Rutgers New Jersey Agricultural Experiment Station

NJ URBAN & COMMUNITY FORESTRY

STORMWATER TREE BED GUIDANCE

FOR THE USE OF STREET TREES AS STORMWATER MANAGEMENT TOOLS

About This Manual

This guidance manual is meant to be used by planners, engineers, and designers for optimizing street trees as tools for stormwater management. This guidance manual may also serve as a basic guide for best practices for general street tree planting. To accomodate a variety of site conditions and budgets, three scales of stormwater tree beds are detailed in this guidance manual: single tree beds, extended tree beds, and tree trenches.

The engineering details found at the below can be used and adapted as needed to work in larger green or complete street designs. Details for several sizes of tree beds are provided, so the appropriate technique can be applied in any project context.

Engineering Details

Introduction

When it rains, untreated stormwater runoff can carry pollutants such as fertilizers, pesticides, oils, bacteria, sediment, and loose garbage into nearby waterways, causing harm to aquatic life and disrupting ecological systems. This type of pollution is known as nonpoint source pollution. Using stormwater tree beds to capture and filter stormwater runoff before it enters local waterways is a great way to improve the health of urban and suburban waterways and to also take pressure off of existing storm sewer systems. Tree beds can help reduce the impact of untreated stormwater by providing space to hold and infiltrate runoff, improving the permeability of the surrounding soil via root growth, and increasing evapotranspiration. In addition to these environmental benefits, trees also provide other valuable benefits to urban and suburban communities by reducing heat island effect, increasing property values, and improving air quality (USEPA, 2013).

Stormwater planter with tree, NYC Department of Parks & Recreation

Site Selection of Tree Bed Installations

Selecting an appropriate location for a tree bed is important to minimize issues with tree health and to provide the best conditions for stormwater capture.

