed would be credited towards MS4 or state permit compliance. This would need to be addressed at a federal permit level for MS4 communities and a state level for non-MS4 communities.

Fees generated would be distributed both to the state and municipality. The state would receive 25% of funds generated to cover program administration, watershed-based retrofits, to fund circuit riders, and other program related activities. 75% of funds generated would remain with the municipality to administer the stormwater utility program and other program related activities.

Stormwater Mitigation Fund (SMF)

A state administered fund would be developed from an impact fee on new and redevelopment projects greater than 10,000 ft^2 which do not meet state requirements. The SMF would be structure in part, similar to the Aquatic Resource Mitigation fund. The SMF could be used to support a circuit rider program, targeted stormwater management improvements, a grant program, and other program related activities.

The fund includes incentives for developers to promote LID land use planning and development. The fund reinforces the connection between stormwater, land use, impervious coverage, and impacts. Incentives would have a fee structure based on % impervious cover (IC) for both new and redevelopment.

This will benefit developers using environmentally sensitive development by reducing and or eliminating fees. New development fee structure could be based on DES anti-degradation undisturbed cover and impervious cover ratios (65:10).

Redevelopment opportunities are tremendous due to high degrees of imperviousness and fee structure would need to differ from new development.. Level and duration of abatement would be based on degree of IC reduction. Redevelopment may present a wide range of constraints and limitations, an evaluation of options may be needed to work in conjunction with broader state watershed goals. Stormwater requirements for redevelopment should vary based upon the surface

area of the site that is covered by existing impervious surfaces. In order to determine the stormwater requirements for redevelopment projects, the percentage of the site covered by existing impervious areas must be calculated.

For redevelopment projects and having less than 40% existing impervious surface coverage, the stormwater management requirements will be the same as other new development projects with the important distinction that the project can meet those requirements either on-site or at an approved off-site location within the same sub watershed provided the project satisfactorily demonstrates that impervious area reduction and LID strategies and BMPs have been implemented on-site to the MEP.

For redevelopment sites with more than 40% existing impervious surface coverage, stormwater shall be managed for water quality in accordance with one or more of the following techniques, listed in order of preference:

a) Implement measures onsite that result in an effective impervious cover of at least 30% of the existing impervious surfaces and pavement areas, and 50% of the additional proposed impervious surfaces and pavement areas through the application of porous media; or

b) Implement other LID techniques onsite to the maximum extent practical to provide treatment for at least 50% of the redevelopment area; or

c) Implement off-site BMPs to provide adequate water quality treatment for an area equal to or greater than 50% of redevelopment areas may be used to meet these requirements provided that the project satisfactorily demonstrates that impervious area reduction, LID strategies, and/or onsite BMPs have been implemented to the maximum extent practical. An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed. The project must also demonstrate that there is no downstream drainage or flooding impacts as a result of not providing on-site management for large storm events.

The fee would be collected locally but is distributed as a component to the state (75%) and component that the municipality (25%), similar to vehicle licensing.

Public Outreach and Education

Public outreach and education must be a critical component of any stormwater utility. Public education and involvement are crucial to successful implementation of a stormwater utility. In addition, 2 of the 6 required elements of an MS4 stormwater management program, pursuant to the U.S. EPA Stormwater Phase II Final Rule as it pertains to MS4's, are *Public Education and Outreach* and *Public Participation/Involvement*. Public participation and involvement is particularly important since it gives citizens the opportunity to participate in the development and administration of the program which is crucial to successful implementation of any program. The general public can also provide feedback that can be beneficial in adapting the stormwater program to a particular community's specific circumstances and needs.

Technical Assistance

The Commission evaluated various means by which technical assistance could be provided to municipalities for managing stormwater programs and activities. One idea that has the popular support of the Commission is the establishment of a circuit rider program. Under the statewide utility concept, the circuit rider wages and expenses could be derived through the revenues generated from the stormwater utility fees. It is less clear as to how this would work under the scenario where numerous municipal and regional stormwater utilities are established to fund stormwater activities across the state.

SAMPLE STORMWATER UTILITIES

Information from some existing stormwater utilities is included in *Appendix D4* of the Commission report.

ECONOMIC CASE STUDIES of LID PRACTICES

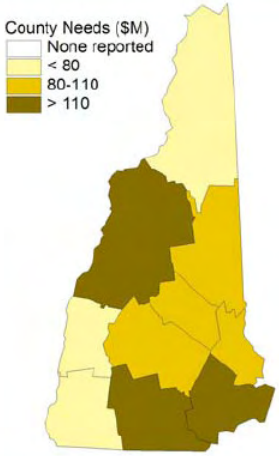
Low Impact Development (LID) represents one of the most progressive trends in the area of stormwater management and water quality protection. This approach involves utilizing strategies to control precipitation as close to its source as possible in order to reduce runoff volumes, promote infiltration, and protect water quality. While better known for its capacity to reduce pollution and manage stormwater more sustainably, LID designs are also economically beneficial and more cost-effective as compared to conventional stormwater controls. Several case studies of projects that incorporated LID practices are included in *Appendix D5* of the Commission report.

The case studies presented in *Appendix D5* of the Commission report show how incorporating a green infrastructure strategy with LID can help cities and municipalities reduce stormwater runoff volumes entering combined systems, lowering treatment costs. Also, as shown, utilizing a combination of grey and green infrastructure strategies for CSO management can be considerably more economically viable than using grey infrastructure alone.

D2 – 2008 New Hampshire Clean Water Needs Survey Summary

New Hampshire
Clean Watersheds Needs Survey 2008

The Clean Watersheds Needs Survey (CWNS) is a comprehensive assessment of needs[1] to meet the water quality and water-related public health goals of the Clean Water Act (CWA). States and the U.S. Environmental Protection Agency (EPA) conduct the CWNS every four years under CWA Section 516 (b). New Hampshire documented needs totaling $1.3 billion in 2008. This is an 82 percent increase from the $685 million in needs documented in 2004.



Documented Needs in New Hampshire

Type of Need	Needs (2008 Dollars, Millions) 2004	2008	Percent Change
Wastewater treatment	$200	$536	168%
Pipe repair and new pipes	$166	$367	121%
Recycled water distribution	nr[a]	nr	0%
Combined sewer overflow correction	$309	$281	-9%
Total Wastewater Treatment Needs	**$675**	**$1,184**	**75%**
Conveyance infrastructure	n/a	$51	n/a
Treatment systems	n/a	$10	n/a
Green infrastructure	n/a	$2	n/a
General stormwater management	nr	$2	n/a
Total Stormwater Management Needs[b]	**nr**	**$65**	**n/a**
Agriculture (cropland) best management practices (BMPs)	nr	nr	0%
Agriculture (animals) BMPs	nr	nr	0%
Silviculture (forestry) BMPs	nr	nr	0%
Ground water protection: unknown source BMPs	nr	nr	0%
Marinas BMPs	nr	nr	0%
Resource extraction BMPs	nr	nr	0%
Brownfields remediation	nr	nr	0%
Storage tank remediation	nr	nr	0%
Sanitary landfills BMPs	$9	$1	-89%
Hydromodification (Water resource restoration and protection)	nr	nr	0%
Other estuary management activities[c]	n/a	nr	n/a
Total Nonpoint Source Control Needs[b,d]	**$9**	**$1**	**-89%**
Total Decentralized Wastewater Treatment Needs[b,d]	**$1**	**nr**	**-100%**
Total Needs	**$685**	**$1,250**	**82%**

[a]Not reported; [b]Actual needs may be higher, since documenting these needs is difficult; [c]In 2004, Other Estuary Management Needs were reported under Separate State Estimates (SSEs); [d]Not included in Official Needs in the Report to Congress.

[1] Documented needs in the CWNS include the unfunded capital costs of projects as of January 1, 2008 that address a water quality or a water quality-related public health problem existing as of January 1, 2008, or expected to occur within the next 20 years; and meet the seven CWNS documentation criteria. All needs are in January 2008 dollars.

New Hampshire Clean Watersheds Needs Survey 2008

Wastewater Treatment Facilities

The enactment of the Clean Water Act (CWA) in 1972 resulted in dramatic improvements in the:

- Number of wastewater treatment plants.
- Percentage of the population served by wastewater treatment plants.
- Quality of effluent treatment from wastewater treatment facilities.

In 2008, 49% of New Hampshire residents received centralized wastewater treatment services at the secondary, advanced, or no discharge treatment level, compared to 10% in 1972.

Number of Centralized Treatment Facilities and Population Served

	Number of Facilities			Population Served				
Treatment Level	1972	2008	Projected[a]	1972	%Total Population 1972	2008	%Total Population 2008	Projected[a]
Less than Secondary	14	1	0	143,000	18	20,617	2	0
Secondary	26	69	62	83,000	10	619,585	47	664,473
Advanced	5	3	11	2,000	<1	11,782	1	104,871
No Discharge	0	13	13	0	0	9,159	1	11,452
Total	**45**	**86**	**86**	**228,000**	**28**	**661,143**	**50**	**780,796**

[a] Number of facilities and population served if all needs documented in the CWNS 2008 are met.

