CT Tree Warden School Training Session

Resource Materials for Presentations by
David Bloomquist
USDA Forest Service

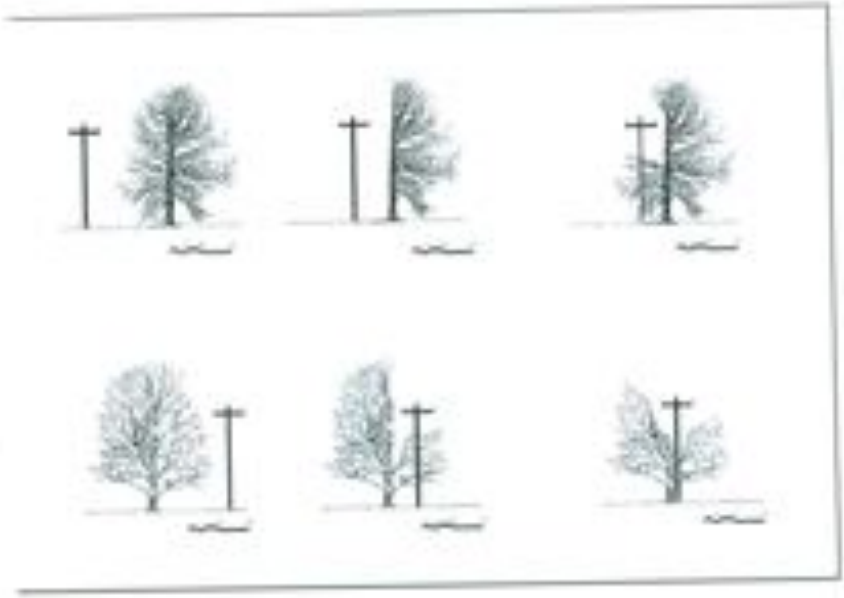
Urban Forestry
Street Tree Planting Design
Planting Technique

USDA
United States
Department of Agriculture
Forest Service
Northeastern
Area

NA

The Urban Ecosystem and Streetscape Design
Street Tree Inventories and Citizen Partnerships
Presented by David V. Bloniarz,
Project Coordinator, Northeast Center for Urban & Community Forestry, Amherst, MA

Design Implications of Overhead Utility Distribution Lines

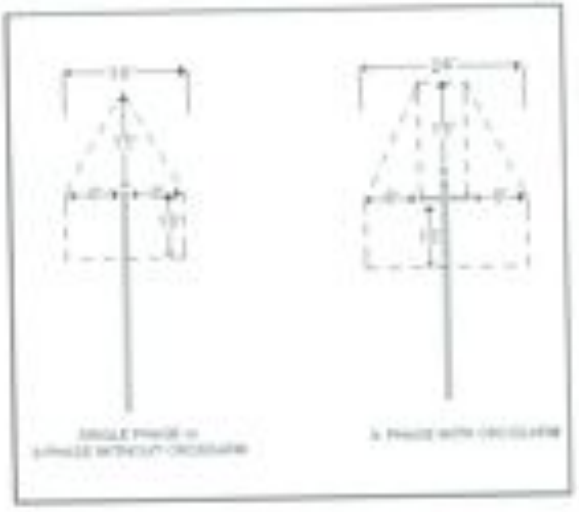


Visual Impacts of Overhead Utilities

Pin Oak w/o Wires

Pin Oak with Wires

Typical Street Tree in Urban Setting

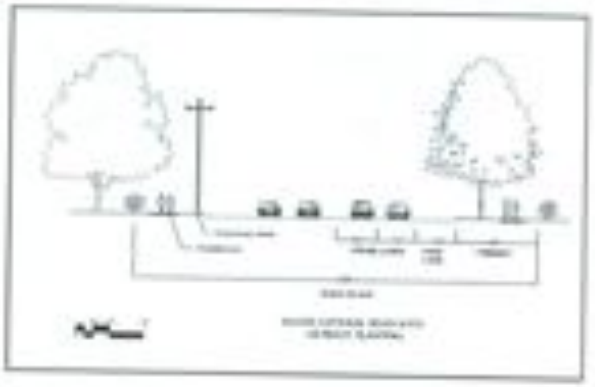


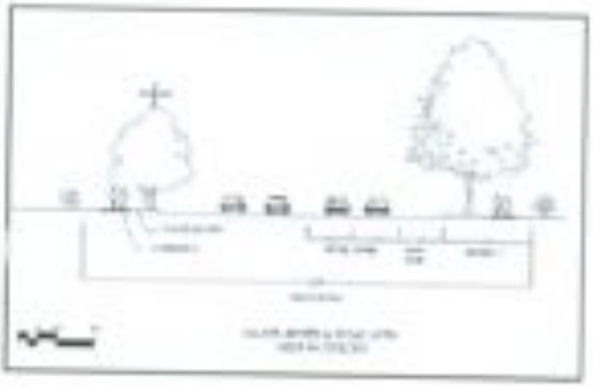
Typical Clearance Distances to Wires

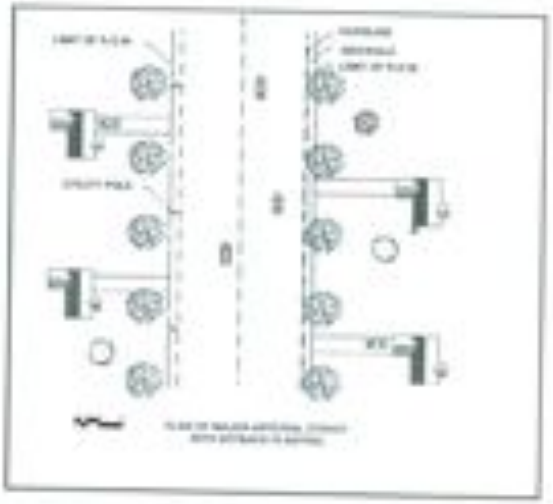
No Overhead Utilities

Impacted by Overhead Utilities

DESIGN ALTERNATIVES





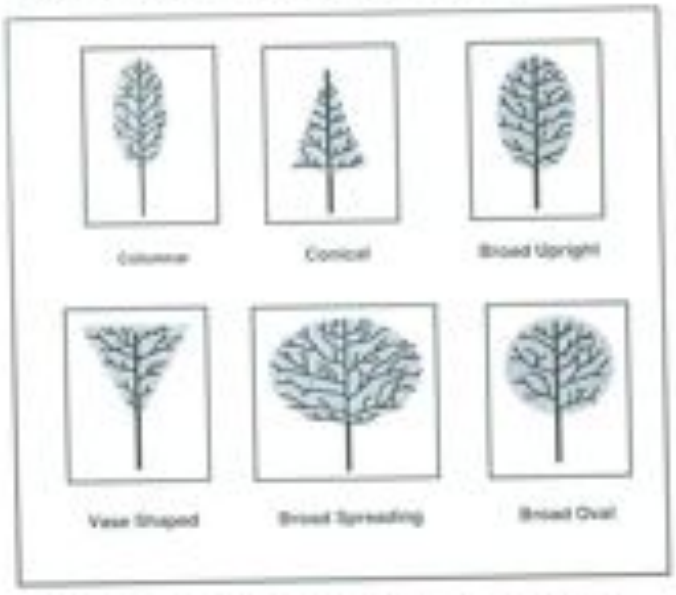


RECOMMENDATIONS

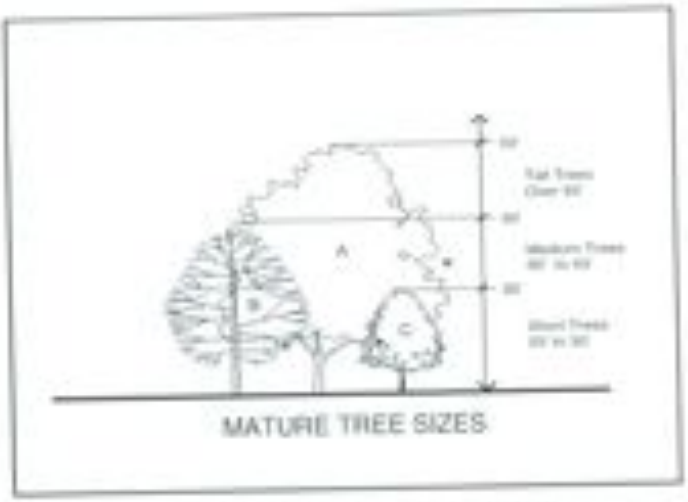
1.) Proper species selection, so that only trees that will not interfere with overhead utility lines, buildings, and sidewalks will be planted along streets.

2.) Setback planting of the street trees to a location where they will be able to grow without interfering with the overhead utility lines, buildings, and sidewalks.

3.) Planting trees in locations within the right of way other than directly below the utility lines, and could include construction of new planting islands along the street edge.



Choose the Appropriate Shape for Design Intent

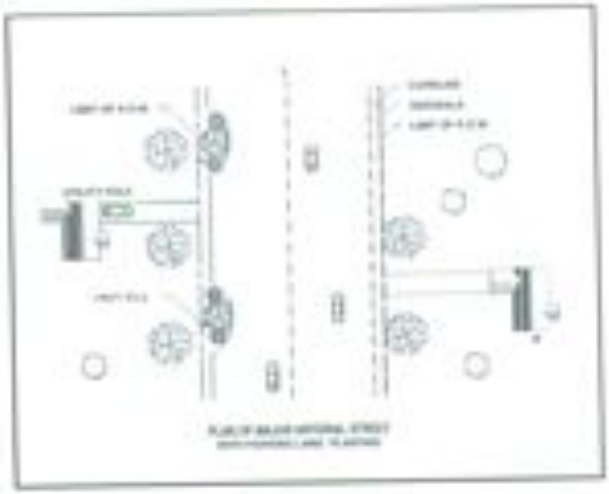


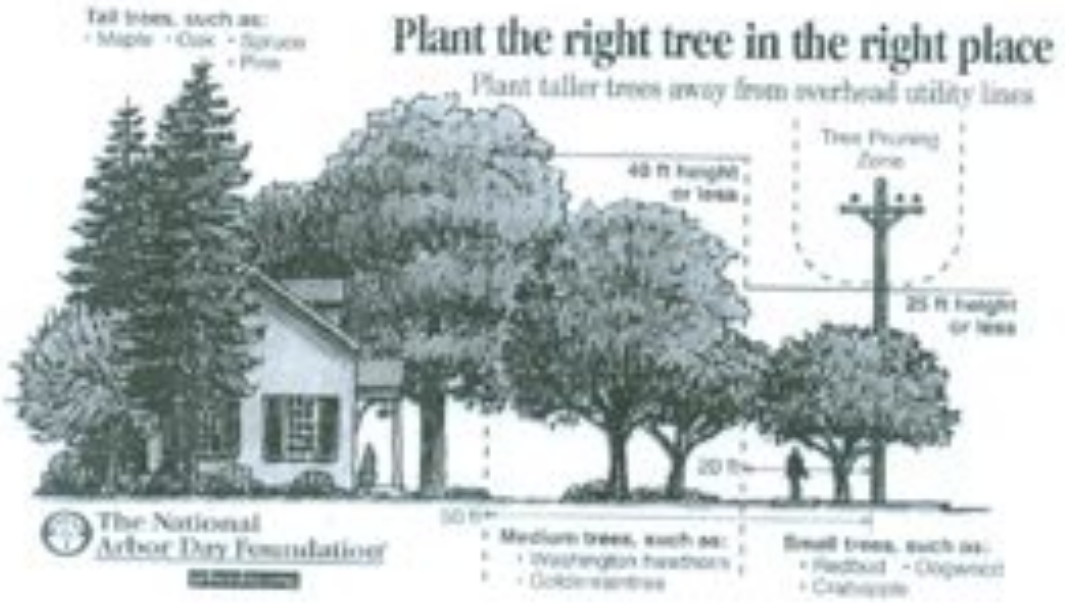
Choose the Appropriate Tree Size

SPECIES SELECTION

In addition to proposing changes in the location that trees are planted, the selection of plant species that will tolerate conditions common to streetscape plantings. The trees must be adaptive to the varied soils that the urban situation presents, must withstand a wide range of moisture availability, have the ability to overcome poorer air quality, and survive people pressure, while at the same time fulfill the design intent of the streetscape. The trees must be able to maintain the shape and form that are true to the species so that their intended use in the landscape is achieved.

In choosing plant species and varieties to be used in streetscape situations the cultural, aesthetic, and maintenance necessities of the plant must be addressed. The ability of a planted tree to adapt, survive and thrive as part of a streetscape is critical to the success of a designed street planting. The plants must be able to overcome the pressures placed on them and grow to a size where their impact on the design intent is greatest. Therefore quality plant stock must always be chosen for planting, and tree species that they are fully hardy in the climactic zone in which they are to be planted. Ideally the plant material should be locally grown, so as to assure the plant hardiness for the particular planting region.




Tall trees, such as:
• Maple • Oak • Spruce
• Pine
Plant the right tree in the right place
Plant taller trees away from overhead utility lines
Tree Pruning Zone
40 ft height or less
25 ft height or less
20 ft
30 ft
The National Arbor Day Foundation
Medium trees, such as:
• Washington hawthorn
• Golden raintree
Small trees, such as:
• Redbud • Dogwood
• Crabapple

DESIGNING ALTERNATIVES TO AVOID STREET TREE CONFLICTS[1]

by David V. Bloniarz and H. Dennis P. Ryan, III[2]

Abstract. The use of representative crossectional illustrations of various street types presents a useful and effective method of examining the relationship between overhead electric lines and street trees. This design system can serve as the basis for proper species and site selection. Through the development of a series of street type criteria, ranging from larger major arterial roads to smaller local streets, this paper presents a workable and useful methodology that is available to municipalities and utility companies for aiding in the selection and management of street trees.