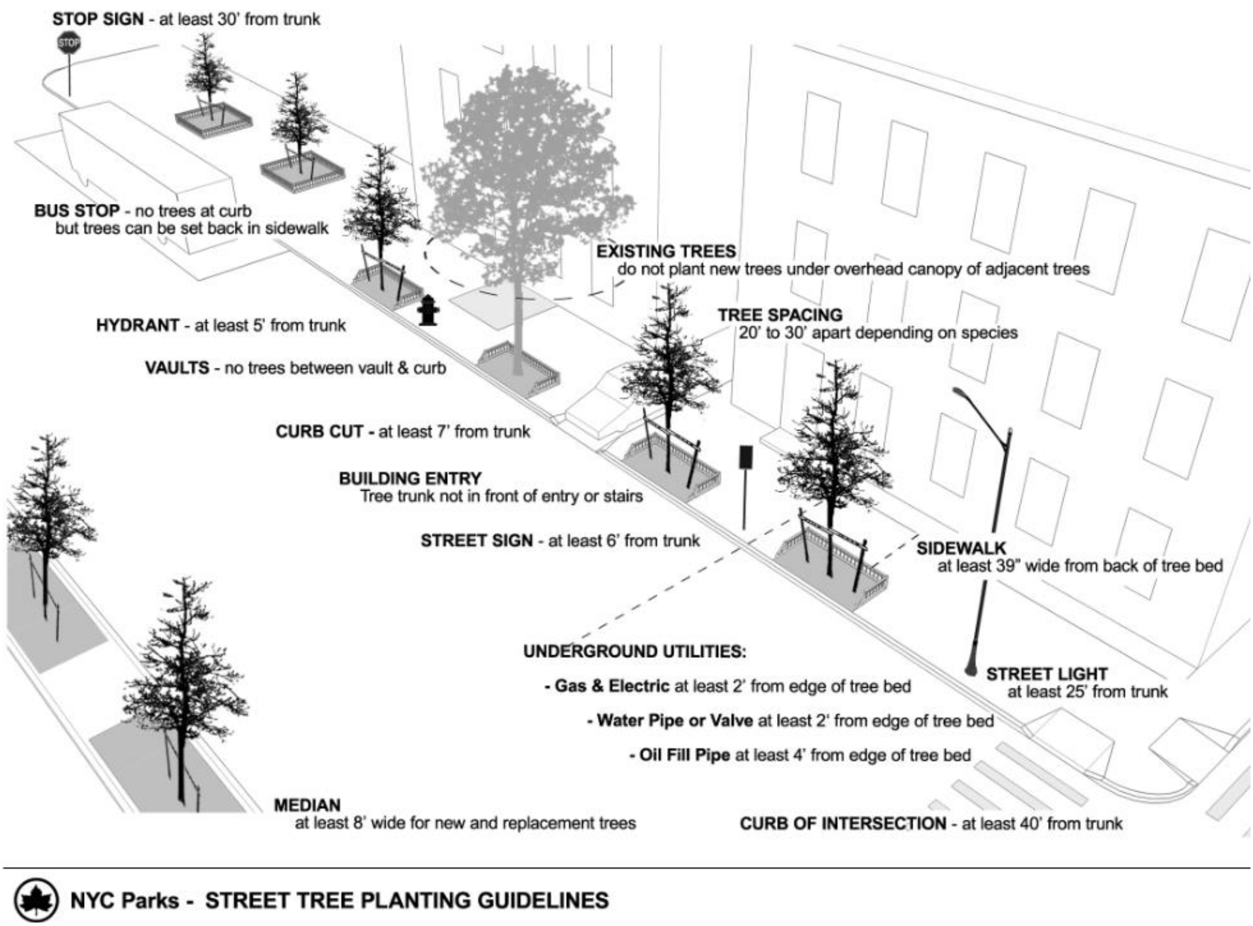
Optimizing for Stormwater Management

To optimize tree beds for stormwater capture, a site should be selected where an appropriate amount of stormwater is able to flow into the inlet; these would be places that are lower points in the landscape such as at the bottom of a small hill or in several locations descending along a larger hill. Care should be taken to avoid using a single tree bed at the bottom of a larger hill as the tree would be subject to the full flow of runoff from the entire hill and would likely overflow the bed unless appropriately designed.

Available Space

Tree bed size can be influenced by space availability within the project location. Nearby buildings, roadways, utility poles, and other adjacent structures should be considered. For instance, the American Disabilities Act (ADA) requires that all sidewalks be at least three feet in width for passing, and as such, no tree beds should be installed that would reduce the sidewalk width to under three feet.

New York City's planting guidelines for street trees clearly displays the many elements that must be considered when deciding where and which species of tree to plant.



Street tree planting guidelines, NYC Department of Parks & Recreation

Site Selection of Tree Bed Installations

Scale of Project

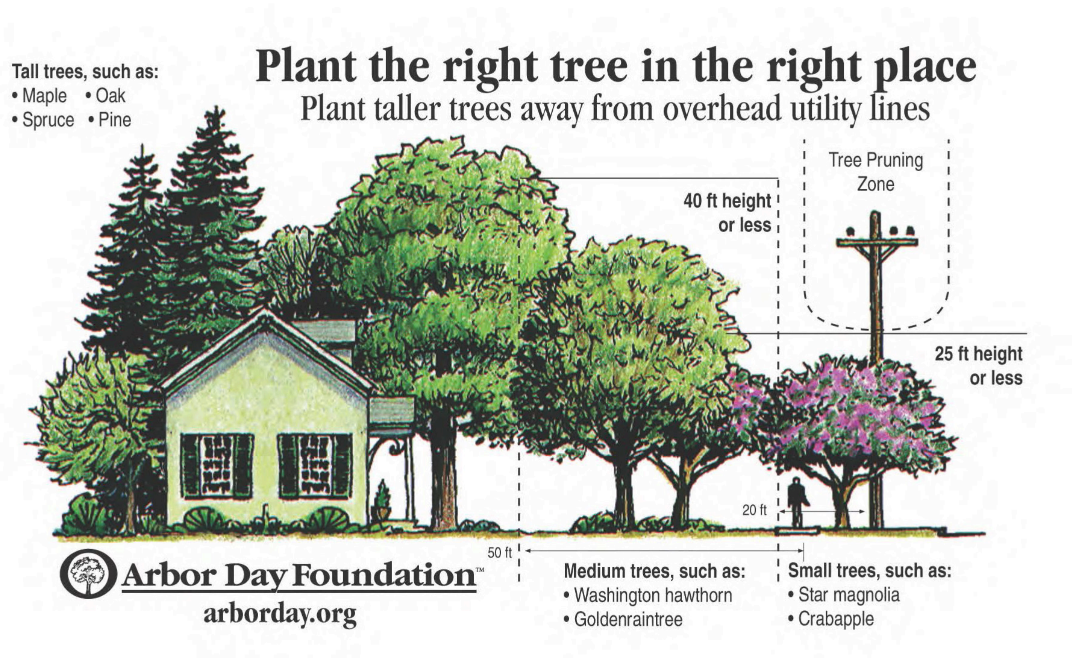
Project budget, available space, and the amount of runoff to be managed should be considered when selecting the size of the tree beds. The tree beds in this guide are provided at three different scales of installation (i.e., small, medium, and large) to help differentiate what can be done to manage corresponding amounts of stormwater. The cost to install the tree beds increases with the scale.

Utilities

Utilities present challenges for stormwater tree bed success. Both overhead wires and below ground utilities should be considered during site selection and avoided as necessary. Many issues with utilities can be resolved by selecting an appropriate tree species. Underground utilities require more attention with stormwater tree beds since the storage areas may increase the area distrubed.

Foot Traffic

The amount of foot traffic near the tree bed is also an important consideration. Where possible, pedestrians should be prevented from walking directly over the tree beds as this may lead to compacted soils over time, resulting in a disruption of ideal root growth. This compaction will also prevent water from entering the soil well, and stormwater tree beds need high flow to through the soil to function properly. Fences or other barriers can be used to deter walking directly over tree beds.



