5.3.11 Stormwater Planter Box

Description

Planter boxes are structures, either elevated or at ground level, which are filled with bioretention soils and plants to capture, detain, and filter stormwater runoff through physical, biological, and chemical processes. Planter boxes are commonly constructed of concrete, concrete masonry units, or brick. Planter boxes can be placed adjacent to the external downspouts of a building to receive rooftop runoff, as shown on Figure 5.3.11-1, or along streets to receive runoff from impervious surfaces such as sidewalks or roadways. Planter boxes are similar to bioretention in function, but tend to be more structural in design and appearance.

Figure 5.3.11-1. A downspout from an existing building is disconnected to a stormwater planter box.

Planter boxes may be designed with open bottoms to infiltrate water (infiltration planter box). Planter boxes may also be designed with an impervious bottom to discharge directly to the storm sewer system after temporarily detaining and treating runoff (flow-through planter box). All planter boxes must be designed with a positive drainage overflow connection to a secondary stormwater management system or storm sewer.

Planter boxes often are designed to provide temporary surface ponding prior to runoff filtering through the soils. Planter boxes may also include an underlying stone stormwater bed to increase stormwater capacity.

BMP Functions Table

BMP	Applicability*	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden*	Cost*
Stormwater Planter Box	U/S	L	M	H	M	H	M	L	M/H	L/M

KEY: U = Urban; S = Suburban; R = Rural; H = High; M = Medium; L = Low

*Rating varies based on design considerations.

Key Design Features
(see Figure 5.3.11-2)

- Use a combination of surface ponding, soil storage, vegetation, and potentially, stone storage and infiltration to treat stormwater runoff.
- Capture the runoff from the small (1.6 inches and less) rainfalls events, and the first portion of larger rainfall events.
- The surface area and size are directly correlated to the contributing drainage area size and land use, especially impervious surfaces. A planter box may not always be able to capture the full SOV.
- Should be level at the bottom.
- Inflow velocities at downspouts or curb cuts may require energy dissipation, such as a stone or concrete splash block, or other velocity control measures to prevent erosion.
- May be designed for infiltration by placing with an open bottom on uncompacted subgrade.
- Planter boxes adjacent to buildings to receive roof runoff should not be designed for infiltration to protect building foundations and basements.
- Planter boxes that cannot infiltrate **must** include a low-flow slow-release system. Lined and slow-release systems may be constructed on compacted fill material.
- Always include an overflow control structure or design to allow large storm events to bypass or discharge at a controlled flow rate without passing through the soils.

Applications

Planter boxes may be installed on virtually any site, but are most useful at providing stormwater management in highly urbanized areas where space is limited:

- Along roadways, sidewalks, and parking stalls
- Rooftop runoff – adjacent to or near buildings
- Treatment of stormwater runoff in urban, high-density residential and commercial sites

Advantages

- Allows for treatment of stormwater runoff in areas where space for larger BMPs is limited.
- Provides water quality treatment within a small footprint.
- Can be incorporated into a larger stormwater management system or "treatment train."
- Excellent option to provide partial SOV capture and improve water quality.
- Well suited for retrofit projects.
- Applicable to small drainage areas.

Disadvantages

- May not provide full management of SOV. However, can be combined with other BMPs to meet SOV.
- May be maintenance intensive.
- May be subject to vandalism and/or accumulated trash/debris, requiring additional maintenance.
- Highly structural nature may be cost-prohibitive in certain applications.