The impact of overhead wiring on the landscape is both physical and aesthetic. Views that otherwise would be unobstructed are often interrupted by the siting of electric distribution lines. The aesthetic quality of the streetscape is often shaped by the location of utility lines, with design responses often patterned after the utility infrastructure. The widespread use of trees along streets as a design element presents problems to the electrical distribution network, since ultimately many trees come in contact with the overhead wiring, causing interruption in the delivery of electricity and becomes a safety issue. Even the use of proper arboricultural pruning techniques has often led to a degradation in the form of the street trees, and has encouraged the development of misshaped and aesthetically unpleasing trees. A reduction in the number of such instances should be paramount in the development of a streetscape that uses trees as a design element.

Species selection, planting location, and cultural practices all have an impact on the visual quality, health, and cost of maintaining a street tree (2). The use of appropriate species, the proper location of plantings, and the implementation of a program of preventive maintenance for the street tree will allow for a cost effective tree management system. Reducing the conflict between utility wires and tree plantings will lead to a less costly procedure for the maintenance of overhead utility lines. The appropriate use of trees along streets also benefits other components of the urban infrastructure, including a reduction in the amount of damage by tree roots to streets and sidewalks.

The development of design criteria leading to more successful and less costly street tree planting and maintenance programs is important for the effective design and management of trees growing along roadways (3). Study of existing examples of street tree plantings allows for the development of design recommendations with appropriate species that will tolerate roadside conditions, reduce municipal infrastructure damage and limit the interface between utility wires and individual trees.

The development of these recommendations is based on street type, street width, size of tree belts, design intent, and the location of the physical infrastructure. The use of a standard set of criteria can ensure that a street tree will be able to develop to its desired shape, fulfill its design intent, and be aesthetically appropriate. The guidelines can be sued to choose the right tree for the right spot, so as not to interfere with overhead utilities, damage the municipal infrastructure, or increase of maintenance costs.

Street Tree and Utility Line Interfacing

The conflict between utility lines and street trees can be found in almost any community one examines. The degree of interfacing between the two is most evident on streets carrying 3-Phase primary conductors, where the wires are anchored to cross-arms. The 3-Phase type of wiring needs more overhead clearance space than does single

1. Presented at the annual conference of the New England Chapter of the ISA in October 1991.
2. Part of this research was funded by a grant from the Western Massachusetts Electric Company/Northeast Utilities.

phase wiring, and therefore increases the potential for interference with trees that grow nearby.

Increased use of the crossarm on many 3-Phase electric delivery systems has presented a problem for street tree managers, since many trees come within the line clearance area as the crossarms are added to nearby poles. The increased use of the crossarm means that the right-of-way or the clearance around the lines is more likely to impact the aesthetics and health of nearby trees. This is critical when crossarms are added to poles previously having no crossarm, making it necessary to dramatically trim trees that formerly did not interfere with the wiring.

Designing Alternatives

Through the use of a set of standard roadway types, an effective mechanism for determining the relationship between street trees, design intent, and electrical distribution is possible. Harris and Dines (1) group roads and street into four categories as the basis for creating a set of standard street types. These include Major Arterial, Minor Arterial, Collector, and Local streets. The addition of Boulevard streets completes the list and serves as a basis for developing a street tree planting program that addresses the aesthetic qualities of the streetscape.

Through the development of design criteria for specific street types, recommendations can be presented in a simple graphic manner. The use of design criteria aids in the implementation of policies that encourage the improved management of street tree inventories, while increasing the aesthetic and ecological quality of the streetscape. This design system also aids in reducing potential physical infrastructure damage to utility lines, and municipal and private property. The proper selection and placement of new trees reduces potential damage to streets, curbs, sidewalks, utilities and subsurface drainage structures. It becomes apparent that street patterns, combined with street types and other site factors, should play a role in the selection of plant materials.

Demonstration of methodology. The relationship between overhead utility lines, street trees and the importance of proper plant selection that is appropriate to the planting location can be illustrated by using the street type as the criteria for making planting and management decisions. Figure 1 shows a Major Arterial Road with two lanes of traffic in each direction with a 12 foot parking lane on both sides of the road. The maximum size of the tree belt is 24 feet, including the areas necessary to construct a sidewalk and plant trees. The trees that are illustrated are medium to large size deciduous shade trees, serving as typical representations of the mature size of many trees along typical roadways. Sidewalks are found on both sides of this type of roadway, reducing available space for tree planting. While the drawing illustrates the minimum design standards for a Major Arterial Road, many roadways fall below these standards.

The examination of a Major Arterial Road type can serve as a guideline to assist in making informed planting decisions for this street type, and can be used as the basis for recommendations for other street types. The recommendations ensure that the design intent is achieved while maintenance costs and damage to physical infrastructure is kept to a minimum. The following recommendations are meant to assist in this process of planting the right tree in the right spot.

When replacing street trees, or there is reconstruction of a Major Arterial Road, there are several alternative planting procedures that can be implemented to allow for increased viability of the streetscape trees and improved aesthetic quality. These alternatives include the following:

- Proper species selection, so that only trees that will not interfere with overhead utility lines, buildings, and sidewalks are planted along streets.
- Setback planting of street trees to a location where they can grow without interfering with the overhead utility lines, buildings, and sidewalks.
- Planting trees in locations within the right-of-way other than directly below the utility lines, including construction of new planting islands along the street edge.

Alternative Recommendations

Figure 2 shows a Major Arterial Road with the trees near the utility lines having been trimmed resulting in a degradation of the aesthetic quality of the streetscape, increased likelihood of insect

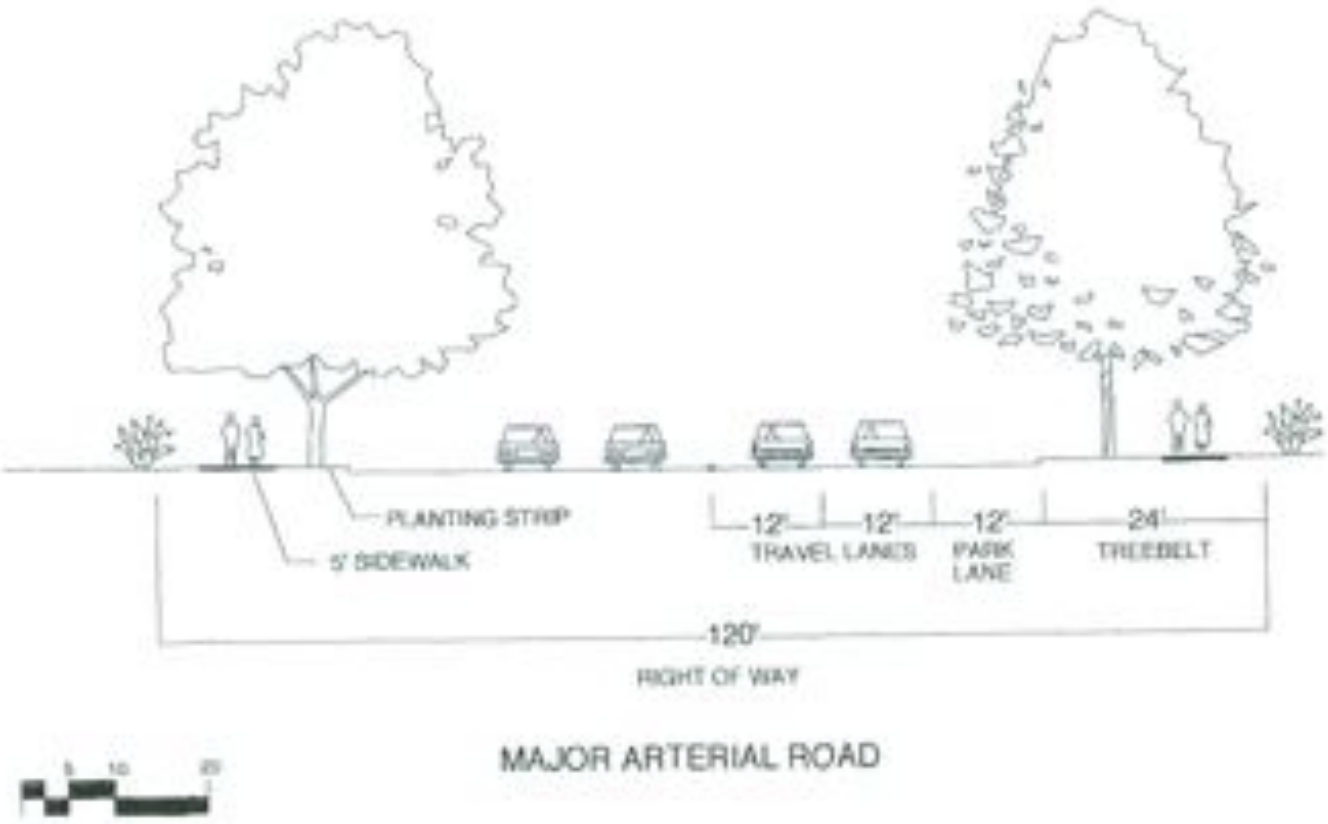


Figure 1. A Major Arterial Road illustrating design features including edge, enclosure and separation. This appearance is what the designer expects to have when the project is complete, but this arrangement does not take into account utilities and municipal infrastructure.

and disease damage, and the possible failure in achieving any design intent that may have been envisioned for the street. The loss of enclosure, edge, and separation of public and private space occurs, changing the entire sense of space that otherwise would be part of this streetscape.

Setback Planting. Figure 3 shows the same Major Arterial Road with the street trees planted in a set back location from the edge of the right-of-way. This planting location allows for sufficient room for the street tree to grow without growing into the utility lines, thereby not requiring the maintenance trimming that street trees planted in a more traditional arrangement on the tree belt or planting strip require. Legislation on a state or local level, allowing for the planting of public shade trees on private property, should be encouraged, enabling this type of planting where appropriate.

Planting with Reduced Plant Size. In Figure 4, the selection of a tree species whose ultimate size will not allow for growth within the vicinity of the overhead utility lines is shown. The use of slower growing and/or smaller species, which also tolerate streetscape condition, can be used to eliminate the need for maintenance trimming near the utility

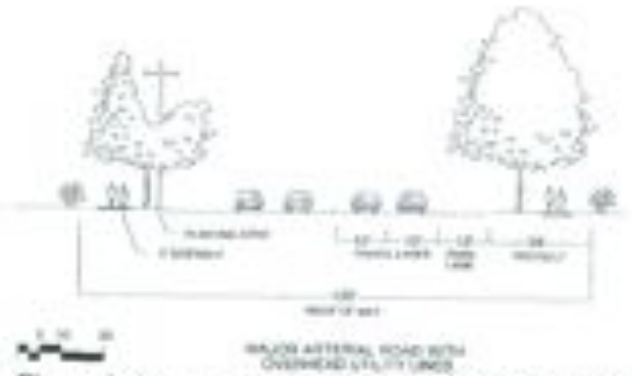


Figure 2. A common urban cross section of a Major Arterial Road, including sidewalks on both sides of the street, planting strips and utility pruning.

lines. The use of newer varieties of plants and the planting of trees that will achieve aesthetically pleasing results, makes this type of planting appropriate in many instances.

Planting with Columnar Plants. When choosing tree species for use on a street where overhead utility lines occur, it may be advantageous to choose a columnar or fastigiate variety of plant species (Figure 5). There are many species and cultivars available that have been developed having a form that will grow in a narrower

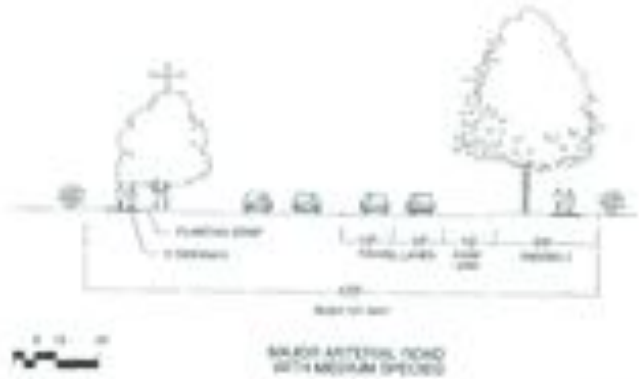


Figure 4. Cross section of a Major Arterial Road with medium size tree species used under the utility lines.

streetscape space. These types of trees can be used to enforce the design scheme, while maintaining the attributes of height, color, and texture that would occur with a species that does not have a columnar form.

Conclusion

The use of representative cross section illustrations of various street types presents a useful and effective method of examining the relationship between overhead electric lines and street trees.

Figure 3. Cross section of a Major Arterial Road with setback planting to avoid the utility lines.

Figure 5. Cross section of a Major Arterial Road with columnar setback planting.

This design system can serve as the basis for proper species and site selection. Through the development of a series of street type criteria, ranging from Major Arterial Roads to smaller Local Streets, a workable and useful methodology is available to municipalities and utility companies for aiding in the selection and management of street trees. By incorporating physical factors with aesthetic and design considerations, this method can be an effective tool in the development of streetscapes that are less costly to maintain, are functionally more successful and are aesthetically pleasing.

Literature Cited

1. Harris, C.W. and N. T. Dine. 1988. Time-saver Standards for Landscape Architecture. McGraw-Hill Book Company. New York.
2. Miller, R.W. 1988. Urban Forestry: Planning and Managing Urban Greenspaces. Prentice-hall, Inc. Englewood Cliffs, NJ.
3. Urban, J. 1989. New techniques in urban tree planting. J. Arboric. 15(11): 281-284.

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Résumé. L'emploi d'illustrations représentatives de coupes de divers types de rues représente une méthode utile et efficace pour l'étude de la relation entre les réseaux électriques aériens et les arbres de rues. Ce système de dessins peut servir de base pour une sélection adéquate des espèces et des sites. À travers le développement d'une série de critères de classement des types de rues, depuis les grandes artères majeures jusqu'aux petites rues locales, cet article présente une méthodologie utile et pratique qui est disponible aux municipalités et aux compagnies de services et qui facilite la sélection et la disposition des arbres de rues.

