Tree Box Filter

Unlike many other forms of urban landscaping, tree filters are not isolated behind curbs and deprived of water and nutrients from runoff. Instead, they receive runoff through breaks in the curbing, and demonstrate strong water quality treatment.

Tree box filters are mini bioretention systems that combine the versatility of manufactured devices with the water quality treatment of vegetated systems. They serve as attractive landscaping and drainage catchbasins. Unlike many other forms of urban landscaping, they are not isolated behind curbs and deprived of water and nutrients in runoff. Their water quality treatment performance is high, often equivalent to other bioretention systems, particularly when well distributed throughout a site.

Where to Use It

Tree box filters can be used throughout the United States, and are especially useful in settings where available space is at a premium. They can be installed in open- or closed-bottomed chambers where infiltration is undesirable or not possible, such as clay soils, sites with high groundwater, and areas with highly contaminated runoff.

Tree box filters are often installed along urban sidewalks, but they are highly adaptable and can be used in most development scenarios. In urban areas, tree filters can be used in the design of an integrated street landscape—a choice that transforms isolated street trees into stormwater filtration devices. They also can be used in designs that seek to convert entire non-functional streetscapes into large stormwater or combined sewer flow filtration systems.

Implementation

These systems are a relatively recent innovation that is growing in usage, especially in urban areas. The cost to install a tree box filter to replace a catchbasin is $2,500. This does not include maintenance. UNHSC observations thus far reinforce stormwater manual assessments that maintenance requirements for these systems are generally minimal.

In general, tree box filters are sized and spaced much like catchbasin inlets, and design variations for these systems are abundant. The system evaluated at UNHSC was designed by center researchers. A similar patented design made by AmeriCast, the Filterra, is also available. Contact the UNHSC for more information about the design of the tree box filter.

Fast Facts

CATEGORY TYPE
Filtration, Infiltration, Urban Retrofit

BMP TYPE
Low Impact Development Design

DESIGN SOURCE
UNHSC

BASIC DIMENSIONS
Diameter: 6 ft
Depth: 4 ft

SPECIFICATIONS
Catchment Area: 0.1 acre
Peak Flow: 0.1 cfs
Water Quality Volume: 425 cf
Tree: Two-inch Caliper Ash

WATER QUALITY TREATMENT PROCESS
Physical, Chemical, & Biological

INSTALLATION COST
$2,500 Per Unit
($22,000 Per Acre Treated)

MAINTENANCE
Maintenance Sensitivity: Low
Inspections: Medium
Sediment Removal: Low

How the System Works

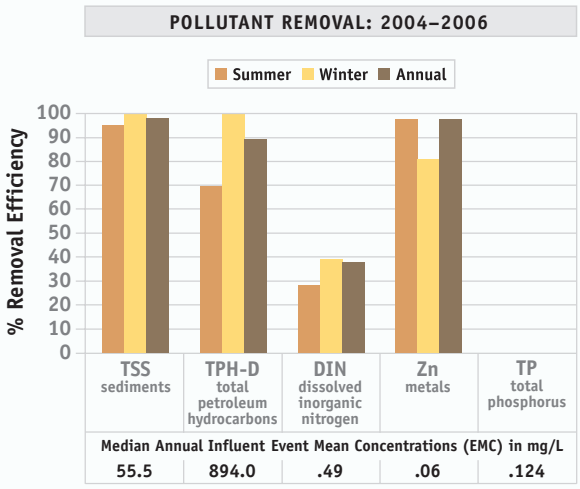
Design

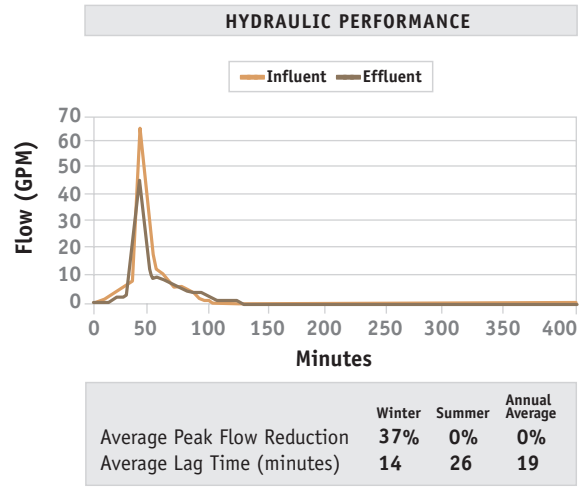
The tree box filter's basic design is a concrete vault filled with a bioretention soil mix (BSM), planted with vegetation, and underlain with a subdrain. The system evaluated at the UNHSC field site is a six-foot diameter, concrete vault with an internal bypass. It is underlain by a subdrain that discharges to existing stormwater drainage. The vault is open-bottomed to enhance infiltration.

