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STORMWATER POLICY AS A GREEN ROOF (DIS)INCENTIVE FOR RETAIL DEVELOPERS

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Abstract

This presentation summarizes an investigation of how local policy and incentives can combine to make vegetated roofs attractive for voluntary installation by large retail developers. For this to occur, the deployment of green roofs must either offer a less expensive method of satisfying zoning and planning regulations than alternative best management practices (BMPs), or derive a favorable return on investment (ROI) from operational savings. A study of long-term data from a Chicago Walmart store by the authors showed that operational savings are significant but unlikely to provide sufficient ROI to be the sole justification for a green roof investment. Local policy initiatives, however, can intervene to create direct or indirect incentives that can result in positive ROI, and in some cases first cost savings.

We selected five municipal regulatory environments, represented by five major metropolitan areas, as paradigms of stormwater management policy and estimated the cost of satisfying local regulations with and without a green roof. We will refer to these as cities A, B, C, D and E in this paper. It was found that the total cost of complying with local regulations varied greatly. In one of the surveyed metropolitan areas the incorporation of green roofs resulted in the lowest first cost for regulation compliance; in two other metropolitan areas the incorporation of green roofs and associated operational savings resulted in positive ROI in less than 20 years.

The policy survey did not include the impact of mandates for green roofs. Rather the goal of the study was to determine what factors would make green roofs attractive from a business perspective for retail developments.

Introduction

Stormwater management regulations and green roof incentives for various metropolitan areas were surveyed and summarized with the objective of determining how these regulations influence development costs. In particular, we were interested in identifying localities where regulations might offer financial incentives for incorporating green roofs on large commercial retail developments.

The structure of stormwater regulations differs widely among states and municipalities. Furthermore, ordinances in metropolitan areas often are unrelated to regulations that may apply in neighboring suburban areas. Typically, stormwater management regulations in urban areas are more favorable toward green roofs and other best management practices (BMPs). With the exception of a few cities where green roofs are required for qualifying new projects, green roofs are frequently identified as an optional alternative method for complying with stormwater requirements. Some cities offer financial incentives (e.g., tax credits, low interest loans, grants, or subsidies) for green roofs. Green roofs have proven cost-effective for meeting open space requirements in some cities as well, but because accessible green roofs are generally not considered in large retail, these are not discussed in this paper.

In many localities stormwater management regulations include provisions to treat runoff and reduce both total volume and peak discharge rates to storm sewers. We have selected five municipal regulations as paradigms that can be used to gauge the impact of various approaches to local stormwater regulation. Three of these offer a coordinated package of regulations and incentives that could make implementation of a green roof attractive to developers of large retail projects.

For each of the regional paradigms, Roofscapes, Inc. evaluated the cost implications of utilizing green roofs as stormwater BMPs. Predictions of runoff conditions were evaluated using local climatic data. Simplified techniques were used to estimate runoff volumes, detention requirements, etc. Refined estimates for green roof performance are not likely to produce significant changes in the overall cost assessments.

Our investigation included the contributions of direct and indirect financial incentives. This survey also took into account operational efficiencies associated with a green roof that could contribute to a positive return on investment (ROI). These would include: 1) savings associated with heating and cooling of the building, 2) reductions in utility fees paid by the property owners, and 3) savings associated with reductions in roof maintenance activities. The investment time horizon for computing ROI, 20 years, was too short for the extended life expectancy of the roofing system under a green roof to make a significant positive contribution (considering current typical roof warranty periods). This paper addresses factors which affect the first cost of installing a green roof as a BMP, as well as the payback period.

