Urban Bioretention

Description: Urban Bioretention is similar to traditional bioretention practices, except that the bioretention is fit into concrete-sided containers within urban landscapes, such as planter boxes or tree planters. Captured runoff is treated by filtration through an engineered soil medium, and is then either infiltrated into the subsoil or exfiltrated through an underdrain.

Variations:
- Stormwater planters – in landscaping areas between buildings and roadways or sidewalks
- Green Street swales and planters – on street edge of sidewalk where street landscaping is normally installed
- Proprietary planting cells

Advantages/Benefits:
- Reduced runoff volume
- Reduced peak discharge rate
- Reduced TSS
- Reduced pollutant loading
- Reduced runoff temperature
- Groundwater recharge (if soils are sufficiently permeable)
- Habitat creation
- Enhanced site aesthetics
- Reduced heat island effect

Disadvantages/Limitations:
- Minimum 2 foot separation from groundwater is required
- Not suitable for pollution hotspots

Design considerations:
- Maximum contributing drainage area of 2,500 square feet
- Min infiltration rate > 0.5 inches per hour in order to remove the underdrain requirement
- Underdrain required if in Right of Way
- Design to drain within 24 hours
- Maximum running slope of 3%

Right of Way Applications
- Used along curbside in urban areas
- Stormwater can be conveyed by sheet flow or curb cuts
- Pretreatment is especially important in roadway applications where sediment loads may be high
- Design as a series of cells running parallel to roadway.
- Impermeable liner must be installed roadside to protect subgrade
- Cannot create hazard or interfere with walkability

Selection Criteria:
LEVEL 1 – 40% Runoff Reduction Credit

Land Use Considerations:
- [X] Residential
- [X] Commercial
- [X] Industrial (with MWS Approval)

Maintenance:
- Regular maintenance of landscaping to maintain healthy vegetative cover
- Irrigation when necessary during first growing season
- Periodic trash removal

Maintenance Burden
L = Low  M = Moderate  H = High
SECTION 1: DESCRIPTION

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into “containers” within urban landscapes. Typically, urban bioretention is installed within an urban streetscape or city street Right of Way (ROW), urban landscaping beds, tree planters, and plazas. Urban bioretention is not intended for large commercial areas, nor should it be used to treat small sub-areas of a large drainage area such as a parking lot. Rather, urban bioretention is intended to be incorporated into small fragmented drainage areas such as shopping or pedestrian plazas within a larger urban development. Urban Bioretention within the ROW can only be used to treat water that falls in the ROW.

Urban bioretention features hard edges, often with vertical concrete sides, as contrasted with the more gentle earthen slopes of regular bioretention. If these practices are outside of the ROW, they may be open-bottomed, to allow some infiltration of runoff into the sub-grade, but they generally are served by an underdrain.

Stormwater planters (also known as vegetative box filters or foundation planters) take advantage of limited space available for stormwater treatment by placing a soil filter in a container located above ground or at grade in landscaping areas between buildings and roadways with liner protection (Figure 2.1). The small footprint of foundation planters is typically contained in a precast or cast-in-place concrete vault. Other materials may include molded polypropylene cells and precast modular block systems. Stormwater planters must be outside the ROW if they are treating roof water or runoff from areas outside of the ROW.
Green Street swales and planters are installed in the sidewalk zone near the street where urban street trees are normally installed. The soil volume for the tree pit is increased and used as a stormwater storage area (Figure 2.2). Treatment is increased by using a series of connected tree planting areas together in a row. The surface of the enlarged planting area may be mulch, grates or pervious pavement (if outside the ROW). Large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment.

![Green Street Planters on Deaderick St., Nashville, TN](image.jpg)

Each urban bioretention variant is planted with a mix of trees, shrubs, and grasses as appropriate for its size and landscaping context.

**SECTION 2: PERFORMANCE**

The runoff reduction function of an urban bioretention area is described in Table 2.1.