Small Communities

In New Hampshire, small community wastewater facilities serve 20% of the population and comprise 22% of total wastewater treatment and collection needs. EPA small community support information is available at: www.epa.gov/owm/mab/smcomm

Reported Needs for Facilities in Small Communities

	Facilities		Needs (2008 Dollars, Millions)	
Population	2004	2008	2004	2008
0-999	6	12	$4	$26
1,000-3,499	8	22	$12	$126
3,500-10,000	17	14	$73	$104
Total	**31**	**48**	**$89**	**$256**

Visit www.epa.gov/cwns for more information including:

- Detailed Reports to Congress
- Other state fact sheets
- Maps, charts, and data downloads for projects, facilities, watersheds, counties, congressional districts, cities, states, and regions

Summary of Reported Costs from 2008 Clean Water Needs Survey

Facility/Project Name	Cost
Amherst MS4	$158,380
Bedford MS4	$1,016,459
Belmont Stormwater Projects	$2,114,958
Berlin Stormwater Projects	$194,679
Boscawen Stormater Projects	$73,357
Bristol Stormwater Projects	$487,006
Canaan Stormwater Projects	$104,346
Chichester Stormwater Projects	$465,537
Claremont Stormwater Projects	$1,682,987
Concord Stormwater Projects	$5,744,922
Derry MS4	$699,827
Dover Stormwater Projects	$3,953,574
Durham MS4	$97,432
Epsom Stormwater Project	$3,706,475
Exeter MS4	$420,697
Goffstown Stormwater Projects	$1,824,529
Gorham Stormwater Projects	$33,387
Greenland Stormwater Projects	$409,108
Hamton MS4	$9,610,978
Harrisville Stormwater Projects	$108,155
Holderness Stormwater Projects	$77,446
Keene Stormwater Projects	$3,446,108
Laconia Stormwater Projects	$3,358,761
Lebanon Stormwater	$122,000
Manchester MS4	$2,098,665
Merrimack MS4	$3,804,654
Milford MS4	$226,118
Nashua MS4	$697,152
Newbury Stormwater Projects	$178,315
Pelham MS4	$77,446
Pembroke Stormwater Project	$1,591,290
Peterborough Stormwater Projects	$666,014
Plaistow MS4	$356,657
Portsmouth MS4	$5,138,256
Rochester MS4	$1,118,834
Salem MS4	$2,078,801
Sanbornton Stormwater Projects	$681,695
Sandown Stormwater Project	$382,313
Seabrook Stormwater Projects	$1,058,194
Somersworth MS4	$473,844
Wakefield Stormwater Projects	$211,608
Windham MS4	$1,489,384
Wolfeboro Stormwater Projects	$2,384,115
Total	**$64,624,463**

D3 – NHDES Extrapolated Stormwater Costs from the 2008 Clean Water Needs Survey

NHDES Extrapolated Stormwater Costs from the 2008 Clean Water Needs Survey

Urbanized Areas

	Municipality	CWNS Stormwater Needs	Area in Acres	Stormwater Capital Costs per Acre	2008 Population
Urbanized Areas	Bedford	$1,016,459	14,150	$72	20,807
	Dover	$3,953,574	11,258	$351	28,706
	Hampton	$9,610,978	5,453	$1,763	15,032
	Manchester	$8,770,350	17,670	$496	108,154
	Merrimack	$3,804,654	16,973	$224	26,139
	Portsmouth	$5,138,256	9,133	$563	20,520
	Rochester	$1,118,834	10,118	$111	30,796
	Salem	$2,078,801	15,853	$131	29,549
	Windham	$1,489,384	7,558	$197	12,823
	Subtotal Urbanized Areas	$36,981,290	108,166	$434	292,526
	Extrapolated State Urbanized Areas	$116,011,960.62	267,213		
Urbanized Clusters	Berlin	$194,679	2,893	$67	10,170
	Claremont	$1,682,987	3,443	$489	12,827
	Concord	$5,744,922	13,542	$424	42,052
	Keene	$3,446,108	6,246	$552	22,653
	Laconia	$3,358,761	6,426	$523	17,233
	Pembroke	$1,591,290	2,822	$564	7,293
	Peterborough	$666,014	2,291	$291	6,172
	Subtotal Urbanized Clusters	$16,684,761	37,663	$416	118,400
	Extrapolated State Urbanized Clusters	$39,311,925	94,586		
	Total Extrapolated State Urbanized Areas	$155,323,885	361,799		
	Total Statewide Culvert Replacement Costs	$27,313,400			
	Total Statewide Stormwater Capital Needs	$182,637,285			

D4 – Stormwater Utility Discussion and Examples

Stormwater Utility Discussion and Examples

What is a Stormwater Utility?

Municipalities employ a variety of funding methods, including service charges, several types of taxes, franchises and other fees, fines, and penalties. The various funding methods have distinctive characteristics, which separate them legally, technically, and in terms of public perceptions. Four major categories of municipal revenue generation methods are taxes, service charges, exactions, and assessments.

Municipal stormwater management programs have been funded using a number of mechanisms as the primary source of funds including: property taxes, sales taxes, state revolving funds, road funding, user fees, bonding, and surcharges on other utility fees. By far the most common current funding method in New Hampshire for stormwater-related activities is property tax based. Other major revenue generators include franchise fees, income taxes, gasoline tax (for roadway related drainage), sales taxes, and stormwater user fees.

In recent years, a major source of funding for stormwater management has been in the form of a user fee system under the auspices of a stormwater utility. This form of funding has several advantages over other competing forms of funding including equitability, stability and adequacy. The user fee concept of a stormwater utility based funding method is fast growing. In the early 1970's there were only one or two true stormwater utilities in existence.

In early 1990's there were over 200. By 2000 the number had grown to 400. This number is expected to more than triple in the next decade as the financial impacts of stormwater quality legislation reach the many small municipalities.

The distinctions of the four revenue categories are very important. One of the critical issues which typically must be resolved if a utility service charge of any type is legally challenged is whether the service charge is clearly related to and incidental to the activities and improvements of the utility, or is in fact merely a means of creating revenue for all governmental purposes generally (a tax), or is it a special assessment (which is supposed to reflect a direct and special benefit). Thus a stormwater utility must be based on a stormwater program and not simply a perceived financial need or willingness to pay.

City of Milwaukee

The Storm Water Management Charge

The Storm Water Management Charge is a tool for communities to invest in reducing pollution from storm water runoff. Storm water is water from rain and melting snow that flows off roofs, driveways, parking lots, playgrounds, streets, and other hard, or impervious, surfaces. The water washes industrial chemicals, gas, oil, antifreeze, road salt, detergents, pesticides, pet waste, and other pollutants into storm drains. The storm drains dump the polluted water, without treating it, directly into Lake Michigan and local rivers. Storm water is the largest polluter of streams, rivers, and lakes. Storm Water Management monies pay for projects to prevent storm water pollution of natural waterways and to operate and maintain storm sewers.

The Storm Water Management Charge was introduced in the 2006 City of Milwaukee budget. Previously, the costs for city sewers, including storm and sanitary sewers, were covered by sewer charges based on drinking water use.

The Storm Water Management Charge distributes the cost of storm water programs to non-profit and tax-exempt organizations, and non-residential and commercial property owners with multiple buildings, parking lots, and paved surfaces. The charge applies to all properties, occupied or vacant, and empty lots.

The charge appears on the Milwaukee Municipal Services Bill administered by the Milwaukee Water Works.

The charge is based on the amount of impervious surface area of a property. A typical residential property has an average impervious surface area of 1,610 square feet. This measurement is called an Equivalent Residential Unit (ERU). The number of ERUs for non-residential, commercial developed property and vacant, improved property is calculated by dividing the impervious surface area of the property by 1,610.

Residential buildings (house, apartment, condominium) with one to four units were billed for 2009 at $8.66 the first quarter and $12.87 the remaining three quarters for an annual rate of $11.82 per quarter.

The charge for commercial property, including buildings with more than four residential units, is based on the amount of hard surface area of the property. Calculate the number of ERUs for a property by dividing the square footage of hard surface of the property by 1,610. The 2009 charge was billed at $8.66 per ERU for the first quarter and billed $12.87 per ERU for the remaining three quarters for an annualized rate of $11.82 per ERU per quarter. For commercial customers billed monthly, the 2009 charge was billed the first quarter at $2.88 per ERU per month, and billed the final three quarters at $4.29 per ERU per month for an annualized rate of $11.82 per ERU per quarter.

Condominium associations are charged based on the amount of hard surface area of the entire property. The charge is billed quarterly to the condominium association.

My residential property has more than four dwelling units. What is the charge?
Residential properties with more than four units are considered commercial developed property when calculating the charge.

How are condominium charged?
Condominium associations are charged based on the amount of impervious surface area of the entire property. Calculate the number of ERUs for the property by dividing the impervious surface area of the property by 1,610. The charge is billed quarterly to the condominium association.

What is an "improved" property?
An improved property is a parcel of land that has a building on it and/or any impervious surface, such as a paved parking area and sidewalks.

Storm Water Management Charge - p. 2

Where does the Storm Water Management Charge appear?
The charge appears on the Municipal Services Bill as a separate line item. The billing unit, ERU (Equivalent Residential Unit) is shown, along with the total charge. The city does not bill fractions of an ERU.

Why is the charge on my "water bill"?
The Municipal Services Bill includes charges for drinking water, Milwaukee Metropolitan Sewerage District (MMSD) sewerage treatment, and certain municipal services provided in the City of Milwaukee. It is more cost-effective to include all charges on one bill rather than to issue multiple bills. The Milwaukee Water Works manages the billing and forwards the collected charges to the city treasurer for distribution to city departments and the MMSD.

I never received a "Municipal Services Bill" before. Why am I receiving one now?
The City of Milwaukee now has the capability to charge properties that receive city services but no water or sewer service. Previously, only those receiving water and sewer service paid local sewerage charges and snow and ice control charges. New accounts were established for properties that previously were exempt from city service charges.

How do I appeal the Storm Water Management Charge if I believe it was incorrectly calculated or charged to my property?
City ordinance established a flat fee for residential properties, so there is no appeal process for residential properties. Appeals are available for non-residential and commercial developed property and vacant improved property. To appeal a Storm Water Management charge, telephone the Milwaukee Water Works Customer Service Center, (414) 286-2830, and leave your name, property address, telephone number, and if available, an email address. The Water Works will forward your appeal to the Department of Public Works for investigation.

If I am a tenant of the property, can I be held responsible for payment of the Storm Water Management Charge?
Your payment responsibility is determined by the terms of your lease, which is a private agreement between you and your landlord. The city is not a party to the lease, and will not become involved in a disagreement between landlord and tenant. The landlord or property owner is responsible for payment of the charge if the tenant fails to pay under terms of the lease.

What happens to unpaid Storm Water Management Charges?
If charges for this service remain unpaid for two or more billing quarters, the charges will be transferred to the property tax account in September and are a lien against the property.

Do tax-exempt properties, such as churches, non-profit organizations, and government-owned properties pay the Storm Water Management Charge?
All properties are charged for use of the city storm sewers, including properties that are otherwise exempt from paying property taxes.

