

*Town of*

**Westminster**

**Best Development Practices**

**Guidebook**

*Version 1, March 2006*

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# Introduction

The Westminster Best Development Practices Guidebook (BDP Guidebook) is a set of guidelines for developers, designers and project reviewers intended to improve the quality of development in Westminster. The Guidebook describes the required and preferred design and construction practices in Westminster related to stormwater management, erosion and sedimentation control, landscape design, and site planning. **Any project proposed in Westminster that requires Planning Board or Zoning Board of Appeals (ZBA) approval shall comply with the requirements of this Guidebook.**

None of the practices in the Guidebook are new, and many have already been used extensively in Massachusetts. The Guidebook codifies these practices as official Town policy, thus taking some of the “guesswork” out of project design and review. The Guidebook also provides a single-source reference book for designers and reviewers working in Westminster. Recognizing that many best development practices are site-dependent, the Guidebook identifies a range of practices that are relevant to development and redevelopment projects on a variety of sites.

The Guidebook is divided into five sections. Section I is a **checklist for designers** to help them determine which best development practices are likely to be applicable to their project. Project reviewers will also use this checklist to assess the project’s compliance with the requirements of the BDP Guidebook. Sections II through V discuss best development practices related to **stormwater management, erosion and sedimentation control, landscape design, and site planning**. These four sections describe the best development practices that are applicable in different situations and some technical details of the practices. References are provided for those who seek more information and design specifications for the various practices.

Thank you for taking the time to read this Guidebook. With your participation, the Town of Westminster will become a model for attractive and environmentally responsible community development.

## I. Checklist for Designers

The Checklist for Designers is a summary of the best development practices that this Guidebook requires or recommends, and when they should be used. Prior to submitting an application for review, the applicant shall fill out this checklist to verify that he or she has complied with Westminster's policies and planned the development or redevelopment site in a way that furthers the goals discussed below. The checklist shall then be submitted with the application. The Planning Board and/or ZBA and their technical consultants will use the checklist to evaluate whether the application complies with this Guidebook.

# Stormwater Management

## GOALS and NEEDS addressed:

1. Protect local and regional wetlands and water bodies
2. Maximize groundwater recharge to retain a viable local groundwater supply
3. Ensure that Westminster complies with the EPA Stormwater Phase II Requirements

## WESTMINSTER POLICIES:

- (A) All new development projects in Westminster shall meet the following three stormwater management performance standards. All redevelopment projects shall meet the standards to the maximum feasible extent, and, if they fail to meet the standards, shall retrofit or expand existing stormwater management systems to improve existing conditions.
1. Post-development peak discharge rates from the site shall not exceed pre-development peak discharge rates from the site.
  2. Annual groundwater recharge from the post-development site shall approximate annual recharge from the pre-development site.
  3. The stormwater management system shall remove at least 80% of the average annual load of total suspended solids (TSS) from the post-development stormwater created on developed site.
- (B) Non-structural stormwater management systems should be used wherever site conditions allow, as outlined in the Guidebook. Drain pipe/catch basin systems may be used, in part or in whole, only if the applicant can demonstrate that other systems are not feasible due to site conditions.

## BEST DEVELOPMENT PRACTICES

One or more of the following must be used to meet the above policies.

Incorporated  
into Project?

**Vegetated swales** (*recommended to collect runoff from roadways & parking lots*)

☐

**Vegetated filter strips** (*recommended to filter and infiltrate runoff from roadways, parking lots, and driveways; use with (a) along roadsides and parking lots*)

☐

**Constructed wetlands** (*preferred method for stormwater retention & pollutant removal*)

☐

**Bioretention cells** (*recommended on residential lots and parking lot islands*)

☐

**Pervious paving surfaces** (*recommended in overflow parking and low-traffic areas*)

☐

**Roof gardens** (*encouraged on flat commercial and industrial rooftops*)

☐

**Retention basins** (*less preferred method for stormwater retention & pollutant removal*)

☐

**Detention basins** (*may be used in series with other practices, such as constructed wetlands, to provide pre-treatment*)

☐

**Drain pipe/catch basin systems** (*discouraged, unless other stormwater collection and conveyance systems have been demonstrated not to be feasible due to site conditions*)

☐

Have you documented that other systems are infeasible?

☐

## Erosion and Sedimentation Control

### GOALS and NEEDS addressed:

1. Minimize erosion
2. Prevent sedimentation of water bodies and its attendant environmental impacts

### WESTMINSTER POLICIES:

- (A) Any proposed project on a previously undeveloped site shall accommodate the development program in a way that minimizes clearing and regrading, especially in areas of steep slopes, erosion-prone soils, or sensitive vegetation. For redevelopment projects, the site plan shall concentrate development in previously-disturbed areas to the extent possible.
- (B) As a condition of approval, every proposed project shall submit and adhere to a construction management plan that addresses soil stabilization, sediment retention, perimeter protection, construction scheduling, traffic area stabilization and dust control.

### BEST DEVELOPMENT PRACTICES

The applicant must comply with all of the following requirements.

Incorporated  
into Project?

**Clearing and regrading have been minimized**

☐

**Development is focused in previously disturbed areas** (*for redevelopment projects*)

☐

**A construction management plan has been prepared**

☐

#### The construction management plan addresses:

Soil stabilization (*cover or stabilize erodible surfaces not in immediate use*)

☐

Sediment retention (*runoff interceptors and sediment traps/ponds*)

☐

Perimeter protection (*vegetated buffers or silt fences at the limit of work*)

☐

Construction scheduling (*minimize disturbed area at any given time*)

☐

Traffic area stabilization (*crushed rock or similar at construction vehicle  
entrance and parking areas*)

☐

Dust control (*plan for stabilizing dusty surfaces when necessary*)

☐

## Landscape Design

### GOALS and NEEDS addressed:

1. Minimize demand for irrigation water
2. Maximize groundwater recharge from landscaped areas
3. Preserve native biodiversity by retaining habitat and defending against invasive species
4. Maximize the value to wildlife of human-managed landscapes

### WESTMINSTER POLICIES:

- (A) Site plans and landscape plans for all proposed projects shall take appropriate steps, as outlined in the Guidebook, to minimize water use for irrigation and to allow for natural recharge of groundwater.
- (B) Landscape plans shall follow the guidelines in the Guidebook for selecting species that are most appropriate to the site conditions. Native species and habitat-creating species shall be used in all landscape plans to the maximum extent possible while still meeting the site's landscaping needs. Invasive species identified in this Guidebook may not be planted in Westminster under any condition.

<b>BEST DEVELOPMENT PRACTICES</b>	<b>Incorporated into Project?</b>
The applicant must comply with all of the following requirements.	
<b>Clearing and regrading have been minimized</b> ( <i>natural vegetation must be retained to the maximum extent possible, given the development program</i> )	<input type="checkbox"/>
<b>Irrigation, if present, is water efficient</b> ( <i>if an in-ground irrigation systems is proposed, it is a water efficient system with automatic sensors to prevent overwatering</i> )	<input type="checkbox"/>
<b>Landscaped areas retain water</b> ( <i>gardens are mulched and designed for water infiltration</i> )	<input type="checkbox"/>
<b>No invasive species are used</b> ( <i>species from the invasive species list may not be used</i> )	<input type="checkbox"/>
<b>Native and habitat-creating species are used</b> ( <i>species from these lists have been incorporated into the landscape design whenever possible</i> )	<input type="checkbox"/>
<b>Species are appropriate to the soil, site, and microclimate conditions</b> ( <i>select appropriate species from the lists of salt-tolerant, urban-tolerant, wetland, moist-tolerant and drought-tolerant species</i> )	<input type="checkbox"/>

## Site Planning

### GOALS and NEEDS addressed:

1. Protect Westminster's natural environment, including habitat, water resources, and ecosystem services
2. Create a visually appealing community
3. Preserve the Town's historic and cultural heritage
4. Stabilize and increase property values
5. Encourage sustainable development

### WESTMINSTER POLICY:

Subdivision plans and site plans for all forms of development shall adhere to the principles of *environmental compatibility, aesthetic compatibility, and energy-efficient design*.

<b>BEST DEVELOPMENT PRACTICES</b>	Incorporated
The site plan must address all of the following principles.	into Project?
<b>Unique natural features have been preserved</b> ( <i>the development program should avoid or else showcase significant natural features</i> )	<input type="checkbox"/>
<b>Historic and cultural resources have been preserved</b> ( <i>the development program should avoid or else showcase significant historic and cultural features</i> )	<input type="checkbox"/>
<b>Clearing, grading, and building placement consider viewsheds</b>	<input type="checkbox"/>
<b>Cut and fill have been minimized</b>	<input type="checkbox"/>
<b>Buildings blend into the natural topography</b>	<input type="checkbox"/>
<b>Buildings are oriented to the sun and wind for maximum energy efficiency</b> Vegetated protection from northwest (winter) winds is provided Deciduous species planted or retained close to the E, S and W building edges	<input type="checkbox"/> <input type="checkbox"/>



## II. Stormwater Management

### a. Overview and Policies

The need for a strong and innovative stormwater management policy is based on Westminster's attempt to address several challenges:

- Westminster has numerous wetlands and water bodies, and is at the headwaters of the Charles River, all of which are affected by polluted runoff.
- The Town relies on local groundwater aquifers for its public water supply; with Westminster facing seasonal water shortages, groundwater recharge is an essential function.
- The U.S. Environmental Protection Agency (EPA) has recently promulgated the so-called "Stormwater Phase II Requirements," which require communities like Westminster to manage polluted runoff effectively.<sup>1</sup> (Notes and references are provided in the endnotes.)

In order to ensure a minimum level of stormwater management for development and redevelopment projects, Westminster has adopted the following stormwater management performance standards.<sup>2</sup> The adoption of performance standards allows the design engineer to select one or more stormwater management systems that are most appropriate and cost-effective for the particular site.

**WESTMINSTER POLICY:** All new development projects in Westminster must meet the following three stormwater management performance standards. All redevelopment projects shall meet the standards and if they fail to meet the standards, shall retrofit or expand existing stormwater management systems to improve existing conditions.

1. Post-development peak discharge rates from the site shall not exceed pre-development peak discharge rates from the site.
2. Annual groundwater recharge from the post-development site shall approximate annual recharge from the pre-development site.
3. The stormwater management system shall remove at least 80% of the average annual load of total suspended solids (TSS) from the post-development stormwater created on developed site.

There is a growing realization among water resource professionals that conventional systems of stormwater collection, conveyance, and end-of-the-pipe dry-basin detention are no longer sufficient to improve the water quality of surface water bodies. Therefore, the Town's general preference is that stormwater be conveyed and treated in natural and vegetated systems such as vegetated swales, filter strips, constructed wetlands, and bioretention cells. While some of these practices may be new to the Town of Westminster, they have been used successfully in other towns and states and have gained support from the EPA because of their generally superior performance in attenuating peak runoff rates, filtering pollutants, recharging groundwater, and allowing retention of the natural landscape. Recognizing

**WESTMINSTER POLICY:** Non-structural stormwater management systems should be used wherever site conditions allow, as outlined in the Guidebook. Drain pipe/catch basin systems may be used, in part or in whole, only if the applicant can demonstrate that other systems are not feasible due to site conditions.

that non-structural systems are not appropriate in all situations, the Guidebook also discusses other practices that will be permissible in certain situations.

This section of the Guidebook discusses nine stormwater management practices that can be used, alone or in combination, to meet the performance standards. Other systems not discussed in this guidebook may also be acceptable if the applicant can demonstrate their fulfillment of the above standards. Table 2-1 provides a summary of the practices discussed in this chapter and when each practice is encouraged or allowed.

**Table 2-1: Use of Stormwater Management Practices in Westminster**

Practice	Westminster's Policy	Appropriate Uses
Vegetated Swales	Strongly encouraged	Roadsides, parking lots
Vegetated Filter Strips	Strongly encouraged	Roadsides, residential frontage areas, parking lots, perimeter protection
Constructed Wetlands	Strongly encouraged	Commercial and industrial sites, office campuses, subdivisions
Bioretention Cells (Rain Gardens)	Strongly encouraged	Residential lots, parking lot islands
Pervious Paving Surfaces	Encouraged	Parking overflow areas
Roof Gardens	Encouraged	Office/industrial buildings
Retention Basins	Neutral	Subdivisions, office developments
Detention Basins	Allowed in combination with other practices	All areas of development, if necessary
Drain Pipe/Catch Basin System	Allowed when other systems are not practical due to site constraints	All areas of development, if necessary

There are several factors to consider when deciding on which practice(s) to implement in any given project. Among these factors are the space required, soils and slopes on site, depth to the water table, maintenance requirements, pollutant removal efficiencies, cost, and ability to meet Westminster's stormwater performance standards.

## b. Summary of Practices

Table 2-2 provides a summary of design and site considerations for the various stormwater management systems.

