PVD TREES + INFRASTRUCTURE

A CONFLICT AVOIDANCE GUIDE FOR THE PROVIDENCE URBAN FOREST

SNEP NETWORK

New England neefc Environmental Finance Center

The Nature Conservancy Rhode Island

PROVIDENCE NEIGHBORHOOD PLANTING PROGRAM

P

PVD TREE PLAN

FUSS & O'NEILL

ACKNOWLEDGMENTS

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The Southeast New England Program Network is a collaborative group of 16 partner organizations with expertise in financing and implementing stormwater and watershed management efforts. The mission of the SNEP Network is to empower communities to achieve healthy watersheds, sustainable financing and long-term climate resilience through management of stormwater and restoration projects. A project of the New England Environmental Finance Center (NEEFC), The Network provides free training and technical assistance to strengthen the capacity of municipalities, organizations, and tribes within Rhode Island and Southeastern Massachusetts. The Network is currently working on a multitude of projects and regional initiatives that have a broad application throughout the region. To learn more about or request network services, SNEP communities can visit the SNEP Network Website.

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PROJECT TEAM

** Cover Photo by Dominique Sindayiganza*

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PURPOSE + INTENT

INTRO

The purpose of this guide is to highlight solutions which may be employed to plant and retain healthy trees and provide accessible, walkable surfaces throughout the City of Providence. This guide has been developed in conjunction with the PVD Tree Plan (https://pvdtreeplan.org/) and presents potential tools, solutions, and recommendations to reduce conflicts between tree roots and sidewalks. It is not uncommon for conflicts to arise between trees and infrastructure, particularly in locations where they were installed some time ago. These conflicts can compromise pedestrian access to the sidewalks and have lasting impacts on tree health.

TREE + INFRASTRUCTURE CONFLICTS

The majority of the world's population lives in urban areas so it is crucial to invest in the health & quality of life of city-dwellers. In the face of increased pollution, more frequent extreme weather events, and spiking summer temperatures, urban trees are an excellent tool in alleviating the harm to our environment and improving the health of our communities. Unlike grey infrastructure, trees are one of the only kind of urban infrastructure that actually increases in value as they age. The larger the tree, the more benefits, or ecosystem services it provides!

Over time, most cities have come to incorporate trees in parks, along streets, and in subdivisions and commercial districts. And as city planning and maintenance practices evolve, urban tree experts have formed strategies to grow large-canopy trees that reap the maximum environmental benefits despite increasingly constrained environments. Trees cause less damage when they are provided rootable space, quality soil conditions, and are situated far from hardscape. Conflicts between tree roots and sidewalks appear to be more related to growing conditions, tree age, and amount of rooting volume than to species and the tools included in this guide address these issues.

HOW TO USE THIS GUIDE

The guide presents implementable solutions organized by the type of tree/infrastructure conflict you may be encountering. Additionally, tools and solutions best used to avoid future conflicts have also been highlighted.

The conflicts between tree roots and sidewalks in Providence are widespread, resulting in recurring expenses for repair, misinformed practices injuring trees, and premature tree removals. Alternative solutions exist, but are not always utilized. This guide aims to provide options.

INTENDED AUDIENCE

This plan is intended primarily for internal use by the City of Providence. It will be particularly relevant many divisions working with streetscape elements that relate to trees and sidewalks. City departments may use the plan as a resource to help manage trees in the city's public right-of-way and/or in public open space.

This plan is also intended to clarify to the broader public the tools and solutions that the City of Providence promotes to manage street trees and infrastructure conflicts. The guide may also be used as a resource for property owners or private developers seeking guidance on installation and maintenance of trees and sidewalks adjacent to their property.

Photos by Dominique Sindayiganza

Photo by Dominique Sindayiganza

SOLUTIONS MATRIX + TOOLS

MATRIX ORGANIZATION

This toolkit includes techniques and materials to guide design, construction, and maintenance activities related to trees and infrastructure. The toolbox is organized into the following five categories organized by the type of tree/infrastructure conflict:

SIDEWALK DAMAGE
SPACE CONSTRAINTS
OVERHEAD WIRES
SUBSURFACE CONFLICT
DAMAGE AVOIDANCE

The images below give a visual summary of what some of these types of tree/infrastructure conflicts can look like.

SIDEWALK DAMAGE


Photo by Dominique Sindayiganza


Photo by Dominique Sindayiganza


Photo by PNPP


Photo by PNPP

SPACE CONSTRAINTS


Photo by Dominique Sindayiganza


Photo by Dominique Sindayiganza


Photo by PNPP

Photo by PNPP

OVERHEAD WIRES


Photo by Dominique Sindayiganza


Photo by PNPP


Photo by PNPP


Photo by PNPP

SOLUTIONS MATRIX + TOOLS

HOW TO USE THIS MATRIX

The structure of the matrix allows for ease of use in determining which tools might be the best fit depending on cost range and/or intended useful life. The matrix indicates which tools are suited for proactive use (at new installations and major reconstruction) versus responsive applications (as part of maintenance). For many projects, multiple solutions could be required to resolve existing conflicts between trees and infrastructure.

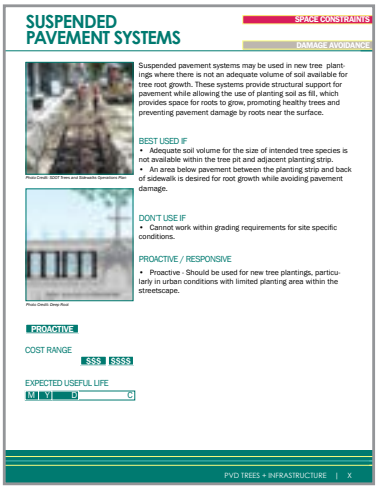
CONFLICT CATEGORY + TOOL NAME	PROACTIVE	RESPONSIVE	COST RANGE				EXPECTED USEFUL LIFE			
			$	$$	$$$	$$$$	Month	Year	Decade	Century
SIDEWALK DAMAGE										
RIGHT TREE, RIGHT PLACE	X		n/a	n/a	n/a	n/a	M	Y	D	
ASPHALT	X	X	$	$$	$$$		M	Y	D	
EXPANSION JOINTS	X	X	$				M	Y	D	
REINFORCED SLAB	X	X		$$	$$$		M	Y	D	
BEVELING		X	$	$$			M	Y		
POROUS PAVEMENT	X	X		$$	$$$	$$$$	M	Y	D	
SHIMS		X	$				M	Y		
DECOMPOSED GRANITE	X	X	$	$$			M	Y		
MONOLITHIC SIDEWALK	X	X			$$$		M	Y	D	C
ADJUSTED PAVEMENT THICKNESS		X			$$$		M	Y	D	
BRIDGING		X				$$$$	M	Y	D	
FOAM UNDERLAY	X	X	$	$$			M	Y		
MODIFIED GRAVEL LAYER	X	X	$				M	Y	D	
ROOT PATHS	X		$	$$			M	Y	D	
SOIL MODIFICATION	X	X	$	$$			M	Y	D	
STEEL PLATES		X		$$	$$$		M	Y	D	
STRUCTURAL SOILS	X	X		$$	$$$		M	Y	D	
ROOT PRUNING		X	$	$$			M	Y		
SPACE CONSTRAINTS										
RIGHT TREE, RIGHT PLACE	X		n/a	n/a	n/a	n/a	M	Y	D	
POROUS PAVEMENT	X	X		$$	$$$	$$$$	M	Y	D	
DECOMPOSED GRANITE	X	X	$	$$			M	Y		
CURB BULBS	X	X			$$$	$$$$	M	Y	D	C
CURB REALIGNMENT	X	X			$$$	$$$$	M	Y	D	C
CURVING OR OFFSET SIDEWALK	X	X		$$	$$$		M	Y	D	C
EASEMENT	X	X	$	$$	$$$		M	Y	D	C
SUSPENDED PAVEMENT SYSTEMS	X				$$$	$$$$	M	Y	D	
LOWERED SITES	X				$$$	$$$$	M	Y	D	
ROOT PATHS	X		$	$$			M	Y	D	
STRUCTURAL SOILS	X	X		$$	$$$		M	Y	D	
SUBSURFACE AERATION & IRRIGATION	X	X		$$			M	Y		

TOOL OVERVIEW

Each tool/solution includes the following information as applicable:

- Description of tool
- When the solution should be applied and when it should not be applied
- Cost range
- Expected useful life

The tools can be found on the pages following the matrix.