I'm selling my house. How do I transfer responsibility for the Storm Water Management Charge and other charges to the new owner?
The Storm Water Management Charges billed to a property sold after July 1, 2006 are the responsibility of the new owner and are handled in the same manner as all current charges (drinking water, sewer, solid waste, snow and ice charge). If a property is sold mid-quarter, for example, the total bill is prorated according to the time of sale so seller and buyer split the cost.

Para una explicación en Español por favor llame (414) 286-2830.

MWW 11/09

Resources

Winooski Natural Resources Conservation District Rain Barrel / Garden Info
vacd.org/winooski/winooski_rainbarrels.shtml
vacd.org/winooski/winooski_raingarden.shtml

South Burlington Low Impact Development (LID) Manual
www.sburlstormwater.com/lid.pdf

Smart Water Ways - info on stormwater in Chittenden County:
http://www.smartwaterways.org/

VT DEC's Small Sites Guide For Stormwater Management
http://www.anr.state.vt.us/dec/waterq/stormwater/docs/swimpairedwatersheds/sw_rda_small_sites_guide.pdf

Mid-America Regional Council Environmental Programs Downspout Redirection Instructions
www.marc.org/Environment/Water/downspout.htm

Urban Design Tools for Low Impact Development
www.lid-stormwater.net

National Low Impact Development (LID) Atlas
http://clear.uconn.edu/tools/lidmap/

For more information

To find out more about runoff in the Lake Champlain Basin, including details on each of these featured home improvements, visit the Lake Champlain Basin website's stormwater page:

www.lcbp.org/stormwater

South Burlington Stormwater Services

About SBSS

South Burlington Stormwater Services, Vermont's first stormwater utility, provides ongoing stormwater system maintenance, upgrades, and technical support for property owners.

The Utility manages stormwater in a cost-effective way for all residential and business property owners.

For more information about South Burlington Stormwater Services please visit:

www.sburlstormwater.com

Lake Champlain Basin Program

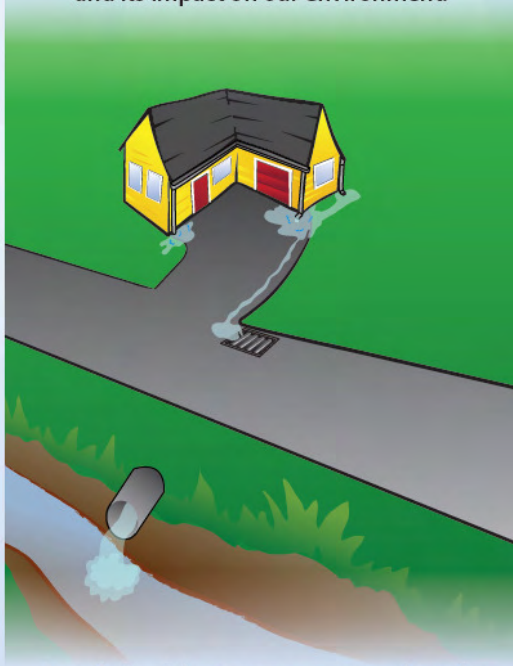
These materials were developed in conjunction with the Lake Champlain Basin Program.

For more information, visit

LCBP.org

Reducing Stormwater Runoff From Your Home

The Lake Champlain watershed typically receives 35 inches of rain annually but we rarely think about where the rain goes and its impact on our environment.

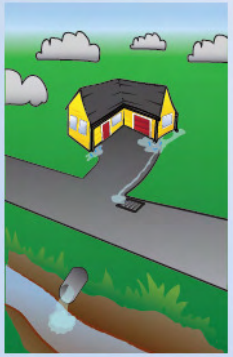


Look inside to see some simple tips to reduce your home's impact on our lake...

The Facts:

- **One acre of developed land** typically sends as much phosphorus to the lake as **three acres of agricultural land**
- During a heavy rainfall, one downspout can drain as much as **12 gallons of water per minute**
- For **as little as $30 or less**, you can greatly reduce your home's impact on the lake

Why Runoff is a Problem



When rain falls on towns and cities, it flows off hard or "impervious" surfaces like roofs, driveways, and sidewalks into the storm drain system instead of soaking into the ground. This increased volume of runoff called "stormwater" can cause stream bank erosion and water pollution.

In the City of South Burlington, one in three homes has a downspout, or vertical pipe for carrying rainwater from a gutter to ground level, that empties into the City's storm drain system. Redirecting your downspout is an easy first step toward reducing the impact your home has on our waterways.

Some simple ways to reduce runoff from your home

Downspout Redirection

Redirecting roof runoff can be as simple as adding a downspout extension. These are plastic (PVC) or metal extensions that attach to the bottom of your existing downspout and direct runoff to your lawn. The extension should carry your roof runoff at least three to five feet away from your home to prevent any water damage to your home or foundation. Keep in mind that not all sites are well suited for simple redirection. If your lawn is small compared to your roof, or if the slope of your lawn is too steep, consider installing a rain barrel or a rain garden instead.

Top: Example of a downspout extension

Middle: Rain garden illustration courtesy RainGardens.org

Bottom: Example of a rain barrel, courtesy www.innercityfarmer.com

Rain Barrel

Installing a rain barrel or series of rain barrels at the end of your downspouts allows you to store rain water for later use. Stored water can be used for watering your lawn or garden, or washing cars and will save money on your water bill. A pre-made rain barrel can cost as little as $60 or you can make your own for less.

Rain barrels are covered with a mesh screen so they don't become mosquito habitat and are available at local hardware and garden supply stores.

Rain Garden

Rain gardens can range in size from small, simple gardens for the average homeowner to large, complex bioretention gardens. Rain gardens absorb 30% more water than the equivalent area of a typical lawn, and the root systems of the plants and layers of porous soil provide even more capacity to filter pollutants. Redirecting a downspout to a rain garden will not only help reduce flooding and pollution, but will also attract birds and pollinating insects, adding to the biodiversity in your neighborhood.

Benefits of a Utility

The Stormwater Utility will:

- Manage and upgrade the City's stormwater infrastructure, such as culverts and storm drains, so that systems continue to meet current regulations and would receive permits.
- Manage, maintain, and handle permitting for residential stormwater systems in the City, after the systems are brought up to current Vermont (2002) standards by residents or homeowners associations.
- Provide technical assistance to South Burlington property owners who need to bring their stormwater system up to current Vermont (2002) standards. A valid stormwater permit is part of the value of your home and property.

Vermont Youth Conservation Corps volunteers plant the Bartlett Brook stormwater treatment wetland.

Your Job, My Job

The City is responsible for parts of the stormwater system that are in the public right of way and located on public property. This includes storm drains, culverts, conveyance piping, catch basins and stormwater outfalls.

Property owners are responsible for everything on their property. This includes cleaning leaves out of your rain gutters and removing gravel from your driveway.

South Burlington
Stormwater Utility
www.sburl.com/stormwater

City of South Burlington
575 Dorset Street
South Burlington, VT 05403
(802) 846-4106
www.sburl.com/stormwater

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South Burlington
Stormwater Utility
www.sburl.com/stormwater

An Introduction to Vermont's First Stormwater Utility

Stormwater drain

What is Stormwater?

Stormwater is water that runs off impervious surfaces such as rooftops, paved roads, driveways, and packed gravel roads.

Stormwater carries sediment and surface pollutants such as petroleum products, trash, phosphorus, and nitrogen. Stormwater is washed down storm drains. Most stormwater is not treated before it empties into our waterways and Lake Champlain.

Construction runoff

Stormwater and South Burlington

South Burlington contains all or a portion of six streams impaired by stormwater runoff, the highest number of any community in Vermont. Unmanaged stormwater is causing water pollution, erosion, flooding, and unstable streambanks in areas of South Burlington. Private stormwater systems that are not maintained have become a public problem. Expired permits and difficulty obtaining a valid stormwater permit are hindering property transfers in South Burlington.

A Stormwater Utility

The City of South Burlington is proud of its history of providing valuable public services for residents and is recognized nationally for its natural resources. Unmanaged stormwater runoff jeopardizes these assets.

There are positive steps the City can and should take at this time to address stormwater and its related problems. Establishing a utility will help the City clean up streams and improve water quality.

The Utility is an efficient way to identify and manage stormwater problems, projects, and infrastructure upgrades. The Utility will provide a stable and adequate source of revenue to complete required maintenance and manage stormwater-related activities.

The entire area of the City of South Burlington, including City-owned and state-owned and maintained roads, culverts, and parking lots, will share the cost and receive services from the Stormwater Utility.

Stormwater is everyone's responsibility. All properties with impervious surface generate stormwater runoff.

For more information visit our Web site, www.sburl.com/stormwater to learn more and view an interactive map which shows stormwater problem areas and improvement projects.

Stormwater Utility Fee

The Stormwater Utility user fee will be listed on existing sewer and water bills. Just like a water bill, the fee is based on service use.

A scientific process was used to calculate impervious surface area. The rate of $4.50 per equivalent residential unit (ERU) per month is based on the typical single-family South Burlington home having 2,700 square feet of impervious surface (rooftops, driveways, walkways).

User Fees

Every single-family home in South Burlington will be assessed a flat fee of $4.50 per month for services provided by the Utility.

Duplexes with fee simple ownership will be assessed $2.25 each per month. Triplexes with fee simple ownership will be assessed $1.50 each per month.

The fee will be billed quarterly. The annual cost is $54 for single-family homes, $27 for duplexes, and $18 for triplexes.

All other property owners (includes condominium ownership properties, businesses, institutions, and government) will be assessed a fee based on the amount of impervious surface.

D5 – Low Impact Development Case Studies

LOW IMPACT DEVELOPMENT CASE STUDIES:
The following is an excerpt from a project documenting the cost benefits of LID stormwater management. The project is titled *Forging the Link: Linking the Economic Benefits of Low Impact Development and Community Decisions.*
The project reference is:
Roseen, R. M., Houle, J. J., Janeski, T. V., Simpson, M. H., and Gunderson, J. (2010). "Forging the Link: Linking the Economic Benefits of Low Impact Development and Community Decisions--DRAFT." The UNH Stormwater Center, Durham, New Hampshire.

Economics of Low Impact Development: Case Studies

Low Impact Development (LID) represents one of the most progressive trends in the area of stormwater management and water quality. This approach involves utilizing strategies to control precipitation as close to its source as possible in order to reduce runoff volumes, promote infiltration, and protect water quality. While better known for its capacity to reduce pollution and manage stormwater more sustainably, LID designs are also economically beneficial and more cost-effective as compared to conventional stormwater controls.