Zusammenfassung. Repräsentative Querschnittsdarstellungen verschiedener Straßentypen sind eine nützliche und wirksame Methode zur Untersuchung der Wechselbeziehungen zwischen den oberirdischen Stromleitungen und den Straßenbäumen. Diese Darstellungsmethode kann als Grundlage für die Wahl geeigneter Arten und Standorte dienen. Durch die Entwicklung einer Reihe von Typenmerkmalen bestimmter Straßen, die von größeren Hauptverkehrsstraßen bis zu kleineren Nahverkehrsstraßen reicht, stellt diese Arbeit eine durchführbare und nützliche Methode dar, die für Gemeinden und Fachfirmen verfügbar ist, um bei der Auswahl und Pflege von Straßenbäumen behilflich zu sein.

Tree Planting Guide

Extension's Successful Gardener
NC State University North Carolina Cooperative Extension

Helping Carolinians Increase Their Knowledge of Gardening, Manage Their Landscape Investment & Protect the Environment

Most homeowners plant trees for their beauty, but a well-situated tree also can reduce energy costs by shading a house from the sun's rays in summer and providing shelter from harsh winter winds. They act as noise buffers, and provide homes for wildlife, making your home a more pleasant place to live.

Trees also can reduce soil erosion by slowing the movement of water that would otherwise carry topsoil away. And since trees take carbon dioxide and other pollutants from the air and release oxygen, they help improve air quality. As you can see, your community shares some of the benefits you receive from trees you plant.

Proper selection and planting are critical to ensure your new tree's long-term survival. This guide will help you select and plant trees.

Selecting the Right Tree for the Right Place

First consider the type of tree for the location you have selected. The right tree in the right place ensures a lifetime of satisfaction with low maintenance. For a list of appropriate trees for North Carolina go to www.ncstate-plants.net or contact your county Cooperative Extension Center. Visit www.ces.ncsu.edu and click on County Centers for contact information.

Consider the tree's final height and spread when making your selection. Will the tree still fit its location after it has been growing taller and spreading for 10, 20 or 30 years? Always look up before planting. Don't plant a tall tree under utility lines. Constant pruning will be required, and the tree's health will suffer. Also consider if the tree can thrive in a particular site. Will the tree tolerate the site's sun or shade? Is the soil too wet or dry for the tree to grow healthy and vigorously? What about pruning, mulching, watering, raking leaves, cleaning up fruits and seeds, and disease and insect concerns? Keep maintenance in mind when you select a tree.

Trees are sold as container-grown, balled-and-burlapped or as bare-root plants. Bare-root plants are the most economical; however, they are usually smaller and can be planted only while dormant, in the fall, winter or early spring. Container-grown and balled-and-burlapped trees can be planted year-round as long as you can water them. Small trees establish faster than large plants and are more economical. Larger landscape trees are grown in the field and are traditionally sold as balled-and-burlapped.

Prior to purchasing and planting the tree, inspect the size, form, vigor, trunk appearance and roots. If you order your trees, make sure the delivery matches the dimensions specified in the order (trunk caliper, height, container or root ball size). The form of the tree should be typical of the species or cultivar. Numerous broken branches are a sign of mishandling. Avoid trees that have numerous branches that originate from a single area. They might look more like a tree at this point but the branching will become a problem later, particularly if the tree will grow to be large. Look for a scaffold of branches 12 inches apart and with a branch angle of 45 degrees or greater. This will contribute to strong limbs as the tree grows.

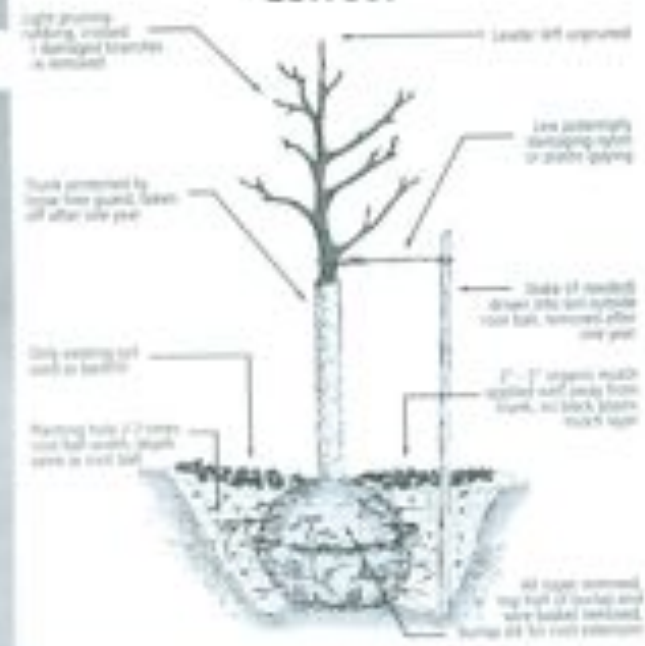
Stems, foliage, buds and bark should look healthy. Do not choose trees that look unhealthy or have insect or disease problems. Avoid trees with damaged, swollen, shrunken or discolored bark. When choosing a balled-and-burlapped tree, be sure the trunk is centered in the root ball and that it feels firmly attached. The trunk should not seem loose. Container-grown trees should be well rooted and established in the container in which they grow. Where possible, check the appearance of the roots. Healthy roots are white, not brown. Roots circling in the container indicate that the tree has been in the pot too long. Circling roots can cause problems later by creating girdling roots as the tree matures. Bare-root trees should have their roots protected from exposure with moist packaging materials. The roots should be damp and flexible.

continued

Tree Planting Guide

Incorrect

Correct



After purchasing your tree, wrap the roots, stem and foliage loosely in burlap or some other cloth to protect it as you transport it home. Be sure to keep the root ball moist until you plant the tree.

Proper Planting Techniques

Dig a hole no deeper than the root ball and two to five times wider than the diameter of the root ball. To encourage root growth away from the root ball, roughen or loosen soil with a shovel several feet around the planting hole. This is particularly important in heavy, compacted soils and is more beneficial to the tree than the addition of soil amendments to the planting hole.

If planting a container-grown tree, carefully remove the tree from the container. Check for circling roots. With a sharp knife, make four or five vertical cuts along the side of the root mass to sever circling roots. Place the tree in the planting hole, making certain the root ball is on solid soil and not on loose backfill. Also ensure the top of the root ball is even with or, as heavier soils, a little higher than, the surrounding soil.

If planting a balled-and-burlapped tree, either remove the burlap or fold it down into the planting hole. You don't need to completely remove the wire basket, but do cut it once the tree is in the hole to allow for future root development. Remove all twine and wire from around the base of the trunk as it can girdle the stem. Also be sure to remove any nylon straps or straps.

After planting, the trunk flare (where the roots spread out from the base of the tree) should be visible. Do not plant too deeply. Make sure the tree is straight, and then gently fill the planting hole with the original soil that was removed from the hole. When the hole is half-filled with soil, slowly water to remove air pockets. Then finish filling the hole with soil.

Remove any broken, dead or crossing branches; other pruning is not necessary. Sometimes a newly planted tree will require additional support. Stake the tree only when necessary, and remove the supports following the first growing season.

Mulch is also very important. Apply a 2- to 4-inch layer of mulch evenly around the base of the tree. Do not, however, let the mulch touch the trunk of the tree as this can lead to decay.

When you have finished planting, water the tree slowly and thoroughly. Water an area beyond the root ball to encourage root spread. Watering will be necessary for the first year until the root system becomes established. As a general rule, trees need 1 inch of water every 7 to 10 days. Water when natural rainfall does not provide this amount.

For more information go to www.ncstate-plants.net or www.arborday.org. To get involved with tree planting programs call your Cooperative Extension Center.

Extension's Successful Gardener

This Tree Planting Guide was produced by Extension's Successful Gardener team. To learn more about the Successful Gardener newsletter and seminars, visit www.successfulgardener.org.

By Robert E. Bardon, Extension Specialist, Department of Forestry; Karen Neill, Extension Agent, Guilford County; and Rory Hahn, Extension Agent, Orange County. Extension's Successful Gardener Editor and Project Coordinator: Leah Chester-Davis, Extension Communications Specialist, Department of Communication Services.

Funding for this project was provided in part through an Urban and Community Forestry Grant from the North Carolina Division of Forest Resources, Department of Environment and Natural Resources, in cooperation with the USDA Forest Service, Southern Region. 1994-2000.

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SITE ASSESSMENT CHECKLIST

1. Site Location _____

2. Site Description _____

3. Climate

a. *USDA Hardiness Zone*

__6b __5b __4b __3b
__6a __5a __4a __3a

b. *Microclimate Factors*

__Re-reflected heat load
__Frost pocket
__Wind
Other _____

4. Soil Factors

a. *Range of pH Levels* _____
(Note actual readings on sketch)

b. *Texture*

__Clayey
__Loamy
__Sandy

c. *Compaction Levels*

__Severely compacted
__Moderately compacted
__Somewhat compacted
__Uncompacted

d. *Drainage Characteristics*

__Presence of mottled soil
__Low-lying topography
Indicator plants suggest site drainage:
__wet __well-drained __dry
Percolation test results (in./hr.)
__poorly drained (< 4"/hr.)
__moderately drained (4"- 8"/hr.)
__excessively drained (> 8"/hr.)

5. Structural Factors

a. *Limitations to above-ground space*

__Overhead wires (height:_____)
Proximity to buildings/structures:
Other_____

c. *Sunlight Levels*

__Full sun (6 hrs. or more)
__Partial sun or filtered light
__Shade

d. *Irrigation Levels*

__No supplemental irrigation
__Automatic irrigation system
Irrigation amount and rate:
_____

e. *Other Soil Considerations*

__Indications of soil layer disturbance
__Evidence of recent construction
__Presence of construction debris
__Noxious weeds present:
_____
_____
_____
_____
__Evidence of excessive salt usage
__Erosion of soil evident
__Evidence of soil contamination
__Usage that compacts soil

f. *Specific Soil Problems*

_____
_____
_____
_____
_____
_____
_____

b. *Limitations to below-ground space*

__Utilities marked and noted on sketch
Approximate rooting volume for site
Length:__ Width:__ Depth:__

6. Visual Assessment of Existing Plants

a. Species	*b. Size*	*c. Growth Rate*	*d. Visual Assessment*

Sketch of Site
Note north arrow; circulation patterns; pH readings; location of overhead wires, underground utilities, buildings and pavement, as well as problem drainage areas.

Planting Trees in Designed and Built Community Landscapes

Checklists for Success

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This Guide and Publication is Humbly and Lovingly Dedicated to Jeanne Ossenbruggen (1943-1998), Mr. Coleman and Friends. It has been both a pleasure and a privilege to see forged a partnership that spanned nearly twenty years, sharing a cumulative, evolving vision that exemplary built landscapes with trees could (and must) be created with a sensitivity to integrating with ecological and cultural connections.

—Mary Reynolds

Acknowledgments

With deep appreciation to State Forester John E. "Jack" Sargent who believed in and championed this project from the beginning; to our teacher and mentor, Alex L. Shigo; to the alchemy of Joni Doherty; to my teachers and mentors Robert S. Pierce, F. Herbert Bormann, Stephen Collins, and Dorothy Noyes Kane; and to Michael T. Rains and Gerard D. Hertel.

All science and new knowledge occur only with collaboration. The authors graciously thank our colleagues who gave so generously of their time to read and review the manuscript, to offer valuable corrections and suggestions for improvement, and to provide the scientific rigor required: Alex L. Shigo, William H. Smith, Kevin T. Smith, Donald H. Marx, Gary R. Johnson, William C. Collins, Raymond M. Bonin, Lawrence V. Collins, William F. Nichols, Richard Herfarth, Lawrence E. Grondin, Jeff W. Ott, Peter C. Hoag, William A. Rae, Gary W. Watson, Hannah Edmonds, Robert E. Thibodo, Ingeborg V. Stuhmyer, William E. Desch, Kenneth M. Desmarais, Wesley McKague, Jeffrey Tarling, Warren Spooner, John Bryant, Jeffrey Good, Susanne Smith Meyer, Byron L. Kirby, John Rossnow, Jennifer L. Bolinger, and Gary Koller.

For major contributions to preparation and publication—including editorial, design, and financial assistance—special thanks are due Kyle O. Rosenberg, Joni Doherty, Michael Cova, Christopher P. Boivin, Robert A. Gagne, Robb R. Thomson, Philip A. Bryer, and Michael T. Rains.

We are also indebted to hundreds of other colleagues worldwide who used previous editions of this publication and who have made outstanding contributions to the development, quality, and usefulness of this publication.

Design: Joni Doherty
Illustration: Scott Hill and H. Sharon Ossenbruggen
Photography: Mary K. Reynolds

1st edition 1991; Reprinted 1992, 1993, 1995; 2nd edition 1998

Cover

The Tree, 1966, a stabile mobile by Alexander Calder (1898-1976). Missouri Botanical Garden, St. Louis, Missouri. Used with permission from the Missouri Botanical Garden.

Trees create green spaces in communities. The right trees in the right places benefit you, your home, and your community now and in the future. It is essential to select *living* trees to create a sense of place within communities.

This publication helps citizens create community green spaces. It encourages both experts and amateurs to plant and grow trees correctly, and to properly maintain new and older plantings. It is designed to be used in contract planting specifications for all public and private tree planting projects.

Trees growing in small parks and commons, along streets, and in the yards and gardens of neighborhoods provide a mosaic of green landscapes within a community. As well as providing beauty, trees moderate the effects of heat, sound, air pollution, excess storm water runoff, and soil erosion. Trees also provide a living space for wildlife, enhance property values, and contribute to the economic vitality of communities.

Greening and maintaining a community landscape is a long term commitment that depends on *people*. Designed, built landscapes with living trees require an infusion of human energy to survive. Parks and other built landscapes need people for completion.

CHECKLISTS FOR SUCCESS

Presented here are the current recommendations and ecological guidelines for tree selection, planting, and after-care based on good science and cutting edge research. For detailed information refer to sources listed at the end of the guide. Six checklists help you select, plant, and care for trees:

Checklist 1: Site Selection (where to plant)
Checklist 2: Tree Selection (what to plant)
Checklist 3: Useful Tools (planting correctly)
Checklist 4: Preparing a Site (planting correctly)
Checklist 5: Planting (planting correctly)
Checklist 6: After-Care (long-term maintenance plan)

Other information includes "Pruning Guidelines" and "Resources: Tree Selection and Care."