<table>
<thead>
<tr>
<th>Stormwater Function</th>
<th>Level 1 Design</th>
<th>Level 2 Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff Volume Reduction (RR)</td>
<td>40%</td>
<td>Level 1 Design Only</td>
</tr>
</tbody>
</table>

Sources: CSN (2008) and CWP (2007)
SECTION 3: DESIGN TABLE

Design criteria for urban bioretention are detailed in Table 2.2, below.

<table>
<thead>
<tr>
<th>Table 2.2. Urban Bioretention Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1 Design Only (RR: 40)</strong></td>
</tr>
<tr>
<td>Sizing (Refer to Section 6.1):</td>
</tr>
<tr>
<td>Surface Area (sq. ft.) = ( \frac{V_t}{\text{Storage Depth}} ) = \frac{(1.0 \text{ inch})(Rv)(A)/12 - \text{the volume reduced by an upstream SCM}}{\text{Storage Depth}} )</td>
</tr>
<tr>
<td>Underdrain = PVC or HDPE with clean-outs</td>
</tr>
<tr>
<td>(Refer to the Main Bioretention Design Specification GIP-01, Section 6.7)</td>
</tr>
<tr>
<td>Maximum Drainage Area = 2,500 sq. ft.</td>
</tr>
<tr>
<td>Maximum Ponding Depth = 6 inches</td>
</tr>
<tr>
<td>Filter media depth minimum = 24 inches; recommended maximum = 48 inches</td>
</tr>
<tr>
<td>Gravel layer depth minimum = 6 inches</td>
</tr>
<tr>
<td>Media and Surface Cover (Refer to GIP-01, Section 6.6)</td>
</tr>
<tr>
<td>Sub-soil testing (Refer to GIP-01, Section 6.2)</td>
</tr>
<tr>
<td>Inflow = sheet flow, curb cuts, trench drains, roof drains, concentrated flow, or equivalent</td>
</tr>
<tr>
<td>Building setbacks (Refer to Section 5)</td>
</tr>
<tr>
<td>Deeded maintenance O&amp;M plan (Refer to GIP-01, Section 9)</td>
</tr>
</tbody>
</table>

Storage depth is the sum of the porosity \( n_r \) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. Refer to Section 6.1.
SECTION 4: TYPICAL DETAILS

Figure 2.4. Stormwater Planter Cross-Section (source: VADCR, 2010)
Figure 2.5. Green Streets Swale Plan View (source: Portland, 2011)
Figure 2.6. Green Streets Swale Section View (source: Portland, 2011)
**Figure 2.7. Green Streets Planter Plan View With Parking (source: Portland, 2011)**
SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

In general, urban bioretention has the same constraints as regular bioretention, along with a few additional constraints as noted below:

**Contributing Drainage Area.** Urban bioretention is limited to 2,500 sq. ft. of drainage area. However, this is considered a general rule; larger drainage areas may be allowed with sufficient flow controls and other mechanisms to ensure proper function, safety, and community acceptance. The drainage areas in these urban settings are typically considered to be 100% impervious. While multiple planters or swales can be installed to maximize the treatment area in ultra-urban watersheds, urban bioretention is not intended to be used as treatment for large impervious areas (such as parking lots).

**Adequate Drainage.** Urban bioretention practice elevations must allow the untreated stormwater runoff to be discharged at the surface of the filter bed and ultimately connect to the local storm drain system.
Available Hydraulic Head. In general, 3 feet of elevation difference is needed between the downstream storm drain invert and the inflow point of the urban bioretention practice. This is generally not a constraint, due to the standard depth of most storm drains systems.

Setbacks from Buildings and Roads. If an impermeable liner and an underdrain are used, no setback is needed from the building. Otherwise, the urban bioretention practice should be 10 feet down gradient from the building.

Proximity to Underground Utilities. Urban bioretention practices frequently compete for space with a variety of utilities. Since they are often located parallel to the ROW, care should be taken to provide utility-specific horizontal and vertical setbacks. However, conflicts with water and sewer laterals (e.g., house connections) may be unavoidable, and the construction sequence must be altered, as necessary, to avoid impacts to existing service.