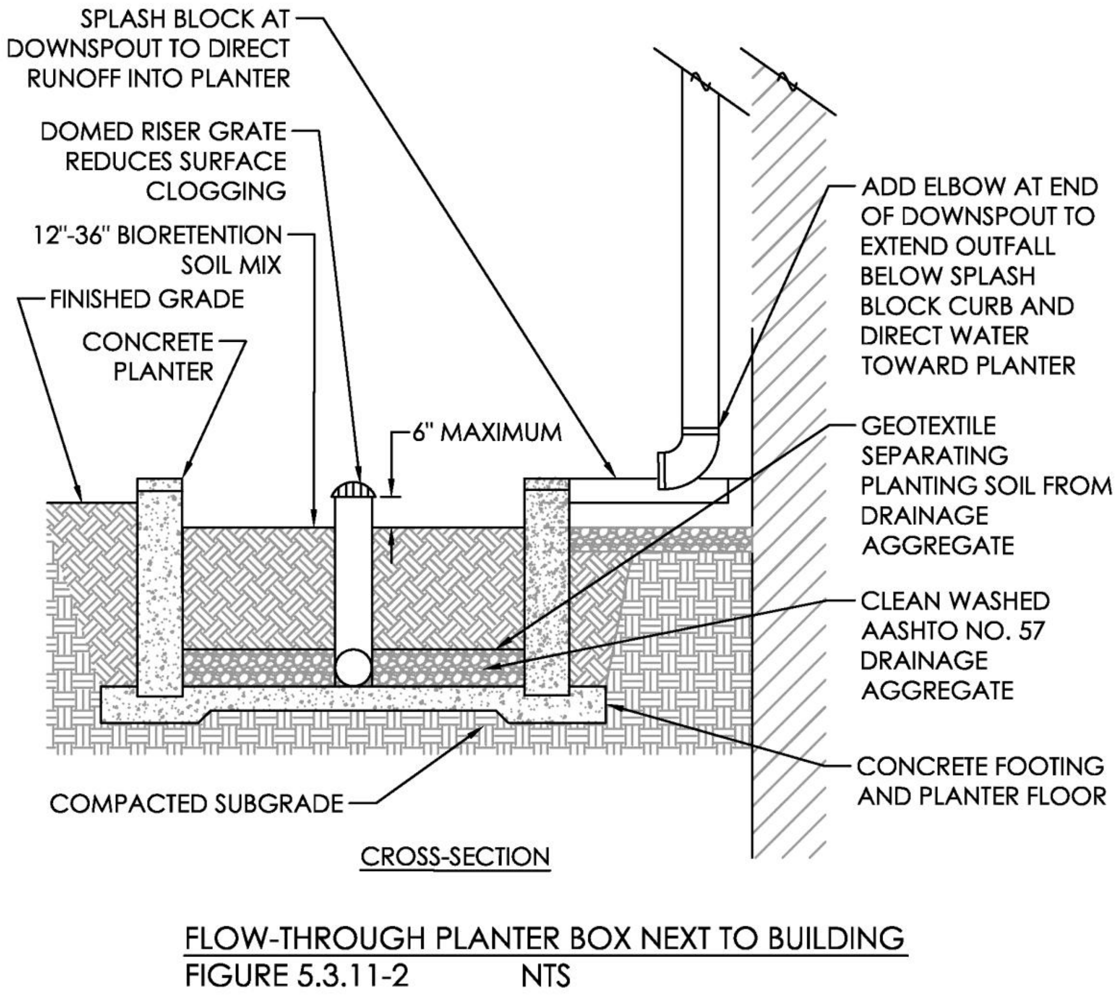


Figure 5.3.11-2. A typical cross-section for a flow-through planter box.

Applications

Planter boxes may be used in myriad ways in the urban and suburban environments, on residential, institutional, and commercial properties and within the public right-of-way. 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.

Streetside Planter Box

Figures 5.3.11-3a and b. This street was retrofitted to incorporate infiltration planter boxes within the right-of-way. Runoff enters the planter boxes through curb cuts.

Parking Lot Planter Box

Figure 5.3.11-4. Infiltration planter box within a parking lot, during construction. Water will enter through curb cuts, which are closed during construction. Note that the asphalt around the planter box was milled and repaved, allowing it to drain to the curb cuts following construction.

