# 5.4.6a Urban Bioretention

## Variations: Planter box, Extended tree pits, Stormwater curb extensions.

**Description:** Urban bioretention SCM 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, urban landscaping beds, tree pits and plazas, or other features within an Urban Development Area. Urban bioretention is not intended for large commercial areas. Rather, urban bioretention is intended to be incorporated into small fragmented drainage areas such as shopping or pedestrian plazas within a larger urban development.

**Figure 1: Urban planter box (Source: The SMART Center).**

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

## 1. Design

### 1.1 Suggested Applications

Potential applications include capturing roof runoff directly adjacent to buildings, within or along parking lots, adjacent to parking stalls on roadways, sidewalks and paths, plazas, playgrounds, and athletic fields and courts.

**Figure 2: Street side planter boxes. runoff enters the planter boxes through curb cuts (Source: The SMART Center).**

**Figure 3: Curb extension (Source: WVDEP).**

Figure 4: Institutional planter box (Source: The SMART Center).

Figure 5: Parking lot planter box (Source: CHCRPC).

### 1.1.2 Variations

- **Curb Extensions/Curb Bump-Out**

  Large planter boxes constructed within and along a street are also referred to as "curb extensions" or "curb bump-outs." These are sometimes constructed within over-wide drive aisles to capture stormwater as well as to provide traffic calming. Curb extensions function in the same way as planter boxes in that they are curbed vegetated areas with soil and potentially stone for stormwater storage. Curb cuts allow the entry of roadway and sidewalk runoff to sheet flow into the system.

  Curb bump-outs and curb extensions must be structurally designed with consideration of the traffic loads both during and after construction.

- **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 adjacent to buildings and/or between buildings and roadways. The small footprint of the planter is typically contained in a precast or cast-in-place concrete vault. Stormwater planters combine an aesthetic landscaping feature with a functional form of stormwater treatment. They generally receive runoff from adjacent rooftop downspouts and are landscaped with plants that are tolerant to periods of both drought and inundation.

- **Extended Tree Boxes** 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 for stormwater treatment. 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, permeable pavers, or conventional pavement. The large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment.

## 1.2 Site Constraints

**Contributing Drainage Area.** Urban bioretention is classified as a micro-bioretention practice and is therefore limited to 2,500 sq. ft. of drainage area to each unit. 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 units 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 to 5 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.** If an impermeable liner and an underdrain are used, no setback is needed from the building. Otherwise, the standard 10 foot down-gradient setback applies.

**Proximity to Underground Utilities.** Urban bioretention practices frequently compete for space with a variety of utilities. Since they are often located parallel to the road right-of-way, 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. Designers should design these practices 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 deign. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard. Designers may also install low fences, grates or other measures to prevent damage from pedestrian short-cutting across the practices.

## 1.3 Design Criteria and Calculations

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| **Sizing** | Surface area = Runoff volume / storage depth (refer to main Bioretention section 1.4.2.3 Equation 1) |
| **Underdrain** | Schedule 40 PVC with clean-outs |
| **Maximum Drainage Area** | 2,500 sq. ft. |
| **Maximum Ponding Depth** | 6 inches |
| **Filter media depth minimum** | Min: 18 inches; max: 24 inches |
| **Gravel layer depth minimum** | 6 inches |
| **Media and Surface Cover** | Refer to the Main Bioretention Design Criteria |
| **Sub-soil testing** | Refer to the Main Bioretention Design Criteria |
| **Inflow** | Sheetflow, curb cuts, trench drains, roof drains, concentrated flow, or equivalent |

### 1.3.1 Practice Dimensions
Sizing the practice dimension can be done using the Tennessee Runoff Reduction Assessment Tool (TNRRAT).

### 1.3.2 Practice Dimensions using other methods
Although using TNRRAT is recommended, designers and engineers can use other methods to size urban bioretention and other SCMs.

#### 1.3.2.1 Runoff Volume
Use standard engineering method to calculate runoff volume.

### 1.3.2.2 Practice Dimensions

The required surface area of the urban bioretention is calculated by dividing the Runoff Volume by storage depth as described in the main Bioretention section 1.4.2.3 Equation 1. The equivalent storage depth is computed as the depth of media, gravel, or surface ponding (in feet) multiplied by the accepted void ratio.

$$\text{Surface area} = \text{Runoff volume} / \text{Storage depth}$$

*(Equation 1)*

## 1.4 Design Elements

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:

- 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

### 1.4.1 Pre-treatment

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.

### 1.4.2 Entrance/flow conditions

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.

### 1.4.3. Filter Media and Surface Cover

- The ground surface of the urban bioretention cell should slope 1% towards the outlet, unless a stormwater planter is used.
- The soil media depth should be a minimum of 18 inches.
- If large trees and shrubs are to be installed, soil media depths should be minimum 4 feet.