In the vast majority of cases, the U.S. Environmental Protection Agency (EPA) has found that implementing well-chosen LID practices saves money for developers, property owners, and communities while also protecting and restoring water quality (USEPA, 2007). Specifically, utilizing LID designs can result in project cost savings by decreasing the amount of expensive below ground drainage infrastructure required, as well as reducing or eliminating the need for other stormwater management-related facilities including curbs, erosion control measures, catch basins, and outlet control structures.

LID designs also have space-saving advantages and can reduce the amount of land disturbance required during construction, saving money on site preparation expenses. In northern Frederick County, Maryland, a number of cost saving benefits were realized by redesigning a conventional subdivision with LID designs. This included eliminating two stormwater ponds representing a reduction in infrastructure costs of roughly $200,000; increasing the number of buildable lots from 68 to 70, which added roughly $90,000 in value; and allowing the site design to preserve approximately 50 percent of the site in undisturbed wooded condition, which reduced clearing and grubbing costs by $160,000 (Clar, 2003). Also, an infill site in northern Virginia was able to save over 50 percent in cost for infrastructure by minimizing impervious surfaces, protecting sensitive areas, reducing setback requirements, and treating stormwater at the source (VADCR, 2000).

Additional economic benefits of LID include reduced flooding costs as well as lower home cooling expenses. For example, natural vegetation and reduced pavement area in the Village Homes LID development in Davis, CA helped lower home energy bills by 33 to 50 percent as compared to surrounding neighborhoods (MacMullan, 2007). Further economic incentives to developers for LID inclusion include the potential for higher property values as well as a reduction in permitting fees – in Dane County, WI, permit fees for development are calculated

based on the amount of impervious area in a site, providing an incentive for developers to use LID. In another example, an analysis of 184 lots in one community found that conservation subdivisions were more profitable than conventional subdivisions. Lots in the conservation subdivisions cost an average of $7,000 less to produce, resulted in a 50 percent decrease in selling time, and had a value of 12 to 16 percent more as compared to lots in conventional subdivisions (Mohammed, 2006).

The following two case studies will show how utilizing an LID approach to site drainage engineering, specifically with porous asphalt installation, led to more cost-effective site and stormwater management designs.

Economic Case Studies

Boulder Hills LID Economic Case Study

In addition to more effective stormwater management, an economic benefit was achieved by utilizing an LID approach that featured porous asphalt for a residential development

OVERVIEW

Boulder Hills is a 24-unit active adult condominium community in Pelham, New Hampshire that features the State's first porous asphalt road. The development was built by Stickville LLC on 14 acres of previously undeveloped land and includes a total of 5 buildings, a community well, and a private septic system. In addition to the roadway, all driveways and sidewalks in the development are also composed of porous asphalt. Located along the sides and the backs of the buildings are fire lanes consisting of crushed stone that also serve as infiltration systems for rooftop runoff.

SFC Engineering Partnership Inc. designed the project site and development plan including all drainage. Dr. Robert Roseen of the University of New Hampshire (UNH) Stormwater Center advised the project team and worked with Pelham town officials, providing guidance and oversight with the installation and the monitoring of the porous asphalt placements.

Prior to development, the project site was an undeveloped woodland area sitting atop a large sand deposit. Soils on the parcel were characterized with a moderate infiltration rate and consisted of deep, moderately well to well drained soils. Wetland areas were located in the south and east sections of the parcel, with a portion of the site existing in a 100-year flood zone.

The benefits of implementing an LID design as compared to a conventional development and stormwater management plan included cost savings and positive exposure for the developers, improved water quality and runoff volume reduction, as well as less overall site disturbance. Over time, the porous asphalt placements are also anticipated to require less salt application for winter de-icing, resulting in additional economic and environmental benefits. By the end of the first winter 2009-2010, the project owners reported using substantially less salt for winter ice management.

DESIGN PROCESS

Initially, SFC Engineering Partnership began designing a conventional development and stormwater management plan for the project. However, according to David Jordan, P.E., L.L.S., manager of SFC Engineering Partnership's Civil Engineering Department, difficulty was encountered because of the site's layout and existing conditions. "The parcel was burdened by lowland areas while the upland areas were fragmented and limited," Jordan said. "Given these conditions, it was challenging to make a conventional drainage design work that would meet town regulations. We found ourselves squeezing stormwater mitigation measures into the site design in order to meet criteria. The parcel also did not have a large enough area that could serve as the site's single collection and treatment basin. Instead, we were forced to design two separate stormwater detention basins, which was more expensive. This approach was also cost prohibitive because of the necessity of installing lengthy underground drainage lines."

When LID and specifically, porous asphalt, emerged as a possible stormwater management option for the site, the developer, Stickville LLC, was receptive. Stickville was aware of the advantages of LID and porous pavement and was interested in utilizing these measures as a possible marketing tool which could help differentiate them as green-oriented developers. SFC Engineering Partnership advised Stickville LLC to pursue this option. Jordan had attended a seminar on porous pavement presented by The UNH Stormwater Center which covered the multiple benefits of utilizing this material, including its effectiveness for being able to meet stormwater quantity and quality requirements.

Figure 1: Comparison of Two Designs, LID Design (left) and Conventional (right) for Boulder Hills, Pelham, NH

"Per regulations, the amount of stormwater runoff from the site after development could not be any greater than what it was as an undeveloped parcel," Jordan said. "In addition to controlling runoff, stormwater mitigation measures also had to be adequate in terms of

treatment. Porous pavement allows us to do both. For a difficult site such as Boulder Hills, that represents a huge advantage."

According to Jordan, the Town of Pelham responded very favorably to the idea of incorporating LID with the project. "The planning board was on board from the very beginning," he said. "They were very supportive of utilizing porous asphalt and recognized the many benefits of this option."

ECONOMIC COMPARISONS

SFC Engineering Partnership designed two development options for the project. One option was a conventional development and drainage plan that included the construction of a traditional asphalt roadway and driveways. The other option, an LID approach, involved replacing the traditional asphalt in the roadway and driveways with porous asphalt and using subsurface infiltration for rooftop runoff, essentially eliminating a traditional pipe and pond approach.

Although porous asphalt was more costly as compared to traditional asphalt, the engineers found that by utilizing this material, cost savings in other areas could be realized. For one, installing porous asphalt significantly lowered the amount of drainage piping and infrastructure required. Using porous asphalt also reduced the quantity of temporary and permanent erosion control measures needed while cutting in half the amount of rip-rap, and lowering the number of catch basins from 11 to 3. Additionally, the LID option completely eliminated the need to install curbing, outlet control structures, as well as two large stormwater detention ponds. Another benefit was a 1.3 acre reduction in the amount of land that would need to be disturbed, resulting in less site preparation costs.

The following table shows the construction estimate cost comparisons between the conventional and the low impact development options. Detailed unit costs for materials are included in Appendix XX.

Table 1: Comparison of Unit Costs for Materials for Boulder Hills LID Subdivision

Item	Conventional Option	Low Impact Development Option	Cost Difference
SITE PREPARATION	$23,200.00	$18,000.00	($5,200.00)
TEMP. EROSION CONTROL	$5,846.50	$3,811.50	($2,035.00)
DRAINAGE	$92,398.00	$20,125.00	($72,273.00)
ROADWAY	$82,054.00	$127,972.00	$45,918.00
DRIVEWAYS	$19,722.00	$30,108.00	$10,386.00

CURBING	$6,464.00	$0.00	($6,464.00)
PERM. EROSION CONTROL	$70,070.00	$50,610.00	($19,460.00)
ADDITIONAL ITEMS	$489,700.00	$489,700.00	$0.00
BUILDINGS	$3,600,000.00	$3,600,000.00	$0.00
PROJECT TOTAL	$4,389,454.50	$4,340,326.50	($49,128.00)

As shown in the table, the LID option resulted in higher costs for roadway and driveway construction. However, considerable savings were realized for site preparation, temporary and permanent erosion control, curbing, and most noticeably, drainage. Overall, the LID option was calculated to save the developers $49,128 compared to a conventional design ($789,500 vs. LID cost of $740,300) or nearly 6 percent of the stormwater management costs as compared to the conventional option.

CONCLUSIONS

Beyond its effectiveness at reducing stormwater runoff, facilitating more groundwater infiltration, and promoting water quality benefits, porous asphalt was shown in this case study to be capable of bringing positive economic results. Primarily, cost savings were achieved in the Boulder Hills site development design through a significant reduction in the amount of drainage infrastructure and catch basins required, in addition to completely eliminating the need for curbing and stormwater detention ponds. Moreover, with considerably less site clearing needed, more economic and environmental benefits were realized. Compared to a conventional development plan, an option utilizing LID featuring porous asphalt was shown in this example to be more economically feasible.

Greenland Meadows LID Economic Case Study

Utilizing an LID approach which featured porous asphalt, a cost-effective drainage system was designed for a large retail development

OVERVIEW

Greenland Meadows is a new retail shopping center built by Newton, Mass.-based Packard Development along in Greenland, New Hampshire that features the largest porous asphalt installation in the Northeast. The development is located on a 55.95-acre parcel and includes three, one-story retail buildings (Lowe's Home Improvement, Target, and a future supermarket), paved parking areas consisting of porous asphalt and non-porous pavements, landscaping areas, a large gravel wetland, as well as advanced stormwater management facilities. The total impervious area of the development – mainly from rooftops and non-porous parking areas – is

approximately 25.6 acres, considerably more as compared to pre-development conditions. Prior to development, the project site contained an abandoned light bulb factory with a majority of the property vegetated with grass and trees.

Framingham, Mass.-based Tetra Tech Rizzo provided all site engineering services and design work for the stormwater management system, which included two porous asphalt installations covering a total of 4.5 acres along with catch basins, sub-surface crushed stone reservoir, sand filter, and underground piping and catch basins. Dr. Roseen of the UNH Stormwater Center provided guidance and oversight with the porous asphalt installations and supporting designs.