SUSPENDED PAVEMENT SYSTEMS

SPACE CONSTRAINTS

DAMAGE AVOIDANCE

Suspended pavement systems may be used in new tree plantings where there is not an adequate volume of soil available for tree root growth. These systems provide structural support for pavement while allowing the use of planting soil as fill, which provides space for roots to grow, promoting healthy trees and preventing pavement damage by roots near the surface.

BEST USED IF

- Adequate soil volume for the size of intended tree species is not available within the tree pit and adjacent planting strip.
- An area below pavement between the planting strip and back of sidewalk is desired for root growth while avoiding pavement damage.

DON'T USE IF

- Cannot work within grading requirements for site specific conditions.

PROACTIVE / RESPONSIVE

- Proactive - Should be used for new tree plantings, particularly in urban conditions with limited planting area within the streetscape.

PROACTIVE

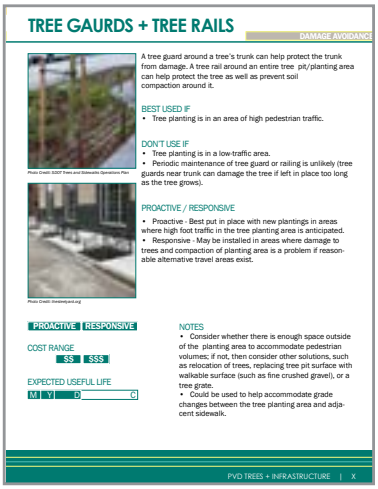
COST RANGE

$$$ $$$$

EXPECTED USEFUL LIFE

M Y D C

PVD TREES + INFRASTRUCTURE | X


TREE GAURDS + TREE RAILS

DAMAGE AVOIDANCE

A tree guard around a tree's trunk can help protect the trunk from damage. A tree rail around an entire tree pit/planting area can help protect the tree as well as prevent soil compaction around it.

BEST USED IF

- Tree planting is in an area of high pedestrian traffic.

DON'T USE IF

- Tree planting is in a low-traffic area.
- Periodic maintenance of tree guard or railing is unlikely (tree guards near trunk can damage the tree if left in place too long as the tree grows).

PROACTIVE / RESPONSIVE

- Proactive - Best put in place with new plantings in areas where high foot traffic in the tree planting area is anticipated.
- Responsive - May be installed in areas where damage to trees and compaction of planting area is a problem if reasonable alternative travel areas exist.

PROACTIVE RESPONSIVE

COST RANGE

$$ $$$

EXPECTED USEFUL LIFE

M Y D C

NOTES

- Consider whether there is enough space outside of the planting area to accommodate pedestrian volumes; if not, then consider other solutions, such as relocation of trees, replacing tree pit surface with walkable surface (such as fine crushed gravel), or a tree grate.
- Could be used to help accommodate grade changes between the tree planting area and adjacent sidewalk.

PVD TREES + INFRASTRUCTURE | X

CONFLICT CATEGORY + TOOL NAME	PROACTIVE	RESPONSIVE	COST RANGE				EXPECTED USEFUL LIFE			
			$	$$	$$$	$$$$	Month	Year	Decade	Century
OVERHEAD WIRES										
RIGHT TREE, RIGHT PLACE	X		n/a	n/a	n/a	n/a	M	Y	D	
CORRECTIVE PRUNING	X	X	$	$$			M	Y		
EASEMENT	X	X	$	$$	$$$		M	Y	D	C
SUBSURFACE CONFLICT										
RIGHT TREE, RIGHT PLACE	X		n/a	n/a	n/a	n/a	M	Y	D	
ROOT BARRIERS	X	X	$				M	Y	D	
FOAM UNDERLAY	X	X	$	$$			M	Y		
ROOT PRUNING		X	$	$$			M	Y		
DAMAGE AVOIDANCE										
RIGHT TREE, RIGHT PLACE	X		n/a	n/a	n/a	n/a	M	Y	D	
TREE GUARDS AND TREE RAILS	X	X		$$	$$$		M	Y	D	
DECOMPOSED GRANITE	X	X	$	$$			M	Y		
TREE PIT SIZING	X	X	$				M	Y	D	
CURB BULBS	X	X			$$$	$$$$	M	Y	D	C
CURB REALIGNMENT	X	X			$$$	$$$$	M	Y	D	C
CURVING OR OFFSET SIDEWALK	X	X		$$	$$$		M	Y	D	C
EASEMENT	X	X	$	$$	$$$		M	Y	D	C
SUSPENDED PAVEMENT SYSTEMS	X				$$$	$$$$	M	Y	D	
LOWERED SITES	X				$$$	$$$$	M	Y	D	
SOIL VOLUME	X	X	$	$$	$$$		M	Y	D	C
MULCH	X	X	$				M	Y		
ROOT BARRIERS	X	X	$				M	Y	D	
CONTINUOUS TRENCHES	X	X		$$	$$$	$$$$	M	Y	D	
FOAM UNDERLAY	X	X	$	$$			M	Y		
MODIFIED GRAVEL LAYER	X	X	$				M	Y	D	
ROOT PATHS	X		$	$$			M	Y	D	
SOIL MODIFICATION	X	X	$	$$			M	Y	D	
STRUCTURAL SOILS	X	X		$$	$$$		M	Y	D	
SUBSURFACE AERATION & IRRIGATION	X	X		$$			M	Y		
CORRECTIVE PRUNING	X	X	$	$$			M	Y		
MONOLITHIC SIDEWALK	X	X			$$$		M	Y	D	C
POROUS PAVEMENT	X	X		$$	$$$	$$$$	M	Y	D	
REINFORCED SLAB	X	X		$$	$$$		M	Y	D	

ASPHALT

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Asphalt is not typically used as a sidewalk material in Providence, however, it may be used as a short- to medium term pavement solution for sidewalk repair or replacement. It has less initial cost, is more flexible, and can more easily be repaired than concrete pavement. However, asphalt has a much shorter expected useful life and requires a higher level of ongoing maintenance than concrete.

BEST USED IF

- A shorter-term repair solution is needed in an area with existing concrete sidewalks.
- A flexible paving material is desirable until specific existing trees are replaced.
- Existing tree roots are anticipated to further damage sidewalks within short period of time.

DON'T USE IF

- Sidewalk segment is short and between existing concrete sidewalks (typically replaced with concrete instead).

PROACTIVE / RESPONSIVE

- Proactive - May be used for new sidewalks in areas where concrete sidewalks are not feasible.
- Responsive - Replace sidewalk with asphalt in situations outlined above.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$** **$$$

EXPECTED USEFUL LIFE

M Y D C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Useful life of asphalt pavement can vary greatly with site conditions.

BEVELING (CONCRETE GRINDING)

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: gibneyCE.com

- Beveling involves cutting/grinding down the raised edge of a concrete panel to make a smoother transition and reduce tripping hazards.

BEST USED IF

- A short-term solution is required.

DON'T USE IF

- Uplift is greater than 2".

PROACTIVE / RESPONSIVE

- Responsive - Provides a relatively short-term solution to raised concrete edges.

RESPONSIVE

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- There is a limit to how much beveling/grinding can be done at each point on a concrete sidewalk based on pavement thickness and severity of uplift.
- Longevity of fix will depend on how rapidly additional damage (uplift/subsidence of concrete) occurs.
- Different grinding/shaving methods produce different sidewalk textures when complete. Need to ensure a smooth, trip free surface. For example, upright grinder locations will likely need to be revisited with an angle grinder.
- Final slope of bevel shall comply with applicable ADA requirements.

BRIDGING

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: harvestingrainwater.com

Bridging can provide grade separation between a sidewalk and the root zone of a tree. Various bridging techniques exist, including pier and beam bridges, cantilevered sections, and boardwalks. Bridging techniques are used to provide space for tree roots to grow in soil without lifting or otherwise damaging the adjacent sidewalk. The "bridge" section of the sidewalk supports itself, from the ends, on piers, without the need for compacted subgrade below it. Various deck materials may be used, including concrete, or steel panels (such as in photo to left) with appropriate non-slip finish.

BEST USED IF

- To preserve a high-value tree and also meet sidewalk accessibility requirements.

DON'T USE IF

- Cannot work within grading requirements for site specific conditions.

PROACTIVE / RESPONSIVE

- Responsive - May be used to replace a damaged sidewalk if other measures (such as root pruning) would not allow for a more basic sidewalk repair and continued root damage would be likely.