Take this guide with you as you select a site and the correct tree for it. Mark as many boxes as necessary in each checklist. Use the center section when planting.

We live in and among ecosystems. Let's help trees grow to be safe, healthy, and attractive in sustainable, *living* community landscapes.

WHY PLANT A TREE?

Decide why you wish to plant. The reasons will help you choose the site. The site you select, whether in your own yard, in a community park, or on the street, affects the choice of tree.

- memorial/gift
- privacy
- reduce soil erosion
- winter windbreak
- summer cooling
- reduce air pollution
- increase property value
- spring bloom/fall color
- fruit/nuts
- landscape design
- wildlife habitat
- sight or sound barrier

CHECKLIST 1: SITE SELECTION

Where will you plant your tree?

- ☐ public land
- ☐ private land
- ☐ lawn
- ☐ rooftop
- ☐ by a patio
- ☐ garden
- ☐ along streets
- ☐ park
- ☐ parking lot
- ☐ landfill
- ☐ municipal building
- ☐ golf course
- ☐ school/playground
- ☐ town green or common

Describe the site:

- ☐ underground utilities
- ☐ near heavy traffic
- ☐ overhead utility wires
- ☐ near winter salted roads
- ☐ near walkway, driveway, or sidewalk
- ☐ sunny
- ☐ shady
- ☐ dry
- ☐ wet

Check soil conditions:

- ☐ severely disturbed/ building rubble
- ☐ shallow soil to bedrock
- ☐ sandy
- ☐ rocky
- ☐ clay
- ☐ silt/loam

Estimate:

Space between curb and sidewalk _____

Lot size _____

Fitting the tree to the site:

- A tree's mature size and shape must be of the proper scale to fit the site and surrounding buildings.
- Trees have roots. Roots spread beyond the branch area of the tree. Most roots are found in the top 18" of soil; most absorbing roots are found in the top 6" of soil.
- Trees crowded in small street spaces may crack sidewalks and paved areas.
- Avoid planting under overhead wires and above underground utilities.
- Do not plant trees near building foundations or walls.
- If you plan to plant near the street or in a parking lot, know the snow removal plans.
- Do not plant trees that produce nuts or large fruit in pedestrian areas.
- Determine the necessary root growth space for the species you select. Think of clustering trees in a park setting or a parking lot to provide larger soil volumes for safe root growth. Grouping spaces in contiguous pits to provide shared soil volumes is recommended, rather than digging several individual pits. Groupings create their own small environments and may survive better.
- Identify legal restrictions for planting for both public and private property.

CHECKLIST 2: TREE SELECTION

Which species?

Show Checklist 1 to the nursery or garden center professional and request a choice of trees appropriate for your site. Ask if the nursery or garden center guarantees its plant material. Note responses in given spaces.

What is tree's mature height? _____

What is tree's projected longevity? _____

How fast will this tree grow? _____

What is tree's mature shape? _____

Is it cold hardy for your area? _____

What are its soil requirements? _____

Does it require a shady or sunny site? _____

Does it require wet or dry site? _____

Is it sensitive to salt? _____

Describe flowers and fruits. _____

What is the autumn/spring color? _____

Is the species unusually susceptible to certain insects or disease, or to storm damage? _____

Note: In a community setting be sure to choose a variety of species. Do not plant large numbers of the same species.

Note species you choose:

Choice 1 _____

Choice 2 _____

Which particular tree?

Now carefully inspect the trees to choose the healthiest ones with the best form. Reject trees that have:

- double stems or multiple branches of stems. Look for a straight, single stem.
- severe pruning cuts. See "Pruning Guidelines."
- dead bark, cankers, or signs of disease or insects on trunk or branches.
- paint on wounds or pruning cuts.
- tight, vertical branches where bark is squeezed between two branches or between trunk and branch.

For commercial municipal contracts, specify that plant material meets the American Standard for Nursery Stock. See "Resources: Tree Selection and Care."

Note: Branches of street trees should be high enough for pedestrians to walk beneath.

Before you dig!

Laws in most states require you to contact utilities. Most have a central toll free number. If you damage any underground utilities you are financially liable.

See "Resources: Tree Selection and Care."

CHECKLIST 3: USEFUL TOOLS

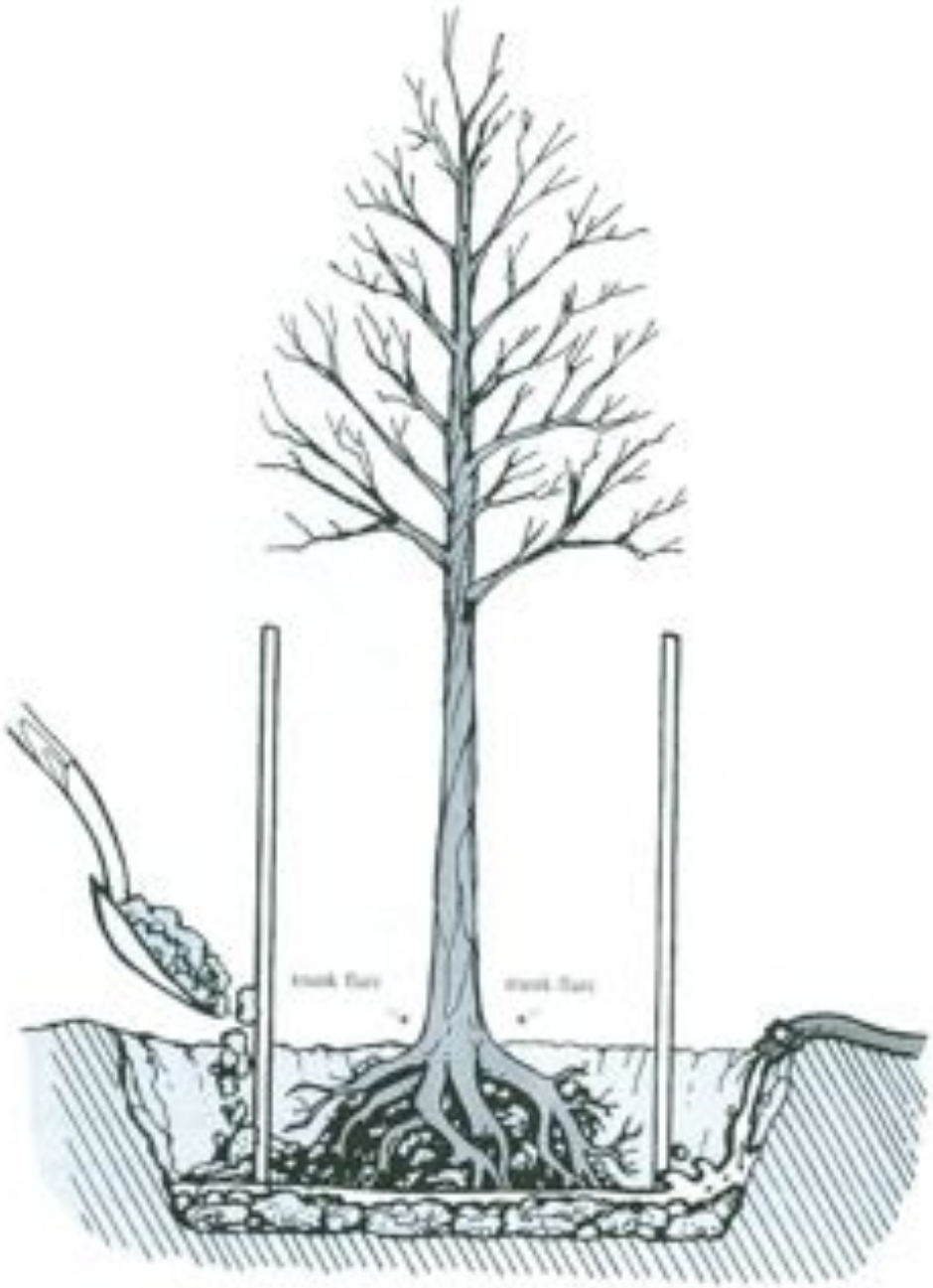
- large spades or shovels
- large tarp to hold soil
- heavy duty wire clippers
- small pruning saw
- hammer or mallet
- measuring stick
- pruning shears
- heavy duty scissors or sharp utility knife
- gloves
- stakes and strapping

CHECKLIST 4: PREPARING A SITE

If possible, prepare the site before you bring in the tree. Keep the root ball well watered and keep the tree in a shaded place until you are ready to plant.

It is imperative to expose the trunk flare on each balled and burlaped tree before the planting site is dug so that the depth of the planting site can be properly measured. The trunk flare is the point where roots begin to branch from the trunk. (The top of the root ball is not always the trunk flare.) Remove burlap from immediate trunk area of tree. Pull back excess soil around trunk of tree to locate trunk flare. Measure the height from the base of the trunk flare to the bottom of the root ball. Dig to the depth of the trunk flare.

- ☐ Trunk flare and top of root ball should be at grade.
- ☐ Dig the space at least 3 times the diameter of root ball.
- ☐ Break up compacted soil. Sides of planting space should not be packed. Leave bottom of space firm.
- ☐ Do not amend soil unless planting in building rubble, poor, or severely disturbed soils.



CHECKLIST 5: PLANTING

- ☐ Lift tree into planting space by root ball, not the trunk.
- ☐ Balance tree upright in center of planting space.
- ☐ For trees in wire baskets, cut and remove wire.
- ☐ Cut away strings and burlap or plastic, exposing root ball. Do not remove soil from root ball.
- ☐ If tree is container grown, cut and remove container.
- ☐ Prune dead or crushed roots and straighten or cut circling roots. Make clean cuts.
- ☐ Begin refilling with soil, watering as you fill to firmly set tree. Gently tamp.
- ☐ Never plant too deep. Trunk flare and top of root ball should be at grade. (Trunk flare may be hidden within the root ball.) Fill soil up to tree base just to where roots begin to branch from trunk.
- ☐ Prune only dead or injured branches. Do not paint wounds.
- ☐ Remove tree wrap, tape, or string on trunk. Trunks should be wrapped only to protect them in transit to planting site.
- ☐ Stake and brace most trees at planting time. Support tree but allow it to move or sway.
- ☐ Use wide, belt-like strapping attached to two sturdy stakes. Do not use rope or wire through a hose.
- ☐ Mulch lightly and evenly with 2" of composted material at least to the diameter of crown of tree. Leave 3" circle of bare soil around the trunk. Deep layers of mulch can be harmful.
- ☐ Do not plant flowers under tree.
- ☐ Do not fertilize at planting time.

CHECKLIST 6: AFTER-CARE

- ☐ Water is the critical factor for tree survival after planting. Deep water regularly throughout first growing season. Allow water to run slowly, soaking the soil, once or twice a week. Do not over water. Water at the perimeter or edge of planting site.
- ☐ Keep lawn mowers and string trimmers away from tree to avoid wounding trunk. Reduce herbicide use near tree and in surrounding lawn.
- ☐ Never fertilize stressed trees. Fertilizer is not tree food. It should be applied (if absolutely necessary) only after first year. When used, fertilizer should be applied at the perimeter or edge of the planting site.
- ☐ Start an annual tree inspection program while tree is young to head off problems early.
- ☐ Replace mulch as needed. Keep grass and weeds out of mulched area. They compete for the same water and elements as tree.
- ☐ Remove stakes and strapping after one year unless site is extremely windy. Do not stake longer than two years.
- ☐ Prune dead or injured branches immediately.
- ☐ Prune while young to maintain size and shape beginning in the second growing season.
- ☐ Do not top trees to reduce height.
- ☐ Call an insured tree care professional for advice on large pruning jobs, hazard trees, and insect or disease problems. Nonprofessionals should never prune near utility wires.
- ☐ Do not plant flowers under a tree. Do not cultivate soil under the tree.
- ☐ Continue deep watering for five years after planting.

Plan in advance to protect established trees on new construction sites.

Fence off wide areas around the trees to protect roots and avoid compacted soil.

Don't allow equipment or materials to be stored near the trees.

Don't change grade levels or cut tree roots when excavating.

Do not top trees.

PRUNING GUIDELINES

Pruning should be done with a purpose and not as an automatic routine. Remove dead and injured branches and those that are crossing and in contact with other branches. Pruning to maintain size must start when the tree is young. You can not cut a 50 foot tree back into a 30 foot tree in any way that is healthy and safe for the tree. Good pruning doesn't show.

Prune with particular care. Proper pruning cuts may make the difference between a tree having a long, healthy life or a short life. There is no mystery to pruning and once learned it becomes second nature.

Dead and injured branches can be pruned anytime. The best time to prune living branches is in late dormant season or very early spring before leaves begin to open. Use sharp tools. Make clean cuts. Use equipment safely. Never prune near utility wires. Call insured professionals for work near wires, for hazardous trees, or for pruning larger trees.

1. Locate branch bark ridge (BBR) and branch collar.
2. Find target A—outside BBR.
3. Find target B—where branch meets collar.
4. If target B can not be found, drop an imaginary line at AX. Angle AXC equals XAB. Note: Locate the branch collar and make the final cut as close as possible without hitting the branch collar.
5. For stub cut, cut a notch under the branch about 1/4-1/3 through to prevent tearing the bark.
6. Cut the branch, leaving a long stub, then . . .
7. Make final cut at line AB (with care, power saws may make final cuts on the upstroke.)

Do not:

- make flush cuts behind BBR.
- leave stubs, living or dead.
- injure or remove the branch collar.
- paint cuts.