This case study will show how a combination porous asphalt and standard pavement design with a sub-surface gravel reservoir management system was more economically feasible as compared to a standard pavement design with a conventional sub-surface stormwater management detention system. Additionally, this analysis will cover some of the site-specific challenges, as well as the environmental issues with this development that mandated the installation of an advanced LID-based stormwater management design.

ENVIRONMENTAL CONCERNS

During the initial planning stage, concerns arose about potential adverse water quality impacts from the project. The development would increase the amount of impervious surface on the site resulting in a higher amount of stormwater runoff as compared to existing conditions. These concerns were especially heightened given the fact that the development is located immediately adjacent to Pickering Brook, an EPA-listed impaired waterway that connects the Great Bog to the Great Bay. One group that was particularly interested in the project's approach to managing stormwater was the Conservation Law Foundation (CLF), an environmental advocacy organization.

According to Austin Turner, a senior project civil engineer with Tetra Tech Rizzo, CLF feared that a conventional stormwater treatment system would not be sufficient for protecting water quality. "Since there was interest in this project from many environmental groups, especially CLF, permitting the project proved to be very challenging," Turner said. "We were held to very high standards in terms of stormwater quality because Pickering Brook and the Great Bay are such valuable natural resources. The CLF wanted this project to have the gold standard in terms of discharge."

In order to ensure a high level of stormwater treatment as well as gain project approval, Tetra Tech Rizzo worked closely with Packard Development, the UNH Stormwater Center, the New Hampshire Department of Environmental Services, and CLF on the design of an innovative stormwater management system with LID designs.

HYDROLOGIC CONSTRAINTS

Brian Potvin, P.E., director of land development with Tetra Tech Rizzo, said one of the main challenges in designing a stormwater management plan for the site was the very limited permeability of the soils. “The natural underlying soils are mainly clay in composition, which is very prohibitive towards infiltration,” Potvin said. “Water did not infiltrate well during site testing and the soils were determined to not be adequate for receiving runoff.” As such, Tetra Tech Rizzo focused on a stormwater management design that revolved around stormwater quantity attenuation, storage, conveyance, and treatment.

ECONOMIC COMPARISONS

Tetra Tech Rizzo prepared two site work and stormwater management design options for the Greenland Meadows development:

Conventional – this option included standard asphalt and concrete pavement along with a traditional sub-surface stormwater detention system consisting of a gravel sub-base and stone backfill, stormwater wetland, and supporting infrastructure

LID – this option included the use of porous asphalt and standard paving in addition to a sub-surface crushed stone reservoir, sand filter beneath the porous asphalt, a subsurface gravel wetland, and supporting infrastructure

The western portion of the property would receive a majority of the site’s stormwater prior to discharge into Pickering Brook. The following table compares the total construction cost estimates for the conventional and the LID option.

Table 2: Comparison of Unit Costs for Materials for Greenland Meadows Commercial Development

Item	Conventional Option	Low Impact Development Option	Cost Difference
MOBILIZATION / DEMOLITION	$555,500	$555,500	$0
SITE PREPARATION	$167,000	$167,000	$0
SEDIMENT / EROSION CONTROL	$378,000	$378,000	$0
EARTHWORK	$2,174,500	$2,103,500	($71,000)
PAVING	$1,843,500	$2,727,500	$884,000
STORMWATER MANAGEMENT	$2,751,800	$1,008,800	($1,743,000)
ADDITIONAL WORK-	$2,720,000	$2,720,000	$0

RELATED ACTIVITY (utilities, lighting, water & sanitary sewer service, fencing, landscaping, etc.)			
PROJECT TOTAL	$10,590,300	$9,660,300	($930,000)

* Costs are engineering estimates and do not represent actual contractor bids

As shown, paving costs were estimated to be considerably more expensive (by $884,000) for the LID option because of the inclusion of the porous asphalt, sand filter, and porous asphalt crushed stone reservoir layer. However, the LID option was also estimated to save $71,000 in earthwork costs as well as $1,743,000 in total stormwater management costs, primarily due to piping for storage. Overall, comparing the total site work and stormwater management cost estimates for each option, the LID alternative was estimated to save the developers a total of $930,000 compared to a conventional design, or about 26 percent of the overall total cost for stormwater management.

Tables 2 and 3 further break down the differences in stormwater management costs between the conventional and LID designs by comparing the total amount of piping required under each option.

Table 3: Conventional Option Piping

	Type	Quantity	Cost
Distribution	6 to 30-inch piping	9,680 linear feet	$298,340
Detention	36 and 48-inch piping	20,800 linear feet	$1,356,800

Table 4: Low Impact Development Option Piping

	Type	Quantity	Cost
Distribution	4 to 36-inch piping	19,970 linear feet	$457,780
Detention*	--	0	$0

*Costs associated with detention in the LID option were accounted for under “earthwork” in table 1.

Although distribution costs for the LID option were higher by $159,440, the LID option also completely removed the need to use large diameter piping for subsurface stormwater detention. The elimination of this piping amounted to a savings of $1,356,800. “The piping was replaced by the subsurface gravel reservoir beneath the porous asphalt in the LID alternative,” Potvin said. “Utilizing void spaces in the porous asphalt sub-surface crushed stone reservoir to

detain stormwater allowed us to design a system using significantly less large diameter pipe. This represented the most significant area of savings between each option."

CONSERVATIVE LID DESIGN

Although the developers were familiar with the benefits of porous asphalt, Potvin said they were still concerned about the possibility of the systems clogging or failing. "The developers didn't have similar projects they could reference," he said. "For this reason, they were tentative on relying on porous asphalt alone."

In order to resolve this uncertainty, the Tetra Tech Rizzo team equipped the porous pavement systems with relief valve designs – additional stormwater infrastructure including leaching catch basins. "This was a conservative 'belt and suspenders' approach to the porous asphalt design," Potvin said. "Although the porous pavement system is not anticipated to fail, this design and strategy provided the developers with a safety factor and insurance in the event of limited surface infiltration."

To further alleviate concerns, a combination paving approach was utilized. Porous asphalt was limited to passenger vehicle areas and installed at the far end of the front main parking area as well as in the side parking area, while standard pavement was put in near the front and more visible sections of the retail center and for the loop roads, delivery areas expected to receive truck traffic. "This way, in case there was clogging or a failure, it would be away from the front entrances and would not impair access or traffic into the stores," Potvin said.

LID SYSTEM FUNCTIONALITY

The two porous asphalt drainage systems – one in the main parking lot and one in the side parking area – serve to attenuate peak flows, while the aggregate reservoirs, installed directly below the two porous asphalt placements, serve as storage. The aggregate reservoirs are underlain by sand filters which provide an additional means of stormwater treatment. Runoff from the sand filters flows through perforated underdrain pipes that converge to a large header pipe. Peak flow attenuation is attained by controlling the rate at which runoff exits the header pipe with an outlet control structure.

After being collected in catch basins, a majority of the stormwater runoff from rooftops and nonporous pavement areas flow to particle separator units, which treat stormwater prior to discharging into the crushed stone reservoir layers below the porous asphalt.

Outlet from the smaller aggregate reservoir, located underneath the side parking area, flows to an existing wetland on the east side of the site, while outlet from the larger aggregate reservoir flows to the gravel wetland on the west side of the site. The gravel wetland is designed as a series of flow-through treatment cells providing an anaerobic system of crushed stone with

wetland soils and plants. This innovative LID design works to remove pollutants as well as mitigate the thermal impacts of stormwater.

CONCLUSIONS

Although the use of porous asphalt in large-scale commercial and residential development is still a relatively new application, this case study showed how porous asphalt systems, if designed correctly and despite significant site constraints, can bring significant water quality and economic benefits. With Greenland Meadows, an advanced LID-based stormwater design was implemented given the proximity of the development to the impaired Pickering Brook waterway. But in addition to helping alleviate water quality concerns, the LID option featuring porous asphalt systems eliminated the need to install large diameter drainage infrastructure. This was estimated to result in significant cost savings in the site and stormwater management design.

LID Retrofit Example: University of New Hampshire Parking Lot Bioretention

Retrofitting of stormwater infrastructure is commonly considered to be very costly compared to new construction. However, in certain instances using existing resources, simple retrofits can be performed at minimal expense. Typically Gray Infrastructure represents the largest expense for construction of stormwater controls, and in combination with labor and equipment, may represent the bulk of project costs. Institutions such as municipalities that have a Public Works can provide both labor and equipment for retrofitting existing infrastructure. In these instances retrofit expenses are limited to design and materials costs only, while installation expenses for labor, equipment, and some infrastructure can be avoided. Personnel training for construction of many LID structural controls such as bioretention can be simple. Training often consists of simply having qualified installation oversight to instruct and train personnel at system construction. The following example details the process and expenses associated with the installation of a bioretention system for an existing parking area on the University of New Hampshire campus.

A bioretention retrofit was performed at the University of New Hampshire (UNH) for a site consisting of a landscaped area with existing stormwater infrastructure. Existing infrastructure consisted of curbing, catch-basins, and a drainage network that directed stormwater runoff offsite. The system was designed by UNH Stormwater Center in conjunction with the Maine Department of Environmental Protection (MEDEP). The system is a conversion of an existing landscape island into a bioretention and used as a source control measure to manage water quantity and improve water quality for parking lot runoff.

PROJECT LOCATION

The bioretention system is installed in an existing commuter parking lot located on-campus in Durham, New Hampshire with routine commuter and bus traffic. The parking lot is a standard design consisting of parking stalls and landscaped islands that are raised, curbed, and vegetated. These islands are approximately 500 feet long, 9 feet wide, and are designed to shed rainwater onto the adjacent impervious surface while the curbing directs runoff to storm drains. Existing stormwater management consists of a conventional catch basin and pipe network draining to a swale. Two catch basins are located near the center of the island, one on each side, draining approximately one acre each with a 12 inch concrete pipe running under the island.