Institutional Planter Box

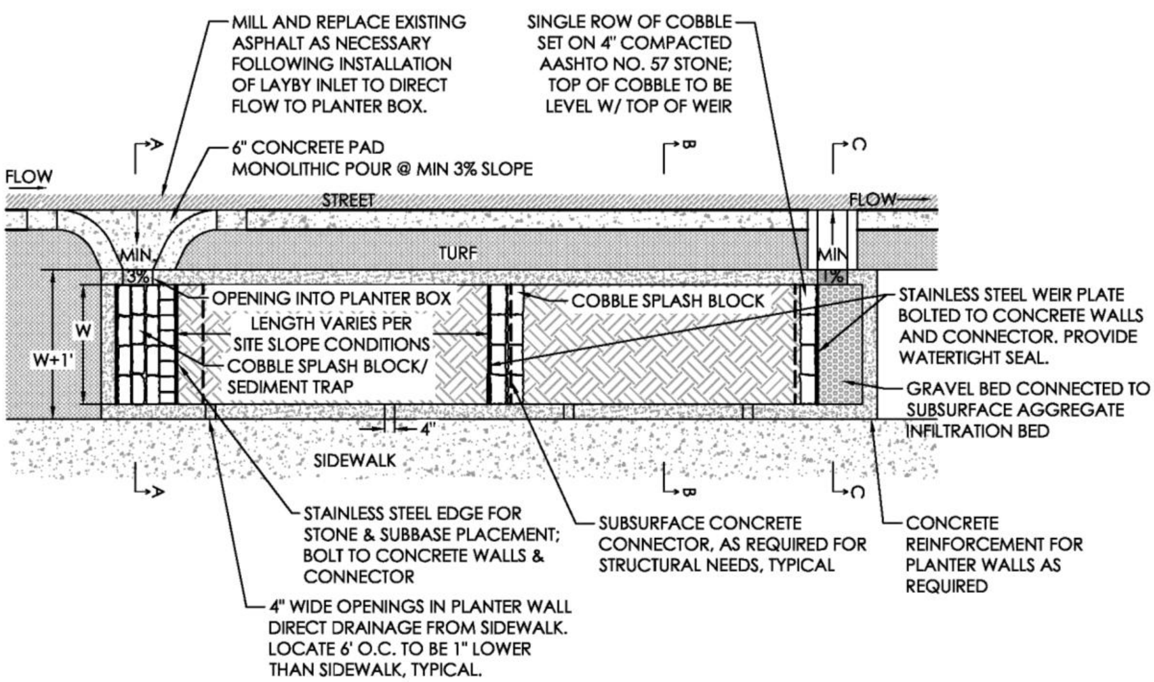
Figure 5.3.11-5. Flow-through stormwater planter boxes adjacent to this library receive roof runoff and provide plantings within the hardscape seating area. Overflow from these planter boxes is directed to a bioretention area (right side of photo). River cobbles (not shown) were added to eliminate any tripping hazard in a high-use area by reducing the depth of the planter box edge to the finished surface.

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. Examples of curb extension planter box design details are shown on Figures 5.3.11-6 through 5.3.11-9.



STREETSIDE PLANTER BOX EXAMPLE (SLOPES ≤ 5%) WITH INFILTRATION BED PLAN VIEW
FIGURE 5.3.11-6 NTS

Figure 5.3.11-6. Example of streetside planter box (plan view). Weirs are used to “step” the sections of the planter box down the slope.