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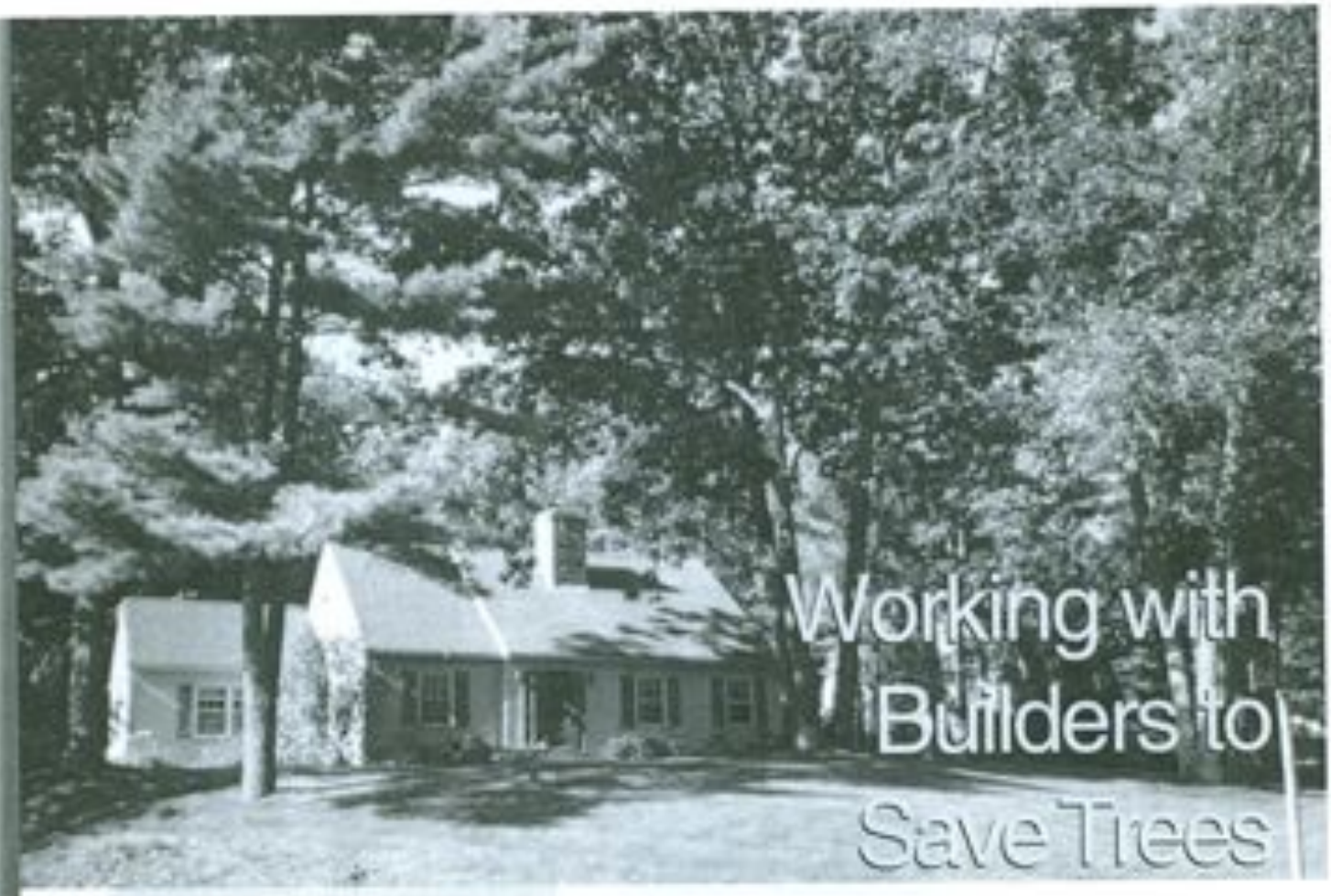
This publication may be used with the companion publication Selecting Trees for Urban Landscape Ecosystems: Hardy Species for Northern New England Communities (Reynolds and Boivin). See "Resources: Tree Selection and Care" above.

DIG SAFE

For toll free local information for all states, call 1•888•258•0808.



Working with Builders to Save Trees

Typical Protective Measures

- ☐ Erect protective fencing around root zone prior to clearing.
- ☐ Do not change the grade around trees.
- ☐ Use pavement materials that allow air and water to pass.
- ☐ Run all utilities in a single raceway or trench.
- ☐ Eliminate or minimize traffic in the protected areas. Build boardwalks.
- ☐ Prohibit the storage of building materials and soil in protected areas.
- ☐ Keep heavy equipment out of the protected zones.
- ☐ Control storm water runoff.

By H. Dennis P. Ryan, Paul Fiorito and David V. Blumisz

Saving trees makes sense. It's good for the environment. It improves profit margins, builder reputation and house sales. Careful planning, solid communication and a basic understanding of what keeps trees growing will make customers happy for a lifetime. In order to save trees, arborists need to become proactive and establish a professional working relationship with landscape architects, builders and developers. We need to establish a working relationship with the builder and the design team before the project commences. In many cases, the arborist will need to educate the contractor on how to save trees, thereby increasing profit margins.

Smart landscaping is the easiest way to increase value and speed the sale of a home. Bank America Mortgage found 84 percent of the real estate agents that they surveyed think that naturally wooded lots are 20 percent more salable. NAHB researchers report 89 percent of the homeowners they polled want builders to leave as many trees as possible on their house lots. In another study, NAHB learned that 43 percent of the homeowners queried actually paid up to $3,000 more for the treed lots they built on, and 27 percent spent over $5,000 more for a naturally wooded site. Trees have market appeal and improve a home's performance.

Benefits

Trees can reduce a home's energy bill. Strategically placed trees keep homes cooler during summer and warmer in winter. For example, we measured the temperature of a brown-colored roof on a hot July afternoon. Its sun-struck surface was 140 degrees. The surface in the shade of a leafy oak was 50 degrees cooler! Leaves give off water vapor, cooling the surrounding air as it evaporates. The combination of shading and evapotranspiration greatly improve a home's natural ability to stay cool.

The area in the foreground has been leveled for a lawn, but the trees beyond have been left untouched and will survive. If necessary, the area can be thinned later by hand, minimizing the risk of mechanical damage and soil compaction.

The EPA calculates that it is possible to reduce mechanical cooling by up to 50 percent with a thoughtful landscaping plan. It is important to shade the east and west sides of a home, since the sun angle is lower and more direct on these sides. Shade the cooling equipment, too. Air conditioners run more efficiently when they are cool. This single detail can save 10 percent on your cooling bill. As an extra bonus, shading a structure improves durability. Direct sun bleaches color from painted surfaces and ages building materials such as plastics, wood, and asphalt roof shingles.

A carefully positioned windbreak lowers the winter heating load by up to 20 percent. Early settlers apparently knew this, but the concept seems lost on a generation of builders who control the winter chill with blankets of insulation and the force of central heating. A screen of evergreens can passively reduce air infiltration and protect walls from heat-scrubbing winds. Don't block south-facing windows that provide solar gain. Even deciduous trees that shed their leaves block 50 percent of the solar gain with their branches. Tree plantings provide an environmental bonus. Lowering a home's energy requirement reduces the amount of pollutants exhausted up your chimney and utility smokestacks.

Preserving native plantings reflects an environmentally sensitive approach to development. Trees and the underlying vegetation intercept and absorb runoff from storm water, reducing erosion and siltation. They filter pollutants such as lawn fertilizers, pesticides and other chemicals present in the landscape. Tree plantings buffer road noise and mask sounds from neighbors. They improve privacy and screen unsightly views. Builders that preserve trees are regarded as environmental stewards. Potential homeowners, regulators, municipal officials, and the media recognize the effort. These projects sell faster because they are set apart from the competition as healthy and friendly. In a recent study of 1,200 households, more than 70 percent of the respondents said, "Trees make you feel good!"

Although the root zone of this tree was defined with snow fencing, lack of adequate site supervision made that a wasted effort (left). The broken limb and damaged bark on the tree above are the most visible injuries, but the excavated material piled beneath it will soon suffocate the roots.

The evidence supporting tree preservation is overwhelming, yet builders continue to strip the vegetation from the sites they build on. Many builders like working with a clean slate. They want unrestricted access to all parts of the site and prefer to plant new trees later in the project. Sadly, the few builders who try to save trees end up losing them to a slow but predictable death. Trees often look perfectly healthy three or four years after construction, however, unintentional construction damage has them marked for the chipper. When a tree finally looks sick, it's too late.

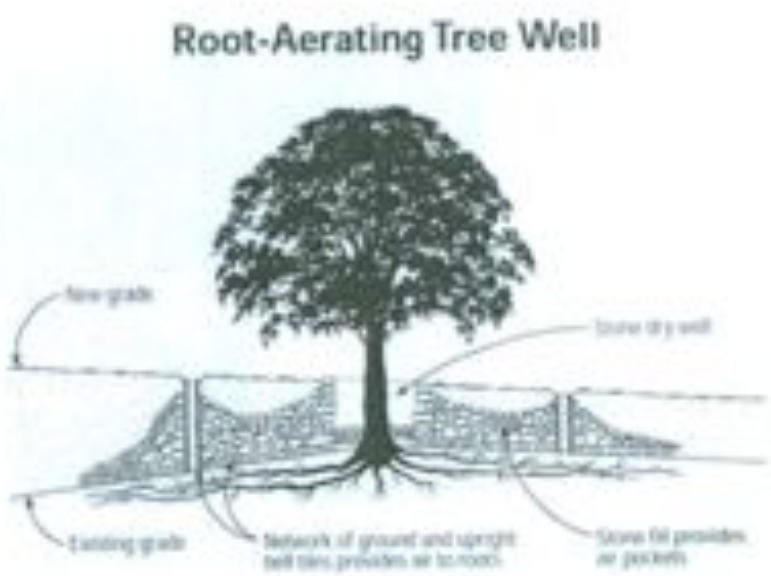
Tree preservation has to be included in the construction master plan, and this is where the arborist can play a critical role in tree preservation. It pays huge dividends through improved curb ap-

peal, enhanced reputation, and wider profit margins. Site development that preserves trees requires careful planning and thoughtful communication between all the members of the construction team. First, arborists, the landscape architect and the builder must understand what a tree needs in order to remain healthy.

The problem

The most obvious injuries to trees are made to trunks and branches. Broken and dangling branches can be pruned and bark injury can be repaired with a limited degree of success, but damage to roots is lethal. The resulting death is unsuspected. Valuable trees often die several years after the project is complete. Homeowners often mistakenly think their favorite tree has a disease or other pest problem. There is no association made between a thinning crown and the long-forgotten construction project that took place years ago.

There's a stiff penalty for unintended damage. It costs 10 times more to remove a tree near a house compared to the same tree on an open lot. As an example, a recent project outlines this scenario: A builder in Denver was asked to preserve a 50-year-old Chinese elm. His clients loved the tree. The tree stood 25 feet from the new home's southwest corner. Its wide-sweeping branches had provided the



If there's no way to avoid raising the grade around a tree, it might be saved by constructing a root-aerating tree well around it. This is an expensive option and one that is best left to an experienced arborist.

homeowners with free air conditioning and a beautiful landscape environment for four years! The tree died, became a hazard, and cost $2,500 to remove from the congested urban lot. The homeowners replanted a 15-foot tree at an installed cost of $500. The case was arbitrated and the parties split the cost. But the process was painful and the damage was completely avoidable with careful planning during the construction phase. Tree preservation programs must be thoughtful, involve a certified arborist and be a central element in the original design process.

Don't try to save trees that can't be saved. The oaks at the edge of this foundation have lost too many of their roots to survive for more than a few years. It would have been cheaper and much less troublesome to remove them before starting to build.

Serious construction damage almost always occurs in the root zone. People don't understand where root systems are located or how sensitive they are to construction activity. Most root networks are shallow, limited to the top 18 inches of soil, and provide the nutrients and moisture required by the plant. Roots extend well beyond the dripline of a tree. They extend in a radius that equals two times the height of the tree. So feeder roots for a 20-foot tree extend 40 feet from the tree stem. The very fine feeder roots grow like branches. They extend farther every year. As the crown of a tree grows and expands, the roots must grow to supply the extra food and water required to support new growth.

Construction threats

There are three main construction activities that kill most trees: cut roots, soil compaction and grade changes. Builders cut roots when they trench or dig near the dripline of a tree. Digging cellar holes, septic systems or even grading a lot will cut roots and kill trees. When roots are eliminated, the tree is not able to draw the water and

nutrients it needs. The tree becomes dehydrated and starts to die at the top of the tree crown.

Soil is compacted when trucks and heavy equipment drive over the root zone. Stockpiling lumber, building materials, loam, or excavated soil over the root zone also compacts the soil, smothering the roots. Many people think that trees breathe in carbon dioxide and give off oxygen. The only parts of the tree that actually do that are the green leaves during photosynthesis. All other living cells take in oxygen for respiration to convert stored sugars and starches into energy (food). The byproduct is carbon dioxide. So if you compact the soil or install a driveway over the roots, you cut the supply of oxygen reaching the roots and carbon dioxide cannot escape. It's just like putting a plastic bag over your head.

When you change the soil grade around a tree, you affect the root system, add soil, remove soil, or undermine part of a tree's anchoring system. Excavation fill is often spread over the site. This raises the grade and smothers the roots. If you lower the grade, you expose roots. A good guide is to maintain the root flare at the base of the tree. Do not bury the trunk flare. Some professionals claim you can add 2 or 3 inches of well-draining topsoil to an older, well-established tree and get away with it, however our experience shows it's best not to add any soil around trees.

Solutions

Arborists and landscape architects interested in preserving trees on construction sites need to introduce themselves to local contractors or the local building association and demonstrate how they can assist the builders in saving trees and increasing the builder's profits. Effective tree preservation must be integrated during the project design and land development process. The contractor needs to hire a arborist that has experience with residential construction projects and knows what issues builders face.

A construction project is no place for an idealistic theorist. The arborist must be familiar with the roles played by members of the project team and become a central member of the team. As an arborist, you must understand the design concept and walk the site before any plans are drawn. The arborist should help to lay out the site and communicate appropriate information at critical times during the project to both the landscape architect and the building contractor.