**Table 2-2: Design and Site Considerations for Stormwater Practices<sup>3</sup>**

	<b>Vegetated Swales</b>	<b>Vegetated Filter Strips</b>	<b>Constructed Wetlands</b>	<b>Bioretention Cells</b>	<b>Pervious Paving</b>	<b>Retention Basins</b>	<b>Detention Basins</b>	<b>Catch Basins</b>
<b>Space Required</b>	Bottom width: 2 ft. min. 6 ft. max.	Recommended minimum width: 10-20 ft.	5% of drainage area	Min width: 5-10 ft Min length: 10-20 ft Min. depth: 2-4 ft	Not a factor	Min. pool surface: 0.25 acres recom'd	1 acre foot per 4 acres drainage area	Not a factor
<b>Soils</b>	Permeable soils perform better, but wet swales can be used in less permeable soils	Permeable soils perform better, but soils are not a limitation	Soils are not a limitation	Permeable soils recom'd (infiltr. rates >0.27 in/hr). Underdrains allow for less permeable soils.	Permeable soils perform better	Not a factor	Not a factor	Not a factor
<b>Slope of Catchment Area</b>	A design consideration, but usually not a limitation	A design consideration, but usually not a limitation	Max. 15% for forested; 5% for shrubs/herbs	A design consideration, but usually not a limitation	Usually not a limitation	Maximum 15%	Maximum 15%	Not a factor
<b>Water Table and Bedrock</b>	Generally not a constraint	Generally not a constraint	Water table should be at or near soil surface, or else a liner can be used	2-4 ft above water table/bedrock recommended	2-5 ft above water table/bedrock recom'd	Not a factor	Generally not a constraint	Not a factor
<b>Proximity to Building Foundations</b>	Min. 10 ft. down-gradient from buildings & foundations recom'd	Min. 10 ft. downgradient from buildings & foundations recom'd	Min. distance 10 ft.	Min. 10 ft. downgradient from buildings & foundations recom'd	Not a factor	Min. distance of 10 ft	Min. distance of 10 ft.	Not a factor
<b>Max. Depth</b>	N/A	N/A	4-6 ft.	2-4 ft., depending on soil type	N/A	3-6 ft.	3-12 ft.	N/A
<b>Maintenance Requirement</b>	Low: routine landscape maint.	Low: routine landscape maint.	Moderate; depends on sediment'n rate	Low: property owner can include in normal site landscape maint.	Low: routine landscape maint.	Moderate; depends on sediment'n rate	Moderate: routine sediment removal	Moderate: routine sediment removal

Table 2-3 should be used in determining compliance with Westminster's 80% TSS removal standard. TSS removal efficiency for each of the various stormwater management systems shall be presumed to be the value shown in Table 2-3 unless the applicant can provide additional satisfactory information or documentation that the system has a greater TSS removal efficiency. Other systems not discussed in this Guidebook may also be acceptable if the applicant can demonstrate their fulfillment of the Westminster stormwater management performance standards.

If more than one practice is used to achieve the required 80% TSS removal, the removal efficiency rates must be multiplied together, not added. For example, if the first practice has a 60% TSS removal rate and the second practice has a 20% removal rate, a total of only 68% of TSS would be removed. (60% of the total, plus 20% of the remaining 40% of TSS.)

**Table 2-3: TSS Removal Rates for Stormwater Management Practices<sup>4</sup>**

<b>Practice</b>	<b>Design Rate for TSS Removal</b> (use this number to calculate compliance with the 80% TSS removal requirement)	<b>Range of Average TSS Removal Rates</b>
Vegetated swale	70%	60-80%
Vegetated filter strip	30% per 10' of width <sup>a</sup>	30-65%, depending on width
Constructed wetland <sup>b</sup>	80%	65-80%
Bioretention cell	80% <sup>c</sup>	65-80%
Retention basin <sup>b</sup>	70%	60-80%
Detention basin <sup>d</sup>	60%	60-80%
Deep sump and hooded catch basin	25%	25% w/cleanout

<sup>a</sup> For widths greater than 10', TSS removal is determined multiplicatively. For example, for a 30' wide strip, the TSS removal rate would be  $(1 - (0.7 \times 0.7 \times 0.7)) = 66\%$ .

<sup>b</sup> Must have sediment forebay or pre-treatment.

<sup>c</sup> If an underdrain is used, the water must be conveyed to a secondary treatment device such as a constructed wetland or a retention basin.

<sup>d</sup> Post-treatment is required (e.g., by a constructed wetland or retention basin).

## c. Discussion of Practices

Each of the nine stormwater management practices is discussed in more detail below. References in the endnotes provide additional information on the use, design, and construction of these practices.

### 1. Vegetated Swales

Swales are earthen channels most commonly covered with a dense growth of grass or other vegetation, and are designed primarily to control water quantity and quality.<sup>5</sup> The design of vegetated swales has improved over the years, enabling engineers and hydrologists to implement them for a variety of different purposes. Depending on hydrological conditions and design, swales can be dry, wet, or grassed:

- **Dry swales** are channels filled with approximately 30 inches of soil (50% sand and 50% loam) that allows full infiltration of the stormwater.
- **Wet swales** are generally used when the water table is at or near the soil surface or when soils are poorly drained. These swales have a ponding area that should be planted with moist-tolerant species to enhance nutrient uptake and sediment retention.
- **Grassed swales** are planted with grass species that provide a dense cover and serve to provide sediment retention, nutrient uptake and filtration. They are suitable for sandy loam soils. Pollutants are removed from stormwater by the filtering action of the grass, sediment deposition, and/or infiltration into the soil. Grass swales are designed to remain dry most of the time and are specifically planted with species to enhance nutrient uptake and filtration.

### Design Considerations

Swales are easily implemented on large lot residential sites (½ to 1 acre or larger), office and industrial campuses, roadways where right-of-way widths are adequate, and parking lot medians and edges (see photo at left). Ideally, stormwater should flow from the impervious surface through a vegetated filter strip before entering the swales (see Figure 2-2). Typically, dry and grass swales are used for low density residential projects or very small impervious areas and require soils that have infiltration rates of 0.27-0.50 inches per hour. Wet swales, on the other hand, are convenient for treating highway runoff in low lying or flat terrain areas and need to be planted with water tolerant vegetation.

Swales should be built at a gentle slope so that water flows at a relatively low velocity. The minimum allowable slope is ½%, while the maximum slope is based on velocity. Water velocity in the swale should generally not exceed 3 feet per second, which typically corresponds to a maximum slope of about 5%. If necessary, the swale may be steeper in places, provided that riprap or other stabilization is used to prevent scouring and erosion within the swale. The side slopes should be at a maximum of 3:1, and the length of the swale should be calculated to accommodate the entire calculated runoff volume from a 10-year storm. Regular maintenance such as mowing, sodding, and repair of eroded areas is necessary for swales. In addition, the accumulated sediment may need to be periodically removed, particularly during the construction and early site stabilization periods.

## 2. Vegetated Filter Strips

Filter strips are typically bands of close-growing vegetation, placed between pollutant source areas and the receiving water body (either a natural water body or a constructed swale). To protect natural water bodies (e.g., streams or wetlands), filter strips should consist of natural buffer strips already existing on the site. Not only do filter strips protect sensitive areas such as wetlands, woodlands and erodible soils; they also reduce runoff impacts by trapping sediment and sediment-bound pollutants, provide some infiltration, and slow and disperse stormwater flow over a wide area.<sup>6</sup> Figure 2-2 illustrates some of the biochemical processes by which filter strips remove pollutants.<sup>7</sup>

### Design Considerations

Treatment of stormwater in filter strips is accomplished physically by a combination of filtration through the standing vegetation and infiltration into the underlying soils. In order to treat stormwater effectively, filter strips must be designed to function as overland flow systems where stormwater is evenly distributed. Because there is a high potential for short-circuiting of the filter strips and reduced pollutant removal, grading must be designed carefully to provide uniform flow into the filter strips.

If filter strips are wide enough and planted with appropriate plant species, they will provide wildlife habitat as well as visual amenities in the landscape. It is important to note that filter strips are usually implemented in combination with other stormwater management facilities that specifically control stormwater volume. Finally, for a filter strip to be efficient, a minimum width of 10-20 feet is recommended. Upkeep of filter strips should be incorporated into routine landscape maintenance, which would include raking the filter strip, removing large trash or debris that has accumulated, and regularly cleaning up sediment.

### 3. Constructed Wetlands

Constructed wetlands (or stormwater wetlands) are shallow pools that create growing conditions suitable for marsh plants. These systems are designed to maximize pollutant removal through retention, settling, and uptake by wetland plants.<sup>8</sup> Stormwater wetlands serve several benefits simultaneously. The primary purpose of constructed wetlands is to improve water quality by removing sediment and pollutants. However, these wetlands can also provide excellent habitat for wildlife and waterfowl. In general, a constructed wetland would be a suitable stormwater management practice for residential subdivisions and commercial developments.

#### Design Considerations

Constructed wetlands must be designed with consideration to the size of the contributing watershed area, amount of baseflow, soil type, and available space. The contributing watershed may be as small as 5 acres; however, the smaller the watershed area, the more difficult it is to create sufficient drainage and runoff to keep the wetland perpetually wet. Since wetlands need to maintain soil moisture throughout the year, it is important to have a dry-weather baseflow or a groundwater supply. The preferred soil types for constructed wetlands are less-permeable soils that have relatively small pores and are less prone to evaporation.

The surface area of constructed wetlands should be at least 1% of the contributing drainage area, and the wetlands should have a length to width ratio of at least 1.5:1.<sup>9</sup> In order to increase the efficiency of the retention pond, a sediment forebay must be incorporated as a pretreatment device.

As with all other stormwater management practices, stormwater wetlands also require ongoing maintenance to retain their maximum effectiveness. However, several design features can decrease the amount of maintenance that a wetland needs. For example, a reverse-slope pipe or a weir outlet with a trash rack should be used to prevent clogging of the outlet; orifices should have diameters no less than 3"; and direct maintenance access should be provided to the forebay to allow for sediment removal. Selection of plant species is one of the most important parts of creating a stormwater wetland, as the plants are largely responsible for the pollutant and sediment retention and uptake. Please refer to Figure 2-4<sup>10</sup> for a sample wetland vegetation layout and **Section III** for a list of plant species suitable for planting in constructed wetlands.

#### **4. Bioretention Cells (Rain Gardens)**

Bioretention cells (otherwise known as rain gardens) are landscaped areas that mimic upland vegetation systems. These systems are designed to trap stormwater, infiltrate it, and treat it by means of vegetational uptake (uptake of certain minerals and nutrients by vegetation), biological degradation (microbial/bacterial metabolic activities), and/or gravitational sediment removal.

Runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants (see Figure 2-7<sup>11</sup>). Runoff passes first over or through a sand bed, which slows the runoff and distributes it evenly along the ponding area. The ponding area is made up of a surface organic layer, ground cover and the underlying planting soil. The ponding area is graded such that there is a depression in the middle where water remains until it infiltrates or evaporates. The depression should be designed to hold up to 6 inches of water.<sup>12</sup> An overflow structure should be provided for situations where the ponding area is not sufficient. As shown in Figure 2-7, the infiltrated water may also be collected through an underdrain and outlet, which would drain water to a constructed wetland or retention pond for further treatment.

Bioretention cells can be used in both residential and commercial projects. In residential subdivisions, bioretention cells are used to retain and infiltrate stormwater locally so that it does not need to be conveyed and treated by means of a more extensive stormwater management system. Each residential lot would typically have one or more bioretention cells (which are essentially landscaped gardens) that receive stormwater from the roof and driveway and infiltrate it to the ground. Each homeowner is responsible for maintaining the bioretention cell(s) on their property, just as they would maintain their garden.

In commercial projects, bioretention cells are installed as depressed islands in the parking lot. Stormwater is directed to these islands, where it is treated and infiltrates into the ground.

#### **Design Considerations**

The design of bioretention cells must consider the site area, slope, soils, groundwater, and maintenance needs. Figure 2-8<sup>13</sup> illustrates a typical bioretention cell installation. Bioretention cells should be designed to occupy 5 to 7 percent of the drainage area multiplied by the rational method runoff coefficient ("c") determined for the site.<sup>14</sup> Recommended minimum dimensions are 15 feet by 40 feet for bioretention cells receiving parking lot runoff. Bioretention cells on individual house lots can be much smaller.

The site should have shallow slopes (approximately 5% or less) so that water flow is guaranteed but velocity is not too high. An underdrain should be used in situations where soils are tight and there is a concern about the cell backing up or flooding. (In areas of less pervious soils, bioretention cells may be constructed by importing more permeable soils for the cell itself, in combination with an underdrain which prevents water from ponding above a less permeable natural soil layer.) An underdrain should also be used where the water table is close to the surface and there is a concern about groundwater pollution. In other situations, an underdrain generally is not needed.

Bioretention cells need to be maintained regularly to ensure the presence of mulch and good soil, attend to any diseased or dead plants, and remove collected sediment, litter and debris.