Tree planting height and power lines, Arbor Day Foundation

Soil Properties

Soil volume and soil matrix must be carefully considered in stormwater tree beds to enhance growth of trees, prevent compaction, and optimize stormwater storage.

Soil Volume

Tree roots need enough uncompacted soil volume to support the growth of the tree. In urban environments, the surrounding soils are typically very compacted to support paved surfaces. The general recommendation is to provide two cubic feet of uncompacted soil volume per one square foot of mature tree canopy (Lindsey & Bassuk, 1992). This does not apply to all species, particularly those with narrow growth patterns which would require more soil volume relative to their canopy. This equates to about 157 cubic feet for a 10-foot diameter tree, 628 cubic feet for a 20-foot tree, and 1,413 cubic feet for a 30-foot tree. At 3' of depth, this requires 49 square feet, 210 square feet, and 471 square feet of space, respectively. In urban environments, providing this soil volume is not always easy to do given constraints with space and utilities, but every effort should be taken to provide soil volumes as close to this criteria as possible. Virginia Tech Urban Forestry program developed a database in 2010 to provide information on the typical canopy dimensions of common landscape trees at functional maturity, which is valuable for planning urban landscapes with respect to proper species selection and planting densities. Strategies can be used to provide soil volume without sacrificing walkable and drivable spaces. Structural cells, suspended sidewalks, and structural soils can provide soil volume to plants by preventing compaction of underlying soils while still supporting the pavement.

Structural Cells & Suspended Sidewalks

These systems are designed to support sidewalks and pavements by creating a grid structure that will support the pavement and allow uncompacted soil to exist within the system. Structural cells, such as Silva Cells, are modular manufactured cells that can be easily placed and filled with soil in the void space. Suspended sidewalks utilize pillar structures to support the pavement instead. Both systems support the use of any soil media but are more complicated to install than structural soils.

Often tree beds are incorporated into streetscape systems that include an underlying stormwater system which connects several boxes (as shown to the left). This is also coupled with pervious concrete to increase the ability of the system to intercept and capture stormwater.

Example of structural cell installation, Rainsmart Solutions

Soil Properties

Structural Soils

Structural soils are a specialized soil that consists of a mix of gravel and soil. CU-Structural Soil® is a standard soil mix created by Cornell University that is commonly used (Bassuk, et al., 2015). The gravel structure supports the pavement while the voids between the gravel provide the soils media for the trees. Due to the gravel, this soil has a lower capacity for nutrients than traditional soil, so it should not be used unless alternatives are not feasible. These soils have a lower porosity compared to a typical sandy loam soil (i.e., 25% vs. 35%), so there is a tradeoff in stormwater management systems. However, these soils have a high infiltration rate and are good for rapid movement of water from the surface into the storage bed. In addition, the pH of the soils should also be considered when selecting a tree species. Depending on the source of the gravel, limestone gravel will result in a higher pH, with other types of gravel having a lesser effect (Bassuk, Trowbridge, & Grabosky, 2014).

Example of structural soil cross section, Urban Horticulture Institute

Soil Amendments

The adjacent soils, the tree species being planted, and the desire for the interception of stormwater should be considered when selecting the specific soil type to be used in a tree bed. Sandy loam soil is usually recommended for tree beds. Typical recommendations for bioretention system soils for stormwater are similar in texture and are usually specified as follows: 85% - 95% sand with no more than 25% of the sand as fine or very fine sands, no more than 15% silt, and with 2% - 5% clay content. The entire mix must then be amended with 3% - 7% organics by weight (NJDEP, 2021). Due to poor nutrient content and compaction in most urban soils, especially under pavement, external soils or amended soils are highly recommended. Depth of soil amendments is recommended at a maximum depth of three feet; deeper than that will not provide significant benefit to the tree. A minimum of 2' is recommended to provide enough soil volume and benefits.

Additional soil amendments may be required depending on the findings from soil testing to help supply additional nutrients or to alter soil characteristics with gypsum, lime, or sulfur. Refer to the “Recommended corrective actions for urban soils” table in USEPA’s Stormwater Tree Technical Memorandum (2016) for more guidance on soil amendments in an urban setting.

Mulch Options

Mulch & Mulch Alternatives

Mulch is an essential element of tree beds especially for young trees as it provides moisture retention for the tree. Organic mulches also provide nutrients back into the soil which are limited in urban settings. For all mulching, it is important to leave space around the trunk unmulched to prevent excess moisture on the trunk as well as to allow for future growth of the tree. Any mulch alternatives must allow flow of air and water to the soil system. When designed for stormwater capture, they should sustain inflow velocities and have high permeability. Mulch materials are preferred over tree grates in most cases; tree grates are not easily maintained, are costlier than alternatives, can be stolen, and encourage the use of small areas when planting trees based on standard grate sizes.

Unmaintained tree grates will choke trees as their trunks grow, prevent easy reapplication of mulch, and allow pedestrians to easily get too close to the tree. Alternatives are easier to maintain as the tree grows and typically cost less.

