

1. PLACEMENT, LOCATION, AND LAYOUT

- a. It is allowable and sometimes beneficial to interconnect multiple SMPs (either of the same type or of different types) or to interconnect SMPs with an adjacent or nearby subsurface storage system. While the term "SMP" refers to one of the specific Green Street practices (e.g. stormwater planter, stormwater bump-out, etc), a Green Street "system" refers to multiple SMPs that are hydraulically connected or to a single SMP that is hydraulically connected to another stormwater storage system.
- b. Green Street systems should be located directly upgrade of existing inlet locations whenever possible or located such that any bypass or overflow from a new Green Street system will be managed by the street's drainage facilities without negatively impacting existing drainage conditions under any circumstances. Appropriate offsets should be maintained from existing inlets if they will not be replaced. Refer to *PWD's Green Stormwater Infrastructure (GSI) Design Requirements and Guidelines* for information regarding replacement of existing inlets.
- c. While the Design Details themselves do not address their application in excessively steep street conditions, use of these details is not precluded by steep conditions. Instead, additional design features and configurations may be necessary to apply them in these conditions.
- d. In order to protect SMPs and Green Street systems from future construction on adjacent parcels, a minimum 3-foot buffer must be provided between the edge of the system and the right-of-way line.
- e. Infiltration systems should be placed at a distance to prevent damage to adjacent buildings. PWD recommends a minimum of 10-feet offset.
- f. Placement and siting of SMPs should consider the adequacy of existing street lighting as well as the interaction of lighting with trees and vegetation in order to improve night-time visibility of SMPs.

2. UTILITIES

- a. All impacts or potential impacts to surrounding utilities must be reviewed and approved by the utility. PWD generally follows and recommends the following clearances between utilities and SMPs/Green Street systems
 - Maintain a minimum of 3-feet horizontal and 6 to 18-inches vertical offset from existing utility lines. Consider the utility type, age, and condition.
 - Maintain an offset from sewers and sewer laterals such that the extents of the SMP/Green Street system are outside of the zone defined by a 1:1 slope line extending from the bottom of the sewer line to the ground surface. If within this zone, use an impermeable liner along the sides and bottom of the portion of the SMP/Green Street system that is within the zone.
 - Maintain a minimum of 5-feet horizontal offset from electric poles or other comparable existing infrastructure. Support and protect such poles during construction as needed.
 - Maintain a minimum of 3-feet horizontal offset from traffic lights.
- b. Utilities other than sewers and sewer laterals may pass under or through an SMP/Green Street system. Specific design requirements are subject to the requirements of each utility owner. At a minimum, anti-seep collars and utility sleeves must be included on service pipes that enter and exit an SMP/Green Street system. Consent from the utility owner should be obtained in writing prior to design.

3. GENERAL CONSTRUCTION GUIDELINES

- a. At a minimum, the following construction guidelines should be communicated for any Green Street project either in construction specifications or as notes on final design plans.
 - Erosion and sediment controls **must** be in place before work begins.
 - Clearly mark areas for SMPs/Green Street systems before any site work begins to avoid soil disturbance and compaction during construction.
 - Excavate SMPs/Green Street systems to proposed depth. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, remove the material and scarify the underlying soils to a minimum depth of 6-inches.
 - Do not compact existing subgrade or subject it to excessive construction equipment prior to placement of any materials into the SMP/Green Street system. It is essential that all construction equipment be operated from outside of the limits of the SMP/Green Street system. If that is not feasible, use low ground pressure equipment approved by the Engineer. Do not use equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires, which will cause excessive compaction. Note the above does not apply to lined SMPs/Green Street systems, which may be compacted as needed. Also note that this rule applies only to the subgrade (i.e. existing soils below the SMP/Green Street system) and other materials within the area of an SMP/Green Street system may and often do require compaction such as the backfill material placed between the top of a tree trench's storage media and the underside of the sidewalk.
 - Obtain approval by the Engineer and hand-rake to scarify subgrades of infiltration systems prior to placing any materials into excavation.

4. OTHER

- a. Except for individual stormwater trees, all disturbed curb and sidewalk must, at a minimum, be replaced to the next joint beyond the limits of disturbance. Individual stormwater trees do not require restoration beyond the footprint of the tree pit disturbance. Additional restoration requirements may be required beyond this minimum as they relate to ADA compliance or specific site conditions. All sidewalk, curb, and pavement restoration is to be in accordance with *Streets Department Standards, Detail L-892*.
- b. The bottom surface (i.e. bottom of excavation) of all SMPs/ Green Street systems should be level.
- c. Designs should consider minimum and maximum depths of excavation due to surface elevation changes over length of systems. It is recommended to limit the total system depth to prevent the need for excavation support during construction or repair and potentially higher installation costs.
- d. Existing trees in good condition are to be preserved wherever possible. Additionally, designs should limit excavation around existing trees whenever possible. Excavation should not be performed within 6 feet of existing trees in good condition and, in general, excavation should be restricted to a distance of one foot for every diameter inch of any adjacent tree. Contact PP&R or a professional arborist for guidance on excavating around and preserving existing trees.
- e. All design shall comply with the *ADA Standards for Accessible Design* and *Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right of Way*.
- f. For PennDOT roads different requirements and criteria for Green Streets may apply and must be coordinated with PennDOT.