### 1.4.4 Conveyance and Overflow

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.

### 1.4.5 Material Specification

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) TDOT #57 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 non-woven, geotextile fabric or a 2 to 3 inch layer of either washed TDOT #8 stone or 1/8 to 3/8 inch pea gravel.

## 1.5 Specific Design Issues

#### Planter Box

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

#### Expanded Tree Pits

- The bottom of the soil layer must be a minimum of 4 inches below the root ball of plants to be installed.
- Expanded tree pits designs sometimes cover portions of the filter media with pervious pavers 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 urban 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 400 cubic feet of shared root space.

#### Curb Extensions

Roadway stability can be a design issue where stormwater curb extensions are installed. Consult design standards pertaining to roadway drainage. It may be necessary to provide a barrier to keep water from saturating the road's sub-base and demonstrate it is capable of supporting H-20 axel loads.

## 1.6 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.

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, the selected perennials, shrubs, and trees must be tolerant of salt, drought, and inundation. Additionally, tree species should be those that are known to survive well in the compacted soils and polluted air and water of an urban landscape.

## 1.7 Typical Details

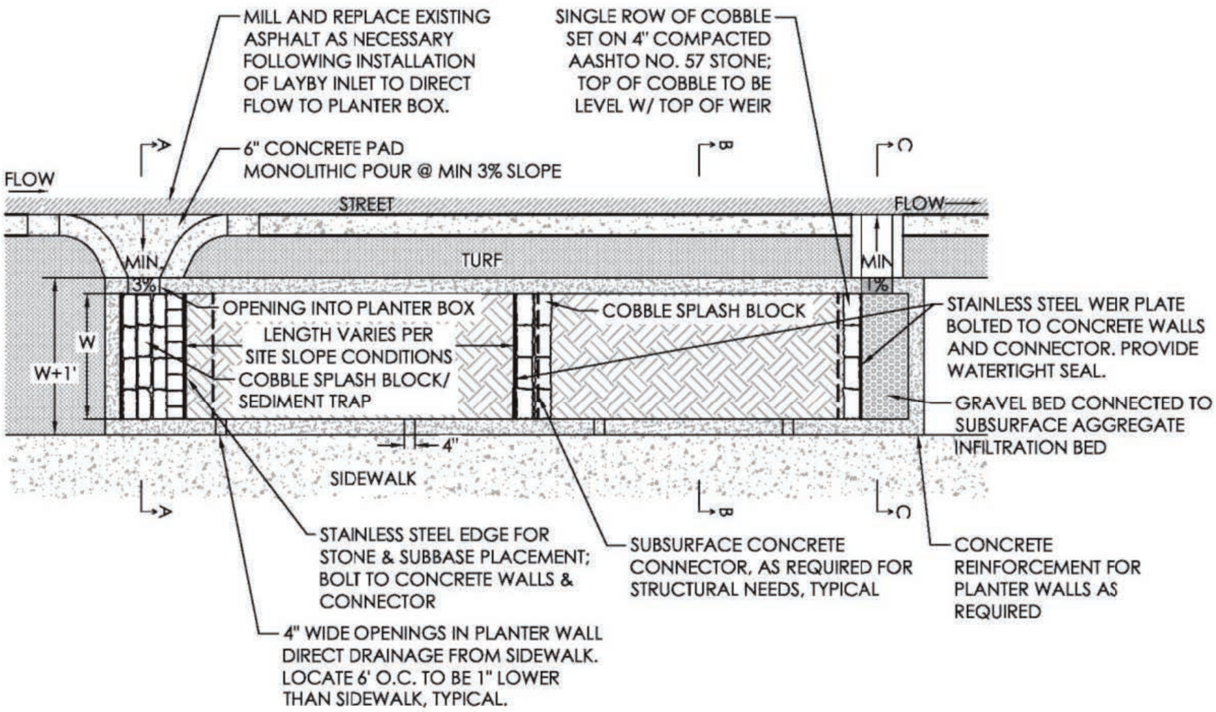


**Figure 6: Example of streetside planter box (slopes <5%) with infiltration bed plan view (Source: CHCRPC).**

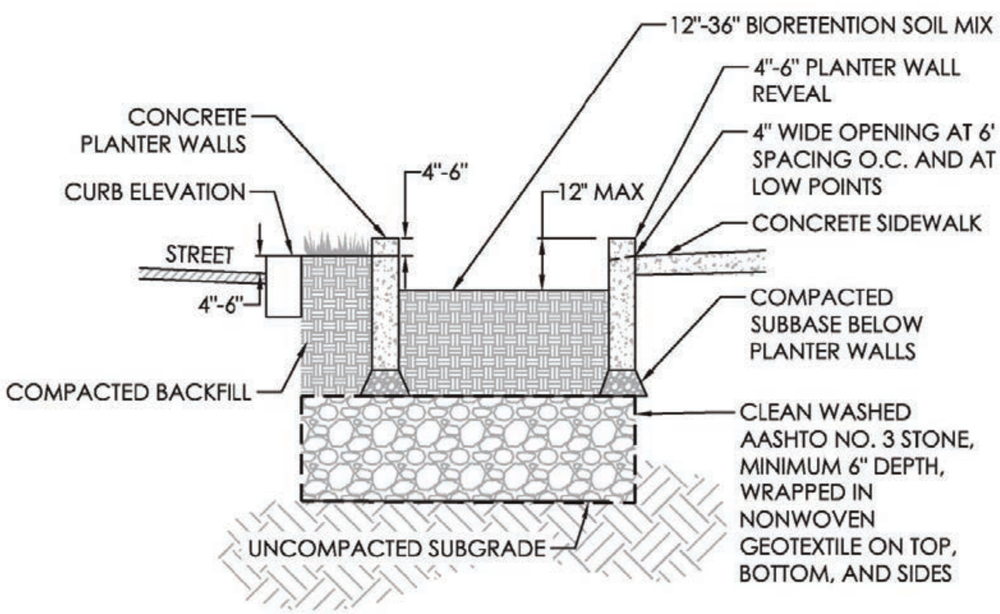