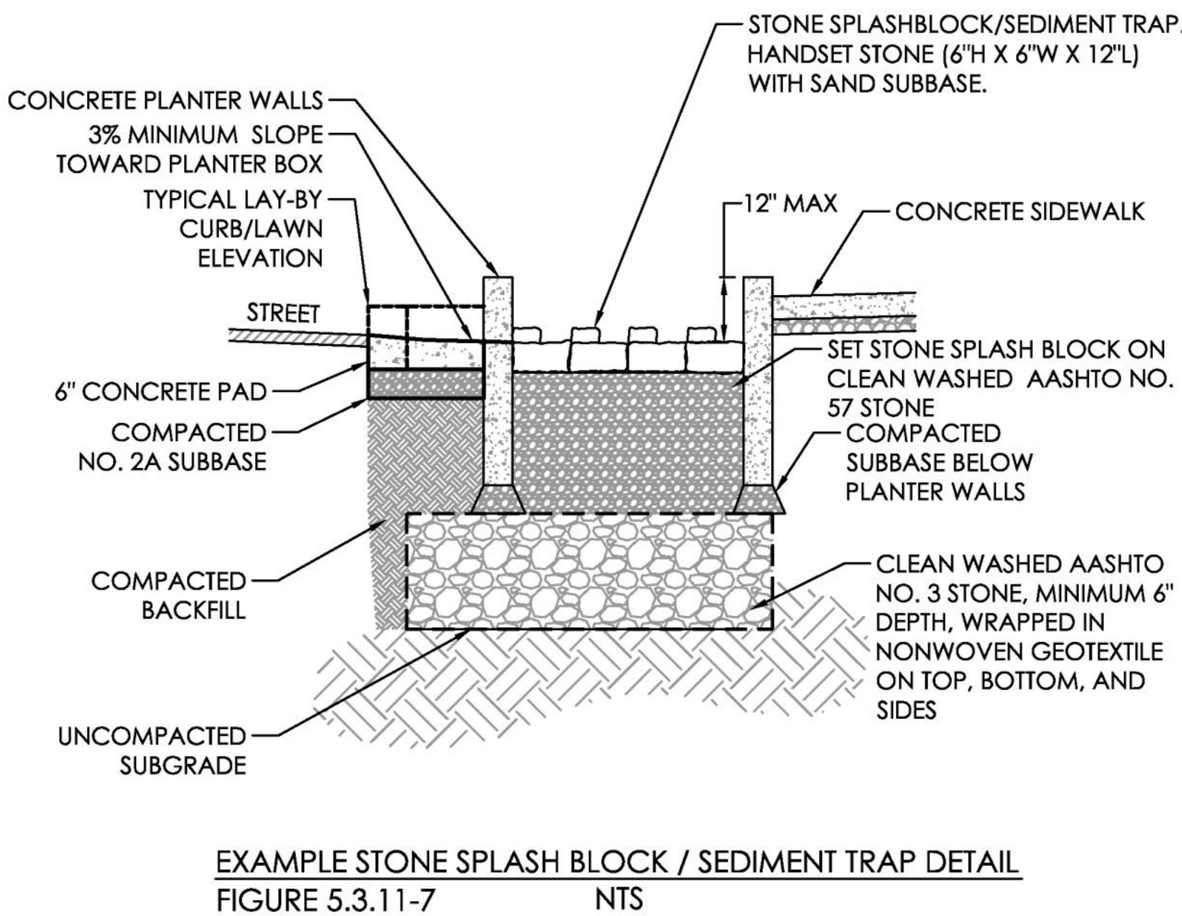


Figure 5.3.11-7. Example of the entrance conditions into a streetside planter box (cross-section A-A').

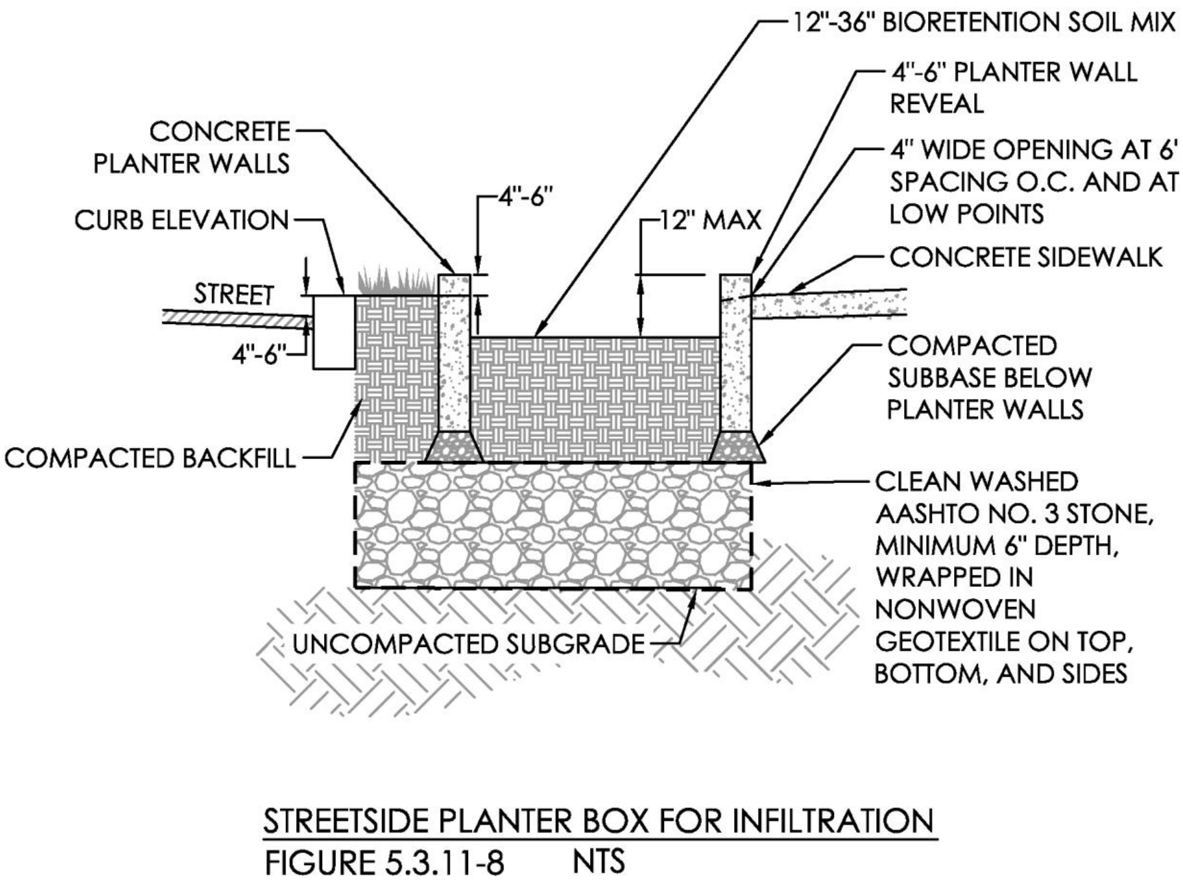


Figure 5.3.11-8. Example cross-section streetside planter box (cross-section B-B'). This planter box includes an underlying stone storage bed to increase storage capacity.