The filter media is three feet deep, and composed of 80 percent sand and 20 percent compost. The mix was designed to maximize permeability while providing minimum organic content (at least 10 percent) to sustain vegetation.

Vegetation selected for these systems should consist of native, drought- and salt-tolerant species. Plants with aggressive root growth may clog the subdrain, and therefore may not be suitable for this type of system.

This tree box filter was sized for the water quality volume (WQ_v), and should allow for four to six inches of ponding. Larger storm events will be bypassed. The system's filter media accommodates a high infiltration rate of 120 feet per day.





	Winter	Summer	Annual Average
Average Peak Flow Reduction	37%	0%	0%
Average Lag Time (minutes)	14	26	19

Water Quality Treatment

The tree box filter does a good job of removing many of the pollutants commonly associated with stormwater treatment performance assessment. It consistently exceeded EPA's recommended level of removal for total suspended solids and meets regional ambient water quality criteria for petroleum products, nitrogen, and total zinc. However, UNHSC research demonstrates that water quality treatment effectiveness can be negatively influenced by an increased hydraulic loading rate, i.e., the filtration of a large surface area by a small filter area. The system does not remove chloride, but does exhibit an ability to dampen chloride peaks.

The chart at top left reflects system performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over two years, with data further divided into summer and winter components.

Water Quantity Control

Unlike other filtration systems, the tree box filter does not reduce peak flows unless sited in appropriate soils, such as those in groups "A" (sand, loamy sand, or sandy loam with high infiltration rates) and "B" (silt loams or loams with moderate infiltration rates). In the figure at bottom left, the tree box filter displays no significant peak flow reduction or lag time for the range of seasons monitored.

Maintenance

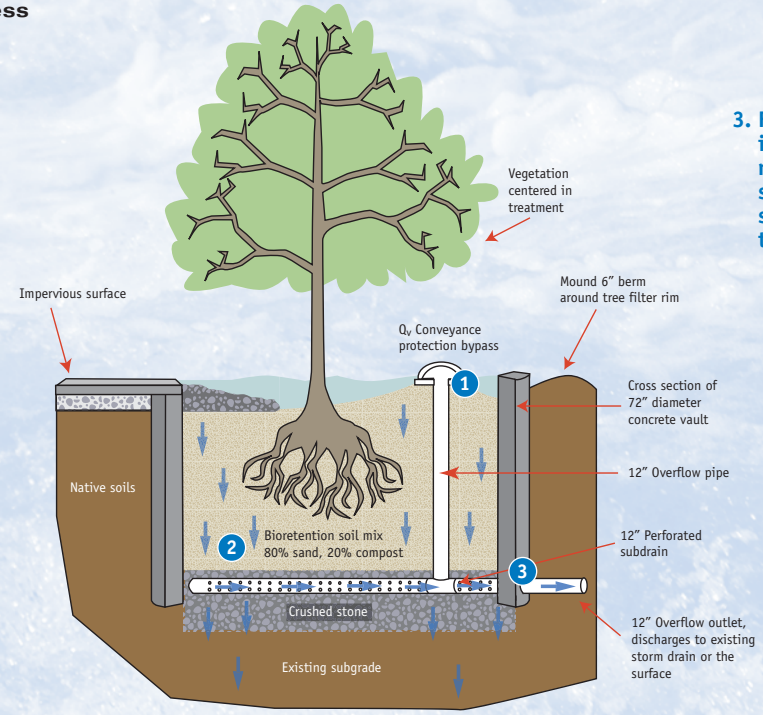
No maintenance has been performed on the tree box filter since it was installed in fall 2005, and the system continues to function well. Generally speaking, these systems are designed to minimize maintenance. Aside from routine trash removal, the highest maintenance burden generally coincides with the establishment of vegetation over the first several months after installation. Once vegetation is established, the maintenance demand decreases. The tree may need to be replaced, depending on hardiness of the selected species. Adaptations to design can prevent root constriction in the planting vault.

Cold Climate

The tree box filter's ability to treat water quality remained relatively stable in all seasons. This is consistent with UNHSC observations of most LID stormwater systems—when they are properly designed and installed, they are not dramatically impacted by seasonal fluctuations. While some seasonal variation in infiltration capacity and nitrogen removal does occur, cold conditions do not seem to warrant significant design alterations.

Water Quality Treatment Process

1. Runoff flows into the tree filter basin from the street and passes into the filter media.
2. In the filter media, biological treatment occurs through the uptake of pollutants, such as nitrogen and petroleum hydrocarbons, by vegetation and soil microorganisms. Physical and chemical treatment also occurs within the soil media. Other treatment unit processes include sedimentation and sorption with organic matter and mineral complexes.



3. Filtered runoff is collected in a perforated subdrain and returned to a storm drain system, infiltrated into the subgrade, or discharged to the surface.