Assumptions

In order to allow valid comparisons to be made among various local regulation environments, we have posited a 'standard' retail development with the following attributes:

1. Total project area will be 450,000 sf
2. 1/3 of total project area will be associated with the building (150,000 sf), with the balance as surfaced parking area
3. The project will be developed on soils conforming to the NRCS Type B classification for infiltration and permeability, making infiltration a viable option.
4. The project will be located in an urban area where pre-development conditions are 80% impervious. These will be previously developed locations and 'brownfield' sites.
5. The project will be located in a Municipal Separate Storm Sewer System (MS4) district.
    - Note: If the city under investigation utilizes combined storm and sanitary sewers, it is assumed that the project will be located in a combined sewer district.
6. Life expectancy of the building, for purposes of estimating ROI will be 20 years.
7. 15% of the parking area is devoted to vegetated medians and margins. These areas have been treated as disconnected open space for purposes of estimating stormwater runoff.
8. Where at-grade water quality BMPs are required, the BMP of choice was pervious pavement, based on cost effectiveness. Pervious pavement was recognized as a water quality BMP in the municipalities that were evaluated.

Unit costs were developed for implementing various BMPs (e.g., pervious pavement, below-grade detention). The unit cost for providing a green roof was $10.00/sf. This includes $7/sf for the green roof itself, $3/sf premium for providing a waterproofing-quality roof membrane. The cost of potential structural upgrades to the roof was determined to be $1.90/sf. The unit cost for providing a subsurface detention basin was $18.50/cf of water storage capacity. The unit cost for providing pervious pavement for water quality treatment via infiltration was $15/cf of water treatment capacity. The unit cost for providing a rain garden for water quality treatment was $36.00/cf of water treatment capacity. (A second case is analyzed in which rain gardens replace pervious pavement as the water quality BMP of choice because not all retail developers find pervious pavement to be acceptable).

Based on monitoring data from a Walmart store in Chicago, we assigned NRCS runoff curve numbers (CN) of 75 and 85 for green roofs subjected to small and large storm events, respectively. Small events have return frequencies of 5 years or less.

The Paradigms

Paradigm A: The regulation includes Rate and Volume Reduction. Rate Reduction requirements assign a fixed discharge release rate based on the size of the site. The reference rainfall event is the 100-year, 24-hour storm. Two options are available for satisfying the Volume Reduction requirement: 1) retain a volume of water based on impervious area, or 2) reduce impervious area by 15%. Green roofs are treated as pervious area when addressing the Volume Reduction requirement. Green roofs are an acceptable BMP for volume reduction and can contribute toward compliance with Rate Reduction requirements, insofar as they decrease the runoff rate coefficient for the site.

Paradigm B: The regulation includes Rate Reduction, and Water Quality improvement in the form of infiltration or treatment. Strategic use of green roofs will exempt projects from rate reduction requirements. The Rate Reduction requirements limit post-construction runoff rates to those of the pre-development condition (assumed in this study to be 80% impervious). Water quality requirements are based on a fixed rainfall event over the impervious area of the site. If infiltration is not feasible, the Water Quality Volume must be treated with a water quality BMP, and extended detention must be provided. Extended detention requirements vary depending on whether the site is located in a combined sewer district or an MS4 district. Green roofs are recognized as pervious space, thus eliminating the Water Quality Volume from the roof area. The green roof is permitted to accept and treat runoff from roofs that are tributary to the green roof. Green roofs also contribute toward compliance with Rate Reduction requirements, insofar as they decrease the runoff coefficient for the site. If the overall impervious area of the site is reduced by a specified percentage, the site can be exempted from the Rate Reduction requirements. Water Quality improvement requirements must still be satisfied. Financial incentives are offered in the form of a one-time tax abatement, reductions in monthly stormwater utility fees, and increased floor-area ratio allowances.

Paradigm C: The regulation includes Rate Reduction and Water Quality treatment. The rate reduction requirements limit post-construction runoff rates to those of the pre-development condition for rainfall events up to the 100-year, 24-hour storm. Water quality requirements involve the treatment of a volume of runoff that is determined by the amount of impervious area on the site. Green roofs are not recognized as an acceptable BMP for water quality treatment, but can contribute toward compliance with Rate Reduction requirements, insofar as they decrease the runoff rate coefficient for the site.