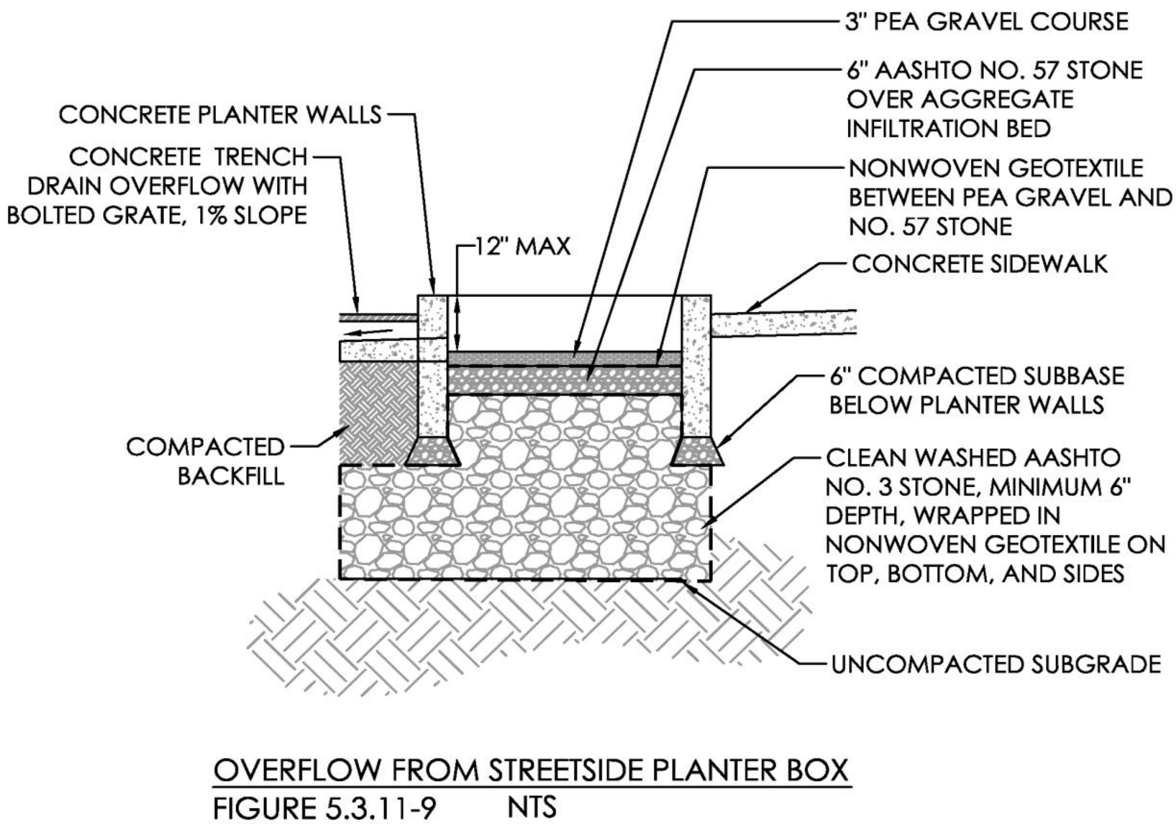


Figure 5.3.11-9. Example of the overflow (exit) from a streetside planter box (cross-section C-C'). In this application, a gravel connection to the underlying stone bed is provided.

Applicable Protocols and Specifications

The following Protocols and Specifications (see Appendices A through F) are applicable to planter boxes and must be addressed:

- Protocol 1 Setbacks from Structures
- Protocol 2 Coordination with Other Utilities
- Protocol 3 Site Evaluation and Infiltration Testing
- Protocol 4 Infiltration System Design and Construction Guidelines
- Protocol 5 Planting and Mulching Guidelines

- Appendix F
  - Aggregates and Drainage Layers
  - Stormwater System Specifications
  - Bioretention Soil Specifications
  - Pipes
  - Control Structures
  - Geotextiles
  - Impervious Liners and Waterproofing

Design Considerations for Planter Boxes

The key design components for planter boxes discussed below allow design flexibility to ensure maximum performance from this BMP.