RESPONSIVE

COST RANGE

$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- If drop to adjacent grade is greater than 18", then bridge would require a handrail.
- If bridge deck is metal, a non-slip texture or surface treatment must be provided.

CONTINUOUS TRENCHES

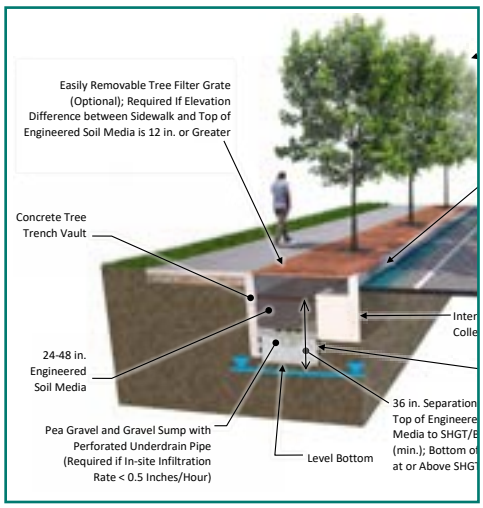


Photo Credit: RIDOT Linear Stormwater Manual

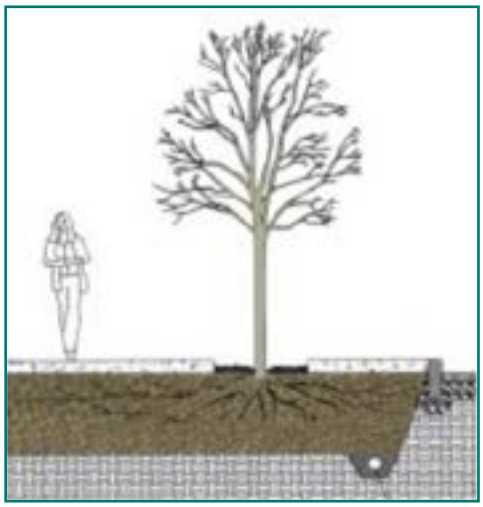


Photo Credit: Casey Trees, Tree Space Design Report

Continuous trenches may be used to provide extra soil volume for root growth underneath pavement. The trench area (typically 6' wide by 3' deep) is excavated and filled with loosely compacted planting soil. Pavement above the trench area must be engineered and self-supporting, spanning the trench area with adequate support on both sides. The trench may connect several tree pits.

BEST USED IF

- Poor native soil conditions and lack of space for tree pits limit soil volume available for healthy tree roots.

DON'T USE IF

- Adequate structural support for pavement above trench cannot be achieved.

PROACTIVE / RESPONSIVE

- Proactive - May be used to provide adequate soil volume for new tree plantings.
- Responsive - May be added in extensive retrofit or repair work, if possible, without extensive damage to existing root systems.

PROACTIVE **RESPONSIVE**

COST RANGE

$$** **$$$** **$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Pavement (sidewalks, step-out zones, etc) above the trench must be supported Structurally, either by bridging to appropriate supports on either side of the trench or by the inclusion of structural support elements (such as DeepRoot SilvaCells or Citygreen Strata Cells) that can accommodate planting soil and root growth within the trench.

CORRECTIVE PRUNING

OVERHEAD WIRES

DAMAGE AVOIDANCE

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Corrective pruning involves above-ground pruning to establish good structural form (proactive), and to remove dead or diseased material and weakly attached parts, and provide clearance for surrounding conditions (such as street traffic, bicyclists, pedestrians, overhead utilities, or adjacent buildings). Trees will typically achieve best form if pruned three times in the first seven years. All pruning maintenance performed on street trees shall be in accordance with current tree industry standards and supervised by an ISA-certified arborist or an ISA-certified tree worker and adhere to the suggested clearances that apply to tree limbs: 14 feet clear above roadways, 10 feet clear above bicycle paths, and 8 feet clear above sidewalks. Must adhere to ANSI A300 standards.

BEST USED IF

- Tree is in good health and vigor and is worthy of preservation.

DON'T USE IF

- Tree is not worthy of preservation or is in poor health to the degree that corrective pruning would not improve its condition.

PROACTIVE / RESPONSIVE

- Proactive - Used to establish good structural form and proactively address potential future clearance issues.
- Responsive - Used to remove dead, diseased, weakly attached parts and to provide clearance.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

CURB BULBS

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: NACTO

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$** **$$$** **$$$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

A curb bulb is a radial extension of a sidewalk at an intersection used to shorten the crossing distance for pedestrians. Curb bulbs may be landscaped and provide additional root growth area for trees and can improve pedestrian crossings. Designs that include trees and landscaping must ensure proper sight lines are maintained.

BEST USED IF

- Additional planting space would likely reduce further sidewalk damage by tree roots.
- Existing planting strip does not have enough space for desired tree species.
- Parking restrictions already exist at location (e.g., within 30' of a crosswalk).

DON'T USE IF

- Relocating the curb will not work due to drainage or other infrastructure conditions.
- Curb bulb will not work due to traffic conditions.
- Other street uses may be planned for the existing roadway width (such as bicycle facilities, etc).

PROACTIVE / RESPONSIVE

- Proactive - Curb bulbs may be used to create a larger planting area for a new tree.
- Responsive - Curb bulbs may be used to give an existing tree more space to grow.

NOTES

- Pavement (sidewalks, step-out zones, etc) above the trench must be supported Structurally, either by bridging to appropriate supports on either side of the trench or by the inclusion of structural support elements (such as DeepRoot SilvaCells or Citygreen Strata Cells) that can accommodate planting soil and root growth within the trench.

CURB REALIGNMENT

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Curb realignment involves shifting the curb location for a significant distance (e.g., along an entire block) in order to widen the planting strip and provide more space for trees.

BEST USED IF

- There is space in the right-of-way to create additional width in the planting strip (generally taking space from the street).

DON'T USE IF

- There is not street width that could be used for planting.
- Shifting the curb would cause conflicts with other existing infrastructure.

Photo Credit: NACTO

PROACTIVE / RESPONSIVE

- Proactive - May be done as part of a large-scale street repair/ reconstruction (e.g., capital improvement project) to provide additional space for new trees.
- Responsive - May be done as part of a large-scale street repair/reconstruction (e.g., capital improvement project) to provide additional space for existing trees.

PROACTIVE **RESPONSIVE**

COST RANGE

$$$** **$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Curb realignment will require traffic studies and engineering.
- Must consider impacts to parking, transit, and other transportation facilities.
- Good when installed consistently along a corridor. Spot locations could lead to traffic issues.

CURVING / OFFSET SIDEWALK

SPACE CONSTRAINTS

DAMAGE AVOIDANCE

Photo Credit: SDOT Trees and Sidewalks Operations Plan

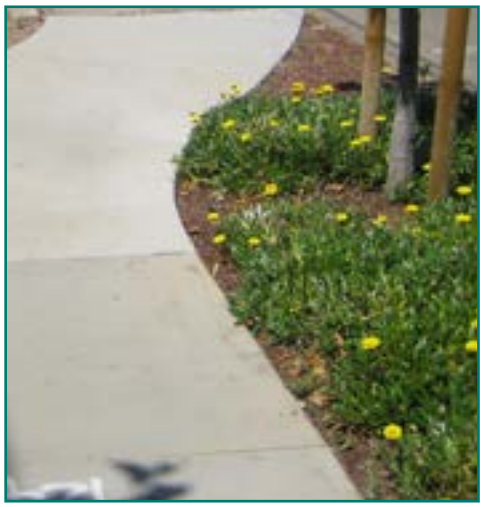


Photo Credit: gibneyCE.com

Curving (or offset) sidewalks may be used to meander around planting areas to give trees more space to grow.

BEST USED IF

- An existing tree is of high value.
- Curving the sidewalk around one or multiple planting areas can provide a significantly better area for new tree planting.

DON'T USE IF

- Space is limited in the right-of-way.

PROACTIVE / RESPONSIVE

- Proactive - May be used to provide increased planting space where larger species of trees will be used.
- Responsive - May be installed in conjunction with sidewalk repair or larger-scale development in order to help preserve mature trees and protect new infrastructure from root damage.

PROACTIVE **RESPONSIVE**

COST RANGE

$$** **$$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Can potentially be combined with an easement to locate the sidewalk on private property adjacent to the right-of-way.

