Low Impact Development Guidebook for Stormwater Management

Town of Lunenburg

Acknowledgements

Prepared by:
Lake Shirley Improvement Corporation
in cooperation with the Town of Lunenburg

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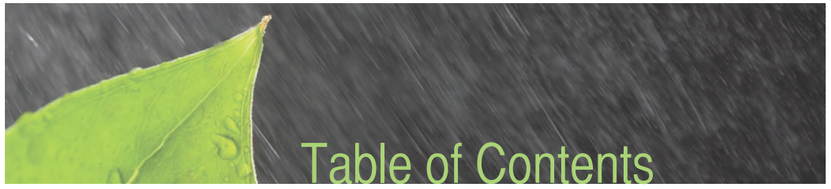
> “LID stormwater management techniques can simultaneously lower the overall costs of development site infrastructure while protecting the environment.”



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Introduction

The purpose of this Town of Lunenburg Low Impact Development (LID) Guidebook for Stormwater Management is to provide Lunenburg officials and designers with guidance for innovative stormwater management techniques.

The guide has been developed by the Lake Shirley Improvement Corporation and the Town of Lunenburg through a 319 grant with the Massachusetts Department of Environmental Protection and the US Environmental Protection Agency. Through this program, LID demonstration projects have been constructed along the Lake Shirley shoreline and inflowing streams. Those demonstration projects are featured as examples of LID projects that can be implemented elsewhere in the town to provide low-cost, environmentally friendly stormwater management approaches. This guide provides a summary of the Town's standards for stormwater management, followed by a description of LID principles and practices.

Stormwater Management in Town of Lunenburg

Stormwater management is implemented in Lunenburg by the Planning Board through their review of development or redevelopment permit applications, and through the Conservation Commission through their permit review for work in wetlands or the 100-foot buffer zone to wetlands.

The Town of Lunenburg's Stormwater Management - NPDES Phase II Permit is included in Section 6.7 of the Town Bylaws. It requires the submission and approval of a stormwater plan to the Planning Board for all development and redevelopment projects that disturb one acre or more of land.

Lunenburg Stormwater Bylaw Objectives:

- Require practices to control the flow of stormwater from new or redeveloped sites to prevent flooding and erosion
- To protect groundwater and surface waters from degradation
- To promote groundwater recharge
- To prevent pollutants from entering the town's drainage system (called the separate municipal stormwater system (MS4))
- To ensure long-term operation and maintenance of structural stormwater best management practices so that they work as designed
- To comply with state and federal statutes and regulations relating to stormwater discharges
- To establish the Town of Lunenburg's legal authority to ensure compliance with the bylaw through inspection, monitoring and enforcement

Lunenburg Stormwater Bylaw Standards:

Projects must meet the standards of the Massachusetts Stormwater Management Policy which are as follows:

1. No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
2. Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.
3. Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type.
4. For new development, stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). It is presumed that this Standard is met when:
   a. Suitable practices for source control and pollution prevention are implemented;
   b. Stormwater best management practices (BMPs) are sized to capture the required runoff volume; and
   c. Stormwater management BMPs are maintained as designed.
5. Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pretreatment is prohibited.
6. Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas (see MA DEP's Stormwater Management Volume1. Stormwater Policy Handbook). Critical areas are Outstanding Resource Waters (ORWs), cold water fisheries, and recharge areas for public water supplies.
7. Redevelopment of previously developed site must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the standards, new (retrofitted or expanded) stormwater management systems must be designed to improve the existing conditions.
8. Erosion and sediment control must be implemented to prevent impacts during disturbance and construction activities.
9. All stormwater management systems must have an Operation and Maintenance Plan to ensure that systems function as designed.
10. When one or more Standards cannot be met, an applicant may demonstrate that an equivalent level of environmental protection will be provided.

ORDER OF PRIORITY

DEP's Stormwater Management Standards require that a project proponent consider the following three stormwater management components in this order of priority :

"Site Planning: Design the development using environmentally sensitive site design and low impact development techniques to preserve natural vegetation, minimize impervious surfaces, slow down times of concentration, and reduce runoff;

Source Controls, Pollution Prevention, and Construction Period Erosion and Sediment Control: Implement nonstructural measures to prevent pollution or control it at its source; and

Structural BMPs: Design, construct and maintain structural BMPs to attenuate peak flows, capture and treat runoff, and provide recharge to groundwater."