Paradigm D: The regulation includes Rate Reduction, Water Quality treatment, and Infiltration. The Rate Reduction requirements limit post-construction runoff rates to those of the pre-development condition for storms up to the 25-year frequency event. Water Quality requirements are designed to treat runoff from a specified rainfall event. Infiltration requirements aim to restore natural ground water recharge characteristics, and calculate the required infiltration volume based on the impervious area. Green roofs are recognized as pervious space, thereby reducing the water quality and infiltration volumes. Green roofs contribute toward compliance with rate reduction requirements, insofar as they result in lower runoff coefficients for the site. Financial incentives are offered in the form of direct cash subsidies, administered through a city-run grant program. Note that availability of direct cash subsidies is limited by the level of capital investment by the city, and that subsidies may not be a permanent offering.

Paradigm E: The regulation includes Rate Reduction and Water Quality treatment. The Rate Reduction requirements limit post-construction runoff rates to those of the pre-development condition for rainfall events up to the 100-year, 24-hour storm. Water Quality requirements are designed to treat a specified rainfall, with respect to the impervious area of the site. Green roofs are an acceptable BMP for Water Quality volume reduction and can contribute toward compliance with Rate Reduction requirements, insofar as they decrease the runoff coefficient for the site. Financial incentives are offered in the form of reductions in monthly stormwater utility fees.

Table 1. Regulatory Framework for Green Roofs in Five Municipalities

	Climate	**Rate Control Requirements**	**Volume Control Requirements**	**Water Quality Requirements**	**Direct Financial Incentives**
Paradigm A	Temperate	Yes	Yes		
Paradigm B	Temperate	Yes *	Yes *	Yes *	Yes
Paradigm C	Subtropical	Yes		Yes	
Paradigm D	Mediterranean	Yes *	Yes*	Yes	Yes
Paradigm E	Cold Temperate	Yes		Yes	Yes

* Green roofs given priority as methods for complying with the requirement

Discussion

Stormwater regulations can be classified into three broad categories:

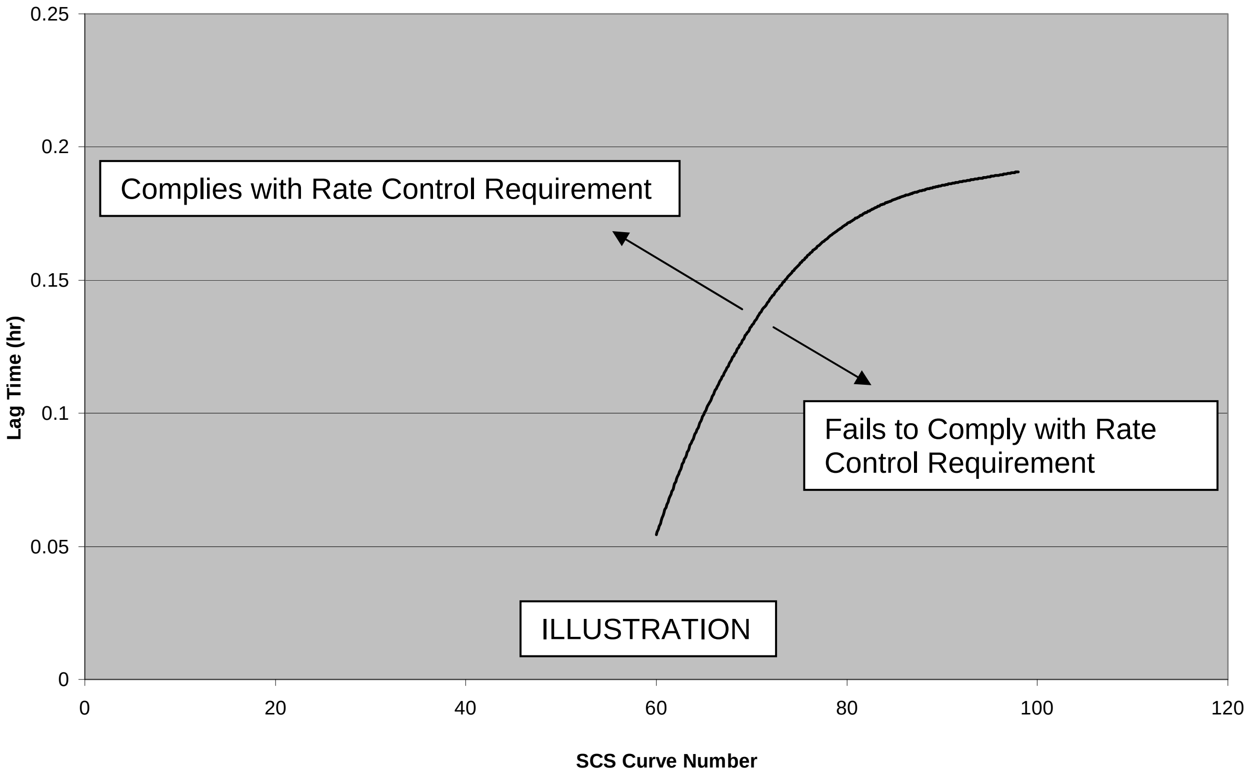
1. Runoff Peak Rate Limitations
2. Water Quality / Runoff Treatment Requirements
3. Volume Release Limitations