Overhead Wires. Designers should also check whether future tree canopy heights achieved in conjunction with urban bioretention practices will interfere with existing overhead telephone, cable communications and power lines.

Minimizing External Impacts. Because urban bioretention practices are installed in highly urban settings, individual units may be subject to higher public visibility, greater trash loads, pedestrian use traffic, vandalism, and even vehicular loads. These practices should be designed in ways that prevent, or at least minimize, such impacts. In addition, designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard and maintain the American with Disabilities Act (ADA) required path of travel. Designers may also install low fences (such as a low garden fence), grates or other measures to prevent damage from pedestrian short-cutting across the practices.

SECTION 6: DESIGN CRITERIA

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into “containers” within urban landscapes. Therefore, special sizing accommodations are made to allow these practices to fit in very constrained areas where other surface practices may not be feasible.

6.1 Sizing of Urban Bioretention

The required surface area of the urban bioretention filter is calculated by dividing the Treatment Volume by the Equivalent Storage Depth (Equation 2.2 below), in the same manner as it is calculated for traditional bioretention. The equivalent storage depth is computed as the depth of media, gravel, or surface ponding (in feet) multiplied by the accepted void ratio.

The accepted porosities (n) are:

Bioretention Soil Media (GIP-01) \( n = 0.25 \) (sandy loam, loamy sand, or loam)
Gravel \( n = 0.40 \)
Surface Storage \( n = 1.0 \)
**Equation 2.1. Urban Bioretention Equivalent Storage Depth**

Equivalent Storage Depth

\[
D_E = n_1(D_1) + n_2(D_2) + \ldots
\]

The equivalent storage depth for an urban bioretention facility with a 6-inch surface ponding depth, a 30-inch media depth, and a 12-inch gravel layer is therefore computed as:

\[
D_E = (2.5 \text{ ft.} \times 0.25) + (1 \text{ ft.} \times 0.40) + (0.5 \text{ ft.} \times 1.0) = 1.53 \text{ ft.}
\]

Where \( n_1 \) and \( D_1 \) are for the first layer, etc.

Surface Area (SA) is computed as:

**Equation 2.2. Urban Bioretention Sizing**

\[
SA (\text{sq. ft.}) = \frac{T_v (\text{cu. ft.})}{D_E}
\]

Where:
- \( SA \) = the surface area of the urban bioretention facility (in square feet)
- \( D_E \) = Equivalent Storage Depth (ft.)
- \( T_v \) = the required Treatment Volume (in cubic feet)

**Equation 2.3. Treatment Volume**

\[
T_v = \left[\frac{(1.0 \text{ inch})(R_v)(A)}{12}\right]
\]

Where:
- \( T_v \) = the required Treatment Volume (in cubic feet)
- \( A \) = the contributing drainage area (in sq. ft.)
- \( R_v \) = Runoff Coefficient found in Volume 5 Chapter 3.2

Equations 2.1 and 2.2 should be modified if the storage depths of the soil media, gravel layer, or ponded water vary in the actual design.

**6.2 General Design Criteria for Urban Bioretention**

Design of urban bioretention should follow the general guidance presented in this Bioretention design specification. The actual geometric design of urban bioretention is usually dictated by other landscape elements such as buildings, sidewalk widths, utility corridors, retaining walls, etc. Designers can divert fractions of the runoff volume from small impervious surfaces into urban bioretention that is integrated with the overall landscape design. Inlets and outlets should be located as far apart as possible. The following is additional design guidance that applies to all variations of urban bioretention:

- The ground surface of the micro-bioretention cell should slope 1% towards the outlet, unless a stormwater planter is used.
- The soil media depth should be a minimum of 24 inches.
- If large trees and shrubs are to be installed, soil media depths should accommodate.
- All urban bioretention practices should be designed to fully drain within 24 hours.
- Any grates used above urban bioretention areas must be removable to allow maintenance access and must be ADA compliant.
The inlet(s) to urban bioretention should be stabilized using course aggregate stone, splash block, river stone or other acceptable energy dissipation measures. The following forms of inlet stabilization are recommended:

- Stone energy dissipaters.
- Sheet flow over a depressed curb with a 3-inch drop.
- Curb cuts allowing runoff into the bioretention area.
- Covered drains that convey flows under sidewalks from the curb or from downspouts (if the bioretention area is outside of the ROW).
- Grates or trench drains that capture runoff from the sidewalk or plaza area.