DECOMPOSED GRANITE

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: KAFKA Granite

Decomposed granite, or small crushed gravel, may be used as a path / walkway surface in residential areas. It may also be used as a finished surface on top of planting soil in tree pits in areas of high pedestrian traffic (see 'Mulch').

BEST USED IF

- Pedestrian volume is relatively low.
- Pathway creates a new pedestrian route (e.g., no sidewalk previously existed on route to be paved with gravel).

DON'T USE IF

- No other ADA-compliant route is available.
- Location is an arterial, business district street, or otherwise busy pedestrian corridor.

PROACTIVE / RESPONSIVE

- Proactive - May be used for a new pathway or section to provide a flexible but walkable surface adjacent to trees and other plantings.
- Responsive - May be used as a temporary surface in root zones where damaged pavement has been removed.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
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NOTES

- Binders and regular (annual) maintenance may be required to meet ADA.
- Consider who will provide maintenance once material is installed. It will require more regular maintenance than asphalt or concrete pavement materials.
- Washout of granular material is likely on sidewalks

EASEMENT

Photo Credit: SDOT Trees and Sidewalks Operations Plan

An easement may allow construction of a sidewalk on private property in order to provide more space for existing or new trees. The width of easements is site specific.

BEST USED IF

- Adequate planting space is not available in the right-of-way.

Photo Credit: SDOT Trees and Sidewalks Operations Plan

DON'T USE IF

- Topography requires new structures, such as walls, in the right-of-way.

PROACTIVE / RESPONSIVE

- Proactive - Can provide a larger planting area for new trees, particularly if larger species are desired.
- Responsive - May provide larger root zone for existing trees, to prevent future damage after any repairs and potentially prolong the life of the tree.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$** **$$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- This requires coordination between the property owners and City of Providence.
- Agreement with property owner may be required. Waiver of liability for the homeowner may be required also.

EXPANSION / CONTROL JOINTS

Photo Credit: Philadelphia Water Department

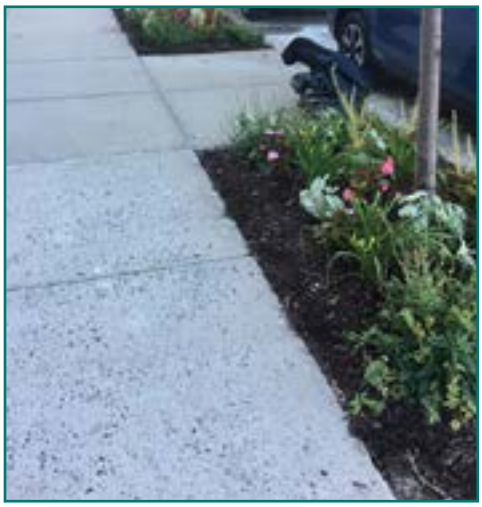

Photo Credit: Green Roofs New York City

PROACTIVE **RESPONSIVE**

COST RANGE

$

EXPECTED USEFUL LIFE

M **Y** **D** C

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D - DECADE
C - CENTURY

Expansion joints are transverse joints used to control the location of cracking and allow movement of concrete due to temperature and subgrade moisture variation. Control joints are shallow groves in the pavement designed to control the location of cracking. The standard interval for expansion joints in Providence sidewalks is 20 feet. When the sidewalk is being replaced, these joints may be strategically located in relation to new or existing adjacent trees and existing root conditions. The control joint is the weakest part of the sidewalk. If a crack occurs, it will follow the control joint and not break up the entire slab. In locations where there is poor soil, a wide range of temperature fluctuations, and expansion and contraction of the sidewalk material, a much closer frequency of control joints may be necessary. For example, a 5 feet wide sidewalk should have control joints 5 feet apart.

BEST USED IF

- Existing roots can be pruned to accommodate the installation and significant future root growth is not anticipated (e.g., tree is mature and/or roots have been provided with space to grow in subgrade through other applied solutions).
- There is adequate soil volume in areas where the roots are intended to grow.

DON'T USE IF

- Tree root growth is vigorous, and the monolithic construction is unlikely to provide more than a short-term solution.

PROACTIVE / RESPONSIVE

- Proactive - When installing a new sidewalk, consider locating expansion joints near trees to reduce potential for differential lifting of slabs.
- Responsive - Expansion joints may be used on replacement slabs, following removal of damaging roots (root pruning) or application of other subgrade solutions. This approach may confine future damage from new roots to a smaller area.

NOTES

- If drop to adjacent grade is greater than 18", then bridge would require a handrail.
- If bridge deck is metal, a non-slip texture or surface treatment must be provided.

FOAM UNDERLAY

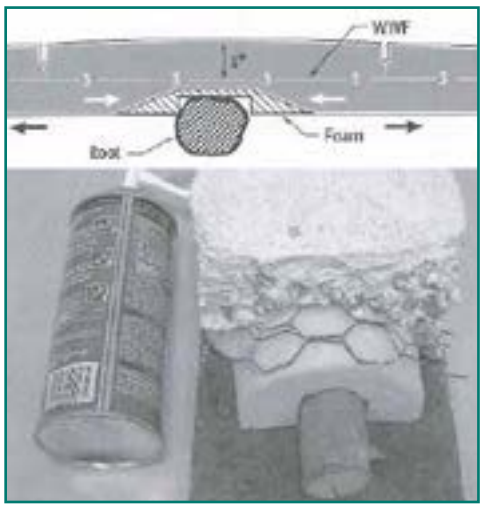

Photo Credit: Costello and Jones, 2003

A foam layer is added between existing roots and new concrete pavement to support the pavement and help prevent movement or damage. Radial root growth (growth in diameter of the root) compresses the foam to some degree before affecting the pavement slab.

BEST USED IF

- Site is a repair at a mature tree (slower root growth).
- Installation is combined with concrete sidewalk replacement.
- Existing roots that cannot be pruned are left near bottom surface of replacement sidewalk pavement.

DON'T USE IF

- Tree (root) growth is expected to be rapid.

PROACTIVE / RESPONSIVE

- Proactive - Rigid foam may be used below the sidewalk pavement to prevent future root damage; may be more effective combined with other tools, such as root barriers.
- Responsive - May prevent or slow further damage to pavement by existing roots when replacing the pavement.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Further research or testing of this tool may be necessary. Compare to use of modified gravel layer. May be used where depth available for modified base course is limited (e.g., under 4").

LOWERED SITES

Photo Credit: IRONSMITH

Lowered sites may be used to provide spatial separation between the finished grade of the tree planting pit and the surrounding sidewalk or another pavement. Pavement over lowered sites require reinforcement for support. Tree grates or other materials may provide a walkable surface level with adjacent grades over the lowered tree pit area.
Trees should be provided with adequate soil volume per the species selected, either within the lowered tree pit or by using other solutions under adjacent pavement such as structural soil and subsurface aeration/irrigation.

BEST USED IF

- Trees are desired in an area with high pedestrian volumes and little available planting space but few underground infrastructure conflicts.

DON'T USE IF

- Space is available for planting trees at grade.
- Underground infrastructure in nearby areas is extensive and would limit available soil volume or present likely conflicts with tree roots.

PROACTIVE / RESPONSIVE

- Proactive - This approach will prevent compaction of soil around the tree pit.

PROACTIVE

COST RANGE

$$$** **$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Maintenance can be an issue with lowered tree planting sites, as the lowered sites tend to accumulate trash and debris and may be more difficult to access.
- Planting techniques and details may be similar to tree planting in bioretention planters (planting areas set below adjacent street grade so that stormwater may flow into them) or using bridging.
- Design must provide drainage in lowered planting area to avoid prolonged soil saturation.
- Vertical separation barrier and maintenance needs to be considered.

MODIFIED GRAVEL LAYER

Photo Credit: SDOT Trees and Sidewalks Operations Plan

An open-graded gravel base course may be applied under the sidewalk pavement to discourage root growth directly under the pavement and reduce likelihood of sidewalk damage.

BEST USED IF

- Depth is available in the pavement profile to include at least 4” of modified gravel layer.

DON’T USE IF

- Extra depth of excavation to install modified gravel layer would damage critical existing roots.

PROACTIVE / RESPONSIVE

- Proactive - Use as a compacted base course below new sidewalk pavement.
- Responsive - Use as a compacted base course below new pavement for sidewalk repairs, as grades allow.

PROACTIVE **RESPONSIVE**

COST RANGE

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EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Thickness of gravel layer can be adjusted around existing tree roots.