> The Conservation Commission plays an important role in ensuring project compliance with the Lunenburg Stormwater Bylaw.

Conservation Commission Stormwater Standards

The Lunenburg Conservation Commission protects Lunenburg's natural resources. One of the primary ways it accomplishes that goal is by reviewing all stormwater discharges within 100 feet of wetlands. Depending on the type and scale of a proposed development, stormwater management requirements can range from very simple erosion/sediment controls (e.g. silt fencing installed during construction) to complex drainage systems presented on engineering plans and supported by hydrologic calculations. If you file a Notice of Intent application to develop property, the Commission will look for the following stormwater management components:

1. **Small projects (e.g. home additions):** The Commission will examine pre- and post-development site grading to ensure flows to wetlands are maintained and that appropriate erosion and sediment controls are used (e.g. silt fencing, hay bales, mulching, etc.).
2. **Medium size projects and paving:** The Commission will examine the proposal to ensure that the use of vegetated swales or catch basins with oil and water separator units are employed to protect water quality.
3. **Large developments (e.g. subdivisions):** The Commission will require all of the above listed items and also at a minimum, the following information from a registered professional engineer:

   a. Hydrologic and hydraulic evaluations to provide protection for on-site and adjacent off-site inhabitants and their property.

   b. Peak runoff discharges for 10, 50, and 100 year recurrence interval storm. Computations will be based on the USDA Soil Conservation Service Technical Release 55 (TR-55). A registered professional civil engineer or other professional competent in such matters shall prepare computations.

   c. Design computations with controls such that post developed peak runoffs do not exceed pre-development peak runoffs for the 10 and 100 year recurrence interval storms.

   d. Lost volumes within the 100 year recurrence interval storm area shall be compensated on a one to one basis within the same volumetric area.

   e. Design criteria for the 100 year event is found with 310 CMR Section 10.57 (2) (a) 3.a (Wetland Protection Act regulations)

   f. Flooding occurring upon adjacent properties will require additional topography over the area affected. Building units, dwellings or structures of any type within proximity to the 100 year elevation line must be evaluated for potential storm related damage.

Low Impact Development Principles

Low Impact Development (LID) is a land planning and engineering design approach for development with a goal of maintaining the pre-development hydrologic regime of a watershed.

LID is a simple approach that emphasizes the use of green space, native landscaping, natural hydrological functions and various small-scale techniques to manage rain water and other forms of precipitation as close as possible to where it hits the ground. One of the primary goals is to reduce runoff volume by infiltrating rainwater into the ground so that it replenishes the natural groundwater system, rather than the more traditional approach of piping stormwater runoff, collecting it and discharging it to local water bodies. LID also emphasizes the use of native vegetation to promote filtering and uptake of sediment, nutrients and other pollutants in stormwater runoff. When properly designed and maintained, LID stormwater techniques result in fewer pollutants discharging to our lakes and streams.

LID stormwater management techniques can simultaneously lower the overall costs of development site infrastructure while protecting the environment. This is accomplished by emphasizing the conservation of the existing natural resources and functions of the landscape by reducing land clearing and grading costs, reducing the need for conventional stormwater systems of pipes, catch basins and other stormwater conveyances, while balancing the need for growth and the protection of land and water resources. LID attempts to reduce stormwater runoff sources by minimizing impermeable surfaces and employing small scale stormwater controls that facilitate local groundwater recharge.

There are a host of different sources of information on LID which are summarized here to assist Town of Lunenburg reviewers and designers find the most up to date information on this rapidly evolving area of design practice. Below is a list of information sources that are available:

LID Information Resources:

- Massachusetts Low Impact Development Toolkit (www.mapc.org/LID.html)
- Massachusetts DEP Nonpoint Source Pollution Management Manual (http://projects.geosyntec.com/NPSManual/)
- Low Impact Development Center web site (http://www.lowimpactdevelopment.org/)
- National LID Clearinghouse (http://www.lid-stormwater.net/clearinghouse/)
- U.S. Environmental Protection Agency (http://www.epa.gov/owow/nps/lid/)
- U.S. Dept. of Housing and Urban Development, Office of Policy Development and Research (http://www.huduser.org/Publications/PDF/practLowImpctDevel.pdf)
- National Association of Home Builders (http://www.toolbase.org/PDF/DesignGuides/Municipal_LID.pdf)
- Prince George's County, Maryland (http://www.lowimpactdevelopment.org/pubs/National_Munuals)
- United States Department of Defense, United Facilities Criteria (UFC), Design: Low Impact Development Manual, UFS 3-210-10, October 2004. (http://www.lowimpactdevelopment.org/lid%20articles/ufc_3_210_10.pdf)
- Project 25-20(01): Evaluation of Best Management Practices for Highway Runoff Control
  (Low Impact Development Highway Manual (National Cooperative Highway Research Program, NCHRP)
  http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_565.pdf
- NRDC Rooftops to Rivers Report: http://www.nrdc.org/water/pollution/rooftops/contents.asp
  (A policy guide for decision makers on how to use Green Infrastructure to address water quality and volume reduction for communities with Combined Sewer Overflow issues.
  Natural Resources Defense Council. Publication Date: June 2006)

LID Summary Table for Designers

TABLE 1: Considerations for Recommended Stormwater Management BMPs

The table below provides summarizes LID techniques that should be considered by project proponents when applying for permits with Lunenburg town boards. Town boards will in turn evaluate proposed development or redevelopment projects for opportunities to incorporate these techniques.

	Technique	Description / Siting Considerations	Benefits/ Effectiveness	Maintenance	Estimated Unit Cost*
	Vegetated Filter Strips /Buffers	Vegetated Filter Strips or Buffers are bands of vegetation maintained or placed between a runoff source and a receiving body of water.	Vegetated buffers slow runoff, trap sediment and pollutants and promote groundwater infiltration.	Low maintenance.	Costs vary depending on size, type of plantings and need for soil amendments: $3-$8/(sf)
	Bioretention Cell	Shallow topographic depressions engineered to accept stormwater runoff and filter, store and infiltrate runoff using specialized vegetation and engineered soils. Bioretention cells are typically designed with piping to convey peak flows to an adjacent catch basin or other drainage structure.	Provide pollutant removal and recharge for "first flush" of storm-water runoff. Remove suspended solids, metals, nutrients and bacteria. Can enhance site aesthetics.	Replace mulch layer and plantings as needed.	Vary with size and complexity: Large (1000+ sf) = $8/sf Medium (500-1000 sf) = $10/sf Small (200-500 sf) = $30/sf Very Small (<200 sf) = $50/sf
	Raingarden	Raingardens are shallow vegetated depressions designed to slow stormwater runoff and allow infiltra-tion. They are used primarily on residential lots to treat stormwater from relatively small areas.			With stone infiltration bed = $12/sf No stone infiltration bed = $10/sf
	Tree Box Filters /Pre-cast Bioretention Units	Tree box filters and pre-fabricated bioretention "boxes" can treat runoff from a .25-acre area. Larger areas can be treated with multiple units.			$7,500 each (installed)
	Vegetated Water Quality Swale	Stormwater conveyance, treatment and infiltration systems designed as an alternative to curbs, gut-ters and pipes.	Reduce runoff velocity and potential for erosion. Remove particulate pollutants and increase infiltration.	Mow periodically (and remove cut-tings) to promote pollutant uptake and prevent growth of woody vegetation.	$10-$15/linear foot (lf) (for engineering, design and construction)
	Pervious Paving Surfaces	Permeable interlocking concrete pavers (PICP) include products such as Uni Eco-Stone and Infiltra. The cost of porous pavers can be reduced by installing in alternating bands with a standard paved surface such as asphalt.	Infiltrate up to 70-80% of annual rainfall. Significantly reduce peak discharge rates. By siting stormwater management system under paved areas, can reduce need for large stormwater structures and increase effective developable area.	Inspect annually. Avoid/minimize winter use of sand and salt. Clean periodically with vacuum sweeper. Grass pavers may require periodic reseeding to fill in bare spots.	$8/sf (large area) to $15/sf (small area), including stone infiltration bed
		Reinforced gravel paving system (e.g. GravelPave)			$8.50/sf
		Porous asphalt; Porous concrete			$7-$10/sf
	Constructed Wetlands	Constructed wetlands are shallow depressions that receive stormwater and have hydrologic and soil conditions suitable for wetland plant growth.	Pollutant removal through vegetative uptake, soil binding, bacte-rial decomposition and settling of particulates.	Removal of accumulated sediment from pre-treatment structures. Removal of debris/trash from outlet.	$10-$20/sf
	Rain Barrels/ Cisterns	Rain barrels are for capture and re-use of rooftop runoff. Most rain barrels average 60 gallons and have connections to a downspout, runoff pipe, and spigot.	Reduce water demand for irrigation and other non-potable uses. Help reduce stormwater runoff volume and peak discharge rate.	Low maintenance.	Rain barrels: $50-$90 each Cisterns: $3,000 for 800 gal. system
	Vegetated Roofs	Vegetated roofs have an impermeable membrane and vegetation on a growing medium or a pre-cultivated mat placed on additional layers providing fertilizing, water storage and root barrier. Can be built almost any flat or low-angle roof.	Reduce stormwater runoff volume and peak discharge rate. Lower heating and cooling costs.	Periodic weeding/mulching. Fertilize annually (as needed).	Typically $14-$25/sf (including roofing membranes)
	Dry Wells / Infiltration Trenches	A dry well is an underground container that receives and infiltrates stormwater. Dry wells range in size and complexity from a simple pit filled with gravel, to large-capacity perforated structures that are fed by drainage pipes. Infiltration trenches are dry wells that are designed as longer linear trench features.	Allow gradual infiltration of runoff and pollutant removal through soil matrix.	Remove accumulated sediment regularly. Periodically remove trash/debris.	Dry Well: $1,000 - $2,000, depending on size and material. Infiltration Trench: $5-$10/cu. ft.