**Figure 7: Example of stone splash block / sediment trap detail (Source: CHCRPC).**

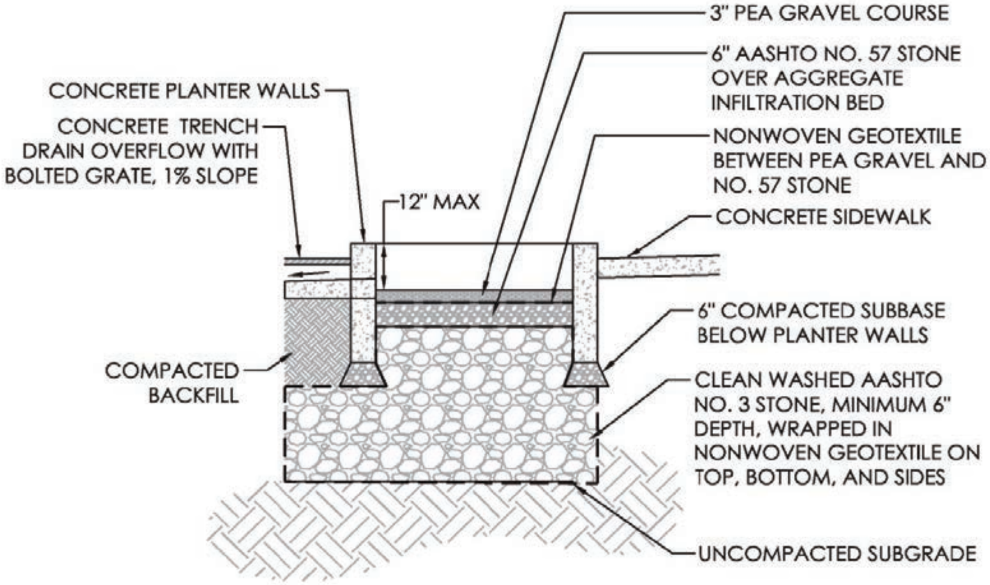


**Figure 8: Overflow from streetside planter box (Source: NCDENR).**

## 2. Construction

The construction sequence and inspection requirements for urban bioretention are generally the same as micro-bioretention practices. In cases where urban bioretention is constructed in the road or right-of-way, 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 8 to 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 for a few days prior to installation of plant materials.

## 3. Maintenance

Routine operation and maintenance are essential to gain public acceptance of highly visible urban bioretention areas. Weeding, pruning, 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. To ensure proper performance, inspectors 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 part of this design specification.

## REFERENCES

*Chattanooga Hamilton County Regional Planning Commission (CHCRPC). "5.3.11 Stormwater Planter Box." Rainwater Management Guide. Chattanooga: 2012.*

*Metro Water Service, Metropolitan Government of Nashville and Davidson County. "Urban Bioretention." Volume 5 Low Impact Development Stormwater Management Manual. 2012.*

*North Carolina Department of Environmental and Natural Resources (NCDENR). "12. Bioretention." NCDENR Stormwater BMP Manual. 2012.*

*VADCR. "Virginia DEQ Stormwater Specification No. 9: Bioretention." Virginia Stormwater Management Handbook. 1.9 ed. 2011.*

*West Virginia Department of Environmental Protection (WVDEP). "Appendix 9-a Urban Bioretention." West Virginia Stormwater Management and Design Guidance Manual. 2012.*