United States
Environmental Protection Agency

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Washington, DC 20460

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Vegetated Roof Cover

Philadelphia, Pennsylvania

Key Concepts:

- Structural Control
- Retrofit Opportunity
- Volume Reduction
- Life Cycle Costs

Project Benefits:

- Runoff Reduction
- Air & Water Quality Improvement
- Aesthetics
- Energy Conservation

LOW-IMPACT DEVELOPMENT CENTER

Introduction

Vegetated roof covers on industrial and office buildings have been used in Europe for more than 25 years to control runoff volume, improve air and water quality, and promote energy conservation. These systems, known as "green roofs" or "extensive roof gardens," also have aesthetic benefits. They typically include layers of drainage material and planting media on a high-quality waterproof membrane. These systems use foliage and a lightweight soil mixture to absorb, filter, and detain rainfall. Some of the conditions responsible for the promotion and acceptance of green roofs in Europe, which many American cities face as well, are

- Widespread implementation of stormwater-related fees or taxes
- Laws requiring mitigation or compensation for the elimination of open space
- Densely populated areas with high real estate values
- Requirements to reduce loads on combined sewer systems (CSSs)

Project Area

The demonstration project was installed on the roof of the Fencing Academy of Philadelphia (Figure 1). Like many urban areas on the East Coast, Philadelphia experiences frequent, small, high-intensity storm events. These short-duration events frequently overload and surcharge sewer systems. In the Philadelphia region, storms with 24-hour volumes of 2 inches or less contribute 90 percent of all rainfall. Vegetated roof covers are designed to control these high-intensity storms by intercepting and retaining water until the rainfall peak has passed, while also allowing larger storm events to be safely conveyed away from the building.

Vegetated roofs are complex structures that require consideration of the load-bearing capacity of roof decks, the moisture and root penetration resistance of the roof membrane, hydraulics, and wind shear.

The plants help recreate the hydrologic function of open space in the following ways:

- Capturing and holding precipitation in the plant foliage
- Absorbing water in the root zone

Figure 1. Fencing Academy of Philadelphia vegetated roof cover.

- Slowing the velocity of direct runoff by extending the flow path through the vegetation
- Cooling the temperature of the air and runoff. (Green roofs can be very effective measures for reducing the "thermal shock" caused by flash runoff from hot roof surfaces.)

Project Description

The vegetated rooftop project at the Fencing Academy of Philadelphia is a 3,000-square-foot vegetated cover installed and monitored by Roofscapes, Inc., on top of an existing structure (Figure 1). The roof system was intended to mimic the natural hydrologic processes of interception, storage, and detention to control the 2-year, 24-hour storm event. The distinguishing features of this system include

- Synthetic under-drain layer that promotes rapid drainage of water from the surface of the roof deck
- Thin, lightweight growth media that permits installation on existing conventional roofs without the need for structural reinforcement
- Meadow-like setting of perennial *Sedum* varieties that have been selected to withstand the range of seasonal conditions typical of the Mid-Atlantic region without the need for irrigation or regular maintenance

The installed vegetated roof cover is only 2.74 inches thick including the drainage layer. The system weighs less than 5 pounds per square foot when dry and less than 17 pounds per square foot when saturated. The saturated moisture content of the media is 45 percent by volume. The saturated infiltration capacity is 3.5 inches per hour. Figure 2 shows the components of the roof system.

The runoff characteristics of the roof were simulated using rainfall records for 1994 from eastern Pennsylvania. The model predicted a 54 percent reduction in annual runoff volume. The model also predicted attenuation of 54 percent of the 24-hour, 2-year Type II storm event and 38 percent of the 24-hour, 10-year Type II storm event. Additionally, monitoring at a pilot-sized project for real and synthetic storm events was conducted for a period of 9 months at 14- and 28-square-foot trays. The most intense storm monitored was a 0.4-inch, 20-minute thunderstorm. The storm event occurred after an extended period of rainfall had fully saturated the system. Figure 3 shows the runoff attenuation effectiveness for this event. Although 44 inches of rainfall was recorded during this period, only 15.5 inches of runoff was generated from the trays. Runoff was negligible for storm events with less than 0.6 inch of rainfall.