** Estimated unit costs listed do not include costs associated with permitting. Costs for engineering, design and construction can vary significantly depending on site features (soils, available space, slopes, etc.) and the specific product used.*

Vegetated Filter Strips or Buffers

In 2008, a 400-foot shrub buffer was installed along the shoreline of Lake Shirley at the Oakes Landing subdivision. The buffer included 274 native shrub plantings, soil amendments and mulch.

Description:
Vegetated Filter Strips or Buffers are bands of vegetation maintained or placed between a runoff source and a receiving body of water.

Typical Use:
Vegetative Filter Strips are used along streams, wetlands and lakeshores to protect the receiving water body. They slow runoff, trap sediment and pollutants and promote groundwater infiltration.

Design Guidelines:
- Maintain natural vegetated strips of 10-20 feet or greater whenever possible along water bodies. This is a very simple effective approach that new projects and redevelopment projects should consider first when projects are designed.
- For constructed filter strips, the minimum recommended width is 10-20 feet for effective filtration.
- Grading must be done carefully when filter strips are constructed to avoid stormwater short-circuiting them, causing direct flow into the water body.
- Wider vegetation strips can also serve as wildlife habitat.
- Maintenance consists of standard vegetation management and may include mowing, irrigation and weeding, inspection, and repair of damaged vegetation.

Bioretention Cells and Raingardens

To eliminate a direct stormwater pipe discharge and reduce pollutant loading to Lake Shirley, a raingarden was installed to infiltrate and treat stormwater at the southern end of Sunset Lane.

Description:
Bioretention Cell or Raingarden is a vegetated depression that collects rainwater and facilitates its infiltration into the ground [2]. Raingardens are another name for a bioretention cell.

Typical Use:
Bioretention areas or raingardens are used to treat stormwater that has run over an impervious surface in a residential, commercial or industrial area. They are typically used for median strips, parking lot islands and swales. They filter out pollutants and contact with soil and vegetation provides better water quality treatment than a dry well or infiltration trench. They are low-technology solutions that are cheaper than conventional piped stormwater systems and they get stormwater back into the local groundwater system.

Design Guidelines:
- Porous backfill is used under the vegetated surface with an underdrain that allows infiltration and water quality filtering while avoiding ponding for an extended period.
- The ponding area should be designed to hold up to 6 inches of water with an overflow structure for larger storms that exceed the capacity of the cell.
- Regular maintenance should include a biannual health evaluation of trees and shrubs and removal of any dead or diseased vegetation.
- If levels of pollutants reach toxic levels that impair plant growth, soil replacement may be required. Other maintenance includes the removal of dead vegetation, evaluation of soil pH and erosion control, mulch replacement, unclogging the underdrain and repairing overflow areas.

[2] From Unified Facilities Criteria (UFC) Low Impact Development. US Dept. of Defense, UFC 3-210-10, October 2004.