5. SMP DEPTHS AND AREA PROTECTION [*Pending confirmation with Risk Management, per meeting minutes from 9/19/2013 meeting*]

- a. Maximum surface depth of all SMPs shall be 15-inches below the sidewalk level unless otherwise approved by the City.
 - b. SMPs within the sidewalk such as stormwater planters and stormwater trees must have an approved form of Area Protection (FS-1) around the SMP in all cases.
 - c. For SMPs in the parking lane or street shoulder such as bumpouts, an Area Protection Barrier (AP-1.1) along the curb line between the sidewalk and the SMP is preferred over a flush curb. If an Area Protection barrier is not used and the curb is flush between the sidewalk and the SMP, some other visual/sensory cue must be provided along the curb line.
 - d. Increasing visibility of SMPs during both day-time and night-time conditions is an important consideration. Area Protection barriers should use contrasting colors that differ from the color of adjacent surfaces as much as possible. Reflective surfaces or reflective features should be considered and incorporated into Area Protection barriers where practical.
6. FS-5 LANDSCAPING:
- a. When trees are planted, 2 1/2 inch caliper trees are recommended.
7. FS-6 PLANTING MEDIA:
- a. Length, width and depth of planting media can vary, but minimum dimensions should be appropriate for the vegetation planted.
 - b. When trees are planted, the soil should provide adequate depths for root balls. Generally, this will be a minimum of 3 feet deep from the planting media's surface elevation. It is preferred that the planting media for trees extend directly to the subgrade without storage media below. Also, it is preferred that storage media not separate the planted trees from adjacent areas of native soil. Root paths should be provided whenever possible to allow roots to readily access native soil.

8. FS-7 STORAGE MEDIA:

- a. The extents of the storage media and the limits of the planting media are not required to coincide and, at times, do not. Often times, the extents of the storage media extend well beyond the planting media in order to provide the stormwater storage capacity required per the design requirements and guidelines (see Chapter 5).
- b. Extending subsurface storage media beneath curbing or using certain sectional geometries (particularly when using stone as the storage media) can create some complexities for construction that should be considered during design.
- c. The subsurface storage media should not extend downslope of the Green Street system lowest point of overflow. This is to prevent the water level in the system from encroaching into the subsurface or through the surface of the downgrade sidewalk.

9. FS-8 MEDIA SEPARATION:

- a. Geotextile fabric is used along the vertical side and top of storage media only. It should not be used along the bottom surface of SMPs/Green Street systems.

10. FS-9 PIPING:

- a. Every straight run of pipe should be accessible from at least 2 points.
- b. 90 degree pipe bends are not permitted. At maximum pipe bends should be at 45 degree angles, though 22 ½ degree bends are preferred.

- c. Pipe bends should be avoided whenever possible. Straight pipes with fewer cleanouts are easier and less time consuming to maintain than pipes with bends and more cleanouts.
- d. All pipes should have a box or sump to which they can be flushed. Typically, flushing can occur back to an inlet structure. However, if pipes do not connect to an inlet structure, then a sump or other flushing collection point should be provided. If the cleaning point will be a domed riser, then the domed riser should be at a minimum 12-inches in diameter, though a 15" diameter is preferred.
- e. Regardless of whether a system is designed for infiltration or for detention/slow-release or if they are shown on the Design Details, underdrains must be installed in all systems. This allows for conversion to a detention/slow-release system if infiltration capacity fails due to clogging in the future. Exception to this rule for stormwater trees has been typical.
- f. Though not necessarily shown on all design details included herein, at least one observation well must be installed per SMP/Green Street system, except for individual stormwater trees. However, additional observation wells should be installed as needed to adequately observe water levels in Green Street systems.
- g. All underdrain and distribution piping must maintain a minimum of 6" of stone on all sides or as required based on specific design application, conditions and pipe manufacturer. Minimum cover over all pipes must also be maintained as required based on specific design application, conditions, and pipe manufacturer. It is preferred to maintain as much clearance as feasible between tree pits and piping. If a material other than stone is used as a storage media (e.g. prefabricated modular materials), other requirements may apply.
- h. Although not typical, underdrains may be installed in a sumped trench that is below the bottom elevation of the system's surrounding storage media if feasible and appropriate.
- i. A perforated distribution pipe should generally run the length of any subsurface storage system. The distribution pipe should be sloped toward the stormwater entrance location at 0.5% so that trash and debris stay at one end of the pipe.
- j. Any pipe run for distribution and underdrain piping should at minimum, have cleanouts every 75' and at the end of all pipes. Additionally, cleanouts should be located upstream of complicated bends and evenly spaced during straight pipe runs.
- k. All intermediate cleanouts and domed riser connections must face upstream to allow for cleaning equipment to flush in the direction of the inlet.
- l. Cleanouts, observation wells, and/or piezometers should not be located in driveways unless necessary.
- m. Underdrains should extend inside the subsurface of the SMP/system for a minimum length of 20-feet where possible. All underdrains should be installed without any slope.
- n. Underdrains should typically connect to an inlet structure and terminate either in a solid cap (infiltration systems) or orifice (detention/slow-release systems). If it is not possible or advisable to connect the underdrain to an inlet structure for infiltration systems, the underdrain must extend for a minimum of 5-feet outside of the system and be capped. This will allow for future access to the underdrain without disruption of the system should the system need to be converted to detention/slow-release.
- o. All distribution and underdrain piping must have anti-seep collars where they enter and exit a Green Street system.
- p. Minimum allowable pipe size for distribution pipes and underdrains is 8-inches.

11. FS-10 IMPERMEABLE BARRIERS:

- a. Systems should be lined and slow-released if there are any geotechnical or contamination issues that would make infiltration inadvisable.