As a professional arborist, you should be ready to supply the following information for the project:

- What trees are healthy, need pruning or need removal;
- What trees will survive proposed changes in the landscape;
- How to accomplish development goals while minimizing injury;
- What trees will pose a hazard due to weak root systems;
- What trees have invasive roots that threaten pipes, utilities and foundations;
- What trees are pest- and disease-re-

sistant:

- How to protect trees that are valued;
- Where to plant new trees, and how and where to transplant existing trees.

Master plan

Successful development requires careful planning. Tree preservation should be an important part of a project's master plan. It should be contemplated at the very first stage of the process, before any work is done on the site. There are several key elements that guide an effective tree preservation plan:

Identify trees suitable for preservation

This step provides the most critical information. Here, the arborist creates a tree inventory that describes the quantity and quality of existing trees on the site. Key team members inspect and analyze the property during this phase. Brainstorming and visualization is encouraged to stir the imagination and build enthusiasm for the project. Valuable trees are identified, tagged, numbered and referenced on the site plan. This should be done when there is a general understanding of the project goals, but before a conceptual plan is completed.

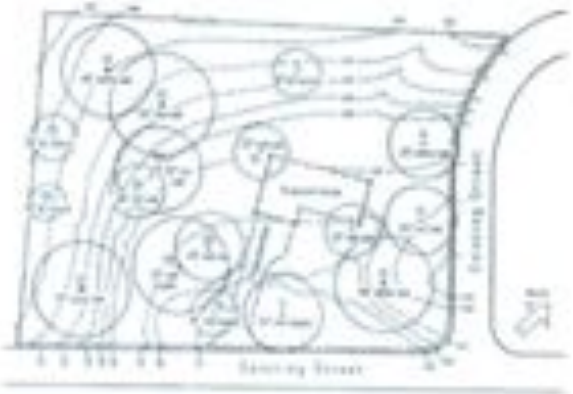
This allows the delineation to influence the placement of roads, driveways, buildings, drainage, scenic vistas, wildlife corridors, and guide the very ambiance of the development. Only trees that have a strong potential for sustained long-term growth and survival are selected for preservation. Remember, the site these trees are growing on is about to be drastically changed, so a projected view of the landscape must be considered.

Characteristics such as species, size and health of the trees are noted. Any work that must be done before the lot is cleared and graded is planned at this time.

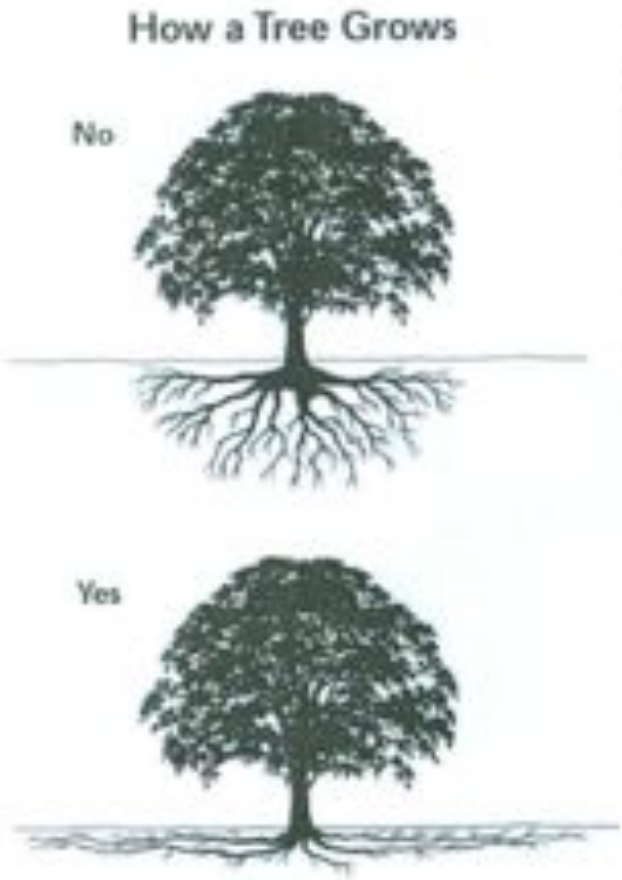
Define tree protection zones

Tree protection zones are the areas located directly around the trees you want to save. Root zones are critical areas. Root zones are depicted as designated circular areas around each tree shown on the landscape plan or site map. These areas are off limits! No construction activity can occur in these zones. That means grading, digging, storing of materials and all traffic is prohibited in these areas. The size of the zone depends on the health, age and species of the trees you are trying to protect. The rule of thumb is to hold all work outside a tree's dripline. However, some trees need more protection. As the professional arborist, remember, protect as much of the root

Tree Protection Plan



The initial site survey of a wooded lot should note the locations of all trees to be saved and delineate root protection zones. Planning well in advance of construction makes it possible to adjust the position of the house to accommodate desirable trees.



While tree roots are often assumed to reach deep underground and extend outward to the drip line (top), they are actually shallower and much wider reaching (bottom). As a result, they are far more vulnerable to surface disturbances than many builders and homeowners realize.

system as you can. The more the better.

It is the arborist's job to minimize damage to valuable trees. All construction activity is referenced on the working drawings and specifications. The trees that could be affected are included in the construction documents and discussed at project meetings. Details regarding the impact should be included in each section of the design plan.

Outline protective measures and develop specifications

With the relevant information delineated on the site map, designers can now locate the building, driveway and utilities, and develop the grading plan. This layer of the plan can be colored to show where construction will affect protected zones. If destructive site development cannot be modified, these overlay warnings may indicate which trees must be removed. It is far better to do removals at the beginning than after the building is constructed. A good site plan will show permitted parking, storage, equipment washouts and other locations critical to the preservation plan.

Materials and methods required to control damage must be clearly described in the construction documents. Include an enforcement or penalty clause in the specifications. Complicated details should be illustrated on the working drawings. Prescriptions are part of the construction documents that are forwarded to the Conservation Commission, building department and subcontractors who will bid on any part of the project. During the pre-construction stage, hold a meeting with the owner, landscape architect, construction foremen, subcontractors, and others who will work on the site. Make it clear that preservation is important on this job, requiring everyone to work together.

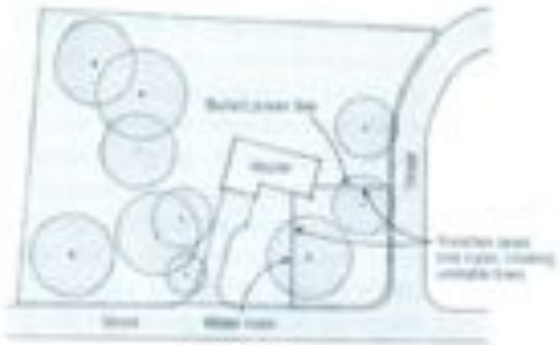
Field inspection and administration

Critical decisions are made during the design phase, but follow-through will make or break even the finest project. You must verify that field workers are following the preservation plan. Tree preservation is unusual for many workers. Some may think the extra care required is a bunch of baloney. Keep a watchful eye.

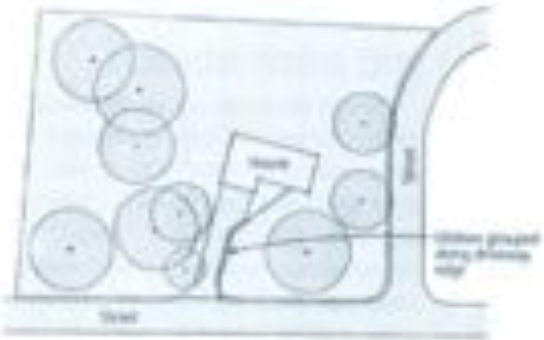
Surveyors, well drillers, excavators and truck drivers are usually first to arrive on site. Meet them as they arrive on the job site. Instruct them not to wash down equipment near desired trees. Trees are sensitive to chemicals and washing out a concrete truck affects the pH of the soil. Petroleum washed from equipment also hurts. Calcium chloride is often used to reduce dust on the site. Be careful, since salt is toxic.

Verify that all workers understand their roles. And be sure the required protective measures are implemented at the appropriate time during the work schedule. The arborist can be hired to oversee field imple-

Laying Out Utility Trenches



Wrong Way



Right Way

Running buried utilities in a series of radiating or parallel trenches creates isolated strips or islands of trees with damaged root systems (top). Bundling utilities in a single trench along the edge of the driveway keeps damage to a minimum and reduces the risk of wind throw (bottom).

mentation, but the most effective policy is to have the arborist advise a fully invested site supervisor.

The site supervisor should clearly mark the location of each tree being saved on the site. Erect signs that mark storage and clean-out areas. Install protective fencing before any work begins. It should be rugged, like an anchor fence or one built using 2x4s. The fence must be conspicuous. It must be high enough to be seen by operators of heavy equipment, so those workers won't run over it. Snow fencing is not good enough. Hay bales should be used to protect wooded areas and individual root zones from silt and run off.

Lowering the grade around this oak has left it with practically no root system. The thin and discolored foliage shows that it's already dying. The inhabitants of the blue house at right might want to sleep in the basement on windy nights.

As the professional arborist you should be hired to perform some important tree-care work before building begins. Tree-care duties:

- Remove unwanted trees;
- Prune and improve saved trees;
- Fertilize, water and aerate where needed;
- Root prune outside of protected root zone;
- Mulch where needed.

Many handbooks recommend tree wells as a system used to change the grade around an existing tree. They should be avoided if at all possible. You can build a stone wall and hold an elevated level of soil back away from the tree trunk, but the rest of the root zone is buried and suffocated. To do it right you must construct a radiating network that provides air and water to the entire root system. Proper tree well construction can be incredibly expensive and impractical in many cases. You are better off working with the existing contour of the land if at all possible.

Building contractors need to know that the cost of hiring an arborist depends on the house and scope of project. The service can run from a couple hundred dollars for a plan review and site visit to a couple thousand for a full consulting service. Given the numerous benefits afforded by professional tree preservation, hiring a arborist is a sound investment that can benefit the entire community. It is also a professional service that the arborist can offer the community year-round. The key to long-term tree health is for the arborist to be involved from the very beginning.

H. Dennis P. Ryan is director of the Arboriculture and Community Forestry Program; Paul Fiorito is director of the Building Materials and Wood Technology Program; and David V. Bloniarz is the USDA Forest Service Urban Forester at the University of Massachusetts in Amherst, Mass. Modified with permission from an article originally published in the Journal of Light Construction. For subscription information, call 1-800-375-5981 or visit www.jlconline.com.

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Additional Information

National Arborist Association, 3 Perimeter Rd., Unit 1, Manchester, NH 03103; 800-733-2622; www.natlarb.com

American Society of Consulting Arborists, 15245 Shady Grove Rd., Suite 130, Rockville, MD; 301-947-0483; www.asca-consultants.org

International Society of Arboriculture, PO Box 3129, Champaign, IL 61826; 217-355-9411; www.isa-arbor.com

National Association of Home Builders, 1201 15th St. NW, Washington, DC; 800-368-5242; www.nahb.com

Trees and Development: A Technical Guide to Preservation of Trees During Land Development
By Nelda Matheny & James Clark

Trees & Building Sites
By Gary Watson and Dan Neely

Building Greener Neighborhoods: Trees as Part of the Plan
By Jack Petit, Debra L. Bassert, and Cheryl Kollin

Planting Techniques
Abstract
Compiled by D.Bloniarz, June 2002

Living Memorials Project Website
www.livingmemorialsproject.net

Once a site has been chosen for planing a new tree, it is important that careful consideration be given to the actual installation technique in order to ensure the survival of the tree in the new landscape setting. Since most trees will be transplanted from a nursery setting, where they have received scheduled care and nurturing, it is critical that proper planting methods be followed in order to reduce the shock of transplanting and establishment. Whether using community volunteers or hired contractors, it is important to plant the tree correctly, giving it the best chance for living a long and healthy life. The following information outlines some recommendations for plating balled and burlapped, and bare root, trees.

Techniques for Planting Balled and Burlapped Trees

Using a step-by-step process to plant trees will help to ensure that they are provided with an opportunity for survival and healthy growth. According to the International Society of Arboriculture, the root system of a balled and burlapped tree has been reduced by 90-95% of its original size during transplanting. This dramatic shock to the tree's physiology often results in slow grown and reduced vigor following transplanting. Proper preparation of the site is critical to provide an opportunity for lessening the rigors of transplanting a tree from a nursery into your landscape.

If possible, prepare the site before you bring in the tree. Keep the root ball well watered and keep the tree in a shaded place until you are ready to plant. It is imperative to expose the trunk flare on each balled and burlapped tree before the planting site is dug so that the depth of the planting site can be properly measured. The trunk flare is the point where roots begin to branch from the trunk. (The top of the root ball is not always the trunk flare.) Remove burlap from immediate trunk area of tree. Pull back excess soil around trunk of tree to locate trunk flare. Measure the height from the base of the trunk flare to the bottom of the root ball. Dig to the depth of the trunk flare.

When planting the tree, the trunk flare and top of root ball should be at grade. Dig the space at least 3 times the diameter of root ball, with the sides of the excavated area at a 30-degree angle. Dig the hole only to a depth that s equal to the height of the root ball. If you plant the tree too deep, newly developing roots will be limited by the reduced availability of oxygen.

Additionally, you will need to break up compacted soil. Sides of planting space should not be packed. Leave bottom of space firm. Do not amend soil unless planting in building rubble, poor, or severely disturbed soils

When actually planting the tree, simple steps for handling the root ball are impoetant to follow.

- Lift tree into planting space by root ball, not the trunk.
- Balance tree upright in center of planting space.
- For trees in wire baskets, cut and remove wire.
- Cut away strings and burlap or plastic, exposing root ball. Do not remove soil from root ball.
- If tree is container grown, cut and remove container.
- Prune dead or crushed roots and straighten or cut circling roots. Make clean cuts.
- Begin refilling with soil, watering as you fill to firmly set tree. Gently tamp.
- Never plant too deep. Trunk flare and top of root ball should be at grade. (Trunk flare may be hidden within the root ball.) Fill soil up to the tree base just to where roots begin to branch from trunk
- Prune only dead or injured branches. Do not paint wounds.
- Remove tree wrap, tape or string on trunk. Trunks should be wrapped only to protect them in transit to planting site.
- Stake and brace large trees, or trees that are plated in windy, exposed location. Support tree but allow it to move or sway.
- Use wide, belt-like strapping to attached to two sturdy stakes. Do not use rope or wire through a hose.
- Mulch lightly and evenly with 2" of composted material at least to the diameter of crown of tree. Leave 3" circle of bare soil around the trunk. Deep layers of mulch can be harmful.
- Do not plant flowers under tree.
- Do not fertilize at planting time.