Vegetated Swales

A vegetated swale was constructed at 53 Pearl Street in Lunenburg to filter and treat stormwater flows that periodically flooded and created erosion on the property. The swale included soil amendments to improve infiltration, shrub and herbaceous plantings, and a stabilized rock outlet to Lake Shirley.

A typical roadside vegetated swale in the Cobbett's Pond watershed (Windham, NH).

Description:
Vegetated swales are broad channels, either natural or constructed, with a surface of dense vegetation whose purpose is to retard or impound concentrated runoff and dispose of it safely into the drainage system.

Typical Use:
Vegetative Swales are used in low to moderate density residential or office and industrial campus settings where there is sufficient room adjacent to parking or roadways areas. The purpose of the vegetated swale is to filter runoff water thereby providing improvements to water quality and reduction in peak runoff..

Design Guidelines:
- Typically used on larger lots of greater than 1/2 acre.
- Slopes of vegetated swales are typically gentle so that water velocity is slow to facilitate infiltration.
- Grass vegetation is typically a dense vegetation cover to facilitate filtration of particles, infiltration of water and nutrient uptake.
- Regular maintenance is required such as mowing, sodding and repair of eroded areas. If sediment accumulation occurs, removal may be required.

Constructed Stormwater Wetlands

A small "pocket" wetland constructed near the shoreline of Long Lake (Littleton, MA) provides additional pollutant removal before stormwater discharges to the lake.

A degraded wetland area adjacent to a Lake Shirley tributary was restored with biodegradable coconut fiber logs and plantings. Over time, the sinuous flow path will become densely vegetated to provide improved pollutant filtering and attenuation.

Description:
Constructed Stormwater Wetlands are shallow depressions that receive stormwater with hydrologic and soil conditions suitable for wetland plant growth.

Typical Use:
Residential and commercial sites with sufficient land and shallow depth to groundwater to maintain hydrologic conditions for wetland plant propagation.

Design Guidelines:
- Should include pre-treatment forebay to prevent excessive sedimentation and allow for periodic sediment removal.
- Typically designed for treatment of drainage areas 10 acres or larger.
- Can be combined with wet ponds or extended detention to enhance performance.
- If no extended detention feature is provided, the permanent pool volume should equal the prescribed water quality volume per Massachusetts Stormwater Management Standard #4 (0.5 inches 1.0 inch sizing rule, as applicable) If extended detention feature is provided, then the combined volume of the permanent pool and extended detention volume should equal the prescribed water quality volume.

[1]From the MassHighway Storm Water Handbook for Highways and Bridges, http://www.mhd.state.ma.us/downloads/projDev/swbook.pdf

Pervious Paving Surfaces

Uni Eco-stone PICP pavers

Porous asphalt

GravelPave open cell paver

Turfstone grass pavers

Description:
Pervious paving surfaces are used to reduce the amount of runoff from paved surfaces and infiltrate into the ground. Depending on design, paving material, soil type and rainfall, permeable paving can infiltrate as much as 70% to 80% of annual rainfall. There are three basic types of porous pavement systems:

Permeable Interlocking Concrete Pavement (PICP, unit pavers): PIPC are "paver" blocks made of brick, stone or concrete. The pavers, designed with large opening voids, are embedded in a stable, highly permeable crushed stone pad, allowing water to percolate down through the voids and stone to subsurface soils. PIPC are suitable for pedestrian walkways and areas with low-to-moderate vehicle traffic such as parking lots. For more information on PIPC, visit:
www.uni-groupusa.org
www.idealconcreteblock.com
www.pavestone.com/

Porous Asphalt/Porous Concrete: Porous asphalt and porous concrete are similar to standard asphalt and concrete, except that the smallest particles have been screened out, allowing water to pass through. A bed of sand and gravel is installed underneath the pavement, allowing stormwater to slowly percolate into the underlying soil. For more information, visit:
www.epa.gov/owow/nps/pavements.pdf
www.stormh20.com

Open-cell Pavers: Open-cell pavers include products made of concrete or synthetic materials, designed with an open structure that is filled with either soil or crushed stone. The cell structure distributes the weight of traffic and prevents compression of the underlying soil. "Grass pavers" incorporate grass and soil within the open cell structure, and may be appropriate in some low-traffic settings. For more information on open cell pavers, visit:
www.invisiblestructures.com
www.interlockonline.com/turfston.html

Design Guidelines:
- Typically used when soils are well-drained or amended to infiltrate rapidly.
- Expense for pervious pavers may exceed conventional pavers, but when they reduce or eliminate the need for conventional stormwater systems, they are cost effective.
- Regular maintenance is minimal but necessary to ensure longer life for these systems. Porous pavers require surfaces to be kept clean of sediment and organic material. Periodic vacuuming, street sweeping and low-pressure washing may be necessary to clean voids.
- Grass pavers need to be mowed on a regular basis. Road salt should not be applied to grass pavers to avoid killing the vegetation.