Pavers,Treestewards.org

Wood Mulch

Wood mulch is the preferred choice where regular maintenance will be conducted; the added nutrients over time will help the trees grow. Care should be taken to choose natural mulches that will maintain permeability, or action should be taken to loosen mulch if matting occurs.

Gravel & Stone

Loose gravel or larger stones can be used as a mulch layer while still providing moisture retention. This requires less frequent replacement compared to wood mulch. This is better where maintenance is limited and discourages walking over the tree bed more than the other options.

Resin Bound Stone & Pervious Pavement

Stone can be resin bound and remain permeable to create a walkable surface. Pervious pavement doesn't use resin, but similarly creates a durable and porous surface. This has benefits over gravel since gravel may be lost over time. Care should be taken to make sure the stone does not get clogged with excessive sediment over time. The area around the trunk should be filled with loose stone to allow future growth.

Mulch Options

Permeable Pavers

Pavers can be utilized with permeable gravel between the pavers to allow water and air exchange. Pavers can be removed as the tree grows.

Rubber Mats

Rubberized mats made from recycled tires are a viable alternative especially in playgrounds or areas where safety is a concern. It is thought that as the rubberized mats break down, chemicals may be leached into the soil that may not be ideal for tree health compared to other options. The use of shredded rubber mulch is strongly discouraged for this reason, whereas the rubberized mats will likely take much longer to degrade.

Gravel, MIG/SvR

(Above and below) Two examples of gravel used as mulch in street tree beds surrounded by varying sidewalk materials

Resin bound, Chameleon Ways

Gravel, Copley Wolff Design

(Left) Example of a resin bound stone mulch used in a street tree bed

Other Concerns

Soil Aeration

Trees need air in their root system to grow successfully which the addition of water may affect. The mulch or mulch alternative must allow air exchange to occur. Some mulch can clump over time, so care should be taken to check and loosen mulch if this occurs. A vertical perforated pipe can be used to assist with air and water exchange to the root zone and is easy to install.

Salts

Care should be taken to avoid concentrated salt inflow into tree beds as most species do not tolerate high salt concentrations. This is particularly important in tree beds specifically designed to capture stormwater as large quantities of salt may enter the system. If salts must be used, alternatives that are less harmful to trees should be considered such as calcium chloride, potassium chloride, and manganese chloride (Fox, 2021). Tree species should be selected that can tolerate high salt conditions where needed.

Maintenance

A maintenance plan should be developed for the stormwater tree beds so that the responsible agency or party can have clear instructions on what to look for when performing health checks and maintenance on the system. The tree bed system should be monitored for clogging of inlets/outlets, integrity of the structure, litter/debris removal, and vent pipe clearing. Over time, if these elements are properly monitored, the stormwater tree bed should remain functional for the life of the tree.

Scales of Tree Bed Installations

Tree bed installations can be made on a variety of scales depending on the space available, cost, and urban forestry goals. Three general sizes are recommended, but these dimensions can be easily adjusted or increased as projects demand.

Table 1 - Tree Bed Soil Volume and Canopy Potential

Tree Bed Type	Bed Size (SF)	Soil Volume (CF)	Potential Tree Canopy Diameter (FT)	Potential Tree Canopy Area (SF)
Single Tree Bed (5' x 5' x 3'D)	25	75	6.9	37.5
Single Tree Bed (6' x 6' x 3'D)	36	108	8.3	54.0
Extended Tree Bed (5' x 15' x3'D)	75	225	12.0	112.5
Tree Trench (5' x 25' x 3'D)	125	375	15.5	187.5
Extended Tree Bed under sidewalk 5' (10' x 15' x 3'D)	75	450	16.9	225.0
Tree Trench under sidewalk 5' (10' x 25' x 3'D)	125	750	21.9	375.0

Tree planting along Ferry Ave in Camden, NJ
An example of what a curbed tree trench could looks like using trench drain to capture water from the roadway

NJ Department of Urban Forestry

(Left) Tree planting of single tree beds in Trenton, NJ along Brunswick Ave at Martin Luther King Jr. Middle School

(Below) Tree planting along Ferry Ave in Camden, NJ using single tree beds and extended tree beds

NJ Department of Urban Forestry

Scales of Tree Bed Installations

Single Tree Bed

A typical tree bed involves simply placing a tree in a square space of about 5' by 5' or 6' by 6' while removing concrete or other pavement where needed. This will be the most cost effective and work in many spaces but may not provide adequate soil volume to the tree if an expanded area is not provided beneath the sidewalk. Only small trees should be planted in these beds. A 5' by 5' bed at 3' deep would give 75 cubic feet of soil allowing a tree of about a 7-foot diameter canopy. A 6' by 6' bed at 3' deep would give 108 cubic feet of soil allowing a tree of about an 8-foot diameter canopy.

