Montgomery County Roadside Tree Protection Law

Design Guidelines & Specifications

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Prepared by

DPS | Montgomery County
Department of Permitting Services

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Preface

Montgomery County's Roadside Tree Protection program began on March 1, 2014. It was established to protect publicly owned trees from construction and maintenance activities that occur in, or adjacent to, county rights-of-ways. The protection and management of our roadside tree population is vital to efforts to build and maintain attractive and walkable neighborhoods, while protecting property values, public safety, and the quality of our air and water resources.

Trees are sensitive to construction activities that damage their trunks, branches, and root systems. Roadside trees that are damaged by construction often decline in health and die. The Roadside Tree Protection program was implemented to minimize impacts to the health and stability of these trees through the review of proposed construction projects, and, to guide replacement efforts when roadside trees are removed.

The primary purpose of this publication is to provide an overview of the matters that must be addressed in order to meet Roadside Tree Protection requirements when applying for right-of-way, sediment control, and building permits. The content is ordered to track the following land development milestones:

- Project planning
- Project design and engineering
- Permit application and review
- Project implementation and inspection

The intended audience is land development professionals who are involved in planning, design, and implementation of construction projects that are located near roadside trees. Other groups, such as homeowners, tree care professionals, landscape professionals, and property managers may benefit from the contents as well.

The Department of Permitting Services
expresses sincere appreciation to ***Ms. Arlene Bruhn***, of *Conservation Montgomery* for volunteering to review, proofread, and edit this publication.

Thank You!

Chapter 1

Why is it Important to Conserve our Urban Forest?

Montgomery County's urban forest is a valuable natural resource that enhances the livability and sustainability of our communities. Roadside trees are an important component of our urban forest and our public infrastructure. When healthy and structurally sound, these trees can provide a wide array of environmental, ecological and socio-economic services. Illustration 1 shows the estimated monetary value of six environmental and socioeconomic services provided by a single 12-inch diameter red maple over a 50-year period. The values are based on those provided by a red maple situated in the front yard of a residence located in the Mid-Atlantic region.

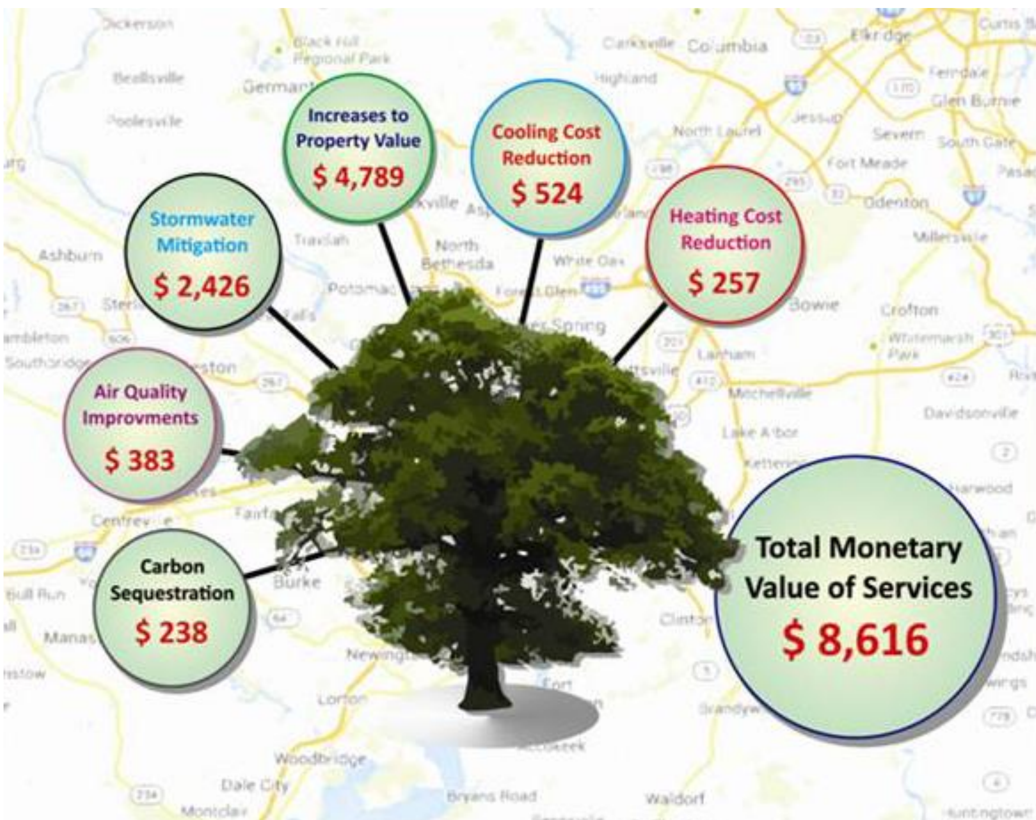

Illustration 1. *Estimated monetary value of six services provided by a single red maple growing in a residential setting over a 50-year period (Adapted from the National Tree Benefits Calculator developed by Casey Trees and Davey Tree Expert Co.).*

Each tree in the urban forest has capacity to deliver a similar range of services as the tree shown in Illustration 1. Can you think of a man-made technology that has the ability to improve air and water quality, reduce stormwater runoff, reduce heating and cooling costs, increase property values, provide food and habitat for wildlife, attract shoppers and encourage repeat visits to retail districts – all at the same time?