#### **5. Pervious Paving Surfaces**

Pervious paving surfaces typically consist of a permeable surface with an underlying crushed/broken stone reservoir to temporarily store runoff before it infiltrates into the ground. The main purposes of this



application are to reduce the amount of stormwater runoff from paved areas and to infiltrate stormwater into the underlying soils. By reducing the amount of stormwater runoff, pervious paving surfaces reduce the cost of stormwater management.

Pervious paving surfaces that are now available include porous asphalt, pervious concrete and grass pavers. Porous asphalt and pervious concrete appear to be the same as traditional pavement from the surface, but incorporate void spaces to allow infiltration. These systems have been applied successfully in a few locations in New England where soils consist of particularly well-drained sands and gravels that allow the pores to drain rapidly. However, in areas of tighter soils, porous asphalt and pervious concrete are generally not recommended in this region because water remaining in the void areas is subject to the freeze-thaw cycle which stresses and weakens the pavement.

Grass pavers, shown in Figure 2-9, are a viable option in New England's climate.<sup>15</sup> Grass pavers consist of concrete interlocking blocks or a synthetic fibrous gridded system with open areas designed to allow grass to grow. The design should allow for infiltration into the underlying soils so that stormwater does not pond near the surface.

### *Design Considerations*

Grass pavers are most suitable for low-traffic areas such as the overflow areas of commercial or office parking lots, residential driveways, and service areas that will be subject to light traffic. Westminster recommends their use in these situations. If these systems are used, stormwater calculations should account for the reduced amount of runoff generated by areas with grass pavers. In general, grass paver systems should not be salted in the winter because this will threaten the viability of the plants. However, salting will not typically be required in the low-traffic areas where grass pavers are recommended.

## 6. Roof Gardens

Roof gardens are precultivated vegetation mats placed on several layers including a fertilizer layer, a substrate mat, a protective fleece and an impervious membrane. Roof gardens provide several functional benefits such as reducing stormwater runoff volume and pollutant load, increasing the energy efficiency of buildings, improving air quality by removing particles in the air and by photosynthesis, and increasing the aesthetic value of the area. Roof gardens can be built on almost any rooftop, from a residential building to a commercial or industrial building. Figure 2-10 shows a typical application.<sup>16</sup> The Town of Westminster recommends that roof gardens be used in large commercial, office, and institutional buildings that have flat roofs.

Once established, roof gardens do not need extensive maintenance other than occasional fertilization and weeding. During the initial stage some watering might be required; however, usually within six months the plants are able to sustain themselves.

Since the soil layer is not deep, it will not support tall vertical growth or large plants; therefore, cutting or mowing is not required. Load reserves of at least 15 pounds per square foot beyond snow load requirements are needed to install a roof garden.<sup>17</sup> If properly built over a suitable roofing membrane, roof gardens do not present a leaking problem.

## **7. Retention Basins**

Retention basins are constructed to have a permanent pool of water to treat stormwater. The pool allows settling of sediments, removal of soluble pollutants by algal uptake, and some groundwater recharge as shown in Figure 2-12<sup>18</sup>. The basins are designed to include additional storage capacity to control peak discharge rates. The primary component of a retention basin is a deep, permanent pool, but the basin may also include a shallow marsh or a sediment forebay to increase sediment and nutrient removal.<sup>19</sup> In general, the Town of Westminster does not recommend that retention basins be used as the primary means of attenuating peak runoff rates or removing pollutants. Constructed wetlands are generally a preferred system since they have greater pollutant uptake functions. However, retention basins may be used in subdivisions as well as commercial and industrial areas when other stormwater management systems are not feasible or sufficient because of site conditions or the nature of the development program. Retention basins may also be used in series with constructed wetlands as a sediment trap, particularly during construction.

### **Design Considerations**

Retention basins must drain a sufficiently large area to maintain a permanent pool of water. The minimum recommended area is typically around 10 acres, assuming impervious surface percentages typical of suburban developments.<sup>20</sup> Within the watershed area that drains to the retention basin, the slopes and the stormwater conveyance system must result in a metered flow of stormwater that does not flood the basin all at once. The use of filter strips and swales can help slow and infiltrate water on its way to the basin.

Retention basins can be constructed in a wide range of soil types. However, when native soils have a rapid percolation rate, soils should be compacted or supplemented sufficiently so that the pond does not dry up during the dry season. The soils should retain sufficient infiltration potential so that the pond also continues to play a role in groundwater recharge. In order to increase the efficiency of the retention basin, a sediment forebay must be incorporated as a pretreatment device. As with constructed wetlands, retention basins should use non-clogging outlets and large orifices (not less than 3 inches in diameter), and should provide easy dredging access to reduce long-term maintenance requirements and difficulties.

## 8. Detention Basins

Detention basins are depressed areas whose outlets have been designed to detain stormwater runoff for some minimum time to allow particles and associated pollutants to settle. Since the aim of detention basins is mainly to control flooding and remove sediments, they do need not to have a permanent pool and therefore can be dry during non-flood conditions. Typically, they are used in conjunction with other stormwater management systems such as retention basins or constructed wetlands as a primary treatment.

The Town of Westminster discourages the use of detention basins as the primary means of flood control. Instead, vegetated swales and filter strips should be used whenever possible to attenuate peak runoff rates. When site characteristics do not allow use of such practices, however, detention basins may be considered as part of the stormwater management system. In addition, detention basins may be used as a pre-treatment device to settle out particulates prior to discharge to a constructed wetland or retention basin, where additional treatment and infiltration will occur.

### Design Considerations

Detention basins are most practical for use on sites that are at least 10 acres, which allows for the use of larger outlet orifices that are less likely to clog. Detention basins can be used on sites with a slope of up to about 15 percent. There is no minimum slope requirement, provided that there is enough change in elevation to ensure flow. Soil type is not a factor except in areas with rapidly percolating soils such as sand. In these areas, an impermeable liner should be used to prevent groundwater contamination from untreated runoff. Detention basins should be designed with sediment forebays, which allows sediment to be trapped prior to entering the detention basin. This feature also reduces maintenance requirements for the detention basin. As with constructed wetlands, detention basins should use non-clogging outlets and large orifices (not less than 3 inches in diameter), and should provide easy dredging access to reduce long-term maintenance requirements and difficulties.

Any detention basin in the Town of Westminster must provide landscaping and planting to minimize its visual impacts. The plants selected for the ponding area should be able to withstand both wet and dry periods. Along the perimeter of the basin, however, the plants should be adapted to dry conditions and should create a visual vegetated buffer.

## 9. Catch Basins and Drain Pipes

Catch basins are storm drains that capture and roughly filter stormwater through a grate or curb inlet and capture sediment, debris and associated pollutants in a deep sump (Figure 2-14<sup>21</sup>). In most cases a hood is also included to separate oil and grease from the stormwater. The essential function of a catch basin is to act as a pretreatment device for other structures incorporated into a storm sewer system. The performance of a catch basin in removing sediment and pollutants will depend greatly on the size of the drainage area, the size of the sump, and the amount of maintenance it receives. Although catch basins are currently used in virtually all circumstances, they typically cannot remove pollutants as well as most of the other practices mentioned in this section and require frequent maintenance. Catch basins should only be used when the other practices mentioned in this section prove unfeasible. The designer must document the reason(s) why the other practices are not feasible before the use of catch basins may be approved.

When catch basins are used, the Town will consider it preferable if they discharge individually or in pairs to nearby swales, constructed wetlands, or bioretention cells, rather than carrying runoff further to a larger retention/infiltration system. Lengthy catch basin-piped drain-manhole networks are discouraged. In general, the goal is to use vegetated, low-velocity channels to hold and infiltrate stormwater locally, not to efficiently capture and deliver stormwater to watercourses.

### Design Considerations

Catch basins should be designed to hold a combined volume of at least 400 cubic feet per acre of contributing impervious area and have sumps that are at least four feet deep. The grates and inlets should be sized and constructed to pass the 10-year storm volume into the deep sump. Flow from the catch basin/drain pipe system should be directed to another stormwater management device, such as a constructed wetland, for further treatment. Catch basin inlets should be cleaned regularly (at least twice a year) and after large storms. Removed sediment should be disposed of in accordance with applicable local, state and federal guidelines and regulations.

### III. Erosion and Sedimentation Control

Erosion and sedimentation control practices should be incorporated into the planning, construction, and operation of any project in Westminster. Specific measures must be presented for review prior to construction.

#### a. Site Planning

The most important erosion control practice is to minimize clearing and regrading, as discussed in **Section V**, Site Planning.

**WESTMINSTER POLICY:** Any proposed project on a previously undeveloped site must accommodate the development program in a way that minimizes clearing and regrading, especially in areas of steep slopes, erosion-prone soils, or sensitive vegetation. For redevelopment projects, the site plan should concentrate development in previously-disturbed areas to the extent possible.

The initial step to control erosion and sedimentation lies in developing a plan that is appropriate to the site features including topography, soils, drainage ways, and natural vegetation. The site planning process should begin with a thorough evaluation of sensitive areas requiring protection as well as less sensitive areas suitable for development. The site plan should delineate a limit of work that limits clearing and regrading and protects the most sensitive areas, based on the criteria in Table 3-1. For example, in residential subdivisions, native vegetation should be retained on individual houselots to the extent possible, rather than creating larger lawns.

**Table 3-1: Guidelines for identifying sensitive site features<sup>22</sup>**

Topography	Drainage	Soils	Natural vegetation
Slopes that are steeper and/or longer typically create more erosion. Slopes that exceed the following thresholds are likely to be sensitive and erosion-prone: <ul style="list-style-type: none"><li>• Slopes of 5-7% longer than 300 feet</li><li>• Slopes of 7-15% longer than 150 feet</li><li>• Slopes of more than 15% longer than 75 feet</li></ul>	Where possible, retain natural drainage ways and depressions and utilize for stormwater conveyance	Consider factors such as erodibility, permeability, depth to water table and bedrock, and soils with shrink/swell potential or slippage tendencies. The most erodible soils contain high proportions of silt and very fine sand. The presence of clay or organic matter tends to decrease erodibility.	This is the most important factor in preventing erosion. Vegetated buffers filter runoff, decreasing runoff velocity, and increase infiltration capacity.

## b. Construction Period Impacts

Prior to the commencement of construction, the limit of clearing and limit of work identified on the site plan and approved by the Town must be suitably marked. Acceptable markers include survey tape or plastic fences. These markers are in addition to any fences that the Conservation Commission may require for sensitive areas such as wetlands, streams and their buffers. Construction activities and construction traffic must be limited to the area identified on the site plan, and no stockpiling of materials, soils, or debris or other activity may occur outside of the limit of work.

**WESTMINSTER POLICY:** As a condition of approval, every proposed project must submit and adhere to a construction management plan that addresses soil stabilization, sediment retention, perimeter protection, construction scheduling, traffic area stabilization and dust control.

## 1. Soil Stabilization

The construction management plan should outline a plan for cover and/or stabilization of erodible surfaces that are not the immediate focus of construction activity. The Town requires covering and stabilization as a way of minimizing soil erosion as well as sedimentation in the Town's water bodies and storm sewer system. Cover measures must be implemented on areas that have already been disturbed but will not be worked on during the next 7 days during dry conditions or next 2 days during wet conditions. Acceptable cover methods include, but are not limited to, the use of mulch, erosion control nets and blankets, plastic covering, seeding and sodding. These are described in the following paragraphs.

Mulching is generally considered to be a suitable short-term protective measure. The main purpose of mulching is to protect the site from erosion by stabilizing soils and reducing stormwater runoff velocity. Mulch can also enhance plant establishment by conserving moisture, holding fertilizer, seed and topsoil in place, and moderating soil temperature. The most commonly used mulches include straw, wood fiber or cellulose, compost and wood chips. The effectiveness of mulching depends on site characteristics and maintenance: if the site is prone to high winds or has steep slopes, additional steps should be taken to anchor the mulch, such as planting vegetation or providing netting or blanketing. The thickness of the cover should be maintained at all times and any area that has eroded should be remulched and anchored until it has been stabilized.

Similar to mulching, plastic covering is also acceptable as a short-term protective measure. This technique simply involves covering the area of concern with a plastic sheet and using tires or sandbags to weight the plastic down. Plastic covering is generally used on cut and fill slopes and stockpiles. Plastic covering should not be used if there is a sensitive area located downslope, because of the rapid runoff created by the plastic covering. Although this is a fairly easy technique to apply, it requires careful maintenance. The plastic cover can easily be torn or damaged by the sun and can clog drainage systems if not removed properly. Therefore, regular maintenance should be provided to ensure that the plastic is undamaged at all times and fully removed after it is no longer needed.

