# Living with Urban Soils

TREE CITY USA® BULLETIN No. 5 Editor: Dr. James R. Fazio • $3.00

*Out of sight, out of mind, is not the right attitude toward soil when trees are at stake. Soils and soil management are especially critical in urban settings where the work of nature has largely been altered by human activity. Your knowledge of soils — and the nourishment, water, and anchorage that they alone can provide for trees — will help ensure success for new transplants and long life for older trees.*

The lowly soil. We call it dirt, walk on it, cover it with concrete, and have long lost the reverence of our forebears who called it Mother Earth. Yet from the soil comes our very existence, and where it is rich, life is rich. The pioneers knew this well and let the soil be their guide to locating farms and villages as they spread across the land.

Today nobody locates their home because of the soil. We live where we must and in most cases never give a thought to the soil. But for those who love trees, soil must once again be our guide. By understanding a few basics, you can be sure to select the species that will do best in your soil. You can also improve the health, vigor, and chances of longer life for your shade trees by including the following soil management techniques in your plans for tree care.

## CITY TREE — COUNTRY TREE

An urban tree and its country cousin are in two different worlds. In a forest, a tree is in a specific site because of the natural sorting and sifting that is part of ecology. The tree is usually well-matched to the microclimate, including the soil in which it is growing. In urban sites, most trees can use a little help from human friends to overcome alterations in the soil and other stresses resulting from the activities of urban life.

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# Understanding the Nature of Soils

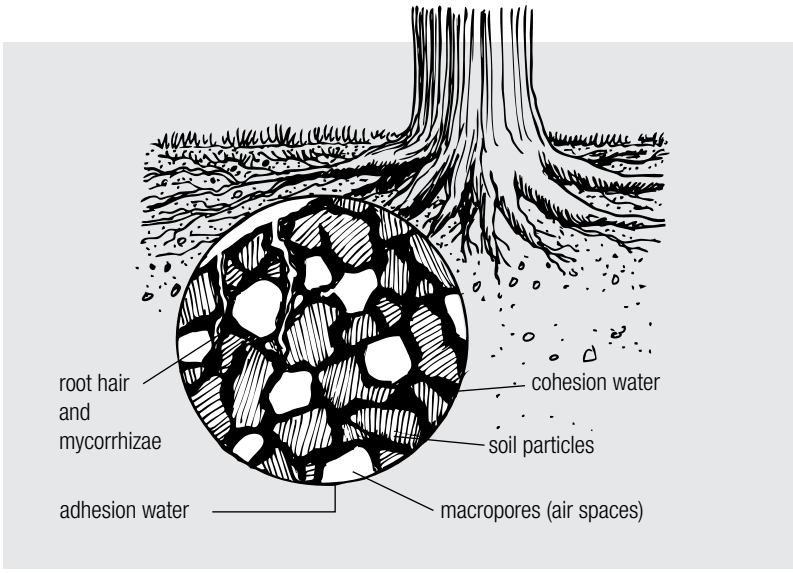
Soil is an unconsolidated mixture of organic and mineral material. There are the particles, born of the earth's bedrock, sometimes right below where they lay, but more often brought there by water, wind, or glaciers of long ago. Some of the particles are organic, the decayed remains of plants and animals. Together, the particles and the soil chemicals that cling to their surface provide 13 of the 16 elements required for plant growth.

Between the particles, water can usually be found, and its excess or scarcity is most frequently the limiting factor in the growth of trees. When the soil is saturated, water fills the large openings, called macropores. As the soil drains and dries, the last of the water defies gravity and clings to the particles through adhesion or sandwiches itself in the tiny micropores, held there — to the benefit of root hairs — by the cohesive attraction between water molecules. When not occupied by water, the macropores are also the passageways that bring life-giving oxygen to roots, a function as essential to trees as the union of air and lungs in humans.

Soil is also dynamic. The quantities of water and gas are constantly changing; nutrients are being added from the air and the decay of plant and animal tissue, while some are being carried away by the roots of plants or moving deeper into the soil (leaching); and all is in constant, beneficial disruption from the plowing actions of soil creatures. Earthworms alone can move 7 tons of soil through their bodies in one year on a half-acre lot.

Soils are highly variable. Their diversity is the product of dozens of physical and climatic factors, all interacting over time to yield the substance that lies under your lawn.