MONOLITHIC SIDEWALK

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: gibneyCE.com

A monolithic sidewalk is where the roadway curb and sidewalk are constructed as one continuous concrete installation as opposed to two separate installations with an expansion joint separating curb and sidewalk. As one continuous installation there is more concrete weight (mass) to resist the uplift of tree roots. The elimination of the expansion joint at the back of curb also eliminates a potential future weakness in the paving infrastructure.

BEST USED IF

- Future root growth is not anticipated, and existing roots can be pruned to accommodate the installation.
- There is adequate soil volume in areas where the roots are intended to grow.

DON'T USE IF

- Tree root growth is vigorous, and the monolithic construction is unlikely to provide more than a short-term solution.

PROACTIVE / RESPONSIVE

- Proactive - Monolithic sidewalks can be used along new installations where the sidewalk is located adjacent to the street to prevent future root uplift.
- Responsive - To correct uplift of the sidewalk and provide resistance from future uplift after corrective actions have been taken and root integrity can be maintained.

PROACTIVE **RESPONSIVE**

COST RANGE

$$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Consider impacts from drainage flow paths for monolithic sidewalks as it is not desirable to convey surface runoff along the face of curb if there is a joint present.
- For optimal tree health, combine with the use of structural soil.

MULCH

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: SDOT Trees and Sidewalks Operations Plan

PROACTIVE **RESPONSIVE**

COST RANGE

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EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

Mulch may be used at the surface to promote tree health, suppress growth of weeds and grasses that compete with a tree for moisture, and encourage root growth in appropriate areas. Arborist wood chip mulch helps prevent soil compaction and allows water to infiltrate into soils in planting areas. Arborist wood chip or other mulch containing compost can contribute beneficial humic acid to the tree's root zone. Crushed gravel may be used as mulch in higher traffic areas as a means of providing a walkable but flexible surface in the tree pit.

BEST USED IF

- Any soil would be left exposed in the planting area, areas that would otherwise not be planted should be mulched.
- Top of soil in the tree pit is lower than adjacent sidewalk.
- Gravel mulch is typically used in tree pits only in neighborhood commercial areas and urban downtown areas.

DON'T USE IF

- Gravel mulch should not be used if the intention is to deter people from walking in the tree pit.

PROACTIVE / RESPONSIVE

- Proactive - New tree plantings should be mulched with a mulch type appropriate to the location.
- Responsive - Mulch should be applied to an existing tree zone where the soil has settled, or the mulch layer has become depleted and there is exposed bare soil.

NOTES

- Existing soil should be loosened/aerated if it is extremely compacted (as possible without root damage) prior to mulch application (see also Soil Modification tool).
- Keep mulch away from trunks; mulch should be avoided in the root crown area for some tree species.
- Use a maximum depth of 3" for wood and crushed gravel mulch.

ADJUSTED PAVEMENT THICKNESS

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: gibneyCE.com

In some cases, thicker pavement may minimize future root damage by providing greater strength and resistance against root pressure. In other cases, thinner (reinforced) pavement can provide more space for existing tree roots.

BEST USED IF

- Additional excavation to accommodate thicker pavement section will not cause unacceptable damage to existing tree roots or infrastructure.
- Thinner pavement will better accommodate existing tree roots.

DON'T USE IF

- Root structure does not allow for desired pavement thickness.
- Vehicular or other anticipated loads will damage thinner pavement.
- Directly adjacent to a driveway or street corner where vehicles may pass.

PROACTIVE / RESPONSIVE

- Responsive - A thicker pavement section would be used in response to an existing issue; new trees should be planted with adequate space and root barrier so as to not require a thicker pavement section.

RESPONSIVE

COST RANGE

$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- This applies to concrete sidewalks only.

POROUS PAVEMENT

Photo Credit: SDOT Trees and Sidewalks Operations Plan

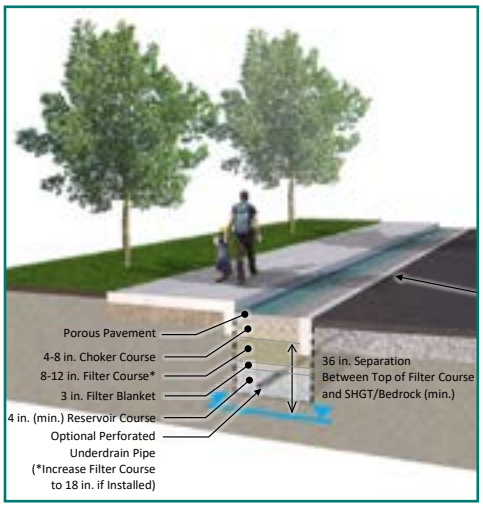

Photo Credit: RIDOT Linear Stormwater Manual

PROACTIVE **RESPONSIVE**

COST RANGE

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EXPECTED USEFUL LIFE

M **Y** **D** **C**

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

Porous pavement is an alternative paving surface that captures stormwater runoff through voids in the pavement surface, where it is filtered and temporarily stored and/or infiltrated in an underlying stone reservoir. Many types of porous pavement are available, but the most common are porous asphalt and pervious concrete. Rubber sidewalks, like Flexi-pave, are being installed in various locations throughout the region and are proving successful to Northeastern winter climate. There are several modular versions as well as a poured in place version similar to a running track installation. All porous pavement has an additional filter course below the pavement and may be lined. Porous asphalt is similar to regular asphalt but will allow water to pass through the pavement. It may be appropriate to use in cases where infiltration in the sidewalk pavement area is desirable for tree health. Pervious concrete allows air and water to pass through to the bedding and soil layers below. If designed and installed properly, it may deter shallow root growth (and reduce root damage to the sidewalk) by allowing water to infiltrate more deeply into the soil profile and providing air contact just below the pavement.

BEST USED IF

- There is adequate space for installation of the pervious concrete and necessary subbase layers without excessive impact to existing roots.

DON'T USE IF

- Only short segments of repairs are needed.
- Site soils will not allow for infiltration of stormwater.
- Adjacent properties are below surface grade of sidewalk.

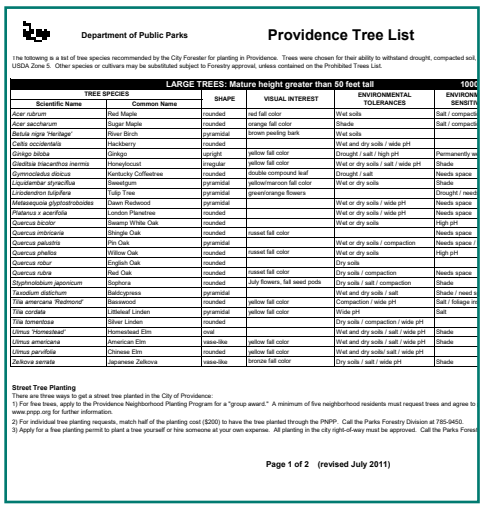
PROACTIVE / RESPONSIVE

- Proactive - May be used for new sidewalks in areas where infiltration is desirable (adjacent to bioretention). May be used to provide better growing conditions in structural or other soils below the sidewalk bedding material.
- Responsive - May be used for replacement sidewalks in areas where infiltration is desirable (adjacent to bioretention). May be used to encourage deeper root growth and/or discourage rooting near surface to deter further sidewalk damage.

NOTES

- Requires more maintenance than standard concrete pavement.
- For porous asphalt, due to manufacturing constraints (can't be produced in very small quantities), should only be used for longer sidewalk segments such as multiple blocks.
- For pervious concrete, economy of scale must be considered to be feasible. Consider grouping known sites for grouping under an individual Forestry Division contract.

RIGHT TREE, RIGHT PLACE



Department of Public Parks

Providence Tree List

The following is a list of tree species recommended by the City Forester for planting in Providence. Trees were chosen for their ability to withstand drought, compacted soil, USDA Zone 5. Other species or cultivars may be substituted subject to Forestry approval, unless contained on the Prohibited Trees List.