Pre-treatment options overlap with those of regular bioretention practices. However, the materials used may be chosen based on their aesthetic qualities in addition to their functional properties. For example, river rock may be used in lieu of rip rap. Other pretreatment options may include one of the following:

- A trash rack between the pre-treatment cell and the main filter bed. This will allow trash to be collected from one location.
- A trash rack across curb cuts. While this trash rack may clog occasionally, it keeps trash in the gutter, where it can be picked up by street sweeping equipment.
- A pre-treatment area above ground or a manhole or grate directly over the pre-treatment area.

Overflows can either be diverted from entering the bioretention cell or dealt with via an overflow inlet. Optional methods include the following:

- Size curb openings to capture only the Treatment Volume and bypass higher flows through the existing gutter.
- Use landscaping type inlets or standpipes with trash guards as overflow devices.
- Use a pre-treatment chamber with a weir design that limits flow to the filter bed area.

### 6.3 Specific Design Issues for Stormwater Planters

Since stormwater planters are often located near building foundations, waterproofing by using a watertight concrete shell or an impermeable liner is required to prevent seepage.

### 6.4 Specific Design Issues for Green Streets Swales and Planters

- The bottom of the soil layer must be a minimum of 4 inches below the root ball of plants to be installed.
- Green streets designs sometimes cover portions of the filter media with pervious pavers (if outside the ROW) or cantilevered sidewalks. In these situations, it is important that the filter media is connected beneath the surface so that stormwater and tree roots can share this space.
- Installing a tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.
- Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the micro-bioretention cell.
- A removable grate capable of supporting typical H-20 axel loads may be used to allow the tree to grow through it.
- Each tree needs a minimum of 100 square feet of shared root space.
- Proprietary tree pit devices are acceptable, provided they conform to this specification.

### 6.5 Planting and Landscaping Considerations

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes. Landscaping in the ROW should be designed to limit visual obstructions for pedestrian and vehicular traffic.
In areas where less maintenance will be provided and where trash accumulation in shrubbery or herbaceous plants is a concern, consider a “turf and trees” landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs are preferred for urban bioretention areas, although some ornamental species may be used. As with regular bioretention, selected perennials, shrubs, and trees must be tolerant of drought, and inundation. The landscape designer should also take into account that de-icing materials may accumulate in the bioretention areas in winter and could kill vegetation. Additionally, tree species selected should be those that are known to survive well in the compacted soils and polluted air and water of an urban landscape.

SECTION 7: MATERIAL SPECIFICATIONS

Please consult the main bioretention design specification (GIP-01, Table 1.9) for the typical materials needed for filter media, stone, mulch, and other bioretention features. In urban planters, pea gravel or river stone may be a more appropriate and attractive mulch than shredded hardwood.

The unique components for urban bioretention may include the inlet control device, a concrete box or other containing shell, protective grates, and an underdrain that daylights to another stormwater practice or connects to the storm drain system. The underdrain should:

- Consist of slotted pipe greater than or equal to 4 inches in diameter, placed in a layer of washed (less than 1% passing a #200 sieve) crushed stone.
- Have a minimum of 2 inches of gravel laid above and below the pipe.
- Be laid at a minimum slope of 0.5%.
- Extend the length of the box filter from one wall to within 6 inches of the opposite wall, and may be either centered in the box or offset to one side.
- Be separated from the soil media by an appropriate filter fabric for the particular application, based on AASHTO M288-06, or a 2 to 3 inch layer of 1/8 to 3/8 inch pea gravel.