The complexity of urban soils is magnified because of human disturbances through the years. They have been dug up, moved about, polluted, compacted, built upon, dug up again, and restructured with deep layers over topsoil and topsoil over parking lot gravel. In any community, the range of soil conditions varies from soil that is unplantable to soil that last year was growing crops.




## KNOW YOUR SOIL

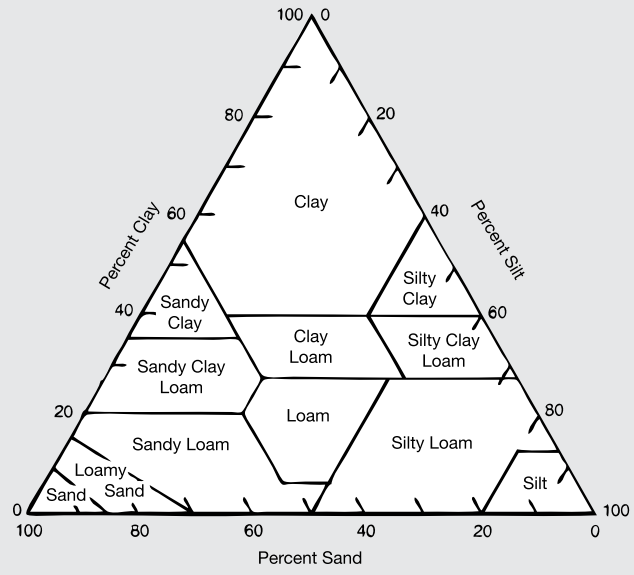
For a description of the soils in your area, there is nothing like a soil map produced by the USDA Natural Resources Conservation Service. Contact your local NRCS office to obtain the soil survey map for your county, which will also warn you of any limitations, such as shallowness, lack of fertility, potential for erosion, and a score of other details.

The soil survey map is especially helpful if part of your property includes undisturbed land or if you are searching for land to buy. Do you want to grow Christmas trees? Make sure the soil on your potential new property is conducive to growing evergreens. Planning to build your dream house with a basement and in-ground pool? Make sure the soil does not have a high water table or the tendency to shrink and swell constantly.

Another source of helpful information is the soil test. In its simplest form, kits and instruments are available from garden stores or forestry suppliers that allow you to determine the acidity or alkalinity (pH) of your soil. More useful, however, is a complete soil analysis that also tells you not only pH, but the presence of nutrients in your soil and any that are deficient. Soil tests are done for a small fee by commercial laboratories, your state agricultural university, or some larger tree care services. For information on how to collect and send your samples to a lab, contact the Cooperative Extension agent in your county.

# Key Soil Features that Affect Tree Growth

- ☑ TEXTURE The size distribution of particles (see chart below).
- ☑ STRUCTURE Groupings of soil particles, held together chemically and electrically and aided by decomposing organic matter. Soil with "good" structure (aggregates of particles) provides a better environment for roots.
- ☑ DEPTH The depth of the topsoil layer, which contains organic matter and the total distance from surface to bedrock.
- ☑ HARDPAN A sub-surface layer impervious to water drainage and root penetration.
- ☑ pH Acidity or alkalinity ranging from 3 (strongly acidic) to 11 (strongly alkaline), with 7 being neutral.
- ☑ NUTRIENTS Essential for plant growth, including trees.
  **Macronutrients:** nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg).
  **Micro (trace) nutrients:** manganese (Mn), zinc (Zn), boron (B), copper (Cu), iron (Fe), molybdenum (Mo), chlorine (Cl).
  **From air and water:** hydrogen (H), oxygen (O), carbon (C).
- ☑ MYCORRHIZAE Certain fungi associated with roots in a symbiotic relationship. The absorptive abilities of roots are enhanced when these fungi are present.

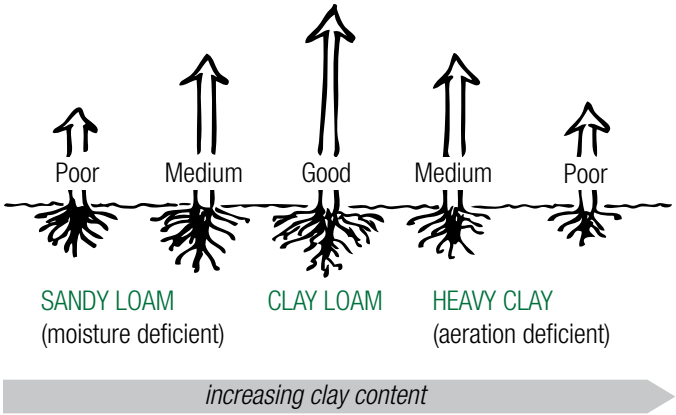




Caution: Fertilizers with an added weed killer can be harmful to trees.