Project Summary and Benefits

This project showed that vegetated rooftop covers can help to reduce peak runoff rates for a wide range of storm events. The project also demonstrated that existing structures can be successfully retrofitted to help prevent CSS surcharging in urban areas. Significant energy

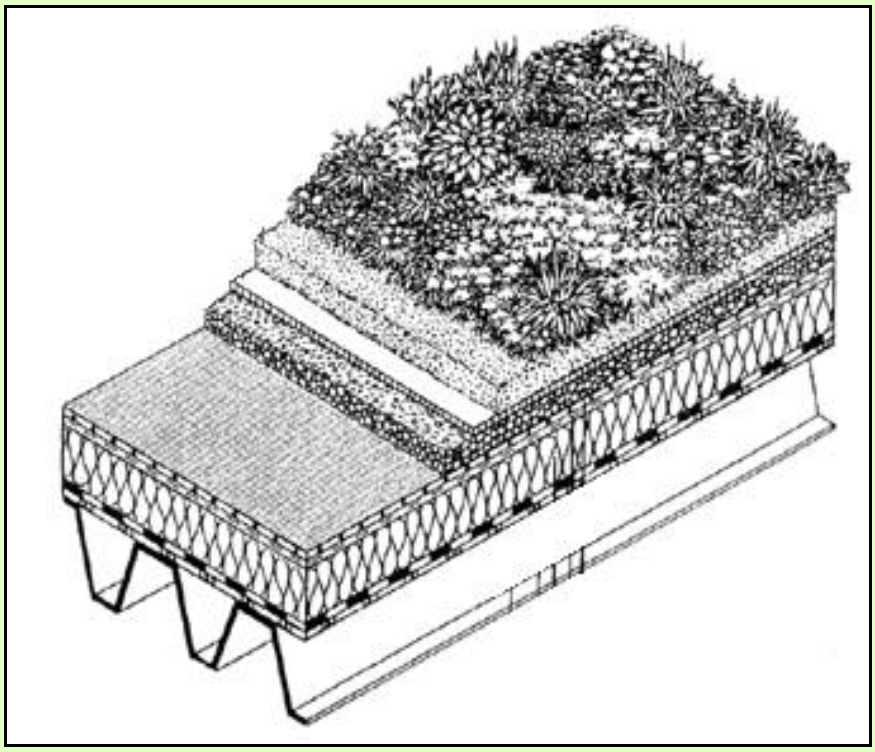

Figure 2. Components of the vegetated roof cover.

conservation benefits also are associated with vegetated rooftop covers. During the spring and summer, temperatures on a neighboring black tar roof varied by as much as 90 °F, while the variation under the 2.74-inch vegetated cover was only 18 °F. The vegetated cover also insulates the roof in winter, and the vegetation protects the roof membrane from the elements. Vegetated rooftop covers can potentially extend the life of a roof by 20 years or more.

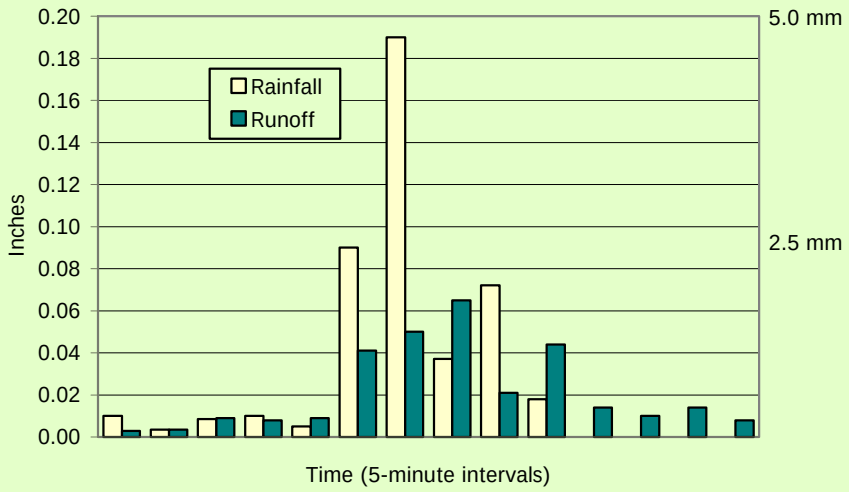

Figure 3. Runoff attenuation efficiency for a 0.4-inch rainfall event with saturated media.

References

Miller, C. 1998. *Vegetated Roof Covers: A New Method for Controlling Runoff in Urbanized Areas*. Pennsylvania Stormwater Management Symposium, October 21-22, 1998, Villanova University, Villanova, Pennsylvania.

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