Seeding, sodding and erosion nets and blankets are usually more appropriate as long-term solutions for areas that will remain unworked for months. **Section IV** lists recommended species to plant for erosion control purposes. A well-designed landscaping plan can easily incorporate areas of planting for permanent erosion control. If the area must be stabilized immediately, then the use of sodding is more appropriate since it can provide immediate erosion protection. Sodding is appropriate for use on residential or commercial lawns, steeply-sloped areas, waterways and channels carrying intermittent flow, and areas around drop inlets that require stabilization.<sup>23</sup> Sod maintenance is essential during the establishment period. Sod should be provided with adequate moisture and fertilizer. If the sod does not root and stay healthy, it should be replaced by new sodding or a different technique.

Erosion control nets or blankets, also referred to as geotextiles, are another suitable long-term stabilization technique (see Figure 3-1<sup>24</sup>). Geotextiles are used for preventing erosion and holding seed and mulch in place on steep slopes, as well as in channels to aid vegetation establishment. Geotextiles can be made of synthetic materials such as polypropylene, polyester, polyethylene, nylon, and polyvinyl chloride as well as biodegradable materials such as mulch matting, jute, coconut fiber and other wood fibers. For effective stabilization, good contact with the ground must be maintained and no erosion should occur beneath the net or blanket. Synthetic geotextiles can be sensitive to light and wind; therefore, they should be inspected regularly and any problematic areas should be repaired immediately.



## 2. Sediment Retention

Sediment retention from construction sites is a three-step process. First, all surface runoff from disturbed areas must be intercepted since this runoff contains high sediment loads. Second, the runoff must be conveyed to a sediment trap or pond where sediment removal will occur. Finally, the cleaned runoff must be discharged downslope of any disturbed areas. Typically, interceptor dikes and swales are used to intercept runoff; check dams are used to reduce flow velocity and remove sediment; ditches and pipes are used to convey the runoff; and riprap or level spreaders are used to dissipate runoff velocity in a non-erosive manner. As shown in Figure 3-2<sup>25</sup>, interceptor dikes can collect the runoff and direct it to pipes and/or ditches which can convey the runoff to a sediment pond. The outflow from the pond can be connected to a stream (as shown in this case) or to a vegetated area. Riprap may be used to stabilize outlets. Check dams can be incorporated into the design to reduce the velocity of the runoff. Typically, check dams are installed in swales or ditches and consist of small gravel, rock, sandbag, log or straw dams.

As mentioned above, sediment must be conveyed to sediment traps or ponds prior to being discharged. Sediment traps should be used for areas less than about three acres, and sediment ponds should be used for larger areas. Stormwater runoff is conveyed through these structures, where sediment is settled (mostly small particles of 0.02 mm or so) and turbidity is slightly reduced.<sup>26</sup> When sediment reaches one foot in depth, the trap or the pond should be cleaned. Any embankments or slopes should also be routinely checked and any damage properly repaired. The construction management plan must state how surface runoff will be intercepted and settled before it is released into the ground or off-site.

### 3. Perimeter Protection

While interceptors and sediment traps/ponds discussed above will provide the primary sediment retention on construction sites, perimeter protection is also required to prevent residual sedimentation of adjacent lands and waters. The construction management plan should identify measures to prevent sediment from being transported off of the site. Again, the purpose of this requirement is to minimize sedimentation in the Town's water bodies, storm sewer system, and adjacent properties. Measures such as vegetated filter strips, silt fences, or brush barriers should be provided at the limit of work to filter runoff and capture sediment. In places where the limit of work is not near the edge of the site, a natural vegetation buffer of 40 feet is generally considered to be an acceptable retention system, except where the natural vegetation is a wetland, a wetland buffer or otherwise sensitive landscape feature, in which case a silt fence or similar device should generally be used. Figure 3-3<sup>27</sup> illustrates proper installation of hay bales for sediment retention purposes.

#### 4. Other Practices

##### Scheduling of Operations

The construction management plan should state when clearing, grubbing, grading, construction, and replanting will occur on each section of the site. If construction phasing has not been determined at the time of the initial permitting, this section of the construction management plan may be submitted later, but must be submitted at least 60 days prior to the desired commencement of construction. Construction must be phased by area so that the smallest practical area of land is exposed for the shortest possible time.

##### Traffic Area Stabilization

To reduce the amount of sediment transported off site by construction vehicles and to reduce the erosion of areas disturbed by vehicle traffic, roads and parking areas should be stabilized immediately after initial grading. Not only will this stabilization reduce amount of sediment transported out of the site; it will also reduce the amount of easily erodible mud that forms on site. Stabilization can be achieved by use of a 6 inch deep layer of crushed rock, gravel base, or crushed surfacing base on the area of construction entrances or roads and parking areas. For any area that will be subject to long-term or high-volume construction vehicle traffic, a truck wash should be implemented, with dirty water channeled through sediment traps or ponds prior to discharge.

##### Dust Control

The construction management plan should commit to minimizing wind transport of dust from exposed soil surfaces onto roadways, drainage ways, and surfaces waters by spraying exposed soils with water until they are sufficiently damp so as to not produce dust, but not so wet as to produce runoff, whenever weather conditions are dry and windy.

## IV. Landscape Design

This section of the Guidebook addresses three critical goals for the Town: stabilizing water use at a sustainable level; creating landscapes that minimize natural habitat destruction and maximize habitat value; and encouraging the development of landscapes that provide environmental quality and visual relief.

### a. Water-Sensitive Landscaping

Westminster currently suffers from a seasonal water supply shortage due in large part to lawn and garden watering. At the same time, development and the attendant rise in impervious surfaces is altering the natural hydrological cycle and reducing recharge to the aquifers. Without careful attention to water use and hydrologic systems, Westminster could face continued water shortages as well as large future expenditures related to public water supply.

**WESTMINSTER POLICY:** Site plans and landscape plans for all proposed projects must take appropriate steps, as outlined in this section, to minimize water use for irrigation and to allow for natural recharge of groundwater.

On previously undeveloped (“greenfield”) sites, the most important water-sensitive practice is to minimize the disturbance and clearing of natural vegetation. Guidelines to meet this objective are provided in **Section III** and **Section V** of this Guidebook. Typically, this will mean preserving some portion of the site as open space, plus reducing the area of lawn and garden in favor of native vegetation in both residential and commercial/industrial projects. In places where native vegetation is cleared, at least some of the area should function as a groundwater recharge system. For example, a landscaped garden could function as a bioretention cell through appropriate subsurface design and selection of species, or portions of a lawn could serve as a vegetated filter strips for driveway runoff if properly graded. In general, the landscape design should aim to:

- Retain and recharge water onsite;
- Preserve existing vegetation to the maximum extent possible;
- Preserve soil permeability during development; and
- Minimize the use of turf grass in landscaping, opting instead for a variety of native species.

To keep the water onsite, impervious areas need to be reduced to the maximum extent practical. Planting beds should be designed to conserve the water they receive. This can be achieved by grading the beds so that slope is gradual and stormwater runoff will have more time to percolate into the soil, and by using plant species that do not require large amounts of water.

To meet its water conservation objectives, Westminster discourages in-ground irrigation systems. However, if irrigation systems are proposed, they shall be water-efficient drip systems or soil soakers equipped with automatic sensors that prevent watering when soils are already wet, or when it is raining. Drip irrigation is defined as the frequent slow application of water to a very small area in the root zone of the plant. Water slowly drips through either porous plastic pipes or emitters located below the soil surface. Drip systems have been found to reduce water use by 20-50%.<sup>28</sup> Soil soakers consist of long plastic or canvas tubes perforated with tiny holes through which the water seeps as a fine mist. Soil soakers are connected to a garden hose and can be left in place on the surface of the planting bed or buried under the mulch.

For garden areas, landscape plans should specify the use of a suitable mulch. Use of mulch is beneficial for several reasons. Mulch layers:

- Help capture moisture for vegetation that would normally be lost through evaporation;
- Prevent erosion by protecting the soil surface from raindrop impacts and by reducing the velocity of overland flow;
- Help prevent crusting, sealing and compaction of the surface, thereby preserving the infiltration rate;
- Protect seeds by forming an insulating layer against extreme heat and cold and by creating a suitable microclimate for seed germination; and
- Reduce weed growth and the need for herbicide application.<sup>29</sup>

Good mulching materials include compost, pine bark, pine straw (pine needle bales), leaf mold, rotted manure, lawn clippings, aged and shredded hardwood bark, aged wood chips, and straw or chopped hay.

## b. Plant Species

In the interest of striking an appropriate balance between community development and conservation, the Town of Westminster is committed to retaining natural habitats and habitat functions on developed sites to the maximum extent possible. In addition, to further the Town's water conservation goals, drought-tolerant species should be used in appropriate situations.

**WESTMINSTER POLICY:** Landscape plans shall follow the guidelines in this section for selecting species that are most appropriate to the site conditions. Native species and habitat-creating species shall be used in all landscape plans to the maximum extent possible. Invasive species identified in this section shall not be planted in Westminster under any condition.

Landscape designers working on Westminster projects should use the following lists to select the most appropriate species for each portion of their site. Recognizing that many species are well-suited to several circumstances, there is much overlap among the nine lists of species provided below. Each list is also divided into different forms of plants, such as shade trees, ornamental trees, evergreen trees, deciduous shrubs, groundcovers, and flowers. The lists are not all-inclusive, and landscape designers may propose the use of other species not included here, provided they are not invasive species. However, these lists are intended to provide a sufficiently wide range of species that the Town considers generally acceptable under different circumstances. Information in this list is based on several sources including 974 CMR 3.05,<sup>30</sup> a wetlands creation manual,<sup>31</sup> landscaping catalogs,<sup>32,33</sup> and professional landscape architects and biologists.

## 1. Native Species

The following species are native to Westminster and well-adapted to the area's climate. Many of the species also provide good wildlife habitat value.

### Shade Trees

#### Botanical Name

*Acer rubrum*  
*Acer saccharum*  
*Betula lenta*<sup>F</sup>  
*Betula alleghaniensis*<sup>F</sup>  
*Betula papyrifera*  
*Carya ovata*<sup>+</sup>  
*Castanea dentata*  
*Fagus grandifolia*  
*Fraxinus americana*  
*Fraxinus pennsylvanica*  
*Juglans cinerea*<sup>+</sup>  
*Liquidambar styraciflua*<sup>F</sup>  
*Liriodendron tulipifera*<sup>F</sup>  
*Nyssa sylvatica*  
*Platanus occidentalis*  
*Quercus alba*<sup>+F</sup>  
*Quercus bicolor*<sup>+F</sup>  
*Quercus coccinea*<sup>+F</sup>  
*Quercus palustris*<sup>+F</sup>  
*Quercus rubra*  
*Salix nigra*  
*Sassafras albidum*  
*Tilia americana* 'Redmond'  
*Ulmus americana*, disease-resist. var.

#### Common Name

Red Maple  
Sugar Maple  
Sweet Birch<sup>F</sup>  
Yellow Birch<sup>F</sup>  
Paper Birch  
Shagbark Hickory<sup>+</sup>  
American Chestnut  
American Beech  
White Ash  
Green Ash  
Butternut<sup>+</sup>  
Sweetgum<sup>F</sup>  
Tulip Tree<sup>F</sup>  
Black Tupelo  
American Sycamore  
White Oak<sup>+F</sup>  
Swamp White Oak<sup>+F</sup>  
Scarlet Oak<sup>+F</sup>  
Pin Oak<sup>+F</sup>  
Northern Red Oak  
Black Willow  
Common Sassafras  
Redmond Linden  
American Elm

#### Notes:

<sup>+</sup> Recommended for planting on the portions of the site away from walks or roads.

<sup>F</sup> These trees need extra care if they are planted during the fall season.

<sup>^</sup> Canadian Hemlock is currently under attack by an insect that has no predator.

### Evergreen Trees

#### Botanical Name

*Ilex opaca*  
*Juniperus virginiana*  
*Pinus rigida*  
*Pinus strobus*  
*Thuja occidentalis*  
*Tsuga canadensis*

#### Common Name

American Holly  
Eastern Red Cedar  
Pitch Pine  
Eastern White Pine  
American Arborvitae  
Canadian Hemlock<sup>^</sup>

## Ornamental Trees

### Botanical Name

*Alnus rugosa*  
*Amelanchier canadensis*  
*Amelanchier laevis*  
*Betula nigra*<sup>F</sup>  
*Betula papyrifera*<sup>F</sup>  
*Carpinus caroliniana*<sup>F</sup>  
*Cercis canadensis*  
*Cornus alternifolia*<sup>F</sup>  
*Cornus florida* <sup>^F</sup>  
*Crataegus punctata*  
*Hamamelis virginiana*  
*Larix laricina*  
*Larix decidua*  
*Ostrya virginiana*  
*Prunus pennsylvanica*<sup>F</sup>  
*Prunus virginiana*<sup>F</sup>  
*Salix discolor*  
*Viburnum lentago*

### Common Name

Speckled Alder  
Shadblow Serviceberry  
Allegheny Serviceberry  
River Birch<sup>F</sup>  
Paper Birch<sup>F</sup>  
American Hornbeam <sup>F</sup>  
Eastern Redbud  
Pagoda Dogwood<sup>F</sup>  
Flowering Dogwood <sup>^ F</sup>  
Dotted Hawthorn  
Common Witchhazel  
American Larch  
European Larch  
Hop Hornbeam  
Pin Cherry<sup>F</sup>  
Common Chokecherry<sup>F</sup>  
Pussy Willow  
Nannyberry Viburnum

### Notes:

<sup>^</sup> *Cornus florida* has been adversely affected by an anthracnose epidemic in the Northeast U.S. in the past two decades. Anthracnose spreads rapidly to other flowering dogwoods. Before using this species, check with local agricultural extensions for the status of anthracnose.