NOTE: On most fertilizer packages used by homeowners there is a three-part figure such as 10-8-6 or 20-20-20. These numbers refer to the main ingredients, nitrogen (N), phosphorus (P), and potassium (K) — always in that order. The numbers are the percentage, by weight, of the three elements. Other elements or compounds are sometimes added and will be labeled accordingly. Most of the package consists of neutral bulk materials.

## SOIL TEXTURE




How texture can affect tree growth. Loblolly pine as an example.

CLAY Smaller soil particles with wafer-like shapes that provide greater surface area, contributing to a higher ability to hold water and nutrients.

SILT Between clay and sand in particle size; spherical and cubical in shape.

SAND Largest particle size; has spherical and cubical shapes that provide smaller surface-to-volume ratio and therefore a soil that is better aerated and easier to work, but which has the lowest water- and nutrient-holding abilities.

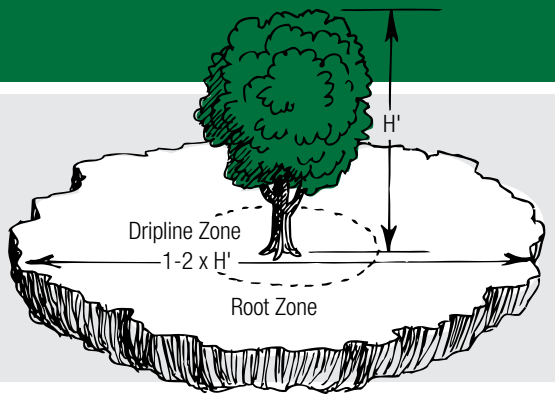
LOAM A combination of all particle sizes, with the desir-

# Solving Problems Created by Soil

The life of your tree depends on the soil in its root zone. The zone occupies a surprisingly large and shallow area, with about 90 percent of all roots in the top 24 inches of soil and usually not extending deeper than 3-5 feet. The outward spread forms an irregular area with an average diameter roughly one to two times the height of the tree. Near the base of the tree, the vast network of roots narrows into fewer, shallower roots, making the dripline zone (the area beneath and within the circumference of the crown) a particularly critical area for the tree.

Within the root zone, and especially within the dripline zone, the dangers and problems faced by an urban tree are immense. Your awareness of the importance of this environment for roots can help safeguard your trees. Following are the major problems and what you can do.

NOTE: Always call 811 before digging. See page 8 for more information.




## NUTRIENT DEFICIENCIES

Like the weak link in a chain, if any one of the essential elements is deficient in the soil, it will control the growth of your tree. Deficiencies show themselves in a number of ways, usually in leaf or needle discoloration and various abnormal growth patterns. An experienced arborist or urban forester can recognize the signs, and excellent guides are available in *Soils and Tree Growth*, referenced at **arborday.org/bulletins** by clicking on "Available Bulletins and Resources" and choosing Bulletin No. 5.

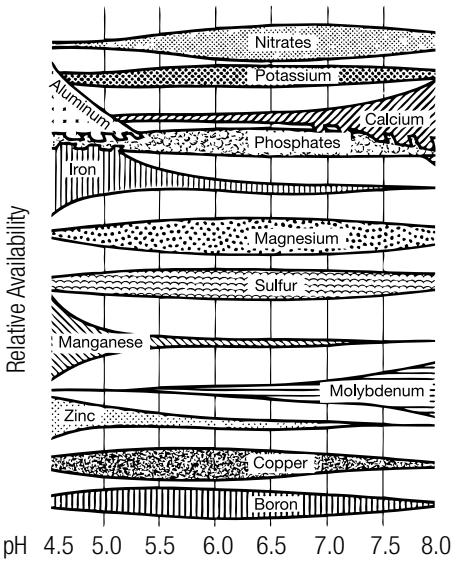
Fertilizing is often the answer to nutrient deficiencies. Fertilizing urban trees correctly is difficult and, when necessary, best done by an arborist. Fortunately, fertilizing is usually not necessary, especially for tree roots growing under lawns that are treated regularly by the broadcast method of application. This is because most of the tree's fine feeder roots are near enough to the surface to utilize the grass fertilizer as it seeps into the soil. While this is good for shade trees as well as your grass, it also points out two dangers to avoid: (1) fertilizer mixes that contain herbicides should be used sparingly, if at all, within the root zones of trees, and (2) fertilizers that are high in nitrogen should be avoided around very young trees and mature trees. Excessive nitrogen fertilization can lead to certain pest problems and can leach into ground water.