The multi-functional nature of urban tree canopy makes it a low-cost and effective solution for many of the environmental and social concerns faced by communities. This is why the majority of local governments in our region, including Montgomery County, have taken steps to conserve this important resource.

Several jurisdictions in the Metropolitan Washington D.C. area have quantified the level of services provided by their urban forest and confirmed the positive effects that trees and forests have on our local quality of life, economy, and the underlying processes that keep our air, water, and ecological resources healthy.

Photo: Kenneth Scott Taylor ©2008

The District of Columbia used iTree software (developed by the U.S. Forest Service) to analyze the effects of its urban forest on air quality and found that the estimated 2.6 million trees growing in the District removed approximately 492 tons of air pollutants per year. The analysis estimates that this level of air quality improvement equates to approximately $2.3 million per year. Across the Potomac River in suburban Virginia, iTree estimated that Fairfax County's 20.9 million trees remove 4,670 tons of air pollutants per year, and that service equates to $21.7 million per year.

These analyses demonstrate that urban forests yield substantial levels of environmental and socio-economic services at jurisdictional scales. And without tree services, communities would need to fund, build, and maintain alternative technologies in order to provide comparable levels of services; or otherwise, experience a corresponding decline in quality of life and environmental health.

Although harder to equate to monetary values, the socioeconomic benefits of urban trees make important contributions to the way people feel about their surroundings. Trees are part of the fabric that can make communities special places to live, work and do business. These natural assets are linked to community identity, lower rates of domestic violence (Kuo, F.E. & Sullivan W.C. (2001), lower crime rates (Troy et al., 2012), retail and commercial districts where shoppers spend more time and money (Wolf, 2005), and human healing (Kaplan, 1995).

What about the undesirable impacts of trees? The size and proximity of urban trees to people, dwellings, and infrastructure can increase the potential for trees to cause human injuries, infrastructure damage, utility outages and other negative impacts. Do the costs associated with these disservices outweigh the benefits provided by the urban forest? A study featured in *Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting* (McPherson 2006) recorded monetary costs associated with street, park, and shade trees, and modeled the benefits to cost ratios for four tree species over a 40-year period. This study projected that $3.74 is returned for every dollar invested in urban trees, and demonstrates that the benefits provided by urban trees typically outweigh their costs.

When we invest resources to protect and manage trees, we are ultimately contributing to the public good and the long-term sustainability of our community. However, in order to maximize the potential of urban trees to deliver their array of important services, we must take steps to minimize their inherent risks. This premise is especially valid when applied to roadside trees, which grow in the same spaces in which people live, work, and travel.

Suggested Reading

iTree Ecosystem Analysis Washington. , Urban Forests Effects and Values. January 2010.
https://www.itreetools.org/resources/reports/Washington%20DC%20Analysis%202010.pdf

iTree Ecosystem Analysis Fairfax County, Urban Forests Effects and Values. August 2010.
http://www.fairfaxcounty.gov/dpwes/environmental/ffcounty_ecoreport.pdf

Kuo, F.E. & Sullivan W.C. 2001. "Aggression and violence in the inner city: Impacts of environment via mental fatigue." *Environment & Behavior* 33(4), 543-571.

Troy, A., Grove, J.M., O'Neil-Dunne, J. 2012. "The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region." *Landscape and Urban Planning*, Volume 106, Issue 3, 15 June 2012, 262–270.

Wolf, K.L. 2005b. "Business district streetscapes, trees and consumer response." *Journal of Forestry* 103, 396–400.

Kaplan, S. 1995. "The Restorative Benefits of Nature: Toward an Integrative Framework." *Journal of Environmental Psychology* 15, 3:169-182.

Dixon, K. K., K. L. Wolf. 2007. "Benefits and Risks of Urban Roadside Landscape: Finding a Livable, Balanced Response." *Proceedings of the 3rd Urban Street Symposium* (June 24-27, 2007; Seattle, WA). Washington D.C.: Transportation Research Board of the National Academies of Science

McPherson, E.G.; Sacamano, P.L.; Wensman, S. 1993. Modeling Benefits and Costs of Community Tree Plantings. Davis, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 170 pp.