<sup>F</sup> These trees need extra care if they are planted during the fall season.

## Deciduous Shrubs

### Botanical Name

*Arctostaphylos uva-ursi*  
*Aronia melanocarpa*  
*Clethra alnifolia*  
*Comptonia peregrina*  
*Cornus alterniflora*  
*Cornus amomum*  
*Cornus racemosa*  
*Cornus rugosa*  
*Ilex verticillata*  
*Lindera benzoin*  
*Myrica pennsylvanica*  
*Azalea nudiflorum*  
*Rhododendron roseum*  
*Rhododendron viscosum*  
*Rhus glabra*  
*Rhus typhina*  
*Rosa carolina*  
*Rubus odoratus*  
*Sambucus canadensis*  
*Vaccinium corymbosum*  
*Viburnum acerifolium*  
*Viburnum cassinoides*  
*Viburnum dentatum*  
*Viburnum trilobum*

### Common Name

Bearberry  
Black Chokeberry  
Summersweet Clethra  
Sweetfern  
Pagoda Dogwood  
Silky Dogwood  
Gray Dogwood  
Redleaf Dogwood  
Common Winterberry  
Common Spicebush  
Northern Bayberry  
Early Deciduous Pink Azalea  
Roseshell Azalea  
Swamp Azalea  
Smooth Sumac  
Staghorn Sumac  
Carolina Rose  
Flowering Raspberry  
American Elder  
Highbush Blueberry  
Mapleleaf Viburnum  
Witherod Viburnum  
Arrowwood Viburnum  
American Cranberrybush Viburnum

## Evergreen Shrubs

### Botanical Name

*Juniperus communis* 'Compressa'  
*Kalmia angustifolia*  
*Kalmia latifolia*  
*Taxus canadensis*

### Common Name

Common Juniper  
Sheeplaurel  
Mountainlaurel  
Canadian Yew

### ***Groundcovers***

#### **Botanical Name**

*Cornus canadensis*  
*Gaultheria procumbens*  
*Mitchella repens*  
*Vaccinium angustifolium*  
*Vaccinium macrocarpum*

#### **Common Name**

Bunchberry Dogwood  
Checkerberry Wintergreen  
Partridgeberry  
Lowbush Blueberry  
Cranberry

### ***Meadow Grasses/Wildflowers***

#### **Botanical Name**

*Festuca elatior*  
*Lolium perenne*  
*Sorghastrum nutans*  
*Panicum*  
*Andropogon gerardii* Vitman  
*Schizachyrium scoparium*  
*Calamagrostis canadensis*  
*Antennaria alpina*  
*Aristida dichotoma*  
*Aster linariifolius*  
*Eragrostis spectabilis*  
*Houstonia caerulea*  
*Juncus bufonius*  
*Senecio aureus*

#### **Common Name**

Tall Fescue  
Palmer II Perr. Ryegrass  
Indian Grass  
Blackwell Switchgrass  
Big Bluestem  
Little Bluestem  
Blue Joint Reedgrass  
Alpine Pussy-Toes  
Poverty Grass  
Bristly Aster  
Purple Lovegrass  
Bluets  
Toad Rush  
Golden Ragwort



## 2. Salt Tolerant Species

These species are well-suited to roadsides and other locations that are likely to collect salty winter runoff.

### ***Shade Trees***

#### Botanical Name

*Acer campestre*  
*Aesculus hippocastanum*  
*Betula lenta*\*<sup>F</sup>  
*Betula alleghaniensis*\*<sup>F</sup>  
*Fraxinus americana*\*  
*Gleditsia triacanthos inermis*  
*Nyssa sylvatica*\*  
*Quercus alba*\*+  
*Quercus macrocarpa*+  
*Quercus robur*+  
*Quercus rubra*  
*Ulmus glabra*  
*Ulmus pumila*

#### Common Name

Hedge Maple  
Horse-chestnut  
Sweet Birch\*<sup>F</sup>  
Yellow Birch\*<sup>F</sup>  
White Ash\*  
Thornless Honeylocust  
Black Tupelo\*  
White Oak\*+  
Bur Oak+  
English Oak+  
Red Oak  
Scotch Elm  
Siberian Elm

#### Notes:

\* Native Plants

+ Recommended for planting on portions of the site away from walks or roads.

<sup>F</sup> These trees need extra care if they are planted during the fall season.

### ***Ornamental Trees***

#### Botanical Name

*Amelanchier canadensis*\*  
*Betula papyrifera*\*<sup>F</sup>  
*Betula populifolia*\*<sup>F</sup>  
*Prunus pennsylvanica*\*<sup>F</sup>  
*Prunus virginiana*\*<sup>F</sup>  
*Pyrus calleryana*<sup>F</sup>  
*Pyrus calleryana* 'Bradford'  
*Salix discolor*\*

#### Common Name

Shadblow Serviceberry\*  
Paper Birch\*<sup>F</sup>  
Gray Birch\*<sup>F</sup>  
Pin Cherry\*<sup>F</sup>  
Common Chokecherry\*<sup>F</sup>  
Callery Pear<sup>F</sup>  
Bradford Pear  
Pussy Willow\*

### ***Evergreen Trees***

#### Botanical Name

*Juniperus virginiana*\*  
*Picea pungens* 'glauca'  
*Pinus nigra*  
*Pinus ponderosa*  
*Pinus rigida*\*

#### Common Name

Eastern Red Cedar\*  
Blue Colorado Spruce  
Austrian Pine  
Ponderosa Pine  
Pitch pine\*

### ***Deciduous Shrubs***

#### Botanical Name

*Arctostaphylos uva-ursi*\*  
*Aronia melanocarpa*\*  
*Aronia prunifolia*\*  
*Hippophae rhamnoides*  
*Lindera benzoin*\*  
*Myrica pennsylvanica*\*  
*Rhus glabra*\*  
*Rhus typhina*\*  
*Salix humilis*\*  
*Salix lucida*\*  
*Shepherdia argentea*  
*Tamarix ramosissima*

#### Common Name

Bearberry\*  
Black Chokeberry\*  
Purplefruit Chokeberry\*  
Common Seabuckthorn  
Common Spicebush\*  
Northern Bayberry\*  
Smooth Sumac\*  
Staghorn Sumac\*  
Prairie Willow\*  
Shining Willow\*  
Buffaloberry  
Five Stamen Tamarisk

*Vaccinium corymbosum*\*  
*Viburnum cassinoides*\*  
*Viburnum dentatum*\*

Highbush Blueberry\*  
 Witherod Viburnum\*  
 Arrowwood Viburnum\*

### **Evergreen Shrubs**

#### Botanical Name

*Pinus mugo*  
*Taxus canadensis*\*

#### Common Name

Mugo Pine  
 Canadian Yew\*

### **Groundcovers**

#### Botanical Name

*Vaccinium angustifolium*\*  
*Vaccinium palladum*

#### Common Name

Late Lowbush Blueberry\*  
 Early Lowbush Blueberry

#### Notes:

\* Native Plants  
 + Recommended for planting on portions of the site away from walks or roads.

<sup>F</sup> These trees need extra care if they are planted during the fall season.

## **3. Urban Tolerant Species**

These species are suitable for planting in “high-stress” environments where there will be pavement within the tree’s drip line, high levels of pedestrian or vehicular traffic, vehicle exhaust and air pollution, or other urban stressors. For example, most of these species are generally well-suited to being planted in parking lot islands or other narrow landscaped areas.

### **Shade Trees**

#### Botanical Name

*Acer campestre*  
*Acer rubrum*\*  
*Acer saccharum*\*  
*Carpinus betulus fastigiata*<sup>F</sup>  
*Celtis occidentalis*  
*Cladastris lutea*  
*Corylus colurna*  
*Eucommia ulmoides*  
*Fraxinus pennsylvanica*\*  
*Ginkgo biloba*  
*Gleditsia triacanthos inermis*  
*Liquidambar styraciflua*\*<sup>F</sup>  
*Maclura pomifera inermis* 'Park'  
*Nyssa sylvatica*\*  
*Platanus acerifolia*<sup>F</sup>  
*Sophora japonica*  
*Tilia cordata*  
*Zelkova serrata*<sup>F</sup>

#### Common Name

Hedge Maple  
 Red Maple\*  
 Sugar Maple\*  
 Pyramidal European Hornbeam<sup>F</sup>  
 Hackberry  
 Yellowwood  
 Turkish Hazelnut  
 Hardy Rubber Tree  
 Green Ash\*  
 Maidenhair Tree (female +)  
 Thornless Honeylocust  
 Sweet Gum\*<sup>F</sup>  
 Park Osage Orange  
 Black Tupelo\*  
 London Plane Tree<sup>F</sup>  
 Scholartree  
 Littleleaf Linden  
 Japanese Zelkova<sup>F</sup>

#### Notes:

\* Native Plants  
 + Recommended for planting on portions of the site away from walks or roads.

<sup>F</sup> These trees need extra care if they are planted during the fall season.

### **Ornamental Trees**

#### Botanical Name

*Betula nigra*\*<sup>F</sup>  
*Cercidiphyllum japonicum*  
*Chionanthus virginicus*  
*Cornus kousa*<sup>F</sup>  
*Crataegus phaenopyrum*  
*Magnolia stellata*<sup>F</sup>  
*Ostrya virginiana*\*  
*Oxydendron arboreum*<sup>F</sup>  
*Prunus sargentii*<sup>F</sup>

#### Common Name

River Birch\*<sup>F</sup>  
 Katsuratree  
 White Fringetree  
 Kousa Dogwood<sup>F</sup>  
 Washington Hawthorn  
 Star Magnolia<sup>F</sup>  
 American Hophornbeam\*  
 Sourwood<sup>F</sup>  
 Sargent Cherry<sup>F</sup>

*Pyrus calleryana*<sup>F</sup>  
*Syringa reticulata*

Callery Pear<sup>F</sup>  
Japanese Tree Lilac

### ***Deciduous Shrubs***

#### *Botanical Name*

*Cornus sericea*  
*Ilex verticillata*\*  
*Ilex verticillata* 'Nana'\*  
*Rhus aromatica* 'Gro-low'  
*Spiraea bumalda* varieties  
*Vaccinium angustifolium*\*

#### *Common Name*

Red Osier Dogwood  
Common Winterberry\*  
Dwarf Winterberry\*  
Dwarf Fragrant Sumac  
Spirea  
Lowbush Blueberry\*

### ***Groundcovers***

#### *Botanical Name*

*Cotoneaster horizontalis*  
*Hedera helix*  
*Juniperus chinensis sargentii*  
*Juniperus horizontalis* varieties  
*Vinca minor*  
*Pachysandra terminalis*

#### *Common Name*

Rockspray Cotoneaster  
English Ivy  
Sargent Juniper  
Creeping Juniper  
Periwinkle  
Japanese Pachysandra

## **4. Species for Erosion Control**

These species can be used for stabilizing the ground and preventing erosion, and should be considered for planting in areas with steep slopes or unstable, erodible soils.

#### *Botanical Name*

*Aegopodium podagraria* 'Variegatum'  
*Celastrus scandens*  
*Clematis paniculata*  
*Cornus*, shrubby types  
*Cotoneaster*, low types  
*Cytisus* spp.  
*Erica* spp.  
*Euonymus fortunei* 'Colorata' and cvs.  
*Forsythia suspensa* and cvs.  
*Genista* x 'Lydia'  
*Hedera helix* and cvs.  
*Hemerocallis*, all  
*Houtuynia cordata* 'Chameleon'  
*Itea* spp.  
*Juniperus*, low types  
*Ligustrum*, all  
*Myrica pennsylvanica*  
*Parthenocissus* spp.  
*Polygonum aubertii*  
*Rhus aromatica* and cvs.  
*Rosa*, most  
*Salix purpurea*  
*Stephanandra incisa*  
*Symphoricarpos* x *chenaultii* 'Hancock'  
*Vinca minor* and cvs.  
*Yucca filamentosa*

#### *Common Name*

Variegated Snow-on-the-Mountain  
American Bittersweet  
Clematis  
Dogwood (Silky, Gray-stemmed, Gray, Redleaf)  
Cotoneaster  
Scotch Broom  
Heath  
Wintercreeper  
Weeping Forsythia  
Genista Lydia  
English Ivy  
Daylilly  
Chaeleon Houtuynia  
Sweetspire  
Juniper  
Privet  
Northern Bayberry  
Ivy  
Silver-vine Fleeceflower  
Fragrant Sumac  
Most roses  
Purpleosier Willow  
Cutleaf Stephanandra  
Chenault Coralberry  
Periwinkle  
Yucca

## 5. Wetland Species

This list of species is generally well-suited for planting in constructed wetlands, wet swales, and other stormwater management areas that will typically be wet. Plantings in each section of the wet area must be selected according to the hydrological conditions in that area. See Figure 2-4 for a sample wetland planting layout.