Except when advised by a competent arborist, extra fertilizing is usually a waste of money. Of the three key nutrients in commercial gardening and lawn fertilizers, nitrogen is usually the only one that is commonly deficient or to which trees will respond. The addition of nutrients that are already available in sufficient quantities is like a healthy person overloading his system with additional vitamins. The excess is purchased and used up, but serves no useful purpose.

## WRONG pH

The pH of your soil affects the availability of various elements; therefore, it is an important part of the soil environment. The pH level is an easy measurement to take. However, it is impractical for most property owners to do enough work on their soil to alter the pH sufficiently to benefit shade trees. It is best to work on any deficient nutrient, making it more available through fertilizing. An even better alternative is to determine the pH before planting, then select species that do best at that level. Professionals in the green industry and a variety of references can provide this information for any species. In general, conifers do best within the slightly acidic range of 5-6, whereas most deciduous trees thrive at a pH of 6-7.

Soil chemistry is a key to tree health. As illustrated, each element becomes more available or less available to tree roots as the pH of the soil changes. For example, iron (Fe) is less available in alkaline soils (above pH of 7) than in acidic soils. This is why pin oak, a tree that thrives in acidic soil, will be deprived of sufficient iron when planted in an alkaline soil, causing its leaves to turn yellow. Source of graph: University of Kentucky Cooperative Extension Service.



## DRYNESS

During their first three to four years of life, urban trees are especially vulnerable to drought. Older trees usually have a large enough root network to draw out water molecules held tightly around soil particles. Even so, deep watering after a prolonged dry spell is beneficial to all but those dryland species that have adapted to such conditions (California live oaks, for example). Conifers need adequate water just before the winter freeze sets in, because these species hold their "leaves" all winter and continue to lose water through transpiration.

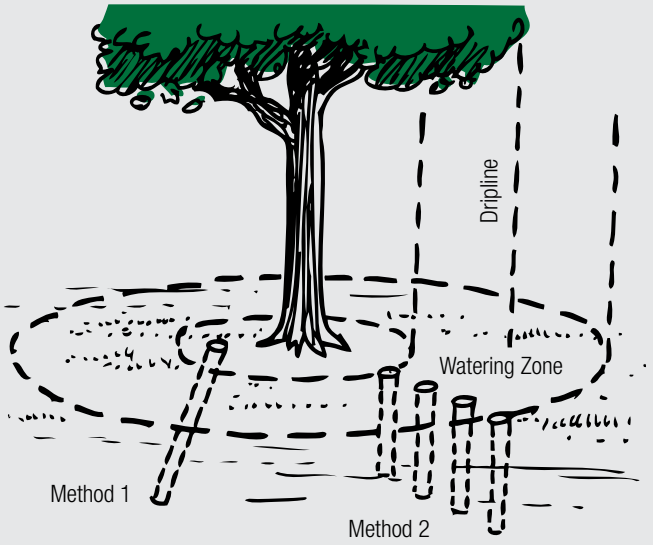
Watering should soak the top 12 inches of soil. Generally, sandy soils need rain or watering every four to seven days, whereas clay soils hold their water in the root zone for up to 10 days. Avoid short, frequent watering, as this usually does not penetrate deep enough and encourages roots to grow toward the surface.

Watering may be effective simply by using the garden hose or sprinkler. However, to aid deep watering, as well as to provide aeration for roots and greater penetration of fertilizer, consider one of the two methods illustrated at right.

## HARDPANS

These impervious layers occur naturally in some soils and vary from less than an inch thick to more than 30 feet. They can occur at any depth. Within the root zone, they can block the advancement of root growth. If they occur deeper than the root zone, they can still cause problems by interfering with sub-surface drainage and causing water-logged soil. In urban settings, hardpans are often created by compacted soil (or even old parking lots and streets) being covered with topsoil. Old fields that were plowed for decades also can exhibit a hardpan where gradual compaction was caused just below the reach of the plow (about 12").