Improper planting depth is often the cause for predisposing new transplants to not only immediate, but also future cultural, insect, and disease problems.

The first problem lies with the depth that the new plant is set at in its new site. Many times the landscape professional is correctly planting to the top of the ball, and sometimes even planting 1-2" high allowing for landscape mulch and a little settling. Often balled and burlapped plant material is handled many times from the wholesale nursery to the retail garden center, and then to the landscape site. This handling causes the soil within the ball to be pulled up around the stem of the plant. Unless this excess soil is removed back down to the stem flare or root collar, these plants, depending on the amount of handling, are likely to be planted at a depth of 2-3" too deep.

Excess mulch is also a big problem in decreasing a plants' ability to thrive. The proper use of landscape mulch is to assimilate the 1-2" of leaf or duff layer found in the plant's natural setting. Landscape mulches, however, being much more aesthetically pleasing than leaf litter, are generally what's used. The purpose of this leaf or duff layer in the natural setting is to: 1) provide organic matter, 2) aid in the soil's ability to retain moisture, 3) regulate soil temperature fluctuations, and 4) keeps weeds and grass away from the trunk which eliminates the potential of mower injury to the trunk. When

applying landscape mulches, the mulch depth should never exceed the 2-3" layer that occurs in the natural environment and should never touch the trunk.

The problem with excess soil and mulches around the stem and root zone areas is a decreased ability for the roots to obtain oxygen. This adversely affects root growth, thus affecting the plant's ability to collect water and nutrients. Furthermore, excess soil and mulch around the plant's stem causes bark to be constantly wet. This can affect plants cold tolerance, encourage fungal pathogen and insect invasions, reduce incremental growth, lead to adventitious and girdling roots.

Assuring proper planting depth and maintaining proper mulching practices will greatly decrease future therapeutic maintenance while enhancing the plant's ability to thrive thus allowing it to become a beautiful asset to the landscape.

Fertilization is usually not necessary or recommended at planting time. If it is desired or necessary, use fertilizer that is organic or slow release. Pruning at planting time should be limited to removing only broken or misshapen branches.

Bare Root Planting

Bare root trees are trees that are dug and stored without any soil around their roots, which allows for more roots to be saved during the transplanting process from the nursery into a new plating site. According to some estimates, bare root trees can have up to 200% more roots than container trees, depending on the soil type and transplanting method used at a particular nursery. Also, since the soil is left at the nursery, only the tree and its roots need to be handled and shipped, which makes these trees much lighter, less expensive and cheaper to transport. Bare root trees are also easier to plant, making this type of tree more appealing to volunteer plating initiatives, which rely on community members to do much of they physical labor involved in planting trees.

Bare root plating is not without some disadvantages, but with careful planning and scheduling, many of these issues can be easily overcome. The use of bare root trees reduces the window of time available for planting. Once bare root trees have been dug and shipped from the nursery, they need to be planted in the ground within a 7 to 10 days, depending on the air temperature and weather conditions. Since there is no soil around the root, the small feeder roots and root hairs will dry out and die if left exposed, making it important to plant the tree as soon as it arrives from the nursery. Also, bare root trees need plenty of soil moisture in order to establish themselves in a new planting location, therefore early spring (before budbreak) and fall (after leaf fall) are the only two possible planting times. Finally, some species may not be available as bare root trees, and some nurseries may not have trees available for bare root retail sale at all.

The following outlines the best techniques to follow for bare root tree planting:

- Use any technique you can to reduce the time the tree roots are bare.
- Order 1.5-2" trees to be dug within 24 hrs of your arrival otherwise be sure they are stored in a cool place.

• Have fall trees dug mid-Oct to late Nov, spring trees late Mar to early May.
• If possible, dip tree roots in slurry of a hydrogel (a synthetic water-absorbing compound, many brands available) or muddy water, then store them in large, pleated plastic bags until planting.
• If no hydrogel is used, soak the tree roots for 12-24 hrs in water before planting.
• Keep trees covered, shaded, and moist until actual planting.

The materials contained in this abstract were adapted from the following publications:

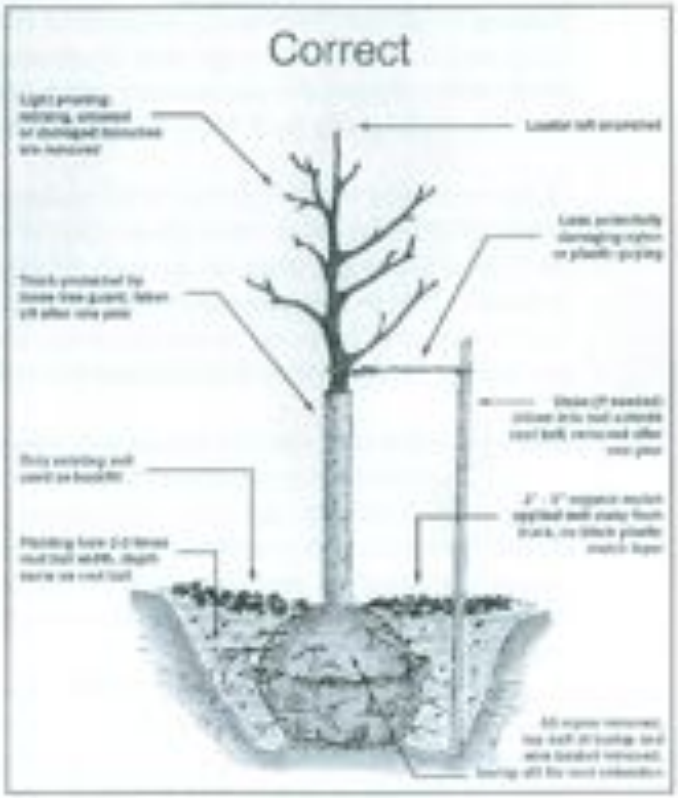
New Tree Planting. 1995. Informational brochure produced by the International Society of Arboriculture, P.O. Box 3129, Champaign, IL 61826-3129. Available online at http://www2.champaign.isa-arbor.com/consumer/planting.html

Bare Root Tree Planting. 1998. Informational brochure produced by Cornell Cooperative Extension of Monroe County, New York, and Community Forestry Education Project. Available online at http://www.cce.cornell.edu/monroe/cfep/factsheets/24bareroottreeplanting.htm#top

Planting Trees in Designed and Built Community Landscapes: Checklists for Success. 1998. Informational brochure by Mary K. Reynolds, Urban Forester, State of New Hampshire Department of Resources and Economic Development and H. Sharon Ossenbruggen, Urban Forester, USDA Forest Service State and Private Forestry, Northeastern Area. Available online at http://www.na.fs.fed.us/spfo/pubs/uf/plant_trees/planting_trees.htm

Tree Planting

To ensure healthy trees, start with Right Tree/Right Location.
Once you select a tree suited for your site and its microclimate, be sure to plant the tree correctly!



Bare Root to Bare Root – Coming Full Circle

Bonnie Appleton, Virginia Tech, and Jim Flott, Community Forestry Consultants, Inc.

Abstract. If the production, harvest, shipping, and planting of trees for landscape use is looked at historically, our industry didn't start with root balls packaged in burlap, rope, and wire, or in containers of varying sizes, shapes, and colors. It started with bare root fruit trees sold by itinerant salesmen. Today a perceived epidemic of tree decline exists in the United States, with an estimated 80 percent of all landscape tree problems originating below ground and relating to quality and placement of the root system. Structural root defects and root planting depth issues can occur during all stages of tree production and establishment including nursery propagation and production, landscape specification development and planting, and post-planting and transplanting maintenance. A proposed technique for revealing tree roots prior to finishing the planting or transplanting process, so that root defects can be seen and if possible, corrected, and planting height can be properly adjusted, is bare rooting. Bare root planting of landscape caliper-sized trees has both advantages and disadvantages compared to planting intact field or container-grown root balls per current industry standards, but bare root planting is the planting technique that was successfully used when the nursery and landscape industry began in the United States.

"It has been said that 80 percent of all landscape tree problems start below ground" (Watson 1994). With increases in the sophistication of tree production and harvest methods at nurseries in the United States has come an apparent increase in root-related establishment and growth problems. Add to this the confounding problem of improper installation (namely root depth and lack of defective root system modification), and a perceived, whether real or not, epidemic of tree decline in the United States is said to exist (Chalker-Scott 2005).

Tree root evolution relative to nursery production, harvest, and shipping method

Trees nursery-produced in the 1700's and 1800's were all harvested and planted or transplanted bare root, and were predominately fruit trees. In the latter half of the 1800's a significant increase in non-food or landscape and ornamental plants was added to commercial production including such trees such as American elm, Lombardy poplar, magnolia, larch, mountain ash, American holly. Again, trees were harvested, sold, and planted bare root (Davidson et. al. 1988).

During the 1800's and early 1900's trees that were not harvested bare root were dug by hand with a soil ball, thus the beginning of balled-in-burlap (B&B) harvest, shipping, and planting. The production, harvest, and shipping of trees with container-grown root systems started at the end of World War II with the use of #10 egg and fruit cans. The first record of the hydraulic digger harvest of nursery trees is 1956 (Davidson et. al. 1988), again producing plants that were then shipped and planted B&B.

Tree root handling relative to landscape planting and transplanting

In the 1906 fourth edition of the *New Cyclopedia of American Horticulture*, Liberty Hyde Bailey, the father of American horticulture, described transplanting as "…a general term used to designate the removal of living plants whereby they may become established in new quarters." He stated that only small herbaceous plants were sometimes transplanted while actively growing, but that most plants should be transplanted when dormant. He went on to describe a dormant transplanting method for large trees that involved "picking out and caving down" soil from

within a tree root system. As the roots would be uncovered they were tied in bundles with lath yarn, and if they were to be out of the ground over one day in dry weather the bundles were to be wrapped in clay mud, damp moss and straw, or burlap. When placed in their final landscape destination the roots were systematically uncovered and then settled into their planting hole by means of a mud slurry and "planting sticks".

In a 1943 National Shade Tree Conference and National Arborist Association publication, a technique similar to the above is recommended: "Digging Specifications: Remove the loose soil or soil above the roots, from the area to be dug. Planting Practices: After the B&B specimen is set in the hole, it is advisable to remove the burlap. Puncturing or breaking the ball - often times plants dug from heavy clay soil will arrive at the planting site with the outer inch or more of the soil ball sufficiently dried out to form a hard crust. Balls planted in this condition are not satisfactory for rapid re-establishment of the roots. The crust may be so hard that it inhibits ready movement of air and water to the roots, and furthermore, the new roots penetrate the crust very slowly, if at all. A method of removing soil from the roots uses a tined spading fork to comb out the roots by inserting the fork into the soil ball and prying against the root ball. Continue working inward until most of the roots are exposed. If practical leave a partial ball or some soil clinging to the roots."(Anonymous 1943).

Current status of handling trees bare root at planting and transplanting

In recent years bare root tree planting has mainly been reserved for the planting of small, mainly deciduous seedlings for reforestation, establishment of riparian buffers, and similar tree replacement projects; for lining-out whips for larger tree production at nurseries; for planting small evergreen seedlings for Christmas tree production; and for the planting of fruit trees. The bulk of these types of planting projects use trees that are dormant. Bare root plants also represent the bulk of the means by which small trees are shipped mail order in the United States.

Web and literature searches (September 20, 2008) regarding bare root planting almost exclusively related to plants harvested and planted or transplanted bare root, not bare rooted at planting or transplant time. *Creating the Urban Forest: The Bare Root Method* by Buckstrup and Bassuk (2003) is the only major publication the authors found that addresses bare root planting in detail, but does not mention bare rooting at planting or transplanting. A search of recent popular literature produced only three articles on bare rooting at planting (Chalker-Scott 2005; Flott 2006; Appleton 2007).

The origin of improper structural root depths

Some deep structural roots get their start during nursery propagation or production. Others start during landscape installation or maintenance, and still other times deep structural roots are a result of cumulative events or handling practices. The following lists enumerate causes of deep structural roots, and can be used to make production, installation, and maintenance changes to minimize or prevent deep structural root development.

Field and container propagation, production, and harvesting

- Seeds planted too deep in direct field or container propagation.
- Deep propagation containers used that tend to concentrate rooted liner roots at the bottom of the container.
- Seedlings and rooted liners potted with their roots too deep in production containers.
- Seedlings, rooted liners, whips, or grafted rootstock roots covered by soil during cultivation for weed control.

- Seedlings, etc. planted too deep because root-to-stem transition zone, root collar, or stem flare not obvious or observed.
- Seedlings, etc. planted too deep to prevent blow over.
- Budded and grafted trees lined out too deep to bury the graft union (or seedling cut back referred to as the "dog leg").
- Root balls topped with additional soil to create a crowned field root ball at harvest.
- Substrate settling around seedlings or liners over time.

Landscape installation and maintenance

- Roots initially too deep in the nursery container or field root ball resulting in planting hole dug too deep. (Fallacy of using soil mark on stem or stem flare as defining mark for establishing hole depth [Bilderback 2006].)
- Planting hole dug too deep due to incorrect planting specifications or digging errors.
- Soft soil underneath the root ball compacts or settles in the bottom of the planting hole.
- Soil displaced by root ball put atop the roots.
- Excess mulch put atop the roots.
- Post-installation grade changes.
-

The origin of defective root roots

As with deep structural roots, root defects can get their start during nursery propagation or production, or can start or be perpetuated during landscape installation or maintenance. They may also be mandated by outdated landscape specifications. The following lists enumerate causes of defective roots, and can likewise be used to make production, installation, and maintenance changes to minimize or prevent development or perpetuation of root defects.