SECTION 8: CONSTRUCTION

The construction sequence and inspection requirements for urban bioretention are generally the same as other bioretention practices. Consult the construction sequence and inspection guidance provided in the main bioretention design specification (GIP-01). In cases where urban bioretention is constructed in the road or ROW, the construction sequence may need to be adjusted to account for traffic control, pedestrian access and utility notification.

Urban bioretention areas should only be constructed after the drainage area to the facility is completely stabilized. The specified growth media should be placed and spread by hand with minimal compaction, in order to avoid compaction and maintain the porosity of the media. The media should be placed in 12 inch lifts with no machinery allowed directly on the media during or after construction. The media should be overfilled above the proposed surface elevation, as needed, to allow for natural settling. Lifts may be lightly watered to encourage settling. After the final lift is placed, the media should be raked (to level it), saturated, and allowed to settle prior to installation of plant materials.
SECTION 9: AS-BUILTS

After urban bioretention has been constructed, the developer must have an as-built certification conducted by a registered Professional Engineer. The as-built certification verifies that the SCM was installed as designed and approved. The following components are vital to ensure that the bioretention area works properly and they must be addressed in the as-built certification:

1. The proper media and gravel depths were installed per plan. Photographs taken during phases of construction should be included to demonstrate.
2. Surrounding drainage areas must be stabilized to prevent sediment from clogging the filter media.
3. Correct ponding depths and infiltration rates must be verified.
4. Landscape plan must be provided.

SECTION 10: MAINTENANCE

Routine operation and maintenance are essential to gain public acceptance of highly visible urban bioretention areas. Weeding, pruning, the removal and replacement of dead vegetation and trash removal should be done as needed to maintain the aesthetics necessary for community acceptance. During drought conditions, it may be necessary to water the plants, as would be necessary for any landscaped area. Maintenance shall be the responsibility of the property owner as outlined in Volume 1, Appendix C.

To ensure proper performance, installers should check that stormwater infiltrates properly into the soil within 24 hours after a storm. If excessive surface ponding is observed, corrective measures include inspection for soil compaction and underdrain clogging. Consult the maintenance guidance outlined in the main bioretention design specification (GIP-01).

SECTION 11: RIGHT OF WAY DESIGN CONSIDERATIONS

Green Street swales and planters are applicable along roads. They can be used along curbside in urban areas with stormwater being conveyed by sheet flow or curb cuts. Green Street swales and planters can also be designed as a series of cells running parallel to roadway. An impermeable liner must separate the road subgrade from the bioretention feature.
Figure 2.6 Flow-through planter. (Source: Portland Bureau of Environmental Services)

Figure 2.7 Infiltration planter (Not for ROW). (Source: Portland Bureau of Environmental Services)

Figure 2.8 Portland State University street planters. (Photo: Martina Keefe)

Figure 2.8 Deaderick Street planters.
SECTION 12: REFERENCES


APPENDIX A

Popular Plants Suitable for Tree Planters in Metro Nashville

Table 2.3. Popular Native Perennials Suitable for Tree Planters – Full Sun

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Size</th>
<th>Spacing</th>
<th>Moisture</th>
<th>Color</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asclepias tuberosa</td>
<td>Butterfly milkweed</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Dry-moist</td>
<td>Orange</td>
<td>2’</td>
</tr>
<tr>
<td>Aster novae-angliae</td>
<td>New England aster</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Wet-moist</td>
<td>Blue</td>
<td>2.5’</td>
</tr>
<tr>
<td>Coreopsis lanceolata</td>
<td>Lance-leaf coreopsis</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-dry</td>
<td>Yellow</td>
<td>6-8’</td>
</tr>
<tr>
<td>Eupatorium purpureum</td>
<td>Sweet Joe-Pye Weed (Dwarf)</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Wet-moist</td>
<td>Purple</td>
<td>3-6’</td>
</tr>
<tr>
<td>Iris virginica</td>
<td>Flag Iris</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-Wet</td>
<td>Blue</td>
<td>2’</td>
</tr>
<tr>
<td>Liatris spicata</td>
<td>Dense blazingstar</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Wet-moist</td>
<td>Purple</td>
<td>1.5’</td>
</tr>
<tr>
<td>Penstemon digitalis</td>
<td>Smooth white beardtongue</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Wet</td>
<td>White</td>
<td>2-3’</td>
</tr>
<tr>
<td>Salvia lyrata</td>
<td>Lyre-leaf sage</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist</td>
<td>Purple</td>
<td>1-2’</td>
</tr>
</tbody>
</table>