Table 2 - Single Tree Bed Soil Volume and Canopy Potential

Tree Bed Type	Bed Size (SF)	Soil Volume (CF)	Potential Tree Canopy Diameter (FT)	Potential Tree Canopy Area (SF)
Single Tree Bed (5' x 5' x 3'D)	25	75	6.9	37.5
Single Tree Bed (6' x 6' x 3'D)	36	108	8.3	54.0

Rendering of single stormwater tree beds planted along a

RCE Water Resources Program

Scales of Tree Bed Installations

Extended Tree Bed

An extended tree bed is an elongated area of about 5' by 15' to provide additional soil volume to the tree. This system requires more space and is more expensive to install but provides much more soil volume to the tree, allowing the planting of larger species. A 5' by 15' bed at 3' deep would give 225 cubic feet of soil allowing a tree of about a 12-foot diameter canopy. The dimensions of these beds can be flexible to support more soil volume for planting even larger species. The soil volume can also be placed below the sidewalk or roadway using structural soils, structural cells, or suspended sidewalks. For example, expanding the soil volume under 5' of sidewalk would give 450 cubic feet of soil allowing a tree of about a 17-foot diameter canopy.

Table 3 - Extended Tree Bed Soil Volume and Canopy Potential

Tree Bed Type	Bed Size (SF)	Soil Volume (CF)	Potential Tree Canopy Diameter (FT)	Potential Tree Canopy Area (SF)
Extended Tree Bed (5' x 15' x3'D)	75	225	12.0	112.5
Extended Tree Bed under sidewalk 5' (10' x 15' x 3'D)	75	450	16.9	225.0