### *Herbaceous Plants*

<u>Botanical Name</u>	<u>Common Name</u>	<u>Water Depth (see below)</u>
<i>Osmunda cinnamomea</i>	Cinnamon fern	Transitional
<i>Osmunda regalis</i>	Royal fern	Transitional
<i>Symplocarpus foetidus</i>	Skunk cabbage	Transitional
<i>Scirpus cyperinus</i>	Woolgrass	Shallow
<i>Thelypteris palustri</i>	Marsh fern	Shallow
<i>Caltha leptosepala</i>	Marsh Marigold	Shallow
<i>Polygonum coccineum</i>	Pennsylvania smartweed	Shallow
<i>Lobelia cardinalis</i>	Cardinal Flower	Shallow
<i>Lobelia siphilitica</i>	Great Lobelia	Shallow
<i>Iris versicolor</i>	Blue Flag Iris	Medium
<i>Acorus calamus</i>	Sweet flag	Medium
<i>Calla palustris</i>	Water arum	Medium
<i>Sparganium eurycarpum</i>	Burreed	Medium
<i>Scirpus americanus</i>	Three-square	Medium
<i>Scirpus fluviatilis</i>	River bulrush	Medium
<i>Sagittaria latifolia</i>	Arrowhead	Medium
<i>Pontederia cordata</i>	Pickernelweed	Medium
<i>Peltandra cordata</i>	Arrow arum	Medium
<i>Potamogeton pectinatus</i>	Sago pondweed	Deep
<i>Vallisneria americana</i>	Tapegrass	Deep
<i>Ranunculus flabellaris</i>	Yellow water buttercup	Deep
<i>Ranunculus aquatilis</i>	White water buttercup	Deep
<i>Scirpus validus</i>	Bulrush	Deep
<i>Nymphaea odorata</i>	Fragrant white lily	Deep
<i>Nuphar luteum</i>	Spatterdock	Deep
<i>Brasenia schrebrri</i>	Watershield	Deep

Transitional: seasonally flooded; Shallow: seasonally flooded to permanently flooded to 15 cm; Medium: 15 to 50-cm water depths; Deep: 50 to 200-cm water depths.

### *Shrubs*

<u>Botanical Name</u>	<u>Common Name</u>
<i>Clethra alnifolia</i>	Summersweet Clethra
<i>Cornus amomum</i>	Silky Dogwood
<i>Ilex verticillata</i>	Winterberry
<i>Kalmia angustifolia</i>	Sheep Laurel
<i>Lindera benzoin</i>	Spicebush
<i>Rhodendron viscosum</i>	Swamp Azalea
<i>Viburnum recognitum</i>	Northern Arrowwood
<i>Vaccinium corymbosum</i>	Highbush Blueberry

## **Trees**

### **Botanical Name**

*Nyssa sylvatica*  
*Quercus bicolor*  
*Fraxinus americana*<sup>+</sup>  
*Fraxinus pennsylvanica*<sup>\*</sup>  
*Acer rubrum*<sup>+</sup>  
*Quercus bicolor*<sup>^</sup>  
*Betula nigra*<sup>^</sup>

### **Common Name**

Black gum  
Swamp oak  
White ash<sup>+</sup>  
Green Ash<sup>\*</sup>  
Red Maple<sup>+</sup>  
Swamp oak<sup>^</sup>  
River birch<sup>^</sup>

### **Notes:**

<sup>\*</sup>Species that will tolerate flooding for more than 1 year

<sup>+</sup>Species that will tolerate flooding for one growing season

<sup>^</sup>Species that will tolerate flooding for less than 30 days during the growing season

## **Woody Wetland Plants**

### **Botanical Name**

*Salix nigra*<sup>\*</sup>  
*Cephalanthus occidentalis*<sup>\*</sup>  
*Cornus stolonifera*<sup>\*</sup>  
*Sambucus canadensis*<sup>+</sup>  
*Vaccinium corymbosum*<sup>+</sup>  
*Chamaecyparis thyoides*<sup>+</sup>  
*Alnus rugosa*<sup>+</sup>  
*Nyssa sylvatica*<sup>^</sup>  
*Ilex opaca*<sup>^</sup>

### **Common Name**

Black Willow<sup>\*</sup>  
Buttonbush<sup>\*</sup>  
Red-osier Dogwood<sup>\*</sup>  
Elder<sup>+</sup>  
Blueberry<sup>+</sup>  
Atlantic white cedar<sup>+</sup>  
Spackled Alder<sup>+</sup>  
Black gum<sup>^</sup>  
American Holly<sup>^</sup>

## **6. Moist Tolerant Species**

These species require significant moisture, and many are adapted to survive periods of standing water. In general, these species should only be planted where local soil and topography produce moist conditions. Landscape designers should not rely upon irrigation to sustain these species.

## **Woody Plants**

### **Botanical Name**

*Acer negundo*  
*Acer rubrum*  
*Alnus rugosa*  
*Amelanchier*  
*Andromeda polifolia*  
*Aralia spinosa*  
*Aronia arbutifolia*  
*Azalea arborescens*  
*Azalea vaseyi*  
*Azalea viscosum*  
*Betula nigra*  
*Calluna vulgaris*  
*Calycanthus floridus*  
*Campsis radicans*  
*Cephalanthus occidentalis*  
*Chamaecyparis thyoides*  
*Clethra acuminata*  
*Clethra alnifolia*  
*Cornus spp.*  
*Erica carnea*  
*Gymnocladus dioica*  
*Halesia diptera*

### **Common Name**

Box Elder  
Red Maple  
Speckled Alder  
Serviceberry  
Bog Rosemary  
Devil's Walkingstick  
Chokeberry  
Sweet Azalea  
Pinkshell Azalea  
Swamp Azalea  
River Birch  
Heather  
Common Sweetshrub  
Trumpet Creeper  
Buttonbush  
Atlantic White Cedar  
Mountain Pepperbush  
Summersweet  
Dogwood (Silky, Shrub, Gray)  
Heath  
Kentucky Coffee Tree  
Two-winged Silverbell

*Hamamelis virginiana*  
*Ilex spp.*  
*Ilex verticillata*  
*Kalmia latifolia*  
*Larix spp.*  
*Leucothoe fontanesiana*  
*Lindera benzoin*  
*Magnolia virginiana*  
*Malus*  
*Myrica pennsylvanica*  
*Nyssa sylvatica*  
*Rhododendron canadense*  
*Rhododendron maximum*  
*Rhus aromatica*  
*Salix*  
*Sambucus canadensis*  
*Sassafras albidum*  
*Vaccinium*  
*Zenobia pulverulenta*

Witchhazel  
 Holly  
 Winterberry  
 Mountain Laurel  
 Larch  
 Drooping Leucothoe  
 Spicebush  
 Sweetbay Magnolia  
 Crabapple  
 Bayberry  
 Black Gum  
 Rhodora (for bogs only)  
 Rosebay Rhododendron  
 Fragrant Sumac  
 Willow  
 American Elder  
 Common Sassafras  
 Blueberry, Cranberry  
 Dusty Zenobia

## ***Perennials***

### *Botanic Name*

*Aconitum carmichaelii*  
*Amsonia hubrechtii*  
*Aruncus dioicus*  
*Clathra palustris*  
*Chelone lyonii*  
*Cimicifuga*  
*Epimedium*  
*Ferns*  
*Filipendula ulmaria*  
*Gillenia trifoliata*  
*Helleborus niger*  
*Hemerocallis*  
*Hibiscus moscheutos*  
*Iberis sempervirens*  
*Iris ensata*  
*Iris siberica*  
*Kirengeshoma palmate*  
*Liatris spicata*  
*Limonium latifolium*  
*Lobelia cardinalis*  
*Lobelia siphilitica*  
*Monarda didyma*  
*Petasites*  
*Phlox divaricata*  
*Platycodonj grandiflorus*  
*Polygonatum*  
*Tradescantia x andersonianan*  
*Trillium*  
*Trollius*

### *Common Name*

Monkshood  
 Star Flower  
 Goatsbeard  
 Marsh Marigold  
 Turtlehead  
 Snakeroot  
 Bishops' Cap  
 Ferns  
 Meadowsweet  
 Bowman's Root  
 Christmas Rose  
 Daylilly  
 Rosemallow  
 Candy Tuft  
 Japanese Iris  
 Siberian Iris  
 Yellow Waxbells  
 Gayfeather  
 Sea Lavender (for salt marsh only)  
 Cardinal Flower  
 Big Blue Lobelia  
 Beebalm  
 Butterbur  
 Woodland Phlox  
 Balloon flower  
 Solomon's Seal  
 Spiderwort  
 Wakerobin  
 Globeflower

## **Grasses**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Carex muskingumensis</i>	Palm Sedge
<i>Miscanthus sacchariflorus Giganteus</i>	Giant Silver Banner Grass
<i>Pennisetum alopecuroides</i>	Fountain Grass
<i>Sisyrinchium</i>	Blue-eyed Grass
<i>Typha angustifolia</i>	Cattail

## **7. Drought Tolerant Species**

These species require relatively little water, can survive longer periods without water, and/or are adapted to grow in well-drained soils. In the interest of minimizing the demand for irrigation water, these species should be considered in sunny areas with well-drained soil that are likely to experience dry conditions.

### ***Woody Plants***

<u>Botanical Name</u>	<u>Common Name</u>
<i>Abies concolor</i>	White Fir
<i>Acer truncatum</i>	Shantung Maple
<i>Aesculus x carnea</i>	Ruby Horsechestnut
<i>Aesculus pavia</i>	Red Buckeye
<i>Aralia spinosa</i>	Devil's Walkingstick
<i>Arctostaphylos uva-ursi</i>	Bearberry
<i>Buddleia alternifolia</i>	Fountain buddleia
<i>Calluna vulgaris</i>	Heather
<i>Campsis radicans</i>	Trumpet Creeper
<i>Caragana microphylla</i>	Littleleaf Caragana
<i>Carpinus betulus</i>	European Hornbeam
<i>Carpinus caroliniana</i>	American Hornbeam
<i>Chaenomeles speciosa</i>	Flowering Quince
<i>Chamaecyparis thyoides</i>	Atlantic White Cedar
<i>Comptonia peregrina</i>	Sweet Fern
<i>Cornus racemosa</i>	Gray Dogwood
<i>Corylus colurna</i>	Turkish Filbert
<i>Cotinus coggygria</i>	Smoke Tree
<i>Crataegus crusgalli</i>	Cockspur Hawthorn
<i>Fraxinus pennsylvanica</i>	Green Ash
<i>Gleditsia tricanthos inermis</i>	Honeylocust
<i>Gymnocladus dioicus</i>	Kentucky Coffee tree
<i>Hamamelis</i>	Witchhazel
<i>Hybiscus syriacus</i>	Rose-of-Sharon
<i>Hydrangea</i>	Hydrangea
<i>Indigofera gerardiana</i>	Himalayan Indigo
<i>Jasminum nudiflorum</i>	Winter Jasmine
<i>Juniperus</i>	Juniper
<i>Kerria japonica</i>	Japanese Kerria
<i>Koelreuteria paniculata</i>	Golden Rain Tree
<i>Kolkwitzia amabilis</i>	Beautybush
<i>Microbiata decussata</i>	Siberian Carpet Cypress
<i>Myrica pensylvanica</i>	Northern Barberry
<i>Pinus banksiana</i>	Jack Pine
<i>Pinus mugo</i>	Mugo Pine
<i>Pinus nigra austriaca</i>	Austrian Pine
<i>Pinus strobus</i>	Eastern White Pine

<i>Platanus x acerfolia</i>	London Planetree
<i>Potentilla fruticosa</i>	Potentilla
<i>Prunus maritima</i>	Beach plum (especially back and scarlet)
<i>Quercus</i>	Oak
<i>Rhus</i>	Sumac
<i>Rosa rugosa</i>	Rugosa Rose
<i>Salix</i>	Willow
<i>Sambucus canadensis</i>	American Elder
<i>Sassafras albidum</i>	Common Sassafras
<i>Shepherdia argentea</i>	Buffalo Berry
<i>Sophora japonica</i>	Scholar tree
<i>Stephanandra incisa</i>	Cutleaf Stephanandra
<i>Vitex agnus-castus</i>	Chastetree