PROJECT DESCRIPTION

The bioretention was designed to treat runoff from a one-inch rainfall on 0.8 acres of pavement over a 24 hour period, and includes a filter area that is 30 feet long and 9 feet wide. The cross-sectional layout of the system from the bottom up consists of native soil; 10 inches of crushed stone; three inches of ¾-inch pea gravel; 24 inches of an engineered bioretention soil mix (BSM); and a 2-inch layer of hardwood mulch. The top layer was planted with several varieties of native perennial wild flowers. The BSM mix was based upon a design develop to meet the State of Maine regulatory requirements for bioretention areas. The system was under-drained and

includes an infiltration reservoir, and high-flow bypass. All drainage was connected to the existing drainage infrastructure by coring into the adjacent catchbasin underneath the retrofit. The sides of the system were fitted with an impermeable liner to prevent runoff from migrating under the existing pavement as well as to prevent migration of adjacent soils into the system. Bioretention construction took three working days and included a construction team consisting of two skilled contractors in addition to an engineering staff which provided oversight.

PROJECT COST:

Total project cost per acre was $14,000. With labor and install provided, and engineering oversight a one-time training event, costs are limited to materials and plantings at $5,500. Costs could be further reduced with onsite preparation of the BSM saving additional materials and trucking expenses.

ITEM	COST PER ACRE ($$)
Labor and Install	$ 8,500
Materials	$ 4,675
Plantings	$ 825
Total	$ 14,000

In addition to this example, numerous municipal projects have been implemented utilizing bioretention, dry well, tree filter, and porous pavement retrofit installations. In these instances minimal expenses were incurred by the municipal partner beyond contribution of labor and equipment. Expenses were typically limited to materials, design, and installation oversight (which doubled as training of municipal personnel and is not expected to be a recurring expense for future installs). In all instances, community partners (such as university cooperative extensions and watershed groups) contributed both expertise in plant selection and installation, and often donated materials as well.

Figure 2: Bioretention retrofit installation at the University of New Hampshire, October, 2008

Figure 3: Completed Bioretention Retrofit Installation 2008

Costs Associated With Combined Sewer Overflow

INTRODUCTION

Combined sewer overflows (CSOs) represent major water quality threats to hundreds of cities and communities in the U.S. that are served by a combined sewer system (CSS). CSO events cause the release of untreated stormwater and wastewater into receiving rivers, lakes, and estuaries, causing a host of environmental and economic-related problems. Costs associated with CSO management are expensive. The U.S. Environmental Protection Agency (EPA) estimates the costs of controlling CSOs throughout the U.S. are approximately $56 billion (MacMullan, 2007).

The traditional approach to CSO management involves the development of a separate drainage system to convey stormwater flows or the use of grey infrastructure and conventional stormwater controls for enhancing the storage and conveyance capacity of combined systems. These approaches can include the construction of large underground storage tunnels that store sewage overflows during rain events for later treatment, as well as necessary improvements and

upgrades to municipal treatment facilities in order to handle increasing volumes. Both approaches, while effective for CSO controls, are very expensive.

Integrating green infrastructure strategies and LID designs into a CSO mitigation plan can help communities achieve CSO management requirements at lower costs. In addition to many benefits including groundwater recharge, water quality improvements, and reduced treatment costs, the use of LID can help minimize the number of CSO events and the volume of contaminated flows by managing more stormwater on site and keeping volumes of runoff out of combined sewers.

Utilizing a combination approach of grey and green infrastructure strategies can be a considerably more cost-effective method for CSO management as compared to a traditional grey infrastructure approach alone. Indeed, LID methods can cost less to install, can have lower operations and maintenance (O&M) costs, and can provide more cost-effective stormwater management and water quality services than conventional stormwater controls. Some LID alternatives are also being initiated by the private sector. While municipalities may provide oversight and consultation, as is the case with the City of Portland, OR, these projects are not controlled by municipalities in regards to implementation, operation, and maintenance. The purpose of this study is to show the cost-benefits of integrating green infrastructure strategies with traditional grey infrastructure. Although communities rarely attempt to quantify and monetize the avoided treatment costs from the use of LID designs, the benefits of these practices for decreasing the need for CSO storage and conveyance systems should be factored into any economic analyses (EPA, 2007).

CASE STUDIES

The following case studies are presented to develop an economic context for the use of green infrastructure and LID designs as a strategy for CSO compliance. The case studies will also identify and contrast historical grey infrastructure approaches to CSO management using store, pump, and treat with approaches using Green Infrastructure/LID designs that focus on reduced stormwater runoff volumes.

Narragansett Bay Commission

***Baseline* grey infrastructure approach to CSO management**

BACKGROUND

The Narragansett Bay Commission (NBC) in Providence, Rhode Island, oversees the operation and maintenance of approximately 89 miles of combined sewer interceptors, including two wastewater treatment facilities. These systems serve a total of 10 different communities, including 360,000 residents, 8,000 businesses, and 160 major industrial users. According to the NBC, approximately 66 CSO events occur each year in the NBC service area, accounting for an

estimated 2.2 billion gallons of untreated combined sewage released into Narragansett Bay and its tributaries.

In order to mitigate these CSOs and protect the Narragansett Bay and the region's urban rivers from sewage overflows, the NBC initiated a three-phase Combined Sewer Overflow (CSO) Abatement Plan. Phase I of the project, which began in 2001, was completed and went on-line in November 2008. The chief component of Phase I includes a three-mile long, 30-foot diameter deep rock tunnel 250 feet below the surface. The Phase I tunnel system has a 62 million gallon capacity and is anticipated to effectively reduce overflow volumes by approximately 40 percent.

ECONOMIC CONTEXT

The total capital costs for Phase I of the NBC's CSO Abatement plan were $365 million. The associated operational and maintenance costs of Phase I, the bulk of which are attributed to electrical costs for pumping, are $1 million per every one billion gallons of stormwater and sewage flow, or $1 for every 1000 gallons (Brueckner, 2009). Phase II of the CSO abatement plan, which will begin in 2011, includes two near-surface interceptors that will convey additional flow to the Phase I tunnel. The estimated capital costs for the Phase II project are $250 million.

The NBC's regulations regarding stormwater management require developers to execute stormwater mitigation plans if required by the NBC. These plans encourage the use of LID strategies, BMPs, and other methods to eliminate or reduce storm flows. Between 2003 and 2008, a total of 67 stormwater mitigation plans were approved and implemented which accounted for 8.9 million gallons of stormwater diverted from the combined system (Zuba, 2009).

Portland, Oregon

Economic benefits of utilizing Green Infrastructure programs for CSO Management

BACKGROUND

The City of Portland, Oregon is considered a national leader in the implementation of innovative stormwater management strategies and designs. Included among the city's Sustainable Stormwater Management Programs is the Innovative Wet Weather Program, the Green Street Program, the Portland Eco-Roof Program, and individual case studies and projects that include commercial and multifamily stormwater retrofits and porous pavement placements.

With Portland receiving an average of 37 inches of precipitation annually, creating roughly 10 billion gallons of stormwater runoff per year, these programs are very important for helping reduce flooding and erosion as well as minimizing CSO events.

Innovative Wet Weather Program. This city-wide program encourages the implementation of stormwater projects that improve water quality and watershed health, reduce CSO events and

stormwater pollution, and control stormwater runoff peaks and volumes. According to the Portland Bureau of Environmental Services, the program goals include:

- Capturing and detaining stormwater runoff as close to the source as possible;
- Reducing the volume of stormwater entering the combined sewer system;
- Filtering stormwater to remove pollutants before the runoff enters groundwater, streams, or wetlands;
- Using and promoting methods that provide multiple environmental benefits; and
- Using techniques that are less costly than traditional piped solutions.

Green Streets Program. Portland's Green Street Program promotes the use of natural aboveground and vegetated stormwater controls in public and private development in order to reduce the amount of untreated stormwater entering Portland's rivers, streams, and sewers. The program is geared towards diverting stormwater from the city's overworked combined system and decreasing the amount of impervious surface so that stormwater can infiltrate and recharge groundwater systems.

The program takes a sustainable and blended approach to finding the most optimal solution for storm and sanitary sewer management. This includes overlaying and integrating green and sustainable stormwater strategies with traditional gray infrastructure to maintain or improve the city's sewer capacity (Dobson, 2008).

Green streets have been demonstrated to be effective tools for inflow control of stormwater to Portland's CSO system. Two such green street designs, the Glencoe Rain Garden and the Siskiyou Curb Extension facilities, were shown to reduce peak flows that cause basement sewer backups and aid compliance with CSO regulations by reducing runoff volumes sent to the CSO Tunnel system (Portland, 2007).The City of Portland also conducted simulated storm event modeling for basement sewer back-ups and determined that two green street project designs would reduce peak flows from their drainage areas to the combined sewer by at least 80 to 85 percent. The City of Portland also ran a simulation of a CSO design storm and found that the same two green street project designs retained at least 60 percent of the storm volume, which is believed to be a conservative estimate.

ECONOMIC BENEFIT

The following sections of this case study communicate the economic context for both the application of LID strategies in Portland, as well as the city's programs that promote the use of green infrastructure designs for stormwater management.

Green Streets Program. For the City of Portland, utilizing green streets is the preferred strategy for helping relieve sewer overflow conditions because it is the most cost-effective and

eliminates the need for expensive below-ground repairs, which often involve replacing infrastructure (Dobson, 2008). As an example, a basement flooding relief project that was under design was projected to cost 60 percent less than what would have been the cost of a traditional pipe upsize and replacement project. This is because the solution, a mix of green streets and private system disconnects, intercepts and infiltrates the water before it enters the public storm system thereby reducing the need to dig up and upsize the existing piped infrastructure.

Cost Comparisons between Grey and Green Infrastructure Strategies---Tabor to the River: The Brooklyn Creek Basin Program. In June of 2000, prior to implementation of the Green Street Program, the City of Portland was faced with the need to upgrade an undersized sewer pipe system in the Brooklyn Creek Basin, which extends from the Willamette River to Mt. Tabor between SE Hawthorne and SE Powell boulevards, and covers approximately 2.3 square miles. Upgrades were needed in order to improve the sewer system reliability, contain street flooding, stop sewer backups from occurring in basements, and help control CSOs to the Willamette River.

At that time, the city considered constructing a new separated stormwater collection system to support the existing undersize pipes in this basin. The original cost estimate for constructing this new system using traditional grey infrastructure was $144 million (2009 dollars). However, following this proposal, a second plan was developed that included a basin redesign using a combined grey and green infrastructure approach. Including a total of $11 million allocated for green solutions, the cost estimate for this integrated approach was $81 million, a savings of $63 million for the city (Portland, 2009).