Table 2.4. Popular Native Perennials Suitable for Tree Planters – Shade

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Size</th>
<th>Spacing</th>
<th>Moisture</th>
<th>Color</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquilegia canadensis</td>
<td>Wild columbine</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-dry</td>
<td>Pink</td>
<td>1-2.5’</td>
</tr>
<tr>
<td>Aster novae-angliae</td>
<td>New England aster</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist-dry</td>
<td>Blue/purple</td>
<td>3-4’</td>
</tr>
<tr>
<td>Aster oblongifolius</td>
<td>Aromatic Aster</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist-dry</td>
<td>Blue/purple</td>
<td>1.5-3’</td>
</tr>
<tr>
<td>Coreopsis lanceolata</td>
<td>Tickseed coreopsis</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-dry</td>
<td>Yellow</td>
<td>3’</td>
</tr>
<tr>
<td>Heuchera americana</td>
<td>Alumroot</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-dry</td>
<td>Purple</td>
<td>1’</td>
</tr>
</tbody>
</table>

DT: Drought Tolerant
FT: Flood Tolerant
### Table 2.5. Popular Native Grasses and Sedges Suitable for Tree Planters

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Size</th>
<th>Spacing</th>
<th>Moisture</th>
<th>Color</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carex muskingumensis</td>
<td>Palm Sedge</td>
<td>1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist</td>
<td>Green</td>
<td>3’</td>
</tr>
<tr>
<td>Chasmanthium latifolium</td>
<td>Upland Sea Oats</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Moist-dry</td>
<td>Green</td>
<td>4’</td>
</tr>
<tr>
<td>Equisetum hyemale</td>
<td>Horsetail</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/18” o.c.</td>
<td>Wet</td>
<td>Green</td>
<td>3’</td>
</tr>
<tr>
<td>Juncus effesus</td>
<td>Soft Rush</td>
<td>Plugs – 1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Wet-dry</td>
<td>Green</td>
<td>4-6’</td>
</tr>
<tr>
<td>Muhlenbergia capallaris</td>
<td>Muhly Grass</td>
<td>1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist</td>
<td>Pink</td>
<td>3’</td>
</tr>
<tr>
<td>Panicum virgatum</td>
<td>Switchgrass</td>
<td>1-3 gal.</td>
<td>1 plant/48” o.c.</td>
<td>Moist-dry</td>
<td>Yellow</td>
<td>5-7’</td>
</tr>
<tr>
<td>Schizachyrium scoparium</td>
<td>Little Blue Stem</td>
<td>1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist-dry</td>
<td>Yellow</td>
<td>3’</td>
</tr>
<tr>
<td>Sporobolus heterolepsis</td>
<td>Prairie Dropseed</td>
<td>1 gal.</td>
<td>1 plant/24” o.c.</td>
<td>Moist-dry</td>
<td>Green</td>
<td>2-3’</td>
</tr>
</tbody>
</table>