When developing a new site for planting, hardpans should be broken up by heavy equipment before final grading or filling with topsoil. (New homeowners can write this soil management technique into their building contract, just as they should require stockpiling and replacing topsoil.) On developed sites, it is sometimes possible to drill holes through the hardpan layer to allow drainage and root penetration.




## DEEP WATERING METHODS

METHOD 1 Drill three or four holes approximately 18" deep and 1"-2" in diameter at an angle and outward from near the base of the tree. Inserting perforated plastic pipe and/or gravel will prolong the use of the holes before new ones need to be drilled.

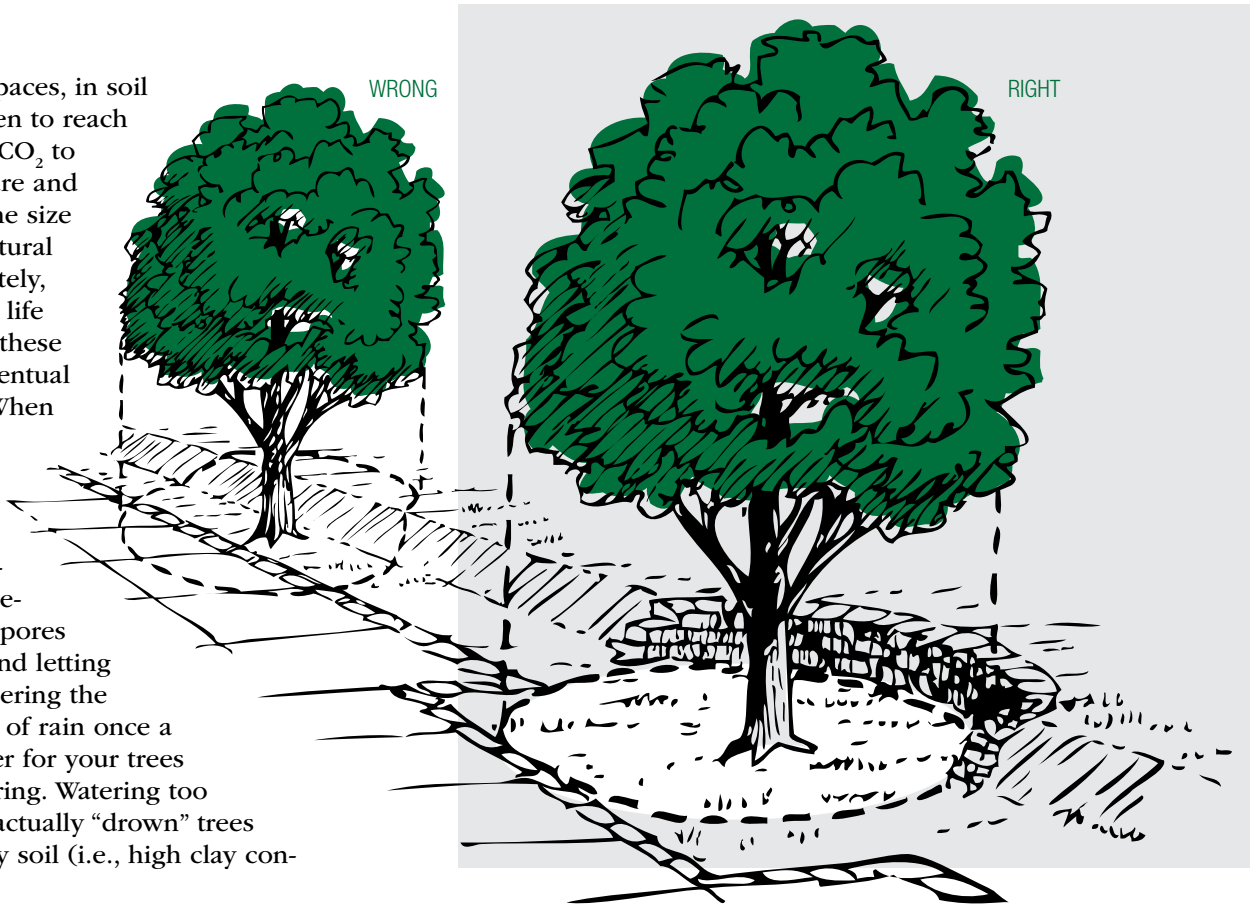
METHOD 2 Drill holes 18" deep, 0.75" - 1.5" in diameter, at 12" intervals around the dripline. Repeat at 12"-24" intervals within the watering zone. Fill holes with coarse sand and peat or fine gravel, or insert perforated pipes. Gravel surrounding a pipe, with less frequent holes, may also be used. Drill new holes when the old ones no longer accept water easily.