In general, green roofs are attractive as stormwater management BMPs provided: 1) local regulations focus on either peak rate limitations, water quality / runoff treatment or volume release limitations, or 2) regulations are designed to allow green roofs to satisfy multiple requirements.

We have determined that under certain circumstances where regulations do not specifically recognize green roofs as BMPs, green roofs can still be used effectively to comply with regulations based on runoff peak rate requirements. Specifically, we investigated conditions where the requirement for rate control would be to maintain the 'post-development' peak runoff rates at or below 'pre-development' levels for the 100-year storm event (Paradigm C). The so-called 'pre-development' condition was assumed to be a previously developed site with an existing average site runoff curve number of 84. Compliance with the regulation can be achieved if the parking area is drained directly to the storm sewer and the building is covered with a green roof. In this case, the contribution of green roof runoff to the peak runoff rate for the overall site will be small.

Green roof designs that provide combinations of effective runoff curve numbers and lag times to peak runoff that plot on or to the left of the curve depicted in Figure 1 will comply with the Paradigm C runoff rate requirement given the assumptions described. Similar diagrams can be created for other pre-development conditions and design storms. However, in all cases, the runoff rate from the developed parcel is dominated not by the runoff curve number, but by the lag in peak rate runoff from the green roof. Considering that the measured time of concentration for a green roof at a Chicago Walmart store exceeded one hour, the potential for exploiting lag-time effects of green roofs becomes apparent.

Figure 1. Contribution of Runoff Curve Number and Lag-Time to Satisfaction of Peak Rate Runoff Control Requirements



In all instances examined, a green roof can be relied upon to satisfy an ordinance based on controlling runoff rates to pre-development levels (note that Paradigm A uses a fixed discharge rate that is less than the pre-development runoff rate). However, this does not mean that green roofs offer the most cost-effective approach. In fact, only in instances where up-front or life-cycle financial incentives were offered was it less expensive to install a green roof than to install below grade detention.

Following the assumptions described above, in each of the five municipalities, we calculated the cost of satisfying regulations with and without a green roof installed. We then analyzed the 20-year ROI and payback period that could be expected based on the first cost differential of the green roof and operating savings. The operating savings are based on the Walmart Chicago results, which are modified as appropriate for climate and regional variation. Table 2 shows the results of this analysis.