LARGE TREES: Mature height greater than 50 feet tall — 100

TREE SPECIES		SHAPE	VISUAL INTEREST	ENVIRONMENTAL TOLERANCES	ENVIRONM SENSITI
Scientific Name	Common Name				
Acer rubrum	Red Maple	rounded	red fall color	Wet soils	Salt / compacti
Acer saccharum	Sugar Maple	rounded	orange fall color	Shade	Salt / compacti
Betula nigra 'Heritage'	River Birch	pyramidal	brown peeling bark	Wet soils	
Celtis occidentalis	Hackberry	rounded		Wet and dry soils / wide pH	
Ginkgo biloba	Ginkgo	upright	yellow fall color	Drought / salt / high pH	Permanently w
Gleditsia triacanthos inermis	Honeylocust	irregular	yellow fall color	Wet or dry soils / salt / wide pH	Shade
Gymnocladus dioicus	Kentucky Coffeetree	rounded	double compound leaf	Drought / salt	Needs space
Liquidambar styraciflua	Sweetgum	pyramidal	yellow/maroon fall color	Wet or dry soils	Shade
Liriodendron tulipifera	Tulip Tree	pyramidal	green/orange flowers		Drought / needs
Metasequoia glyptostroboides	Dawn Redwood	pyramidal		Wet or dry soils / wide pH	Needs space
Platanus x acerifolia	London Planetree	rounded		Wet or dry soils / wide pH	Needs space
Quercus bicolor	Swamp White Oak	rounded		Wet or dry soils	High pH
Quercus imbricaria	Shingle Oak	rounded	russet fall color		Needs space
Quercus palustris	Pin Oak	pyramidal		Wet or dry soils / compaction	Needs space /
Quercus phellos	Willow Oak	rounded	russet fall color	Wet or dry soils	High pH
Quercus robur	English Oak	rounded		Dry soils	
Quercus rubra	Red Oak	rounded	russet fall color	Dry soils / compaction	Needs space
Styphnolobium japonicum	Sophora	rounded	July flowers; fall seed pods	Dry soils / salt / compaction	Shade
Taxodium distichum	Baldcypress	pyramidal		Wet and dry soils / salt	Shade / need s
Tilia americana 'Redmond'	Basswood	rounded	yellow fall color	Compaction / wide pH	Salt / foliage m
Tilia cordata	Littleleaf Linden	pyramidal	yellow fall color	Wide pH	Salt
Tilia tomentosa	Silver Linden	rounded		Dry soils / compaction / wide pH	
Ulmus 'Homestead'	Homestead Elm	oval		Wet and dry soils / salt / wide pH	Shade
Ulmus americana	American Elm	vase-like	yellow fall color	Wet and dry soils / salt / wide pH	Shade
Ulmus parvifolia	Chinese Elm	rounded	yellow fall color	Wet and dry soils/ salt / wide pH	
Zelkova serrata	Japanese Zelkova	vase-like	bronze fall color	Dry soils / salt / wide pH	Shade

Street Tree Planting

There are three ways to get a street tree planted in the City of Providence:

1) For free trees, apply to the Providence Neighborhood Planting Program for a "group award." A minimum of five neighborhood residents must request trees and agree to www.prpp.org for further information.

2) For individual tree planting requests, match half of the planting cost ($200) to have the tree planted through the PNPP. Call the Parks Forestry Division at 785-9450.

3) Apply for a tree planting permit to plant a tree yourself or hire someone at your own expense. All planting in the city right-of-way must be approved. Call the Parks Forest

Page 1 of 2 (revised July 2011)

Photo Credit: City of Providence

The PVD Approved Street Tree List provides guidance on selecting trees that are appropriate for the available planting space, considering constraints such as overhead wires, planter width (soil volume), underground utilities, clearances for vehicles, pedestrians, ADA compliance, safety, and traffic control devices, and other required clearances. The Providence Tree List can be found on the City of Providence Forestry Division website: https://www.providenceri.gov/parks/street-tree-planting/

BEST USED IF

- A tree is being selected for planting in City of Providence right-of-way.

DON'T USE IF

- The current list should always be consulted for plantings within Providence's public right-of-way. Other species (not on the list) may be considered for use in particular circumstances (such as larger than typical planting space or matching historic plantings). However, right-of-way planting of trees not on the list will require PVD Forestry Division review and Approval.

PROACTIVE / RESPONSIVE

- Proactive - Used for new tree plantings (including replacement trees).

PROACTIVE

COST RANGE

N/A

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

REINFORCED SLAB

Photo Credit: SDOT Trees and Sidewalks Operations Plan

A reinforced or thicker (than standard 4” concrete thickness) sidewalk can be used to help resist uplift of tree roots. Reinforcing may include the use of steel rebar or wire mesh. The use of thicker pavement is similar to the design of sidewalks at driveways, which employ a thicker sidewalk section (8” concrete thickness) to support vehicular traffic.

BEST USED IF

- Minimal future root growth is anticipated, and existing roots can be pruned to accommodate the installation.
- There is adequate soil volume in areas the roots are intended to grow.

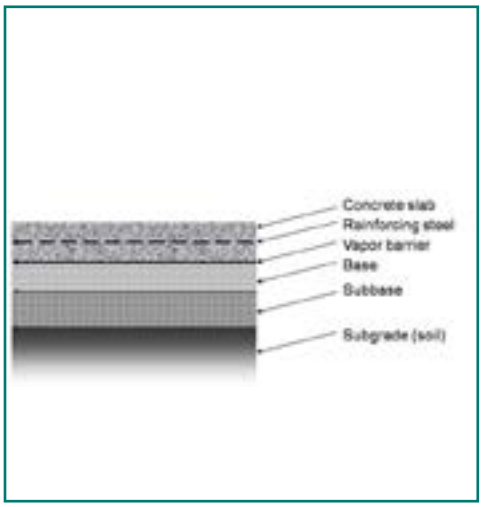


Photo Credit: Concrete Network

DON’T USE IF

- Tree root growth is vigorous, and the reinforced or thicker sidewalk is unlikely to provide a lasting solution.

PROACTIVE / RESPONSIVE

- Proactive - Used along new installations to prevent future root uplift.
- Responsive - To correct uplift of the sidewalk and provide resistance from future uplift after corrective actions have been taken.

PROACTIVE **RESPONSIVE**

COST RANGE

$$** **$$$

EXPECTED USEFUL LIFE

M **Y** **D** C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Reinforced pavement may not be allowed in areas where future utility installation is required.
- For optimum tree health, combine use with modified gravel layer, structural soil, or a foam underlay.

ROOT BARRIERS

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Root barriers are physical barriers (commonly plastic sheeting or interlocking panels) installed from surface level to a depth of 12”-24” or more at the interface between a tree zone and adjacent paving or other infrastructure. They are intended to deter root growth near the surface that may damage pavement. Typical placement is vertical, Although horizontal root barriers also exist.

BEST USED IF

- A new tree is being installed and there is pavement nearby that may be damaged by future root growth.
- There is adequate soil volume in areas the roots are intended to grow.

Photo Credit: Flexible Lining Products

PROACTIVE / RESPONSIVE

- Proactive - Root barriers are best used for new tree plantings to prevent future damage to adjacent sidewalks and other infrastructure.
- Responsive - Root barriers may be added in specialized retrofit conditions.

PROACTIVE **RESPONSIVE**

COST RANGE

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EXPECTED USEFUL LIFE

M **Y** **D** C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Note that root barriers are strongly suggested adjacent to sidewalks (18” depth) and curbs (24” depth) for new tree plantings.

ROOT PATHS

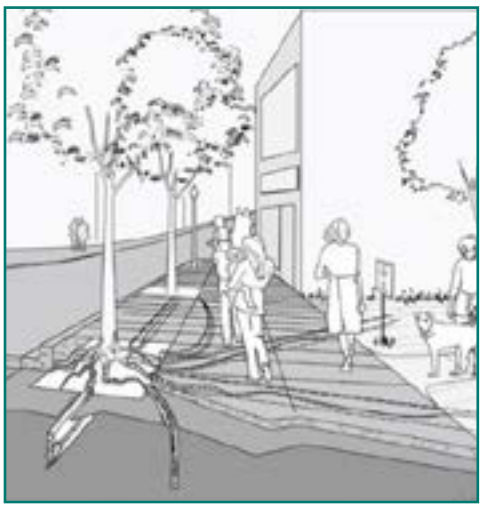

Photo Credit: Arlington, VA, Department of Community Planning, Housing, and Development

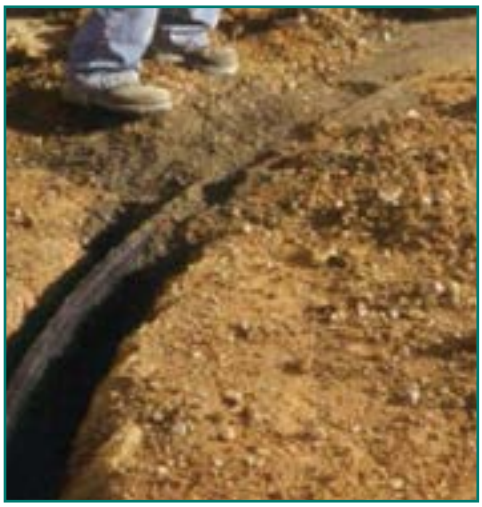

Photo Credit: Casey Trees, Tree Space Design Report

Root paths are narrow trenches, roughly 4” wide by 1’ deep, installed in compacted subgrade before the gravel base for pavement is added. A commercially available strip drain material could be added to the trench to support drainage, and the remaining space backfilled with planting soil. Root paths extend radially from tree pit locations, and may connect to adjacent tree pits, and/or other nearby planting areas (lawns, etc.).