The combined grey and green approach was chosen as the 2006 Recommended Plan for the Brooklyn Creek Basin, and includes project objectives of reducing CSO events, improving surface and groundwater hydrology, protecting and improving sewer infrastructure, optimizing cost-effectiveness, boosting water quality, and enhancing community livability.

The approved basin improvement plan consists of 35 public and private sector projects over the next 10-20 years. Grey infrastructure upgrades include repairing or replacing 81,000 feet of combined sewer pipes, while the green infrastructure strategies include building green roofs, retrofitting parking lots with sustainable stormwater controls, planting nearly 4,000 street trees, and adding more than 500 green streets with vegetated curb extensions and stormwater planters.

Green Infrastructure for CSO Compliance: Cost Comparisons. Portland's combined sewer system covers 26,000 acres and contains 4,548,000 linear feet (861 miles) of gravity drained, combined sewer pipe. The city's combined system also includes 42 separate basins connected via three major interceptor systems and served by three major pump stations.

The City of Portland, under federal and state requirements as well as stipulations from the Clean Water Act to comply with regulations regarding CSO management, initiated the construction of a new pump station and two CSO tunnels (West Side and East Side CSO Tunnels) which would

serve as the primary means to protect the city's receiving waters from future CSO events. However, in addition to these initiatives, more projects and programs were needed for providing additional CSO mitigation.

In December of 2005, the City of Portland's Bureau of Environmental Services prepared a report (Portland, 2005) charged with sizing of the East Side CSO Tunnel and providing recommendations for long-term operations and flow management of the Willamette CSO system. The city's final recommendations included the following for the Willamette CSO tunnels and supporting infrastructure:

Table 5: CSO Infrastructure Costs for City of Portland, OR

Project	Total Capital Costs	Annual O&M Costs
East Side CSO Tunnel	$624,892,000	$22,700
Swan Island CSO Pump Station – Phase 2	$7,500,000	$3,100,000
Portsmouth Force Main	$55,306,000	$12,000
Balch Consolidated Conduit	$22,052,000	$3,900

East Side CSO Tunnel – This storage facility will be constructed with a 22-foot diameter and will have a capacity of 83 MG. Total length is 29,145 linear feet; annual O&M costs are $0.78 per linear foot. Design life is 50 years.

Swan Island CSO Pump Station – This facility pumps approximately 500 MG per year with an annual O&M cost of $0.0002 per gallon for pump station operations and $0.006 per gallon for Columbia Boulevard Wastewater Treatment Plant treatment. Design life is 50 years.

Portsmouth Force Main – This infrastructure is 66 inches in diameter and 15,000 feet in length. Annual O&M costs are $0.80 per linear foot. Design life is 50 years.

Balch Consolidated Conduit – This infrastructure is 84 inches in diameter and 4,900 linear feet. Annual O&M costs are $0.80 per linear foot. Design life is 50 years.

Along with determining the final recommendations for the East Side CSO Tunnel and supporting infrastructure, the city considered a range of possible alternatives for additional CSO mitigation. This included 12 different stormwater separation projects as well as a number of watershed health initiatives, some of which involved green infrastructure strategies including:

Eastside Curb Extensions – involved the use of vegetated swales at a cost of $50,000 per acre and O&M costs of $2,000/year/acre.

Eastside Roof & Parking Inflow Control – parking retrofits use vegetated infiltration basins at a cost of $90,000 per acre and O&M costs of $1,100/year/acre. Rooftop stormwater controls use either stormwater planters ($40,000 per acre; O&M costs of $600/year/acre), or vegetated infiltration basins.

Green Roof Legacy Project – retrofit 20 acres of rooftop in an industrial district with eco-roofs. Project costs include $285,000/acre/year for design/construction and $935/acre/year for O&M activities.

Extended Downspout Disconnection Program (DDP) – continues the city's successful existing DDP at the cost of $22,300 per acre and O&M costs of $7/year/downspout. Depending on site conditions, this can include the use of LID strategies including rain gardens and soakage trenches built by private citizens with City of Portland consultation.

The City's goal was to determine which project/program alternatives would be the most cost-effective for long-term CSO management. The basic metric common to the projects identified for CSO control was the amount of stormwater volume that could be removed from the CSO tunnel system. The city's final evaluation was based on the relationship between project capital costs and stormwater volume that could be removed from the system. This analysis took into account cumulative capital costs, marginal costs for gallons removed, and cumulative volume removed from the system.

Table xx shows all stormwater separation and watershed health projects/programs considered by the City of Portland. The projects/programs are sorted by dollars per gallons of stormwater that can be removed (marginal cost). Project staff agreed that cost-effectiveness was determined by an inflection point, or knee-of-the-curve point, on a graph that compared costs to stormwater volume that could be diverted from the CSO system. This inflection point was determined to be approximately $4 per gallon removed the system.

Projects/programs costing at or below $4 per gallon were the ones recommended for further design and eventual implementation for long-term CSO control. These projects/programs are the first seven listed in Table XX.

Table 6: CSO Control Alternatives Costing for Portland, OR

Project/Program	Effective Imp. Acres Controlled	Est. 3-year Volume Removed (MG)	Capital Cost	Marginal Cost ($/Gallon)	Cumulative Volume Removed (MG)	Cumulative Capital Cost
Extended Downspout Disconnection Program (can include LID)	284	7.45	$6,633,000	$0.89	7.45	$6,633,000
School Disconnection*	68	1.77	$1,954,000	$1.10	9.22	$8,587,000
Church Disconnection*	32	0.96	$2,031,000	$2.12	10.18	$10,618,000
Beech-Essex Sewer Separation	37	1.40	$3,889,000	$2.78	11.58	$14,507,000
ES Curb Extensions (LID)	349	4.29	$12,323,000	$2.87	15.87	$26,830,000
Tanner Phase 3 Sewer Separation	85	3.10	$10,767,616	$3.47	18.97	$37,597,616
ES Roof & Parking IC (LID)	475	17.64	$72,047,000	$4.08	36.61	$109,644,616
NWN Pre-design – Tanner North Sewer Separation	14	0.22	$1,127,000	$5.12	36.83	$110,771,616
Carolina Stream & Storm Separation	93	1.02	$5,319,000	$5.21	37.85	$116,090,616
NWN Pre-design – Tanner South Sewer Separation	13	0.26	$1,602,000	$6.16	38.11	$117,692,616
NWN Pre-design – Tanner Central Sewer Separation	2	0.04	$269,000	$7.60	38.14	$117,961,616
NWN Pre-design – Nicolai/Outfall Sewer Separation	34	0.54	$6,321,000	$11.76	38.68	$124,282,616
NWN Pre-design – Nicolai/Outfall 13 Sewer Separation	52	0.68	$8,217,000	$12.04	39.36	$132,499,616
Green Roof Legacy Project (LID)	20	1.04	$14,179,000	$13.65	40.40	$146,678,616
NWN Pre-design – Nicolai/Outfall 15 Sewer Separation	24	0.36	$6,546,000	$17.98	40.77	$153,224,616
Holladay Sewer Separation	125	0.69	$14,360,000	$20.94	41.45	$167,584,616
NWN Pre-design – Balch Neighborhood Sewer Separation	8	0.14	$7,664,000	$55.06	41.59	$175,248,616
NWN Pre-design – Balch/Forest Park Storm Separation	5	0.13	$12,026,000	$93.82	41.72	$187,274,616

* Church and School Disconnection programs assumed downspout disconnection and drywells would remove this stormwater volume. The former is an LID method.

The projects/programs chosen on the basis of cost-effectiveness included the Eastside curb extension projects (vegetated swales), the Eastside roof & parking inflow control projects (vegetated infiltration basins & stormwater planters), three disconnection programs (which can include LID strategies) and two stormwater separation projects.

LID Avoidance Costs. The City of Portland recognizes two avoidance costs for incorporating LID strategies with combined sewer systems. One of these avoidance costs is annual O&M costs to pump and convey stormwater through the existing combined sewer system. The city measures this by applying a rate of $0.0001 per gallon treated and $0.0001 per gallon pumped. This equates to an annual O&M avoidance cost of $0.0002 per gallon.

Secondly, the City of Portland recognizes an avoidance cost that benefits the CSO system. This is based on the relationship between project capital costs and stormwater volume removed from the CSO system, which was described above. The cost-effectiveness point for projects/programs that remove stormwater volume from the CSO system ($4 per gallon) is also considered as the avoidance cost of constructing a larger CSO tunnel. In life-cycle cost analyses, this "savings" can reduce the capital costs of other LID facilities that the city builds for objectives other than CSO control (e.g. water quality improvements, basement flooding relief), but still removes stormwater from entering the CSO tunnels (Owen, 2009).

Kansas City, Missouri

Economic benefits of integrating green solutions with grey infrastructure for CSO compliance

BACKGROUND

The City of Kansas City, Missouri has committed to implementing a green design initiative that will be considered a community amenity and will work to reduce the amount of water entering the city's combined system.

Under a USEPA mandate, the City of Kansas City, Missouri is required to update its network of aging sewer infrastructure in order to address overflows from its combined and separate sewer systems. Kansas City's 318-square mile sewer system includes 58 square miles of a combined system and 260 miles of a separated system. The overall system serves 668,000 people and includes 7 wastewater treatment plants with a total capacity of 153 million gallons per day (MGD).

Overflows in the combined system amount to 6.4 billion gallons in a typical year, and on average, 12 rain events per year are responsible for 67 percent of this total overflow. This contributes to the poor water quality of Kansas City's streams, urban lakes and rivers.

The original planned improvements associated with upgrading the city's combined system include 310 MGD of additional treatment capacity, 25 million gallons (MG) of in-line storage, 10 separation areas, neighborhood sewer rehabilitations, as well as pump station and treatment plant modifications. Three storage tunnels from 16 to 26 feet in diameter are also proposed which would run between 1.4 and 3.4 miles in length and would be capable of storing 78 MG of overflow. The goals of the improvements in the combined sewer system are to capture 88 percent of flows, reduce the frequency of overflow events by 65 percent, and lower the 6.4 billion gallons of overflow per year down to 1.4 billion gallons (Kansas City, 2009).