Cross sectional rendering of an extended tree bed

RCE Water Resources Program

Scales of Tree Bed Installations

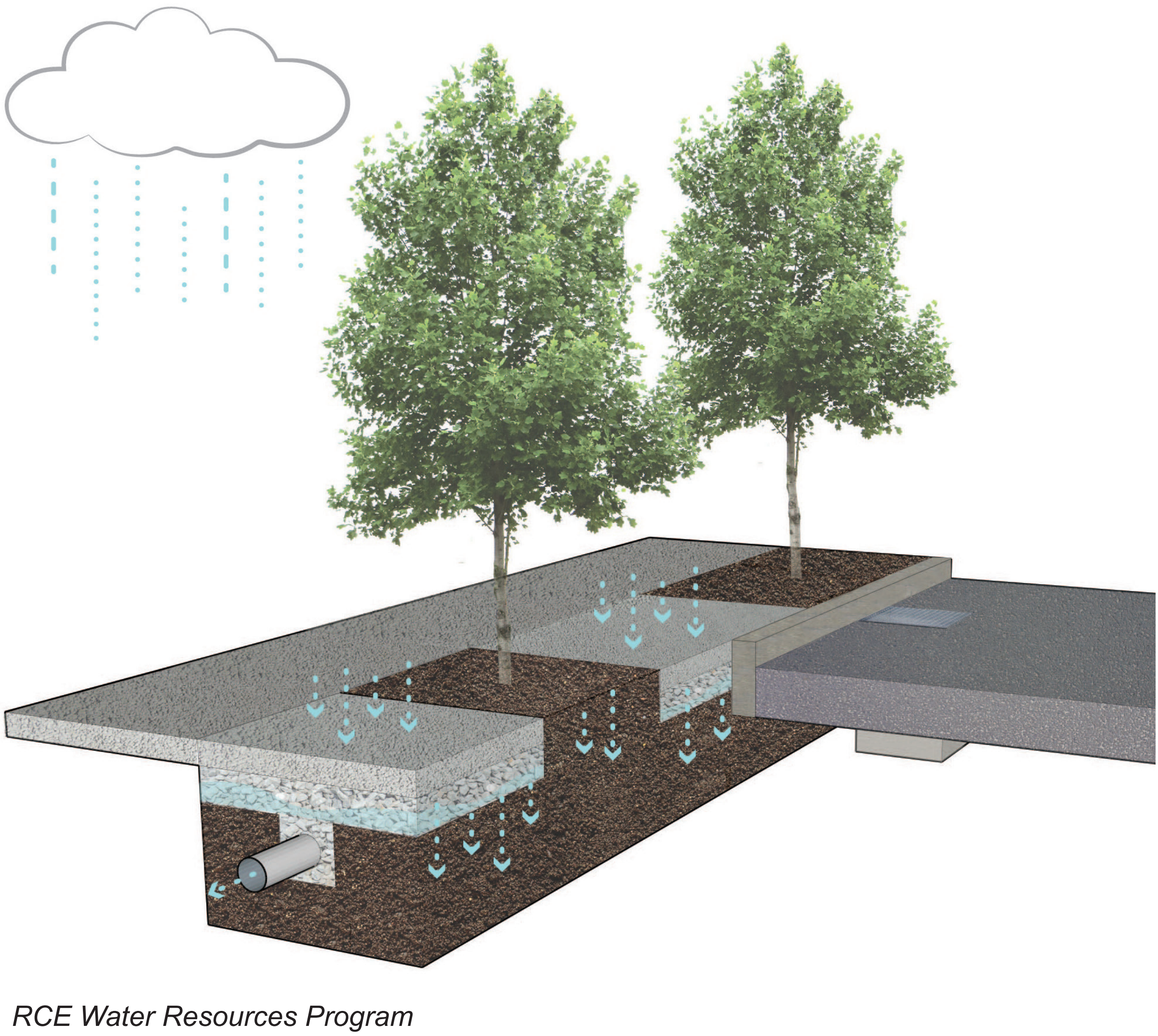
Tree Trench

A tree trench system is a flexible system that can provide soil volume to tree beds by utilizing the space between them. The main benefit to this system is that trees can share the same soil volume with adjacent trees, reducing the total soil volume needed for planting multiple trees. While the surface of these systems can be mulched or vegetated, it can also be a form of pavement to allow a walkable surface between the tree beds. Under these areas there should be structural soils, structural cells, or suspended sidewalks. Ideally, the surface between the tree beds should be highly permeable or make use of a trench drain to allow more stormwater to enter the system. A 5' by 25' tree trench at 3' deep would give 375 cubic feet of storage allowing a tree canopy diameter of about 15.5'. Much like extended tree beds, soil volume can be expanded into adjacent storage. For example, expanding the soil volume under 5' of sidewalk would give 750 cubic feet of soil allowing a tree of about a 22-foot diameter canopy.

Table 4 - Tree Trench Soil Volume and Canopy Potential

Tree Bed Type	Bed Size (SF)	Soil Volume (CF)	Potential Tree Canopy Diameter (FT)	Potential Tree Canopy Area (SF)
Tree Trench (5' x 25' x 3'D)	125	375	15.5	187.5
Tree Trench under sidewalk 5' (10' x 25' x 3'D)	125	750	21.9	375.0

Cross sectional rendering of a tree trench



RCE Water Resources Program

How to Plan Tree Bed Systems for Stormwater

Standard tree beds are not designed for capturing stormwater. Trees need adequate water to grow, and standard tree beds do not typically provide adequate water to trees, especially in heavily paved areas. Flooding and stormwater pollution are challenging issues in urban environments where space is limited. These issues can be addressed together by allowing tree beds to act as stormwater management systems. A variety of practices can be implemented to enhance the ablility of tree beds to uptake water. This includes increasing the interception of stormwater into tree beds, maximizing canopy coverage, and providing storage for stormwater in the soil system. Refer to the engineering details for detailed drawings of these practices.

Interception

To capture stormwater, the water needs to be redirected into the tree bed system. In an urban environment, the main sources of stormwater are from impervious surfaces such as sidewalks, rooftops, and roadways. Since tree beds are typically planted in the area between the sidewalk and roadway, these two areas are the main focus for interception. All tree beds can intercept stormwater from the sidewalk, but intercepting stormwater from the roadway requires additional measures.

Sidewalk Level Interception

Sidewalk runoff can be intercepted either by allowing flow into a bed directly or by using something between tree beds. For runoff flowing directly into a bed, the water should be able to be intercepted and flow into the soil if it is permeable enough. To enhance this effect, a strip of stone can be utilized to ensure movement through the mulch layer. For runoff between tree beds, pervious pavement would allow water to flow quickly into the soil media below. Alternatively, a trench drain could be utilized to direct water into tree beds if normal pavement is preferred. If the tree bed is curbed, slits can be made in the curbing to allow sidewalk runoff to flow into the tree bed. This level of interception is appropriate for all scales of tree beds.

Street Level Interception

To capture stormwater from the roadway, tree beds will need to be set below the sidewalk level preferably below street level by about 6" to allow stormwater to enter. To avoid tripping hazards, curbing or fencing is required around these systems.

To capture the water from the street, a curb cut can be used. To help redirect flow into the system, a concrete flow pad should be utilized that slopes into the tree bed. If there is parking adjacent to the roadway, a trench drain can be utilized to set the tree bed further back from the street while still allowing stormwater to reach it. If there are concerns about trash ending up in the tree beds or curbs cuts, a curb head inlet can be used to create a smooth curb while still allowing stormwater to flow into the tree bed. Alternatively, a catch basin can be integrated into the tree bed system to intercept the water. For systems incorporating a distribution pipe, the tree beds could be kept at sidewalk level, and the catch basin could be used to intercept and distribute water throughout the system instead. This level of interception is appropriate for extended tree beds and tree trenches.

How to Plan Tree Beds Systems for Stormwater

Simple Depaving

Depaving alone will make a huge difference in providing a way for stormwater to soak into the ground. Even if soils below the pavement are not replaced to provide soil volume, depaving adjacent areas provides more opportunity for water to reach the tree and intercept stormwater runoff.

Rooftop Interception

Rooftop runoff can be intercepted with sidewalk runoff by simply letting downspouts drain onto the sidewalk. While this a simple solution, this can lead to ice during winter months. Alternatively, downspouts could be directly tied into the tree bed systems with a distribution pipe to help allow water to move rapidly though the system below the surface level.

Storage

For proper stormwater management, systems also need some degree of storage to capture and hold stormwater. This allows stormwater to be detained and treated before either infiltrating or slowly being released through an underdrain. Storage can be open air or void space between soil pores or stone. Tree beds can provide storage which goes hand in hand with the desire to provide adequate soil volume for the tree.