Soils around construction sites can become compacted. If covered by topsoil without first being broken up, the compacted soil presents an impediment to tree growth.

# Solving Problems Created by Soil (continued ...)

## SUFFOCATION

The pores, or air spaces, in soil are essential for oxygen to reach the root cells and for $CO_2$ to be released. Soil texture and structure determine the size of the pores under natural conditions. Unfortunately, the activities of urban life lead to the closing of these vital pores and the eventual suffocation of roots. When roots die, so do branches. Here's how:




- OVERWATERING Keeping soil excessively wet prevents the macropores from draining and letting in air. Deep watering the equivalent of 1" of rain once a week is healthier for your trees than daily watering. Watering too frequently will actually "drown" trees planted in heavy soil (i.e., high clay content).

- COMPACTION Cars, heavy equipment, and feet break down the soil structure and close pores. The most vulnerable time in the root zone is while drying occurs, usually within a day or so after a heavy rain or irrigation. Preventing excessive foot or vehicular traffic over the root zone is the best way to prevent compaction.

- FILLING OR PAVING Paving near trees or covering the root zone with even a few inches of fill can reduce the roots' oxygen supply significantly. Retaining walls and careful planning of paved areas can add many years to the life of a tree.

## MULCH: A TREE'S BEST FRIEND

Mulch is any material placed on soil to cover and protect it. Common mulches include bark, wood chips, pine straw, decorative gravel, and crushed lava.

Mulch covering all or a portion of a tree's dripline zone can significantly enhance growing conditions. There are some dangers, including fire hazard, insect or disease enhancement, fluids toxic to young trees, and nitrogen depletion in the soil as some materials (such as straw or sawdust) decompose. It is especially important to keep mulch a few inches back from the trunk. Overall, most of the problems are preventable and are easily balanced by the many benefits. A few are listed at right.

## BENEFITS OF MULCH

- Retention of soil moisture
- Weed and grass control
- Protection of the trunk and surface roots from mowing equipment
- Erosion control, since mulch breaks the impact of rain
- Increased soil fertility when organic mulches placed directly over the soil decompose
- Improved soil structure (better aeration, temperature, and moisture conditions)
- Simplified maintenance
- Improved appearance
- Reduced soil cracking that can damage small roots and speed drying
- Help in preventing soil compaction

# Soils and the Urban Forestry Program

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Municipalities vary widely in their consideration of soil as part of a tree care program. While some focus only on highly visible aspects of urban forestry, others recognize that soil and its management are keys to a healthy community forest.

Recognizing soil management as being important is the first step. The second step is to realize that unlike the forest under natural conditions, urban soil management may require a financial investment for making it into a healthy environment for root growth.

Here are some comments from experts.

- ☑ Appearance and size alone are poor ways to select trees. Planners should work with foresters and arborists to match species with soil conditions.
- ☑ When extensive planting is planned, soil data should be collected and mapped. Highlight areas of human activities, such as the heavy use of deicing salts or anything else that may significantly affect soil conditions. This will aid in species selection for affected sites, as well as indicate possible drainage or watering needs.
- ☑ Soil pH is simple and inexpensive to determine. It is much less expensive to measure pH where a tree is to be planted and select a species accordingly than it is to attempt modifying pH-related nutrient deficiencies later on.
- ☑ Accept the fact that drainage or watering may be a necessary part of growing trees in a public place. Watering may require the installation of irrigation devices, or it may mean developing a schedule of watering manually by crews during prolonged dry spells.
- ☑ In some cases, urban soils may consist of old waste dumps, building foundations, road or parking lot surfaces, or other materials that make root growth virtually impossible. Under these extreme conditions, an extra-large planting hole must be dug, then filled with soil from another site. Or you can plant in topsoil or woodchip berms constructed on top of poor soil. Costs can be reduced by stockpiling good soil whenever it is available from road construction or other building activities.
- ☑ When planting trees above hardpans, drill through the hardpan to create positive drainage.