The original estimated capital costs associated with overhauling Kansas City's total sewer system is $2.4 billion dollars, of which $1.4 billion would go towards the combined system. The yearly operations & maintenance costs (O&M) of this total upgrade are estimated at $33 million per year.

Green Solutions. In developing a plan for the combined sewer system upgrade, Kansas City began exploring the possibility of incorporating green infrastructure strategies in combination with grey infrastructure improvements. The city formed a green solutions subcommittee and later developed a green solutions position paper, which eventually resulted in a city council resolution directing city staff to develop a plan to implement green infrastructure strategies.

Green Overflow Control Plan. In May of 2008 the Kansas City Water Services Department proposed $30 million in green solutions during the first five years of the proposed $1.4 billion overflow control plan. This plan included language to allow green solutions to replace grey infrastructure. Upon review, however, the city council determined that additional green infrastructure strategies were needed in the overflow control plan and directed the water services department to request a 6-month extension for submittal of the plan. The extension was granted by the Missouri Department of Natural Resources and EPA Region 7.

The city moved ahead in developing a more green-orientated overflow control plan and conducted reviews of basins located within the combined system in order to identify areas where green solutions could replace grey infrastructure in whole or in-part. High altitude desktop analyses were performed in order to assess the potential for shifting from grey storage to green solutions for storage in three major basins. The types of green solutions considered included catch basin retrofits, curb extension swales, pervious pavement, street trees, green roofs and stormwater planters.

Two principal assumptions were included with these considerations. Firstly, storage volume in green solutions would replace an equal volume in conventional storage facilities; and secondly, each 1-MG of green storage would result in 0.5 MGD reduction in capacity of downstream pumping stations and treatment facilities due to infiltration and evaporation (KCWSD, 2009). Following revisions, the city's submitted a new plan that proposed a total of $80 million in green solutions programs.

Economic Benefit

Based on city analyses, it was determined that replacing grey infrastructure with green solutions would be cost-effective in portions of the Middle Blue River Basin (MBRB), a 744-acre region with 34 percent impervious surface. Based on calculations, the city estimated that it should be possible to completely replace two CSO storage tanks with distributed green solutions without increasing costs or reducing CSO control performance (Leeds, 2009).

The original MBRB Plan was based on a traditional grey infrastructure design with controls capable of proving 3 MG of storage. The capital costs associated with these upgrades were

estimated at $54 million, an average of $18 per gallon, and would be capable of reducing overflows in the MBRB to less than 6 per year, on average.

The revised MBRB Plan is a non-traditional design that includes grey infrastructure projects as well as green infrastructure strategies and will provide distributed storage of at least 3.5 MG. The revised plan would also eliminate the need for storage tanks while still achieving the goal of reducing the amount of overflows to less than 6 per year. The projected costs associated with this revised plan are $35 million, potentially $19 million less than the original grey infrastructure plan. However, because of uncertainties, the green solutions project budget has been set at $46 million.

Middle Blue River Basin Green Solutions Pilot Project. A large-scale study was needed to test the city's key assumptions regarding the performance of green solutions. As such, the city initiated a pilot project within a 100-acre area of the MBRB. The MBRB Green Solutions Pilot Project will help determine the effects of widespread implementation of distributed storage utilizing green solutions, infiltration, and inflow rehabilitation on combined sewer overflows and is potentially the largest green solutions-based CSO control project in the nation.

Green-based strategies in the pilot area will be installed on both residential and commercial areas and will need to provide at least 0.5 MG of distributed storage, replacing an equal amount of stormwater stored in conventional concrete tanks. Following implementation, post-construction monitoring will be conducted to determine functionality and performance.

Green solutions unit costs

In developing unit costs for green solutions, the city used a number of assumptions including:

- Green roofs have incremental costs above normal roof replacements with 3 to 4 inches of growth media providing 1 inch of storage. Incremental capital costs associated with green roofs are $14 per square foot.
- Deciduous street trees have interception storage of 0.032 inches, 20-foot crown radius, with 25 gallons per tree.
- Porous pavements would provide effective storage for an area approximately 3 times its surface area.

The following table (Leeds, 2009) presents unit costs, in dollars per gallon, used by the city for each type of green solution:

Green Solution	Unit Cost ($/Gall.)
Catch Basin Retrofits in Road & Street ROW	$2.28-$7.13 ($5 avg.)
Porous Pavement	$4.62
Street Trees (Residential)	$10.80
Street Trees (Commercial)	$23.36

Curb Extension Swales	$10.86
Replacement of Sidewalks in ROW with porous pavement	$11.62
Conversion of Roof Areas to Green Roofs	$22.68
Stormwater Planters	$26.83

The results of the pilot project will be used to guide work in the remaining 644 acres as well as other future green solutions projects.

Chicago, Illinois

Utilizing Green Infrastructure for Reducing CSS Volumes

BACKGROUND

The City of Chicago has implemented a number of innovative plans geared towards building community resiliency toward climate change, while promoting sustainability and conservation and is recognized as a worldwide leader in terms of its environmental initiatives. In addition to green building and energy efficiency, Chicago has implemented advanced city-wide programs that address water quality, water efficiency, and stormwater management.

As part of the Chicago Water Agenda, the city is committed to managing stormwater more sustainably and encourages the use of BMPs that include a range of green infrastructure designs such as green roofs, permeable paving, filter strips, rain gardens, drainage swales, naturalized detention basins, as well as the use of rain barrels and natural landscaping. These measures are important strategies for facilitating infiltration, improving water quality and minimizing the potential for basement flooding. BMP strategies which divert water away from the combined sewer system also reduce the energy demands associated with pumping and treating the combined sewage.

Chicago's gravity based combined collection system includes 4,400 miles of sewer main lines that flow to interceptor sewers that are owned and operated by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). The interceptor sewers are a pumped system which conveys dry weather flow to the MWRDGC's treatment plants. During storm events, excess flows are diverted to the MWRDGC's Tunnel and Reservoir Plan system for storage, which is intended to prevent combined sewer overflows to the city's waterways. This tunnel reservoir system is the largest in the world and includes 109 miles of 30-foot diameter pipes that is generally located 200 feet below the Chicago River system.

CSO events occur with regular frequency each year, causing untreated wastewater and stormwater to be released into the city's river systems as well as Lake Michigan. Green infrastructure controls and other BMP measures are needed in order to limit inflow stormwater volumes to the system, thus reducing the frequency and intensity of CSO events.

Chicago Green Alley Program. One of the city's more progressive green infrastructure initiatives is the Chicago Green Alley Program, which has been developed to alleviate flooding in the city's extensive alley network, which consists of approximately 1,900 miles of public alleys and roughly 3,500 acres of impervious surface. The program encourages the use of porous pavements in order to reduce the city's quantity of impervious surface, as well as filter runoff, and recharge groundwater.

In addition to facilitating infiltration and diverting stormwater from Chicago's combined system, the Green Alley Program brings environmental benefits such as heat reduction, material recycling, energy conservation, and glare reduction.

ECONOMIC BENEFIT

The City of Chicago actively records the ongoing number or coverage area of various green BMP designs that are added within city limits. This includes the year-to-date number of rain gardens and rain barrels added / downspouts disconnected, as well as the effective square footage of green roofs, green paving, turf to native grass, and Stormwater Management Ordinance (SMO) permits. Each of these BMP designs has been assigned an equivalence factor by the City of Chicago, which, when multiplied by the actual number or amount of square footage of each BMP, will calculate a more accurate shed of capture for each representative design.

The following table (Chicago, 2009) presents data that shows estimated year-to-date numbers or square footage totals (as of November, 2009) for each type of BMP measure that has been implemented.

Table 7: City of Chicago Volume Reductions and Square Footage for CSO Controls

BMP	Actual SF or number	Annual volume (gallons) diverted from combined system
Green Paving (SF)	182,400	4,832,080
Green Roofs (SF)	100,000	1,907,400
Rain Gardens (#)	5	52,983
Rain Barrels/Downspout Disconnections (#)	2,220	8,280,659
Turf to Native Grass (SF)	1,700,500	23,425,521
SMO Permits (SF)	1,868,724	31,683,593

* SMO permits can include any number of BMP designs. SMO permit data does not overlap with data from individual BMPs.

In order to calculate the volume of stormwater that is diverted from the combined system, the City of Chicago uses a conversion factor of 21.19 that is multiplied by the SF equivalence of each corresponding BMP design. Based on the above BMPs, equivalent factors, and calculations, a total of 70,182,236 gallons of stormwater is estimated to have been diverted from Chicago's combined system in 2009 through November, 2009.

CONCLUSIONS

The case studies presented in this report show how incorporating a green infrastructure strategy with LID can help cities and municipalities reduce stormwater runoff volumes entering combined systems, lowering treatment costs. Also, as shown, utilizing a combination of grey and green infrastructure strategies for CSO management can be considerably more economically viable than using grey infrastructure alone.

This was clearly demonstrated in the City of Portland's Tabor to the River plan, which showed a cost benefit of $63 million to the city by the inclusion of green strategies in combination with a grey infrastructure approach for upgrading an undersized sewer pipe system in order to help control CSOs and improve sewer system reliability. An economic benefit potentially as much as $19 million was also estimated by the City of Kansas City for incorporating green infrastructure strategies along with a traditional grey infrastructure approach for the Middle Blue River Basin Plan, a part of Kansas City's city-wide Overflow Control Program.

An economic context for the use of LID was also established for the City of Portland's overall approach for CSO management. The City of Portland determined that watershed health initiatives, which included LID and green infrastructure strategies, were cost-effective project alternatives for the city to implement as part of its approach for long-term CSO management. Additionally, the Chicago case study demonstrated the city's commitment to using green infrastructure for the purpose of CSO control. Although economically-based information depicting the future cost of construction for CSO separation was not available, the City of Chicago has shown a major reduction of stormwater volume to its combined system as a result of LID.

The projects and plans presented throughout this report establish an economical and performance-based benefit for LID and green infrastructure. Shown in the context of actual project designs, incorporating these strategies alongside grey infrastructure improvements can result in significant cost savings for cities pursuing and implementing CSO management. This study demonstrates the beneficial economic context for the implementation of green infrastructure and LID design for future CSO compliance projects.

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