Typical sandy loam soils provide approximately 35% void space for storing water. Structural soils only provide about 25% void due to the gravel matrix. This makes structural soils less ideal for storing stormwater, but it is highly permeable and allows rapid movement through the soil bed. Just like for tree health, it is important that soils do not become compacted to retain void storage and retain high rates of infiltration. Tree beds can be further optimized for storage by creating vaulted storage, which would create a 100% void space to store additional water. This would create a trade-off with the volume of soil available to the tree though.

Open air storage can be created when the tree bed is set below street level. A maximum of 6" of ponding is recommended to avoid issues with ponding water and to avoid creating a safety hazard. This can help provide additional storage especially where space is limited.

How to Plan Tree Beds Systems for Stormwater

Canopy

Tree canopy also plays a role in intercepting stormwater since leaves and stems retain a portion of the water that lands on them. The Center for Watershed Protection (2017) found the extent of this interception is highly variable and based on storm characteristics and the species utilized. Most reports assess canopy capture on an annual basis and have found capture ranging from 6.5% - 66.5% for all trees in both urban and forested settings. For urban trees, values were more frequently calculated in the range of about 7% - 20% with coniferous trees showing higher interception on average. Since canopy plays a notable role, maximizing canopy where possible will provide additional stormwater capture especially in areas that are not part of the drainage area directed into the storage system. As previously noted, potential canopy is largely limited by the available soil volume, so efforts should be made to be sure adequate soil volumes are provided when trees with large canopies are selected. Considering the selection of evergreen trees may provide additional interception especially during winter months as well.

Underdrains

Tree beds typically do not include underdrains, but they may be necessary when systems are designed for stormwater management depending on existing soil conditions. For stormwater systems to work effectively, they need to be adequately drained before the next storm event. If existing soils do not drain sufficiently, an underdrain is needed. Where tested infiltration rates do not exceed 1 in/hr, an underdrain is highly recommended. Because soils in urban environments are compacted, infiltration rates will typically be low, and underdrains may be needed in many cases. Underdrains would need to tie into the closest access to the stormwater system.

Optionally, low flow orifices can be added to the outlet of pipes to help control detention times and increase treatment of stormwater runoff. This will enhance the overall performance of stormwater management. The Philadelphia Stormwater Management Guidance Manual (Table 4.1-4) offers recommendations for orifice diameter based on the drainage area (Philadelphia Water Department, 2019).

Stormwater Management Calculations

To assess the effectiveness of different scales of tree beds, calculations for various sized tree beds were conducted. All stormwater calculations for impervious cover use the SCS (US Soil Conservation Services) curve number methodology with a curve number of 98. Table 2 summarizes the calculation of available storage in typical tree beds.

Table 2: Stormwater Storage and Runoff Volume Calculations

Tree Bed Type	Bed Size (SF)	Soil Volume (CF)	Open Volume (CF)	Stormwater Storage Volume (CF)	IC Area (SF) per WQ storm (1.25")	IC Area (SF) per 2-YR storm (3.3")	WQ storm Volume Reduction (gal)	Estimated Annual Volume (gal)
Single Tree Bed (5' x 5' x 3'D)	25	75	-	26	304	103	196	6,493
Single Tree Bed (6' x 6' x 3'D)	36	108	-	38	438	148	282	9,355
Extended Tree Bed (5' x 15' x3'D)	75	225	-	79	913	308	589	19,500
Tree Trench (5' x 25' x 3'D)	125	375	-	131	1,522	514	982	32,508
Extended Tree Bed under sidewalk 5'	75	450	-	158	1,827	616	1,178	39,022
Tree Trench under sidewalk 5'	125	750	-	263	3,045	1,027	1,964	65,037
Extended Tree Bed w/ 6" Open Space	75	75	38	116	1,348	455	869	28,791

To assess canopy interception, i-Tree Hydro, a stormwater modeling software designed to account for trees was utilized. An extended tree bed was used with a tree having a 100-square foot canopy, which is about 11' in diameter and approximately the size a 5' by 15' by 3' tree bed can support. This lead to the canopy area being 60.9% pervious and 39.1% impervious. The area of 100 square feet was used in i-Tree Hydro under two cases, one with tree canopy and one without tree canopy to compare the results. All parameters were left at default. Weather data loaded into i-Tree Hydro from the Philadelphia weather station from 2005-2012 was used to determine an average annual performance value. Data was averaged on an annual basis as well as a monthly basis to assess the seasonal variability for deciduous trees. The results of the analyses are summarized in Table 3. As stated previously, tree canopy calculations are highly variable depending on