## ONE COMMUNITY'S EXPERIENCE WITH VERTICAL MULCHING

Trees are a source of joy for the citizens of Mariemont, Ohio, a small residential community in the rolling hills not far from Cincinnati. The village's magnificent trees were planted in the early 1930s, including a number of white oaks, which now measure 36 inches or more in diameter. Understandably, a few years ago when consecutive years of below-normal rainfall led to the thin, stressed appearance of the oaks, community leaders became concerned.

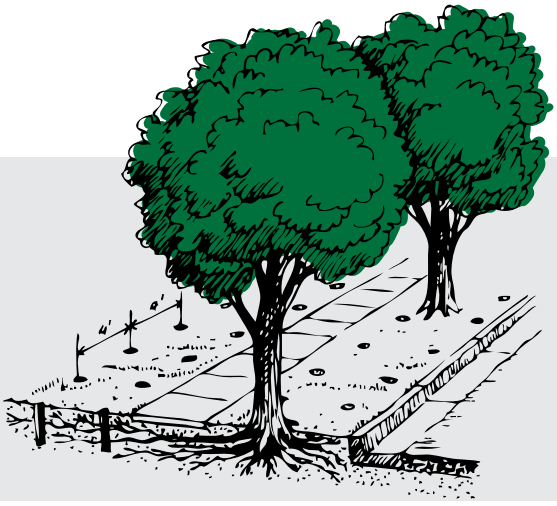
The late Steve Sandfort, former urban forest manager for the City of Cincinnati, was called in as a consultant for Mariemont and soon recommended a treatment called vertical mulching. This technique is much like the deep watering methods illustrated on page 5.

"Basically, it is a method for channelling water, oxygen, and fertilizer through the sod and compacted soil to the roots of a stressed tree," Sandfort said.

Treatment consisted of drilling 3- to 4-inch holes 18-24 inches deep in a 4-foot grid pattern around each tree. In each hole was placed a carefully determined amount of 10-6-4 fertilizer covered by coarse sand and organic matter.

Did it work? For years to come, the columns served not only as channels for life-giving water and oxygen, they also gave the roots new growing space. Within two years, the results were evident. The signs of stress in the oaks disappeared.

The results of this soil management technique were so positive that plans were then made to extend vertical mulching to traffic islands and play areas. The leaders and citizens of Mariemont recognize the monetary and environmental value of their trees, and the community will benefit increasingly from the improved health of its shade trees.



# Finding More Information

For current resources about urban soils, please visit **arborday.org/bulletins**. This is the official website of the Arbor Day Foundation and includes not only more helpful materials related to *Tree City USA Bulletin No. 5*, but also additional tips on tree care, how to purchase trees online, and an online tree guide. The guide offers detailed information about dozens of commonly planted landscape trees that grow throughout the United States, including their soil requirements.

The government organization most closely related to soils is the Natural Resources Conservation Service, once known as the Soil Conservation Service (soils.usda.gov).

## DO YOU KNOW YOUR STATE SOIL?

You have heard of state flowers, state trees, and state birds, but did you realize you have a state soil?

According to the Natural Resources Conservation Service, each state in the United States has selected a state soil and almost half of the states have actually designated an official state soil by legislation. The selected soil has a particular significance and shows what great variation there is from place to place. To find your state soil along with its description and photos, go to the website listed above and type "state soils" in the search box.

There are so many underground utilities that it is important that you know where these are before digging to plant a tree, dig out a stump, lay an irrigation line, or do any other digging. A nationwide number is now available to make it easy to have your underground utilities located and marked — and the service is free. A few days before you dig, simply phone 811 and your call will be directed to the local one-call number and appropriate local utility. This will help avoid damage, disrupted service, and possible fines and repair costs.

811 Know what's below. Call before you dig.

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## WATERING BAGS KEEP SOIL MOIST

Tree watering bags come in various sizes and shapes and go by names such as Ooze Tube and Treegator Bags. While these are not for all landscape trees, they can be especially handy for newly planted trees on sites that are difficult to otherwise water regularly. Another advantage is they keep the soil cooler beneath them and help prevent weed cutter damage.

## CALL BEFORE YOU DIG

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