1. Location and Capture Area

- When possible, the planter box should be located directly downstream of the existing stormwater source to maximize runoff capture.
- Planter boxes shall be constructed a minimum of 2 feet behind the curb if they are located adjacent to on-street parking. If planters are constructed in an area where there is no parking or loading, they may be constructed directly behind the curb.
- Planter boxes may intrude into the walking zone a maximum of 1 foot. A minimum walkway width of 4 feet must be maintained, 5 feet is preferred, and even greater may be required on high-volume pedestrian streets. ADA requirements must be followed.
- Planter boxes may not be placed adjacent to a designated handicapped parking space.
- Planter boxes are best suited to capture smaller drainage areas and may only capture a portion of the SOV.
- If applicable, consider linking subsurface storage beds to complementary BMPs as part of a larger system, or “treatment train,” to achieve additional stormwater and streetscaping benefit.

2. Entrance/Flow Conditions

Runoff can enter a planter box from roof leaders or through stormwater pipes, sheet flow, or curb cuts. All planter boxes must be designed to receive flow that will not cause scour or erosion at the soil surface. Roof drains and concentrated flows should be directed onto a stabilized surface within the planter box, such as a splash block or cobbles, to minimize entrance velocities.

Curb cuts or trench drains are sometimes used to convey runoff from the street to stormwater planters. Curb cuts are used when planter boxes are constructed directly behind the curb (see Figure 5.3.11-10). Trench drains are used when the planter is set back from the curb and water must be conveyed under an area with pedestrian access. Concrete aprons can be placed on the street side of curb cuts or trench drains to facilitate capture. Splash blocks or another energy dissipater should be placed on the planter side of the trench drain to prevent erosion (see Figure 5.3.11-11). To capture sidewalk runoff, notches may be cut in planter walls every few feet, depending on grade and the size of contributing drainage areas.

Figure 5.3.11-10. Curb cuts convey street runoff into and out of this streetside planter box. Overflow from the planter box is captured by the downstream storm sewer inlet.

Figure 5.3.11-11. A concrete splash block at a downspout to a flow-through planter box prevents erosive conditions at the soil surface.

3. Management of Sediment, Trash, and Debris

Planter boxes may often collect sediment, leaf litter, trash, and other debris, so they may require frequent inspection and maintenance for removal of accumulated trash and debris. In areas of high trash or with specific concerns such as plastic shopping bags (a common concern in commercial areas), the entrance conditions may include a screen to prevent material from entering the planter box. Plant selection should consider the amount and type of trash that may enter the planter box. Items such as windblown plastic shopping bags that adhere to vegetation should be considered when selecting plants.

All plants, entry points, and structural components should be inspected and maintained in accordance with Chapter 8 of this manual.

4. Storage and Stay-on-Volume

A planter box provides volume management within the surface ponding area, the bioretention soil area, and the stone storage bed (if applicable). Because water must move **through** the bioretention soils, the entire volume is storage. This is different from non-vegetated BMPs, such as pervious pavement wherein the pavement section is excluded.

The **SOV** is a function of the storage volume available for the 1.0-inch or 1.6-inch storm.

Storage Volume (ft^3) =

Surface Water Volume + Soil Storage Volume + Stone Storage Volume

Surface Water Volume: Available surface water storage between soil surface and overflow structure (always equal to or less than 6 inches).

Soil Storage Volume: This is the bioretention soil volume x 0.20 void space ratio.

Soil Storage Volume (ft^3) = Soil Area (ft^2) x Soil Depth (ft) Below Overflow x Void Ratio

Stone Storage Volume: This is the stone storage volume x 0.40 void space ratio.

Stone Storage Volume (ft^3) = Stone Area (ft^2) x Stone Depth (ft) Below Overflow x Void Ratio

Void ratios are generally:

- 0.20 for bioretention soils
- 0.40 for clean-washed aggregate such as AASHTO No. 3
- 0.85 to 0.95 for manufactured storage units depending on manufacturer

5. Area and Dimensions

One of the benefits of planter boxes is that they can be adjusted to fit the dimensions of very small spaces such as narrow spaces adjacent to buildings, along walkways and streets, and adjacent to parking areas. Planter box surface depth and curb requirements should always be considered to avoid creating trip hazards for pedestrians. The bottom of each planter box should be level.