## ***Perennials***

<u><i>Botanical Name</i></u>	<u><i>Common Name</i></u>
<i>Anthemis tinctoria</i>	Golden Marguerite
<i>Artemisia</i>	Wormwood
<i>Armeria maritima</i>	Thrift
<i>Asclepias tuberosa</i>	Butterfly Milkweed
<i>Aubrieta deltoidea</i>	False Rock Cress
<i>Aurinia saxatilis</i>	Basket-of-Gold
<i>Callirhoe involucrata</i>	Poppy Mallow
<i>Campanula carpatia</i>	Carpathian Bellflower
<i>Centaurea Montana</i>	Mountain Bluet
<i>Cerastium tomentosum</i>	Snow-in-Summer
<i>Echinacea purpurea</i>	Coneflower
<i>Echinops ritro</i>	Globe Thistle
<i>Eryngium planum</i>	Sea Holly
<i>Eupatorium</i>	Hardy Ageratum
<i>Gaillardia x grandiflora</i>	Blanket Flower
<i>Geranium dalmaticum</i>	Cranesbill
<i>Geranium macrorrhizum</i>	Bigroot
<i>Gypsophila</i>	Baby's Breath
<i>Helianthus grosse-serratus</i>	Sawtooth Sunflower
<i>Hemerocallis fulva</i>	Daylily
<i>Lamium maculatum</i>	Spotted Dead Nettle
<i>Lewisia cotyledon</i>	Bitter Root
<i>Nepera x faassenii</i>	Persian Catmint
<i>Oenothera</i>	Evening Primrose
<i>Opuntia humifusa</i>	Prickly Pear
<i>Papaver orientale</i>	Poppy
<i>Perovskia atriplicifolia</i>	Russian Sage
<i>Phlox subulata</i>	Moss Pink
<i>Polemonium caeruleum</i>	Jacob's Ladder
<i>Rudbeckia</i>	Coneflower
<i>Salvia verticillata</i>	Purple Rain
<i>Santolina chamaecyparissus</i>	Lavender Cotton
<i>Sedum</i>	Stonecrop
<i>Sempervivum</i>	Houseleek
<i>Stachys byzantina</i>	Lamb's Ears
<i>Stokesia laevis</i>	Stoke's Aster
<i>Thymus serpyllum</i>	Mother-of-Thyme
<i>Yucca</i>	Desert Candle



## **Grasses**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Bouteloua gracilis</i>	Blue Gramma
<i>Elymus arenarius</i>	Blue Lyme Grass
<i>Festuca cinerea</i>	Blue Fescue
<i>Schizachyrium scoparium</i>	Little Bluestem

## **8. Habitat Creating Species**

Habitat creating species provide food or home sites for birds and other animals.

The following plants provide good habitat value for birds and animals.

### **Trees**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Acer rubrum</i>	Red Maple
<i>Acer saccharinum</i>	Sugar Maple
<i>Amelanchier canadensis</i>	Serviceberry
<i>Betula nigra</i>	River Birch
<i>Betula papyrifera</i>	White Birch
<i>Celtis occidentalis</i>	Hackberry
<i>Cornus, most</i>	Dogwoods
<i>Crataegus, most</i>	Hawthorn
<i>Malus, most</i>	Crabapple
<i>Nyssa sylvatica</i>	Black gum
<i>Picea glauca</i>	White spruce
<i>Picea pungens</i>	Blue Spruce
<i>Pinus strobus</i>	White Pine
<i>Populus, most</i>	Poplars
<i>Quercus alba</i>	White Oak
<i>Quercus palustris</i>	Pin Oak
<i>Quercus rubra</i>	Red Oak
<i>Sorbus aucuparia</i>	Mountain Ash
<i>Tsuga canadensis and cvs.</i>	Eastern Hemlock

### **Shrubs**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Amelanchier canadensis and cvs.</i>	Serviceberry
<i>Aralia spinosa</i>	Devil's Walking Stick
<i>Aronia spp. And cvs.</i>	Chokeberry
<i>Cornus, most</i>	Dogwoods
<i>Cotoneaster spp. and cvs.</i>	Cotoneaster
<i>Ilex glabra</i>	Inkberry
<i>Juniperus virginiana and cvs.</i>	Eastern Red Cedar
<i>Myrica pensylvanica</i>	Bayberry
<i>Rosa rugosa</i>	Rugosa Rose
<i>Salix discolor</i>	Pussy Willow
<i>Viburnum dentatum</i>	Arrowwood

The following plant species provide persistent fruit that lasts into the late fall and winter, thus providing food for wildlife during the critical months when food is most difficult to find.

### **Trees**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Cornus mas</i>	Cornelian Cherry Dogwood (Golden Glory)
<i>Crataegus phaenopyrum</i>	Washington Hawthorn
<i>Malus spp., most</i>	Crabapple

### **Shrubs**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Aronia arbutifolia</i>	Red Chokeberry
<i>Ilex glabra</i>	Inkberry
<i>Juniperus spp. and cvs.</i>	Juniper
<i>Myrica pennsylvanica</i>	Bayberry
<i>Pyracantha coccinea and cvs.</i>	Firethorn
<i>Rhodotypos scandens</i>	Black Jetbead
<i>Rhus spp.</i>	Sumac
<i>Rosa rugosa and cvs.</i>	Rugosa Rose
<i>Rosa wichuriana and cvs.</i>	Memorial Rose
<i>Viburnum dilatatum</i>	Linden Viburnum
<i>Viburnum setigerum</i>	Tea Viburnum

## **9. Invasive Species**

Invasive plants are introduced species that tend to spread into natural habitats and outcompete native species because of their superior reproductive ability, aggressive growth pattern, or (most commonly) lack of native competitors, herbivores, parasites, or diseases. In terms of maintaining native biodiversity, invasive species are a serious threat because they compete with native species for limited land, water and sunlight. Westminster's policy prohibits the planting of invasive species that appear in the following list.

### **Shade Trees**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Acer ginnala</i>	Amur Maple
<i>Acer platanoides</i>	Norway Maple
<i>Acer pseudoplatanus</i>	Sycamore Maple
<i>Populus alba</i>	White Cottonwood
<i>Robinia pseudoacacia</i>	Black Locust

### **Deciduous Shrubs/Vines**

<u>Botanical Name</u>	<u>Common Name</u>
<i>Ampelopsis brevipedunculata</i>	Porcelain Berry
<i>Berberis thunbergii</i>	Japanese Barberry
<i>Berberis vulgaris</i>	Common Barberry
<i>Celastrus orbiculata</i>	Oriental Bittersweet
<i>Cynanchum louiseae</i>	Black Swallow-wort
<i>Elaeagnus umbellata</i>	Autumn Olive
<i>Elaeagnus angustifolia</i>	Russian Olive
<i>Euonymus alatus</i>	Winged Euonymus
<i>Euphorbia cyparissias</i>	Cypress Spurge
<i>Hesperis natonalis</i>	Dame's Rocket

<i>Ligustrum obtusifolium</i>	Blunt-leaved Privet
<i>Ligustrum vulgare</i>	Privet
<i>Lonicera japonica</i>	Japanese Honeysuckle
<i>Lonicera maackii</i>	Amur Honeysuckle
<i>Lonicera morrowii</i>	Morrow's Honeysuckle
<i>Lonicera tatarica</i>	Tatarian Honeysuckle
<i>Lonicera xbella</i>	Morrow's x Tatarian Honeysuckle
<i>Polygonum cuspidatum</i>	Japanese Knotweed
<i>Pueraria lobata</i>	Kudzu
<i>Rhamnus cathartica</i>	Common Buckthorn
<i>Rhamnus frangula</i>	Shining Buckthorn
<i>Rosa multiflora</i>	Multiflora Rose

### ***Meadow Grasses/Wildflowers***

<u><i>Botanical Name</i></u>	<u><i>Common Name</i></u>
<i>Achillea millefolium</i> var. <i>millefolium</i>	Common Yarrow
<i>Aegopodium podagraria</i>	Goutweed
<i>Alliaria petiolata</i>	Garlic Mustard
<i>Cabomba caroliniana</i>	Fanwort
<i>Centaurea maculosa</i>	Spotted Knapweed
<i>Cirsium canadense</i>	Field or Canada Thistle
<i>Coreopsis lanceolata</i>	Lance-leaved Coreopsis (Tickseed)
<i>Cytisus scoparius</i>	Scotch Broom
<i>Daucus carota</i>	Queen Anne's Lace
<i>Egeria densa</i>	Giant Waterweed
<i>Epilobium hirsutum</i>	Hairy Willow-herb
<i>Euphorbia cyparissias</i>	Cypress Spurge
<i>Galium mollugo</i>	Field Madder
<i>Glaucium flavum</i>	Sea Poppy
<i>Glechoma hederacea</i>	Gill-over-the-ground (Ground Ivy)
<i>Holcus lanatus</i>	Velvet Grass
<i>Hypericum perforatum</i>	Common St. John's Wort
<i>Iris pseudacorus</i>	Yellow Iris
<i>Linaria vulgaris</i>	Butter and Eggs
<i>Lysimachia nummularia</i>	Moneywort
<i>Lythrum salicaria</i>	Purple Loosestrife
<i>Myosotis scorpioides</i>	True Forget-me-not
<i>Myriophyllum heterophyllum</i>	Variable Water-milfoil
<i>Myriophyllum spicatum</i>	Spiked Water-milfoil
<i>Najas minor</i>	Lesser Naiad
<i>Nasturtium officinale</i>	Watercress
<i>Phalaris arundinacea</i>	Reed Canary Grass
<i>Phragmites australis</i>	Phragmites
<i>Plantago lanceolata</i>	Ribgrass (Lance-leaved Plantain)
<i>Poa compressa</i>	Canada Bluegrass
<i>Potamogeton crispus</i>	Curly or Crisped Pondweed
<i>Ranunculus acris</i>	Tall Buttercup
<i>Ranunculus bulbosus</i>	Bulbous Buttercup
<i>Ranunculus repens</i>	Creeping Buttercup
<i>Ribes rubrum</i>	Garden Red Currant
<i>Rumex acetosella</i>	Sheep Sorrel
<i>Rumex crispus</i>	Curled Dock
<i>Rumex obtusifolius</i>	Bitter or Broad-leaved Dock
<i>Solanum dulcamara</i>	Bittersweet Nightshade
<i>Trapa natans</i>	Water Chestnut

*Tussilago farfara*  
*Verbascum thapsus*

Coltsfoot  
Flannel-leaved Mullein

***Lawn Grasses***

*Botanical Name*

*Agrostis gigantea*  
*Festuca longifolia*  
*Festuca ovina*

*Common Name*

Redtop, Upland Bentgrass  
Hard Fescue  
Sheep Fescue

## V. Site Planning

Westminster's site planning policy is intended to further the Town's goals of:

- **Protecting the environment**, including wildlife habitat, water resources, and "ecosystem services" such as groundwater recharge, flood attenuation and pollutant removal;
- **Creating a visually appealing community**;
- **Preserving the Town's cultural heritage**, including historic sites, view corridors, trees and other noteworthy features;
- **Stabilizing and increasing property values**; and
- **Encouraging sustainable development** that minimizes energy use and pollution.

**WESTMINSTER POLICY:** Subdivision plans and site plans for all forms of development shall adhere to the principles of *environmental compatibility*, *aesthetic compatibility*, and *energy-efficient design*.

In order to minimize costs related to design and engineering (as well as construction), it is recommended that applicants follow the **four-step planning process** described in Appendix A. Creative designers will usually be able to find many cost savings in Westminster's site planning guidelines related to a reduction in clearing, cut and fill, replanting, and stormwater management needs.

Guidelines and criteria for site planning include the following:

- **Refrain from disturbing unique natural features of the site to the maximum extent possible.** Depending on the site, such features could include wooded areas, specimen trees (e.g. larger than 10" diameter at breast height), knolls, and rock outcroppings as well as the more typically conserved streams, wetlands and ponds. These features should be identified early in the site planning process (for example, in the survey or an early site visit) and incorporated into the site plan either as "focal points" for the development or as protected areas, whichever is more appropriate. In general, clearing of vegetation and alteration of topography shall be limited to the maximum percent lot coverage stated in the zoning bylaw (structures plus paving) plus 10% (e.g., 35% in the RR-I district and 70% in the C-II district). Native vegetation shall be planted in disturbed areas as needed to enhance or restore wildlife habitat. Disturbance shall be limited to construction areas only. Preservation of groups of trees (e.g., beech, oak, hickory, etc.) is encouraged.
- **Refrain from disturbing sites of historic and/or cultural significance.** Significant sites could include old buildings, cellar holes or graveyards, as well as historic trees that have a diameter at breast height of 20" or greater.
- **Preserve views and vistas both into and out of the site.** A visual analysis should be conducted to identify any scenic "windows" into the site and preserve the aesthetic value of these views whenever possible.
- **Minimize cut and fill.** Roads should follow the natural contours whenever possible, taking a steeper path only if necessary. Steep areas on individual house lots should generally be left as natural vegetation, not regraded to allow for a sloping lawn. This approach can reduce grading costs and stormwater control costs because it often results in less land being disturbed, thereby creating fewer erosion or runoff problems. In addition, future homeowners will have fewer

expenses and hassles related to maintaining steep lawns and landscaped areas, which are often costly to maintain and have low utility as yards.