### Table 2.6. Popular Native Trees Suitable for Tree Planters

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>DT-FT</th>
<th>Light</th>
<th>Moisture</th>
<th>Notes</th>
<th>Flower Color</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer rubrum</td>
<td>Red Maple</td>
<td>DT</td>
<td>Sun-shade</td>
<td>Dry-wet</td>
<td>Fall color</td>
<td></td>
<td>50-70’</td>
</tr>
<tr>
<td>Betula nigra</td>
<td>River Birch</td>
<td>FT</td>
<td>Sun-pt shade</td>
<td>Moist-wet</td>
<td>Exfoliating bark</td>
<td></td>
<td>40-70’</td>
</tr>
<tr>
<td>Carpinus caroliniana</td>
<td>Ironwood</td>
<td>FT</td>
<td>Sun-pt shade</td>
<td>Moist</td>
<td>White</td>
<td></td>
<td>40-60’</td>
</tr>
<tr>
<td>Carya aquatica</td>
<td>Water Hickory</td>
<td>FT-DT</td>
<td>Sun</td>
<td>Moist</td>
<td>Fall color</td>
<td></td>
<td>35-50’</td>
</tr>
<tr>
<td>Cercus Canadensis</td>
<td>Redbud</td>
<td>DT</td>
<td>Sun-shade</td>
<td>Moist</td>
<td>Pea-like flowers, seed pods</td>
<td>Purple</td>
<td>20-30’</td>
</tr>
<tr>
<td>Liquidambar styraciflua</td>
<td>Sweetgum (fruitless)</td>
<td>DT-FT</td>
<td>Sun-pt shade</td>
<td>Dry-moist</td>
<td></td>
<td></td>
<td>60-100’</td>
</tr>
<tr>
<td>Nyssa sylvatica</td>
<td>Black Gum</td>
<td>Sun-Shade</td>
<td>Moist</td>
<td>Fall color</td>
<td></td>
<td></td>
<td>35-50’</td>
</tr>
<tr>
<td>Platanus occidentalis</td>
<td>Sycamore</td>
<td>FT</td>
<td>Sun-pt shade</td>
<td>Moist</td>
<td>White mottled bark</td>
<td></td>
<td>70-100’</td>
</tr>
<tr>
<td>Quercus nuttalii</td>
<td>Nuttall Oak</td>
<td>DT</td>
<td>Sun</td>
<td>Dry-moist</td>
<td>Acorns</td>
<td></td>
<td>40-60’</td>
</tr>
<tr>
<td>Quercus lyrata</td>
<td>Overcup Oak</td>
<td>FT</td>
<td>Sun</td>
<td>Moist</td>
<td>Acorns</td>
<td></td>
<td>40-60’</td>
</tr>
<tr>
<td>Quercus shumardii</td>
<td>Shumard Oak</td>
<td>DT</td>
<td>Sun</td>
<td>Moist</td>
<td>Acorns</td>
<td></td>
<td>40-60’</td>
</tr>
<tr>
<td>Ulmus americana</td>
<td>American Elm</td>
<td>DT-FT</td>
<td>Sun-pt shade</td>
<td>Moist</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DT: Drought Tolerant  
FT: Flood Tolerant
### Table 2.7. Popular Native Shrubs Suitable for Tree Planters

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
<th>Light</th>
<th>Moisture</th>
<th>Notes</th>
<th>Flower Color</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Clethra alnifolia</em></td>
<td>Sweet Pepper Bush (Dwarf)</td>
<td>Sun-pt shade</td>
<td>Dry-moist</td>
<td>Hummingbirds</td>
<td>White</td>
<td>5-8’</td>
</tr>
<tr>
<td><em>Hydrangea quercifolia</em></td>
<td>Oakleaf Hydrangea</td>
<td>PT shade – shade</td>
<td>Moist</td>
<td></td>
<td>White</td>
<td>3-6’</td>
</tr>
<tr>
<td><em>Hypericum frondosum</em></td>
<td>Golden St. John’s Wort</td>
<td>DT Sun-pt shade</td>
<td>Dry-moist</td>
<td>Semi-evergreen</td>
<td>Yellow</td>
<td>2-3’</td>
</tr>
<tr>
<td><em>Ilex glabra</em></td>
<td>Inkberry (Dwarf)</td>
<td>DT Sun-pt shade</td>
<td>Moist-wet</td>
<td>Evergreen</td>
<td></td>
<td>4-8’</td>
</tr>
</tbody>
</table>

DT: Drought Tolerant  
FT: Flood Tolerant