Planter boxes are typically designed to have some surface ponding and soil storage, and they sometimes are designed with stone storage below the planting soil. By constructing the planter box without a liner or concrete bottom, a planter box may be designed for infiltration.

A basic guideline is to plan for a planter box with a surface area that does not exceed a rule-of-thumb ratio of the impervious and compacted pervious areas draining to it. The amount of rainfall volume must also be considered. The following ratios based on design rainfall depth can be used to estimate a planter box area:

1-inch Rainfall
1:10 ratio of surface area to impervious drainage area

1.6-inch Rainfall
1:8 ratio of surface area to impervious drainage area

The dimensions of ponding depth, planting soil depth and width, and stone depth and width within a planter box are a function of the quantity and velocity of stormwater it is intended to receive, and the available space for construction. The designer should estimate the depth of water, soil, and stone storage using the Sizing Calculations Worksheet.

As a general rule-of-thumb, planter boxes should meet the following guidelines:

- Surface ponding depths should not be greater than 6 inches, especially when constructed in pedestrian areas.
- Planting soils should be a minimum of 12 inches in depth and should be adequate to support the vegetation types selected for planting.
- The internal dimensions of a planter box will vary based on site conditions and the desired stormwater capture.
- If stone storage is required, the footprint of the stone may extend outside of the limits of the planter box if it is constructed without a bottom.

The recommended depths for surface water storage, soil storage, and stone storage are:

Surface Water Storage Depth: 6 inches maximum in high-use areas (along streets, at schools, in public landscapes, etc.)

Bioretention Soil Depth: Between 12 and 36 inches

Stone Storage Depth: Minimum 6 inches

6. Overflow and Peak Rate

All planter boxes must provide a safe way for water to exit the system when large storms generate more stormwater runoff than the planter box can hold. The inclusion of a positive overflow route ensures that flooding risks and related property damage are minimized.

The positive overflow route is often in the form of a domed riser or grated pipe that is placed within a planter box at the maximum ponding depth elevation (see Figure 5.3.11-12). The domed riser or grated pipe may create a direct connection of the planter box surface to the subsurface soil or stone, and it may also serve as a positive overflow connection designed to allow high flows to be conveyed through the device to an approved discharge point. **The minimum allowable diameter of an overflow pipe for small**

planter boxes (such as adjacent to buildings) is 4 inches. All overflows must safely convey the 10-year peak rate. Designs should also ensure that in the event that an overflow pipe becomes clogged or a rain event larger than a 10-year event occurs, then overflows will have a safe emergency escape route rather than being allowed to flood buildings or other structures.

Figure 5.3.11-12. A grated pipe in a stormwater planter box provides overflow to existing storm sewer when ponding above the designed water level occurs on the surface (similar to Figure 5.3.11-2).

Planter boxes designed with surface entry points, such as through curb cuts or trench drains, may be graded such that, once full, they do not receive any more water and flow back onto the contributing surface to a complementary BMP or other approved discharge point.

Peak Rate Control and Infiltration Credit

For the purposes of site peak rate control, the designer may adjust the curve number value based on the volume managed by both the SOV and the infiltration volume that occurs during a portion of a 24-hour storm event. This will allow the designer to account for runoff that was captured by applying LID, and develop a representative lower curve number. This is described in Chapter 7.

When adjusting the curve number, the infiltration volume can be estimated as the infiltration that occurs during 12 hours of a 24-hour design storm. This will ensure that estimated infiltration volumes are not greater than the actual volume captured within the BMP.

Infiltration Volume (ft^3) = Planter Box Bottom Area (ft^2) x Infiltration Rate (in/hr) x 1/12 x 12 hours

7. Freeboard

It is recommended that planter boxes include a **minimum of 4 inches of freeboard** above the overflow route. Higher freeboard may create a deeper planter box surface, which may be undesirable in pedestrian areas. The designer should consider the potential for flooding onto sidewalks or other areas and provide control measures.

8. Underdrain

When a planter box is not designed for infiltration but is constructed with a liner or an impermeable box structure, an underdrain is required. The underdrain is used to ensure that water moves through the system so water does not pond for excessive time periods on the surface or become stagnant below grade. **Underdrain systems must be included in the design if the native soil infiltration is less than 0.1 inch per hour or if the system is lined with an impervious liner** and intended for slow release only. Underdrains must be located at the intended bottom of the planter box system (i.e., below soils and stone if applicable). See Protocol 3 for the infiltration testing procedure and Protocol 4 for infiltration system guidelines.