BEST USED IF

- Underlying (native) soil supports some rooting even when it is somewhat compacted.

DON’T USE IF

- Positive drainage out of / away from root path cannot be achieved.

PROACTIVE / RESPONSIVE

- Proactive - Root paths should be installed for new plantings during construction, at the time of subgrade preparation (before paving).

PROACTIVE

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M **Y** **D** C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Root paths may be most applicable in urban areas where tree roots need to be directed around utilities and planting space is limited.

ROOT PRUNING

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: gibneyCE.com

RESPONSIVE

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

Root pruning is a responsive treatment in which tree roots that are causing issues, such as sidewalk uplift, are removed, typically in conjunction with repair of damaged sidewalks or other infrastructure. The amount of root pruning that a tree can handle varies by tree size, species, condition, age, and root distribution, and must be supervised by a qualified arborist. Root Pruning is the least desirable solution because it requires the roots to be cut and removed.

BEST USED IF

- A minimal amount of root pruning can prevent or defer future damage caused by the tree's roots.
- Removal of specific roots makes space available for an appropriate repair (e.g., allows proper sidewalk width and/or grading).

DON'T USE IF

- Arborist determines that root pruning would significantly impact health or structural integrity of the tree.
- Qualified arborist has not been consulted.

PROACTIVE / RESPONSIVE

- Responsive - This practice is used to address tree roots that are directly contributing to an infrastructure issue.

NOTES

- PVD Urban Forestry Division should approve removal/pruning of roots greater than 2" in diameter within the dripline of a street tree. All root pruning within the critical root zone of a street tree must be supervised or directed by a representative from PVD Urban Forestry Division.
- Best Practices: For trees 12 inches in trunk diameter or less, excavation work or root cutting should not occur closer than 3 feet from the trunk of the tree. Trees greater than 12 inches in trunk diameter should not be cut closer than the distance measured by the circumference of the trunk or 6 feet from the trunk, whichever is more. If roots need to be severed closer than this, tree removal should be considered since it is very likely that tree stability will be affected. Soil excavation work is permitted closer if all the excavation of soil is done by hand or water spade or by airtooling and no roots greater than 2 inches in diameter are cut. A trained arborist should do all of the root pruning. All root-pruned trees should receive an annual inspection to check their stability and recovery.

SHIMS

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: West Side Seattle

Shims, also called wedges, are temporary or interim measures to treat cracked or lifted sidewalks to reduce tripping hazards and improve accessibility. Asphalt is typically used to construct a shim.

BEST USED IF

- Immediate solution to problem is needed.
- Problem is minor enough to address with shim (generally 1" or less lift) and space is available to install shim at 4H:1V max slope.

DON'T USE IF

- Uplift is too significant to address with shim.

PROACTIVE / RESPONSIVE

- Responsive - Shims are used in response to an issue that must be immediately addressed.

RESPONSIVE

COST RANGE

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EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- In general, shims are considered a temporary measure and will require more frequent repair or replacement than a fully repaired sidewalk.
- The asphalt at the low side may ravel and may lead to secondary trip hazard.

SOIL MODIFICATION

Photo Credit: Organic Soil Solutions

Soil modification includes improvements and amendments to site soils, or the use of specific beneficial soils to replace existing soils, to improve conditions for root growth in desirable locations. One recommended amendment is humic acid, an organic soil treatment that can loosen tightly packed soils to improve water infiltration and help foster root growth deeper in the soil horizon. The addition of a high-quality, biologically active and pathogen-free compost in soil areas where root growth is desirable is also recommended.

BEST USED IF

- Tree roots are staying largely near the soil surface and soils are hard and difficult to penetrate.

DON'T USE IF

- Proposed soil modification would cause excessive root damage.

PROACTIVE / RESPONSIVE

- Proactive - Humic acid may be used with new plantings at the surface of any prepared subgrade where roots may develop.
- Proactive - Soils should be improved in any planting bed areas adjacent to tree plantings to encourage root growth in planted areas rather than under pavement.
- Responsive - Humic acid should be used around any exposed roots and at the base of any excavation to encourage deeper root development and discourage pavement damage.

PROACTIVE **RESPONSIVE**

COST RANGE

$** **$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- Also ensure adequate soil volume is available (see Soil Volume solution).

SOIL VOLUME

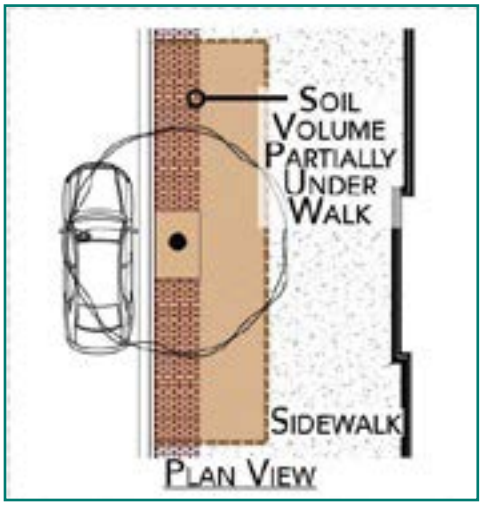

Photo Credit: District of Columbia Dept. of Transportation

All street trees should have an adequate volume of soil of a type and depth that promotes healthy tree and root growth. Many tree and sidewalk conflicts arise due to tree roots growing directly under sidewalks, with compacted fill and other poor soil below. Providing adequate volume and depth of appropriate soils will help grow healthier trees and reduce tree and sidewalk conflicts. Soil volume requirements vary by tree species and location, but a general guideline is two cubic feet of soil per one square foot of area within the tree's mature drip line. Generally, the following volumes should be provided:

- small tree = 600 cubic feet of soil
- medium tree = 1,000 cubic feet of soil
- large tree = 1,500 cubic feet of soil

BEST USED IF

- New tree plantings are being planned and installed.
- Opportunity exists to augment the planting soil available to existing trees without adversely impacting the roots.

DON'T USE IF

- Adding soil volume would require cutting or damaging critical roots on an existing tree.

PROACTIVE / RESPONSIVE

- Proactive - Require adequate tree pit size and/or provide soil under adjacent pavement for new tree plantings.
- Responsive - Increase tree pit size and provide soils that promote healthy root growth to extent possible when repairing sidewalks around existing trees.

PROACTIVE **RESPONSIVE**

COST RANGE

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EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
Y - YEAR
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C - CENTURY

NOTES

- Planting soils under or at back of sidewalk may count towards soil volume if appropriate soils are provided for tree root growth.
- Actual soil volumes needed for optimum tree health will vary with location, tree species, and other conditions.

STEEL PLATES

Photo Credit: Gordon Mann

Steel plates are placed above existing roots and anchored into place to prevent upward root expansion. Pavement is placed over the steel plates.

BEST USED IF

- An existing root should not be pruned but needs to be constrained to prevent or slow further sidewalk damage.

DON'T USE IF

- Steel plate would be placed above an underground utility.

PROACTIVE / RESPONSIVE

- Responsive - Steel plates should be used in response to an issue that has developed. Proactive measures should be used to prevent pavement damage for new plantings.

RESPONSIVE

COST RANGE

$$** **$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
Y - YEAR
D - DECADE
C - CENTURY

NOTES

- The City should develop and implement a method to track locations where steel plates are installed and alert individuals who may be doing construction work near them to their presence.