- **Locate houses and buildings in a way that blends into the natural topography.** Buildings should not be set high up on a hill where they will be an eyesore or a focus of attention. Generally buildings should be situated near the grade of the road, unless this would require extensive regrading, in which case they may be higher or lower. For buildings located much above the road, an extra effort should be made to recess these buildings into the treeline to reduce their visual impact.
- **Conserve energy by orienting buildings to the sun and wind for maximum efficiency.** Buildings should be aligned to be protected from cold winter winds, shaded from summer sun, and open to winter sun. Protection from cold winter winds can be achieved by retaining natural vegetation at a building's northwest edge or by planting evergreen species such as white pine (*Pinus strobus*) in this location. For summer shading and winter heating, deciduous species can be planted close to the building, along the east, south and west exposures. Winter sunlight will penetrate the empty branches and provide heat. Home interiors should be laid out with time-of-day occupancy in mind.<sup>34</sup> Living and high-activity rooms should be placed on the south side where they are heated by the low winter sun and shaded from the high summer sun. Garages, utility rooms and closets can be positioned to provide insulating barriers on the northeast and northwest sides.

# Appendix A

This Guidebook requires site plans and subdivision applications to consider the presence of natural, cultural, and aesthetic features on any proposed development or redevelopment site. To meet this requirement, the Town recommends that designers utilize a four-step planning process to identify and plan for these site features.<sup>35</sup> The Town also recommends this process as a way of expediting the project review and approval process and minimizing the need for re-designs.

Under the four-step process, the applicant first prepares an “environmental constraints and opportunities plan” for an initial Planning Board meeting. At this meeting, the applicant and the Planning Board identify those portions of the site that should be conserved (e.g., wetlands, viewsheds, specimen trees, historic sites), and those that are most suitable for development. This analysis should consider natural and visual features, as well as the site’s orientation with respect to the sun and wind. With this input, the designer then identifies building sites and lays out the internal circulation network in a way that minimizes clearing, vegetation disturbance and regrading, and situates the buildings within the natural topography. The last step is to draw in the lot lines, if applicable. The goal of this process is not to reduce the overall development program, but rather to lay it out in a less expensive and more environmentally and aesthetically compatible fashion.

The four site planning steps are described below.

## 1. Constraints and Opportunities Plan

Site planning should begin with the preparation of a **constraints and opportunities plan** to understand the site’s features and its context. The plan should identify water resources (wetlands, streams, ponds, vernal pools, floodplains, and springs or seeps), site conditions (steep slopes, significant rock outcroppings, landforms such as knolls and hollows, hydric soils, and prime aquifer recharge areas), ecological features (woodlands, wildlife habitat, and rare species), scenic/visual features (specimen trees, farmland and meadows, and views both into and out from the site), and historic and archaeological resources. The constraints and opportunities plan may be prepared in conjunction with the site survey, but will require more investigation and analysis than a survey usually provides. Ideally a multidisciplinary team with an engineer, scientist, and landscape architect will visit the site and prepare the constraints and opportunities plan. During this step, the designer should also consider the locational context, including surrounding land uses, water resources, historic sites, and other features. The constraints and opportunities plan can either be a single plan or a series of layers of clear plastic or tracing paper, each representing one set of site features.

## 2. Identify the Conservation and Development Areas

Once all of the existing conditions information has been combined on the constraints and opportunities plan, the most suitable areas for development and conservation will become apparent. Conserved lands should include *primary conservation areas* (areas such as wetlands, floodplains, and steep slopes that are generally unbuildable due to environmental regulations or site conditions) as well as *secondary conservation areas* (unique or attractive site features, or areas that are important for environmental protection but not otherwise regulated). Working within the zoning guidelines, the designer should identify areas that will be conserved and areas that will be developed. The designer should be creative in trying to site the desired development program outside of the identified conservation areas, using Westminster’s flexible development options if appropriate.

### **3. Locate the Building Sites and Lay Out the Roads and Trails**

Building sites should be sited within the identified development areas to the maximum extent possible. Again, use of Westminster's various flexible development options may be necessary to meet this goal. In addition, the site will need to be designed carefully, with the site's constraints and opportunities in mind. Sensitive features in the conservation areas (e.g., vernal pools) should be buffered from the development areas, while scenic or historic features (e.g., knolls, meadows, or rock outcroppings) could be "showcased" by providing an open view to toward them. In residential projects, natural vegetation will often need to be retained on individual house lots so that the total development program can fit into a development area that is only a fraction of the site's total land area. Finally, buildings should be sited with consideration to the view from the public way as well as the view out from the buildings. In suburban and rural sections of the Town, developments should generally be as naturally camouflaged as possible.

As discussed in **Section V**, buildings should also be oriented to the sun and wind for maximum efficiency. Protection from cold winter winds can be achieved by retaining natural vegetation along a building's northwest edge or by planting evergreen species such as white pine (*Pinus strobus*) in this location. For summer shading and winter heating, deciduous species can be planted close to the building, along the east, south and west exposures. Winter sunlight will penetrate the empty branches and provide heat. Home interiors should be laid out with time-of-day occupancy in mind. Living and high-activity rooms should be placed on the south side where they are heated by the low winter sun and shaded from the high summer sun. Garages, utility rooms and closets can be positioned to provide insulating barriers on the east and west sides.

During this step, the system of roads and pedestrian network (if any) should be laid out based on the most efficient way to access the building sites with a minimum of environmental and aesthetic impacts. From an engineering standpoint, it is important to consider the topography; from an environmental approach, to consider mature tree stands, wildlife habitat areas, wetlands, etc.; and from an aesthetic and speed control perspective to build "slow" roads. "Slow" roads are naturally curving, or have short straight segments connected with relatively tight bends that force drivers to go slowly. As with the siting of buildings, preserving vistas should be a prime consideration.

### **4. Draw in the Lot Lines**

Once steps 1 through 3 have been completed, the lot lines (if any) can be drawn in based on the building locations. The location of the buildings may necessitate a subdivision plan that takes advantage of Westminster's flexible development options.



## Endnotes

<sup>1</sup> Overall, these practices will aid Westminster in meeting the EPA Stormwater Phase II requirements. The EPA's goals are to minimize polluted stormwater entering rivers and streams by reducing the discharge of pollutants to the maximum extent practicable; to protect water quality; and to satisfy the appropriate water quality requirements of the Clean Water Act. Phase I of EPA's plans was initiated in 1990 and regulated municipal separate storm sewer systems (MS4s) that were defined as "large" and "medium." Phase II, which was recently finalized, focuses on "small" MS4s. Westminster operates a small MS4 and is therefore subject to the Phase II requirements. To comply with the Phase II requirements, the EPA requires that towns set in place regulations and programs that include public education and outreach, public involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control and pollution prevention/good housekeeping.

<sup>2</sup> These stormwater management standards are adopted from the Massachusetts Department of Environmental Protection (DEP) Stormwater Policy Handbook. The DEP standards already apply to any project that falls under the jurisdiction of the Wetlands Protection Act. Westminster has adopted three of the nine DEP standards, and has incorporated by reference the relevant portions for the DEP's Stormwater Policy Handbook that relate to the implementation of these standards. For Westminster standard #2 (DEP standard #3), engineers should consult the DEP Handbook to determine the requirement for on-site recharge and how to demonstrate compliance with this requirement. For Westminster standard #3 (DEP standard #4), engineers should also consult the DEP Handbook for additional information. The Stormwater Policy Handbook and an accompanying Stormwater Technical Handbook may be downloaded from the DEP's website at [www.state.ma.us/dep](http://www.state.ma.us/dep) or purchased at the state bookstore.

<sup>3</sup> Adapted from the *Low Impact Development (LID) Design Strategies: An Integrated Design Approach*, Department of Environmental Resources, Prince George's County, Maryland, June 1999, [www.co.pg.md.us/Government/DER/PPD/pgcounty/pdf/LID/LiDNatl.pdf](http://www.co.pg.md.us/Government/DER/PPD/pgcounty/pdf/LID/LiDNatl.pdf). Additional information from the *DEP Stormwater Policy Handbook* and *EPA Stormwater Phase II Best Management Practices Factsheets*, [www.epa.gov/npdes/menuofbmps/menu.htm](http://www.epa.gov/npdes/menuofbmps/menu.htm).

<sup>4</sup> Based on the table in the *DEP Stormwater Policy Handbook*, with additional information on other systems added from *Prince George's County LID Design Strategies*.

<sup>5</sup> *Prince George's County LID Design Strategies*.

<sup>6</sup> *Prince George's County LID Design Strategies*.

<sup>7</sup> *Northern Virginia Planning District Commission (NVPDC) Nonstructural Urban BMP Handbook*, Department of Conservation and Recreation/Division of Soil and Water Conservation, December 1996, [www.novaregion.org](http://www.novaregion.org).

<sup>8</sup> *NVPDC Nonstructural Urban BMP Guidebook*.

<sup>9</sup> *Stormwater Management Fact Sheet: Stormwater Wetlands*, The Stormwater Center, [www.stormwatercenter.net](http://www.stormwatercenter.net).

<sup>10</sup> *NVPDC Nonstructural Urban BMP Handbook*.

<sup>11</sup> *Bioretention: A Low Impact Stormwater Best Management Practice*, University of Maryland, [www.ence.umd.edu/~apdavis/Bioret.htm](http://www.ence.umd.edu/~apdavis/Bioret.htm).

<sup>12</sup> *EPA Stormwater Technology Fact Sheet – Bioretention*, EPA 832-F-99-012.

<sup>13</sup> *Maryland Stormwater Design Manual*.

<sup>14</sup> EPA Stormwater Technology Fact Sheet.

<sup>15</sup> EPA Stormwater Phase II Best Management Practices Factsheets, [www.epa.gov/npdes/menuofbmps/menu.htm](http://www.epa.gov/npdes/menuofbmps/menu.htm).

<sup>16</sup> [www.uncommonplants.com](http://www.uncommonplants.com)

- <sup>17</sup> *Green Roofs: Stormwater Management From the Top Down*, Katrin Scholz-Brath, [www.edcmag.com](http://www.edcmag.com), January/February 2001.
- <sup>18</sup> The University of Florida Natural Area Teaching Lab has been working on retention basin designs as part of their Stormwater Ecological Enhancement Project. See [natl.ifas.ufl.edu](http://natl.ifas.ufl.edu).
- <sup>19</sup> *DEP Stormwater Manual*.
- <sup>20</sup> *DEP Stormwater Manual*.
- <sup>21</sup> *EPA Stormwater Phase II Best Management Practices Factsheets*.
- <sup>22</sup> *Prince George's County LID Design Strategies*.
- <sup>23</sup> *EPA Stormwater Phase II Best Management Practices Factsheets*.
- <sup>24</sup> Geotextiles and other erosion control and stormwater management products may be purchased from numerous commercial vendors. Vendors include Synthetic Industries, [www.fixsoil.com](http://www.fixsoil.com); Pinelands Nursery, [www.pinelandsnursery.com](http://www.pinelandsnursery.com); North American Green, [www.nagreen.com](http://www.nagreen.com); and the American Excelsior Company, [www.amerexcel.com/erosionindex.htm](http://www.amerexcel.com/erosionindex.htm).
- <sup>25</sup> *Surface Water Design Manual*, King County, Washington, Department of Natural Resources, September 1998.
- <sup>26</sup> King County, WA, *Surface Water Design Manual*.
- <sup>27</sup> *Best Management Practices for Minnesota: Protecting Water Quality in Urban Areas*, Minnesota Pollution Control Agency, 1991.
- <sup>28</sup> *NVPDC Nonstructural Urban BMP Handbook*.
- <sup>29</sup> *NVPDC Nonstructural Urban BMP Handbook*.
- <sup>30</sup> Devens Enterprise Commission list of native species, invasive species, and other species for use in project landscaping. See [www.devensec.com](http://www.devensec.com).
- <sup>31</sup> *Creating Freshwater Wetlands*, Donald A. Hamoner, Lewis Publishers, Michigan, 1992.
- <sup>32</sup> Lake County Nursery, Inc. Catalog, Perry, OH, 1995
- <sup>33</sup> Weston Nurseries Catalog, Hopkinton, MA, 1999, [www.westonnurseries.com](http://www.westonnurseries.com).
- <sup>34</sup> *Best Development Practices*, Reid H. Ewing *et al.*, Planners Press, 1996.
- <sup>35</sup> . This process is based on the work of Randall Arendt as presented in his book *Conservation Subdivision Design*, 1996. The images used in this section of the Handbook are taken from Arendt's book.