Planter boxes require very low discharge rates when managing the water quality volume. However, planter boxes are generally small in area and it may be difficult to construct an underdrain that can extend the discharge rate over more than 48 hours. Planter boxes that capture less than 1,000 square feet of impervious drainage are assumed to provide water quality volume with a discharge of the water quality storm between 24 and 48 hours.

9. Waterproofing

Planter boxes are uniquely able to fit into spaces where space limits the use of other BMPs, such as adjacent to structures and roadways. When planter boxes are designed near existing infrastructure or buildings, they should be designed with a liner or impermeable box structure to prevent water from causing damage to foundations and other infrastructure components (see Figure 5.3.11-13). The liner, if applied, must meet the guidelines provided in the Stormwater Specification. It is recommended that planter boxes adjacent to buildings be fully lined. Other planter boxes, such as along streets and parking lots, may be designed to discharge through the bottom of the planter box provided that the requirements of Protocol 1, Setbacks from Structures, and Protocol 2, Coordination with Other Utilities are met.

Figure 5.3.11-13. A waterproof liner is placed in the stormwater planter box to protect the adjacent building.

10. Bioretention Soils

Planter boxes should have soils adequate to support vegetation and stormwater absorption, and should meet the intent of the soils specified in Appendix F – Bioretention Soil Specification. If the planter box is intended to infiltrate, it is essential that the native subsoil within the infiltration footprint is not compacted with construction equipment.

Planter box bioretention soils must never be placed when wet or during wet weather. Soils should be protected from saturation until plant installation, and from sediment deposition into the planter box.

11. Vegetation

The type of plant and planting plan for planter boxes must comply with Protocol 5 (Appendix E) of this guide. Plants appropriate to the aesthetic and visibility needs of planter boxes should be specified. When located along streets, plant material selection must consider visibility for traffic needs. Plants cannot grow to block signs or obstruct views.

12. Water Quality/Total Suspended Solids

Planter boxes that can capture and manage the required SOV through infiltration are considered to meet all water quality requirements. Planter boxes that are underdrained must be sized to provide water quality treatment. See Chapter 7 for additional discussion.

Sizing Calculations Worksheet for Planter Boxes

(Link to worksheet)

Construction Considerations

Planter boxes should be built in the final phase of construction to prevent damage.

No sediment-laden waters should enter the planter box at any time. The planting of vegetation should coincide with the plant's growth cycle to promote successful establishment, and the planter box should be protected from runoff entering until the vegetation is adequately established.

Construction Sequence Example

Step 1 Excavate Planter Box

a. Protect planter box area from sediment and stormwater runoff during construction.
b. Excavate to the bottom elevation of the system, either the bottom of soil, the bottom of the stone, or the bottom of the structural box. If the planter box is designed for infiltration, care should be taken not to compact the existing subsoil.

Step 2 Install Planter Box

a. Construct planter box sides (and bottom) as required (see Figure 5.3.11-14).
b. Place geotextile at the bottom elevation of the excavated area for an infiltration planter box. For a flow-through planter box, place liner or waterproof constructed box (see Figure 5.3.11-15).
c. Install underdrain system if required.
d. Install stormwater piping and structures at specified elevations. Ensure that all stormwater structures are protected from sediment.
e. Fill planter box with planting soil and/or stone at elevations specified in the design (see Figure 5.3.11-15). Complete final grading of the planter box after the top layer of soil is added. Lightly tamp down soil.
f. Construct splash blocks at entry points to the planter box.
g. Construct curb cuts and/or trench drains into the system if applicable.
h. Seed and vegetate according to plans. Plant the planter box at a time of the year when successful establishment without irrigation is most likely. Temporary irrigation may be needed in periods of little rain or drought.
i. Mulch planted area with compost mulch to prevent erosion while plants become established.
j. Protect planter boxes from sediment at all times during construction.
k. Before erosion and sediment control measures are removed or downspouts are disconnected in a planter box, verify that vegetation is sufficiently established.

Figure 5.3.11-14. A stormwater planter box during construction. The sidewalls of the planter box are constructed once the final surface grade outside the box is met.

Figure 5.3.11-15. A stormwater planter box that includes a stone bed during construction with geotextile to separate the soil and stone.

Operations and Maintenance

Both the structural components and vegetation within planter boxes require routine inspection and maintenance. Plants may require additional water during extremely dry periods and care should be exercised to ensure that appropriate measures are taken to protect plantings during periods of frost and other damaging weather events.

All inflow and outflow structures must be inspected and maintained to ensure removal of accumulated sediment and debris. See Chapter 8 for additional guidance.