Roof Gardens or Vegetated Roofs

Roof gardens can be built almost any flat roof top, from residential to commercial to industrial.
Photo credit: http://www.livegreencincinnati.com

Description:
Roof Gardens or Vegetated Roofs consist of an impermeable membrane affixed to a structural roof that is covered with vegetation on a growing medium or a pre-cultivated mat that acts as a root barrier and allows for water storage. [1,2]

Design Guidelines:
- The soil layer is typically not deep, thus it does not support large plants which require cutting or mowing.
- A more intensive roof garden with a greater depth of media may be used to grow larger vegetation, which in turn would require more horticultural maintenance.
- Additional structural load bearing capability is a consideration when designing a roof garden, in particular a more intensive roof garden.
- Once installed, the maintenance of a typical roof garden is usually minimal.

[1]From Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas http://www.mass.gov/dep/water/laws/policies.htm#storm

[2]From Unified Facilities Criteria (UFC) Low Impact Development. US Dept. of Defense, UFC 3-210-10, October 2004Control Guidelines for Urban and Suburban Areas http://www.lowimpactdevelopment.org/publications.htm

Dry Wells / Infiltration Trenches

A stackable concrete drywell section.

A stone infiltration trench designed to infiltrate stormwater from an adjacent parking area.

Description:
A dry well is an underground container that receives and infiltrates stormwater. Dry wells can range in size and complexity from a simple pit filled with gravel, to large-capacity perforated structures that are fed by drainage pipes. Infiltration trenches are dry wells that are designed as longer linear trench features.

Typical Use:
Dry wells typically are located to catch and infiltrate water from roof downspouts or paved areas. Infiltration trenches may be used in conjunction with other stormwater management systems, such as a detention pond, to provide water quality filtration and peak flow attenuation.

Design Guidelines:
- Dry wells are often used for capturing rain from roof downspouts or driveways. Maintenance is usually minimal and may only require roof gutter cleaning to prevent clogging of the dry well.
- Dry wells typically incorporate a screen or filter fabric into the design to prevent clogging with fine sediment particles. If clogging does occur, maintenance would consist of digging out the organic or sediment material that is clogging the well or trench.
- Dry wells are can be located either directly under the wet area or piping can be used to direct water to a location with better draining soil.
- If the runoff contains high levels of sediment or hydrocarbons, pretreatment should occur before discharging to a dry well or infiltration trench.

Tree Box Filters

Filterra™ tree box filter installed to reduce pollutant loading to Long Lake (Littleton, MA).

Description:
Tree Box Filters are tree-containers that are installed in the ground to capture and treat localized stormwater run-off from pervious surfaces in more urban or village-center locations.

www.greenstreetsystems.com
www.filteria.com

Typical Use:
Tree Box Filters are an attractive landscape and stormwater treatment approach that can be used along streets and roadway islands to capture runoff from urban, suburban or village locations.

Design Guidelines:
- Tree Box Filters must be integrated into the overall landscape and infrastructure design taking into consideration site grading, drainage and soil conditions.
- The drainage area for each Tree Box Filter is relatively small, therefore a number of these units are typically installed as part of the overall project development.
- Tree Box Filters can be already manufactured off-site or assembled at the site.
- They are installed after the project site has been fully stabilized in terms of sediment control.

Rain Barrels / Cisterns

Rain barrel capturing roof runoff at the Acton Discovery Museum.

Description:
Rain Barrels are rain storage containers that are placed outside of a building to capture roof runoff typically at a downspout. Cisterns are larger rain storage containers or tanks that may be installed underground.

Typical Use:
These devices typically rely on gravity flow to collect the rain and may use pumps to distribute the water for landscaping.

Design Guidelines:
- Rain Barrels or cisterns can vary greatly in design and cost depending on the volume of water collected.
- For winter use, underground installation is required.
- For large units for storage and delivery of larger water volumes, filters, valves and pumps may be required which will add to project cost and maintenance.

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