STRUCTURAL SOILS

Photo Credit: Environmental Research Group

Photo Credit: Cornell Urban Horticulture institute

PROACTIVE **RESPONSIVE**

COST RANGE

$$** **$$$

EXPECTED USEFUL LIFE

M **Y** **D** C

M - MONTH
Y - YEAR
D - DECADE
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Structural soils are soils that are specially designed to provide nutrients, space, and porosity to accommodate root growth while also allowing for compaction to support pavement without settling. There are proprietary structural soil mixes available as well as various non-proprietary mixes that have been used in many municipalities.

BEST USED IF

- Structural soil can be placed in adequate depths to allow for root growth away from the bottom of the pavement.

DON'T USE IF

- Depth of at least 12" of structural soil cannot be achieved for a new tree planting (shallow depths will encourage root growth near the bottom of the pavement).

PROACTIVE / RESPONSIVE

- Proactive - May be placed under new pavement areas or under planting soil in planting beds to provide soil volume for root growth.
- Responsive - May be used as fill material around existing roots in areas where sidewalk will be replaced above if adequate structural soil depth can be placed.

SUBSURFACE AERATION + IRRIGATION

SPACE CONSTRAINTS

DAMAGE AVOIDANCE

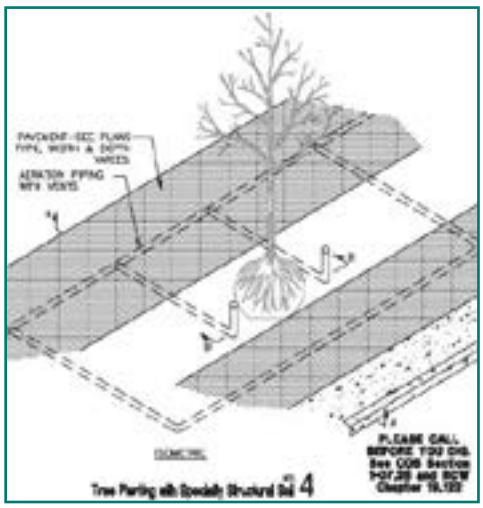

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: SDOT Trees and Sidewalks Operations Plan

PROACTIVE **RESPONSIVE**

COST RANGE

$$

EXPECTED USEFUL LIFE

M	Y	D	C

M - MONTH
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Aeration piping may be installed to help encourage deeper root growth by providing some air to deeper layers of soil, particularly where covered by pavement. In some cases, the addition of an irrigation system (typically drip tubing) within the perforated aeration piping can further aid in desirable root growth.

BEST USED IF

- Placement of structural soil or other fill allows for installation of aeration piping at least 12” below finished grade.
- Aeration piping may be added under paved areas.

DON’T USE IF

- Installation of piping would require damage to critical existing roots.
- Piping cannot be installed at adequate depth or in areas where encouraging root growth would be beneficial.

PROACTIVE / RESPONSIVE

- Proactive - Aeration piping and subsurface irrigation may be installed during subgrade preparation under pavement adjacent to tree plantings.
- Responsive - If pavement is to be replaced or added adjacent to existing trees the addition of subsurface aeration piping may help maintain adequate growing conditions for existing roots.

NOTES

- Aeration piping may become defunct (due to root intrusion or other causes) within 5-10 years, which is acceptable if the tree(s) have become established in their growing conditions.

SUSPENDED PAVEMENT SYSTEMS

SPACE CONSTRAINTS

DAMAGE AVOIDANCE

Photo Credit: SDOT Trees and Sidewalks Operations Plan

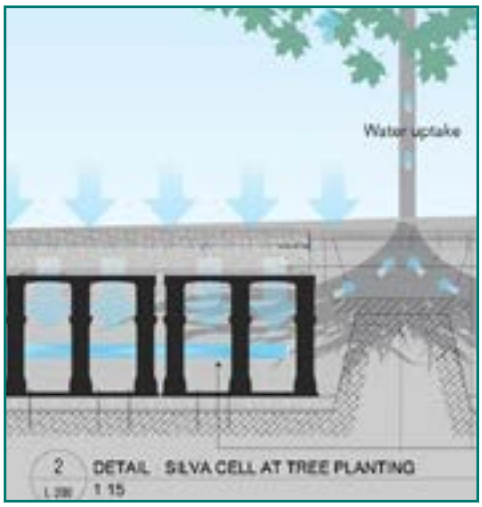

Photo Credit: Deep Root

Suspended pavement systems may be used in new tree plantings where there is not an adequate volume of soil available for tree root growth. These systems provide structural support for pavement while allowing the use of planting soil as fill, which provides space for roots to grow, promoting healthy trees and preventing pavement damage by roots near the surface.

BEST USED IF

- Adequate soil volume for the size of intended tree species is not available within the tree pit and adjacent planting strip.
- An area below pavement between the planting strip and back of sidewalk is desired for root growth while avoiding pavement damage.

DON'T USE IF

- Cannot work within grading requirements for site specific conditions.

PROACTIVE / RESPONSIVE

- Proactive - Should be used for new tree plantings, particularly in urban conditions with limited planting area within the streetscape.

PROACTIVE

COST RANGE

$$$** **$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

M - MONTH
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NOTES

- Suspended pavement systems give the benefit of adaptability to existing utilities through the integration the cells provide to existing utility corridors running underneath pavement.

TREE GUARDS + TREE RAILS

Photo Credit: SDOT Trees and Sidewalks Operations Plan

Photo Credit: thesteelyard.org

A tree guard around a tree's trunk can help protect the trunk from damage. A tree rail around an entire tree pit/planting area can help protect the tree as well as prevent soil compaction around it.

BEST USED IF

- Tree planting is in an area of high pedestrian traffic.

DON'T USE IF

- Tree planting is in a low-traffic area.
- Periodic maintenance of tree guard or railing is unlikely (tree guards near trunk can damage the tree if left in place too long as the tree grows).

PROACTIVE / RESPONSIVE

- Proactive - Best put in place with new plantings in areas where high foot traffic in the tree planting area is anticipated.
- Responsive - May be installed in areas where damage to trees and compaction of planting area is a problem if reasonable alternative travel areas exist.

PROACTIVE **RESPONSIVE**

COST RANGE

$$** **$$$

EXPECTED USEFUL LIFE

M Y D C

M - MONTH
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NOTES

- Consider whether there is enough space outside of the planting area to accommodate pedestrian volumes; if not, then consider other solutions, such as relocation of trees, replacing tree pit surface with walkable surface (such as fine crushed gravel), or a tree grate.
- Could be used to help accommodate grade changes between the tree planting area and adjacent sidewalk.

TREE PIT SIZE

Photo Credit: APWA

Tree pits are typically used as an alternative to planting strips in business districts where additional sidewalk width is important to accommodate pedestrian volumes. In Providence, when used as an alternative to planting strips the minimum square footage for a tree pit should be 24 square-feet of open area (typically 4' x 6' or 5' x 5'). Any proposed variations to suggested square footage should ensure that the design meets public safety standards and the design provides adequate conditions, including soil volume, to support trees. Sidewalk widths in many locations are generally 7.5' (Back of curb to property line) or narrower. Tree pits need to be sized accordingly to provide adequate pedestrian space and accommodate ADA requirements. It is strongly encouraged by the City of Providence to allow for the largest tree pit possible in each scenario to ensure the health of the tree.

BEST USED IF

- A continuous planting strip is not a good option for the site (e.g., in a busy/pedestrian setting, or adjacent to curbside parking with frequent turnover).

DON'T USE IF

- Continuous planter strips are more appropriate for the site.

PROACTIVE / RESPONSIVE

- Proactive - Tree pits for new plantings should allow adequate room for trunk and root growth for the species of tree being planted.
- Responsive - In some cases tree pits may be enlarged to alleviate constrained root or trunk space and provide better growing conditions for an existing tree. Could be used as a stand alone measure, or in conjunction with beveling and/or select sidewalk repair.

PROACTIVE **RESPONSIVE**

COST RANGE

$$$** **$$$$

EXPECTED USEFUL LIFE

M | Y | D | C

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NOTES

- Planting soils under or at back of sidewalk may count towards soil volume if appropriate soils are provided for tree root growth.
- Actual soil volumes needed for optimum tree health will vary with location, tree species, and other conditions.

REFERENCES + RELATED DOCUMENTS

PROVIDENCE TREE LIST, RETRIEVED FROM CITY OF PROVIDENCE FORESTRY DIVISION WEBSITE: HTTPS://WWW.PROVIDENCERI.GOV/PARKS/STREET-TREE-PLANTING/

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Photo by Dominique Sindayigaruza