Table 3: Deciduous Tree Canopy Interception Rates

Time Period	Rainfall (in)	Pervious Area Reduction	Impervious Area Reduction	Volume Capture (CF)	Volume Capture (gal)
Annual	46.86	3.9%	6.6%	12.12	90.7
January	3.08	1.1%	6.2%	0.54	4.0
February	2.22	4.7%	5.8%	0.44	3.3
March	3.28	2.6%	3.9%	0.52	3.9
April	4.44	2.9%	6.5%	1.05	7.9
May	3.03	13.0%	11.5%	1.41	10.6
June	3.95	7.6%	10.1%	1.56	11.7
July	3.82	9.6%	11.0%	1.58	11.8
August	6.44	3.3%	5.2%	1.56	11.7
September	4.37	2.5%	7.2%	1.10	8.3
October	5.11	3.5%	5.6%	1.31	9.8
November	2.8	4.2%	4.6%	0.56	4.2
December	4.31	0.5%	3.5%	0.49	3.7

Stormwater Management Calculations

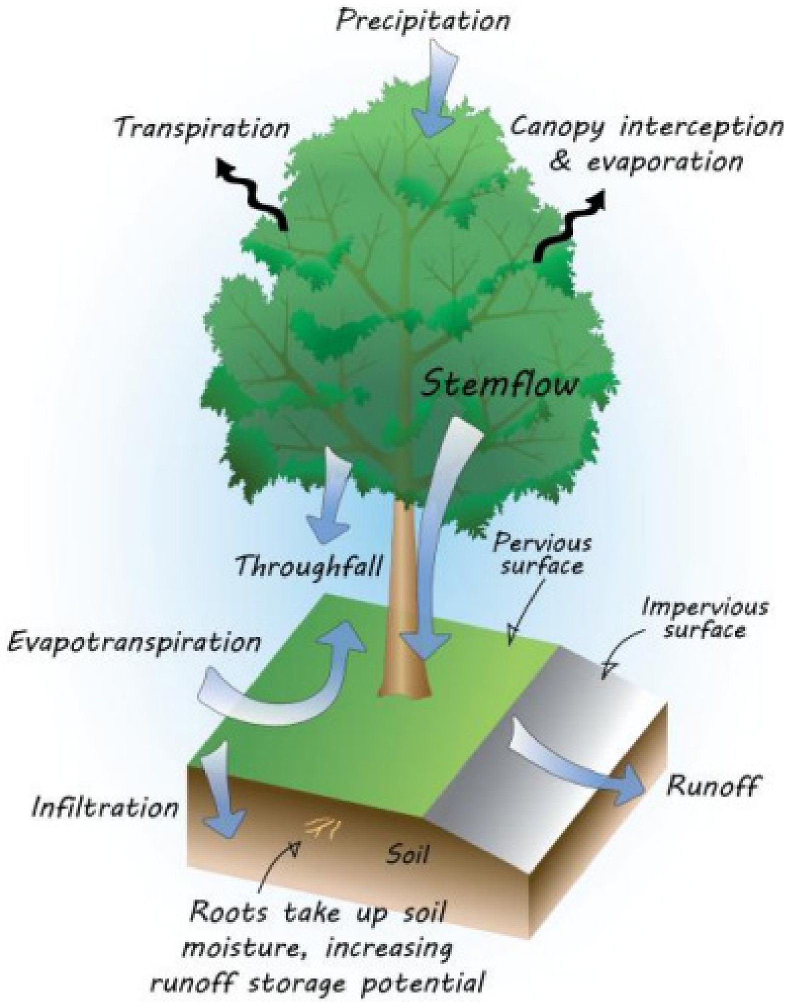
The analysis shows an annual reduction of about 3.9% for pervious areas and 6.6% for impervious areas. The monthly variation ranges from a maximum of 13.0% for pervious and 11.5% for impervious in May to a low of 0.5% for pervious and 3.5% for impervious in December. Although these estimates are on the low range of the Center for Watershed Protection's 2017 study, this analysis helps convey the magnitude of canopy interception relative to the storage volume. For the extended tree bed, these estimates show the tree canopy capture only accounts for 0.46% of the storage capacity of the soil. This means that from a stormwater design standpoint, it makes more sense to focus on creating storage capacity in the soil rather than focusing too much on the tree canopy. More research is needed to prioritize trees that will provide significant enough canopy interception to include in stormwater management calculations. Perhaps for specific species, especially in larger sizes, the effect of tree canopy may play a larger role. However, in tree beds, tree size is often restricted to smaller species.

Planted stormwater tree beds designed to capture runoff from the sidewalks; photographed by planting volunteer in the fall of 2019.

Conclusion

Trees are not always seen for their ability to contribute to our built environment's longevity, but they can be valuable assets for stormwater management. Street trees naturally contribute to stormwater capture via the mechanism of canopy interception, and well-designed stormwater tree beds can maximize the value of trees in urbanized environments. By constructing a tree bed to capture and infiltrate stormwater, one can ensure the health of the tree as it grows, reduce incidents of localized flooding, and contribute to improved local air quality and ecological habitat.

Engineering Details



Hydrology of a tree, CLEAR CHOICES CLEAN WATER® INDIANA

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RUTGERS COOPERATIVE EXTENSION WATER RESOURCES PROGRAM

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