Field and container propagation and production

- Seedlings, liners, whips, or grafted rootstocks started in propagation and/or small production containers and then lined out or potted up without removal or correction of circling roots (Figure 1).
- Seedlings, etc. settled into narrow planting furrows or trenches, or off center into containers, via root dragging or "sweeping" (produces "J" roots) (Figure 2).
- Trees shifted up ("up canned") to larger size production containers without removal or correction of circling roots.
- Field-grown liners or finished trees potted up into containers without removal or correction of circling of J-roots

Landscape installation and maintenance

- Planting or transplanting field or container-grown trees with deep structural and/or defective roots.
- Not roughing up or creating root passages in planting hole walls when augering creates slicked or impenetrable walls (mainly in heavy clay soils).
- Digging plants holes deeper than the actual depth of the tree root system (leading to stem girdling roots [SGRs]).
- Using outdated landscape planting or transplanting specifications.

Advantages to bare rooting during production, harvesting, shipping, and planting and transplanting

Bare rooting, or the removal of field soil or container substrate, at planting and transplanting has many advantages that can address the above mentioned structural root depth and defective root system problems. Bare rooting also has advantages relative to other production, harvesting, shipping, and planting and transplanting components, with the following being a compilation of the major advantages across all phases of plant handling:

- Root defects and structural root depth can be corrected prior to tree harvest if bare rooting occurs during each propagation or production stage, or during planting or transplanting.
- Root pruning stimulates new root growth.
- Field soil and container substrate can be retained at the production nursery.
- Transmission or transport of soil-borne weeds, insects, and pathogens can be minimized.
- May help in dealing with quarantines relative to soil-borne insects and pathogens.
- May give nurseries that produce quality root systems a marketing and pricing advantage.
- Trees may be less expensive and easier to store at the nursery prior to shipping.
- Growers will get a more correct tree inventory if structural roots are correctly located (not too deep) in the soil.
- Trees will be less expensive to ship and therefore potentially less expensive to the buyer.
- Trees can be transported into more confined spaces if both their branches and their roots can be compressed.
- Trees will be easier to handle from a weight perspective.
- Planting holes will be easier to dig and will require less heavy digging equipment (with a side advantage of reduced soil compaction).
- Removes problems that can result from incorrect installation handling of balling burlap, ropes, and straps, and wire baskets.
- Resolves soil and container substrate disparity or hydrologic discontinuity problems.
- Root systems are more uniformly moistened by "mudding in" (creating a soil slurry to settle into and stop the bare root system), and large air pockets are removed.
- All structural and absorbing roots are in contact with the planting site soil, not just the roots/root tips on the outside of the root ball.
- "Mudding in" creates greater direct root anchorage and reduces the need for supplemental stabilization (staking or root anchoring). This in turn reduces maintenance cost and potential tree and human hazards when no stabilization method needs to be removed.
- Fewer injuries should occur to green industry personnel.
- Potential to increase the period of time of the tree guarantee or warranty.
- Trees with poor quality roots can be refused or returned with proof of the structural defect or root depth problem.

An additional, non-production or installation advantage noted by the junior author when employed as a municipal arborist was increased volunteer participation in tree planting activities due to the lighter weight, more consumer friendly bare root tree.

Disadvantages (real or perceived) to bare rooting at planting and transplanting

Just as bare rooting, or the removal of field soil or container substrate, at planting and transplanting has many advantages that can address structural root depth and defective root system problems, there are likewise disadvantages that should be considered. The following is a compilation of the major disadvantages across all phases of plant handling:

- Removal of often significant root volumes due to disease, damage, or structural malformation revealed by bare rooting.
- Improper handling during the bare rooting process including the need to prevent root desiccation.
- The need to dispose of substrate (soil or potting) removed from root systems during the bare rooting process.
- The need to alter tree planting specifications to reflect reconfiguring the planting hole with varying dimensions.
- The need for bare rooting supplies and equipment for either bare rooting off or on the planting site.
- Differences in species adaptation to bare rooting including phenological growth stages (timing of bare rooting, especially relative to bud break) and ability to rapidly recover following planting or transplanting.
- Resistance to the principle of bare rooting by nursery growers, landscape designers, architects, and contractors, and arborists.
- The cost (labor, equipment) to bare root and plant a B&B or container-grown tree vs. the cost to "drill and drop" plant B&B or "pop and drop" container-grown trees, especially if large numbers of trees are being planted.
- Research shows that bare rooting, via "root washing" or soaking for a period of time in water, may remove or dilute stored nutrients and may also remove desirable rhizosphere organisms (mycorrhizal fungi, etc.).
- Nurserymen and landscape contractors may refuse to guarantee or warranty bare root planted and transplanted trees.

Bare rooting at planting and transplanting research

One approach to correcting structural defect and depth problems is to bare root field and container-grown trees at planting time. Though modern horticultural and arboricultural references all give recommendations for how to plant bare root trees (Whitcomb 1987; Gilman 1997; Watson and Himelick 1997; Hartman et al. 2000; Lilly 2001; Harris et al. 2004; Watson and Himelick 2005; Urban 2008), only Gilman addresses to any extent actually bare rooting field or container-grown trees at planting, and two others bare rooting when transplanting (Hartman 2000; Harris et al. 2004). Possible bare rooting techniques are discussed in trade publications (Chalker-Scott 2005; Flott 2006; Appleton 2007) and a few major arboricultural references (Hartman 2000; Harris et al. 2004), but no research into a comparison of possible bare rooting techniques was found in the literature.

In addition, there are reported differences in the ease of handling or planting different tree species bare root (Whitcomb 1987; Avent 2003; Buckstrup and Basuuk 2003). Said differences are in part due to root growth periodicity among different species (Harris et al. 1995; Kozlowski and Pallardy 1997). The objectives of the research were therefore to investigate 1) the effect of different bare rooting techniques on tree survival and growth; and to 2) determine whether time of year or phenological growth stage would have an effect on bare root planting success; and to 3) determine whether there might be differences in species response depending on nursery production method, bare rooting technique, or time of year of bare rooting.

Two species of tree – red maple (*Acer rubrum* 'Red Sunset') and willow oak (*Quercus phellos*) were selected for use due to anecdotal reports of differences in conventional (not bare rooted – ie, field soil or container substrate not removed) planting success at different stages of

tree growth (dormant vs. active). In 2006, at Virginia Tech's Hampton Roads Agricultural Research and Extension Center in Virginia Beach, four root ball handling techniques were applied to field-grown 3"-4" caliper red maple at planting: 1) no soil removed; 2) bare rooted via air excavation (Figure 3); 3) bare rooted via pressure washing (Figure 4); and 4) bare rooted via drop from 12' in air (Figures 5). Air excavation was achieved using a commercial Air Spade. Root ball dropping was achieved by lifting root balls in the air with a tree spade, opening the blades, and letting the root ball fall to and hit the ground. After dropping all wire baskets, burlap, and ropes were removed and loose soil allowed to fall from the roots. Trees were treated and planted in both March and July to represent dormant and actively-growing planting.

In 2007, three root ball handling techniques were applied to both field and container-grown 3" caliper red maple and willow oak: 1) no soil or substrate removed; 2) bare rooted via pressure washing; and 3) bare rooted via soaking. Pressure washing in both years used a stream of water produced by a 5 mph commercial engine on a water wagon. Root soaking was achieved by placing the root balls in a trough of water for approximately 12 hours, then hand raking out any soil or substrate still remaining within the root ball (Figure 6). Both species were treated and planted as above in March and July to represent dormant and actively-growing planting. The willow oak were also treated and planted in October to represent planting as trees are going dormant.

Trees whose root balls were not bare rooted were planted according to Virginia Cooperative Extension tree planting recommendations (Appleton and French 2004). Trees whose root balls were bare rooted were planted into shallow holes that matched the depth and spread of the bare root system, using a slurry of planting hole soil and water in a process that author Flott termed "madding in". A similar process is described in by Bailey in 1906.

Data collected and subjected to analysis of variance were percent live trees (which in the case of willow oak included some whose main stem had died but which had sprouted from the base), and increase in caliper measure at 6" above soil level. For field-grown red maple bare rooted in 2006, after two years of growth there were no significant differences in bare rooting technique or whether bare rooted while dormant of actively growing.

This same trend was true after one year for red maple, both field and container-grown, that were bare rooted in 2007. For willow oak, however, significant differences occurred for all treatments, and there were significant interactions. Production method, bare rooting technique, and time of year of bare rooting were all significant.

Most notable was the timing, with most trees bare rooted while dormant, regardless of production method or bare rooting technique, alive and with similar caliper growth. Nearly half of the willow oak bare rooted while actively growing were dead, with more trees alive that had been field rather than container-grown, or in some cases that were bare rooted by soaking rather than by pressure washing. A slightly higher percent of willow oak bare rooted in the fall when going dormant were alive compared to the actively growing bare rooted trees, again with production method and bare rooting technique interactions. (Data will be presented in a follow-up manuscript to be submitted for publication consideration to Arboriculture & Urban Forestry.)

Caution needs to therefore be exercised when deciding whether to bare root trees at planting, since tree species vary in their response to bare rooting, especially relative to time of year or growth stage. Further research is planned to continue to examine this phenomenon, and to determine if treating the roots to prevent desiccation or to stimulate new root growth after bare rooting will enhance bare rooted tree planting or transplanting success.

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Figure 1. Circling roots on trees from within a field (B&B) root ball (left) and from production in a container (right). The field ball circling roots developed in the initial propagation or production container before the tree was lined out in the field for final caliper growth.

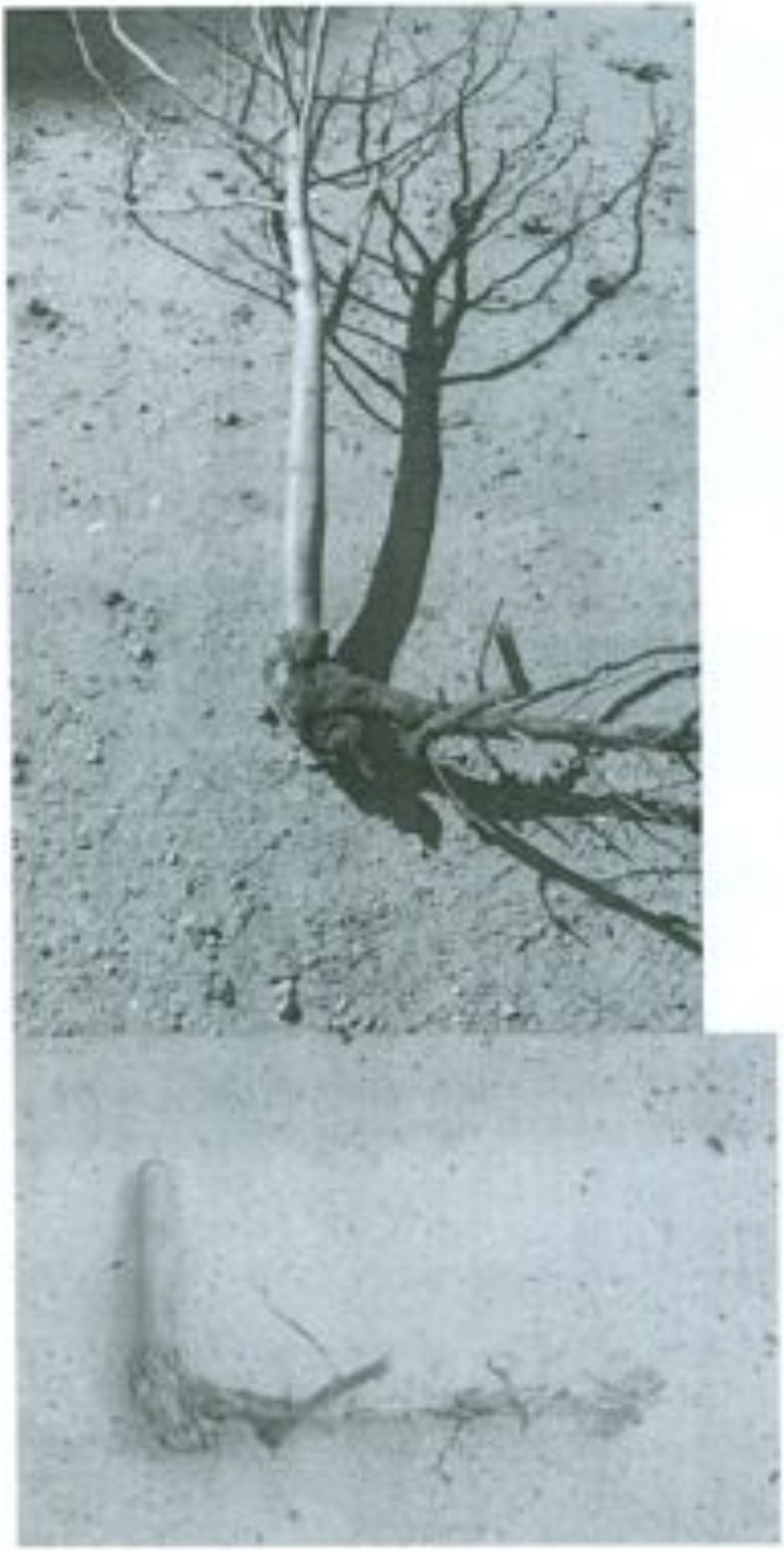

Figure 2. "J" root created by settling a seedling or liner into a narrow planting furrow or trench via root dragging or "sweeping".

Figure 3. Bare rooting a field-grown root ball while dormant (top) and while actively growing (bottom left) via air excavation. Example of a partially air excavated root ball.

Figure 4. Bare rooting a field-grown root ball while dormant (top) and while actively growing (bottom left) via pressure washing. Example of a pressure washed root ball.

Figure 5. Dormant field-grown tree lifted into air to be dropped to bare root the tree.

Figure 6. Root balls being soaked, and substrate being raked out, to bare root trees.