Table 2. Effect of Local Policy on the Cost of Installing a Green Roof

	First Cost **Full Compliance with Stormwater Regulation, Including Incentives ***		**Net Cost of Implementing a Green Roof**	**Annual Maintenance Savings Estimate**	**Annual Energy Savings Estimate**	**Annual Stormwater Utility Fee Savings Estimate**	**Payback (years) at 2% Discount Rate**	**Value in today's dollars (NPV) of green roof over 20 years at 2% discount rate**
	Without Green Roof	With Green Roof						
Paradigm A	$2,257,772	$3,169,280	$911,508	$14,240	$10,427	$0	28	-$508,167
Paradigm B	$1,368,360	$2,058,500	$690,140	$14,240	$10,427	$14,922	15	$42,803
Paradigm C	$1,481,226	$2,329,125	$847,900	$14,240	$5,520	$0	31	-$524,795
Paradigm D	$3,307,020	$2,221,050	-$1,085,970	$14,240	$4,968	$5,582	0	$1,491,319
Paradigm E	$1,551,010	$2,130,780	$579,771	$14,240	$11,469	$8,271	15	$24,143

∗ Installed cost for 150,000 square-foot green roof = $1,780,000

As shown, in policy paradigms A and C, it is more cost-effective even with a 20-year horizon to satisfy regulations without a green roof. In paradigms B and E, the payback is less than 20 years for installing a green roof, and ROI at 20 years is positive. Paradigm D is the most favorable to the green roof, and it is a more cost-effective option for satisfying the regulations than the alternative BMPs (permeable pavement and detention tanks).

As mentioned, in some cases, pervious pavement is not viewed by retail developers as an acceptable BMP (due to compaction or other concerns). To address these cases, the analysis was also run with the next least expensive water quality BMP, rain gardens, substituted for pervious pavement. In this instance, the total cost of complying with the regulations is higher. However, the difference in cost between development schemes that do, or do not, include green roofs is smaller. The associated payback period for the green roof is, accordingly, shorter . Table 3 shows the resulting payback periods for meeting requirements with a green roof in cities A – E. Note that the payback is reduced to under ten years for paradigm E.

Table 3. Effect of Local Policy on Payback for Installing a Green Roof if Rain Gardens rather than Pervious Pavement constitute the alternative for satisfying Water Quality requirements

	Payback (years) at 2% Discount Rate
Paradigm A	18
Paradigm B	13
Paradigm C	31
Paradigm D	0
Paradigm E	6

This analysis did not include the potential influence of low-cost loans that are offered by some cities to developers to help fund BMPs. The effect of such loans is to reduce the first costs, which can represent a signficant business incentive. However, the overall payback period may not be signicantly reduced.

Conclusion

Considering the findings discussed above, factors that may favor the implementation of green roofs as stormwater BMPs include:

- Stormwater regulations which specifically recognize green roofs as appropriate BMPs to address: volume reduction, water quality, and rate control requirements.
- Regulations that are responsive to new data and research on green roof performance.
- Municipalities that asses stormwater utility fees based on impervious area [and treat green roofs as pervious area].
- Municipalities that use larger design storms as the basis for regulations.
- Spatial constraints on development, restricting the use of land area for stormwater management.
- Other regulations, such as open space mandates, that can be satisfied by green roofs.
- Availability of financial incentives directed specifically at encouraging green roof installation.
- Style of development, particularly the treatment of parking (large surface lots may dilute the benefits of green roofs).
- Climate.

In order for green roofs to consistently offer developers a positive ROI, financial incentives are essential. Those cities that offer attractive polices for green roofs are often doing so in order to reduce the massive outlays that will be associated with infrastructure upgrades required to comply with the NPDES Part II (Clean Water Act) requirements. For these cities, the cost of incentives such as tax abatements and fee reductions are outweighed by the savings achievable by downsizing or delaying infrastructure improvements. This has been the largest driving factor behind the green roof phenomenon in Germany and the United States.

From city to city, there is clearly a very large range in the financial incentives for developers to build green roofs. The conclusion of this survey was that in order for developers of large retail stores to realize a positive return on their investment: 1) vegetated roofs must be given priority as methods to satisfy local stormwater management requirements, and 2) the value of the savings realized in reduced long-term public infrastructure costs must be passed on to developers in the forms of tax abatements, utility fee reductions, and direct financial incentives.