McPherson, E.G.; Simpson, J.R.; Peper, P.J.; Gardner, S.L.; Vargas, K.E.; Maco, S.E.; Xiao, Q. 2006. Piedmont Community Tree Guide: Benefits, Costs, and Strategic Planting. Davis, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. http://www.fs.fed.us/psw/publications/documents/psw_gtr200/psw_gtr200guide.pdf

National Tree Benefits Calculator, Casey Trees and Davey Tree Expert Co.
This on-line calculator allows anyone to make a simple estimation of the benefits individual street-side trees provide. http://www.treebenefits.com/calculator/

iTree Tools, USDA Forest Service. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. https://www.itreetools.org/

Chapter 2

Purpose, Goals, and Outcomes of the Roadside Tree Protection Law

The Montgomery County Council enacted the Roadside Tree Protection law in 2013 to help protect and sustain roadside trees in order to enrich the quality of life experienced in Montgomery County.

The following goals support the purpose and intent of the Roadside Tree Protection Law:

- Maximize the level of environmental, ecological, and socio-economic services provided by roadside trees.

- Minimize the undesirable impacts that roadside trees can have on public infrastructure, private property, and transportation corridors.

- Limit the unnecessary removal and injury of roadside trees through review of land development activities.

- Ensure that roadside trees protected during land development survive in a healthy and sound manner.

- Ensure that roadside trees are replaced with species that will complement the roadside environment and develop into attractive and functional assets.

- Minimize unnecessary tree work and harmful practices that can injure or kill roadside trees.

These goals are consistent with the *conservation* approach to managing natural resources. The term "conservation" conveys the wise use of roadside trees for the ultimate benefit of the human community. Although tree preservation is the most desirable outcome of the roadside tree review process, the biological limitations of trees necessitate the inclusion of removal and replacement practices in the set of tools used to conserve the resource. These features are necessary to protect the health and well-being of our citizens and visitors; to replenish the roadside tree population over time; and to ensure that the benefits and services provided by this resource will be enjoyed by future generations.

In the framework of Montgomery County's land development process, roadside tree conservation is realized through the review of right-of-way, sediment control, and building permit applications. This process normally results in one or more of the following outcomes:

- A review of proposed construction indicates that conservation practices are not required because roadside trees are not likely to be injured. In these cases, a Roadside Tree Protection Plan is not required.

- A review of proposed construction indicates that roadside trees are likely to sustain some level of injury, but it is reasonable to expect the trees to survive if they are adequately protected during construction. In these cases, the submission of a Roadside Tree Protection Plan is required to demonstrate how impacts will be mitigated and the trees protected.

- A review of proposed construction indicates that roadside trees need to be removed because construction activities are likely to cause severe injuries that are not feasible to mitigate through arboricultural practices. In these cases, submission of a Roadside Tree Protection Plan is required to demonstrate how trees and stumps will be removed and how new trees will be planted in their place.

Any of the outcomes above is valid if the following efforts are given due diligence during the planning and design stages of projects:

- The location, species, diameter, and general condition of roadside trees growing within 50 feet of property lines of the subject property are identified.

- The opportunity to preserve roadside trees is given thoughtful consideration during planning and design stages.

- The decision to preserve or remove roadside trees is based on industry-accepted tree care practices and applicable risk management concepts.

- The species used to replace roadside trees are carefully selected to thrive in the roadside environment and to complement transportation functions.

Importance of Early Planning

Preserving the predevelopment health and structural condition of roadside trees requires careful planning. Land development professionals (land developers) and their clients must treat roadside trees as a fundamental design component during the planning and design stages of projects. Otherwise preservation efforts are likely to be unsuccessful. Waiting to find preservation opportunities after the site has been fully engineered rarely results in success, and may introduce delay and inefficiency into the permit review and construction processes. Early planning proves to be especially valid in the context of infill land development where available space comes at a premium and where there is heightened potential to damage roadside trees.

Suggested Reading

Montgomery County's Roadside Tree Protection Law is comprised of language located in several parts of the Montgomery County Code. As of the date of this publication, relevant code language is located in:

Chapter 8, Buildings

- Section 8-26 (n) Tree Protection

Chapter 19, Erosion, Sediment Control and Storm Water Management

- Section 19-71. Tree Protection

Chapter 49, Streets and Roads,

- Article 3. Road Design and Construction Code,
  - Section 49-35. Right-of-Way permit
  - Section 49-36A. Roadside tree work

COMCOR 49.36A.01 Roadside Trees Protection – Right-of-Way Permits

Montgomery County Code is available at:
http://www.amlegal.com/codes/client/montgomery-county_md/

A chart is provided on p. 8 that depicts the sequence of decisions and actions that are typically associated with the roadside tree plan review and enforcement process.

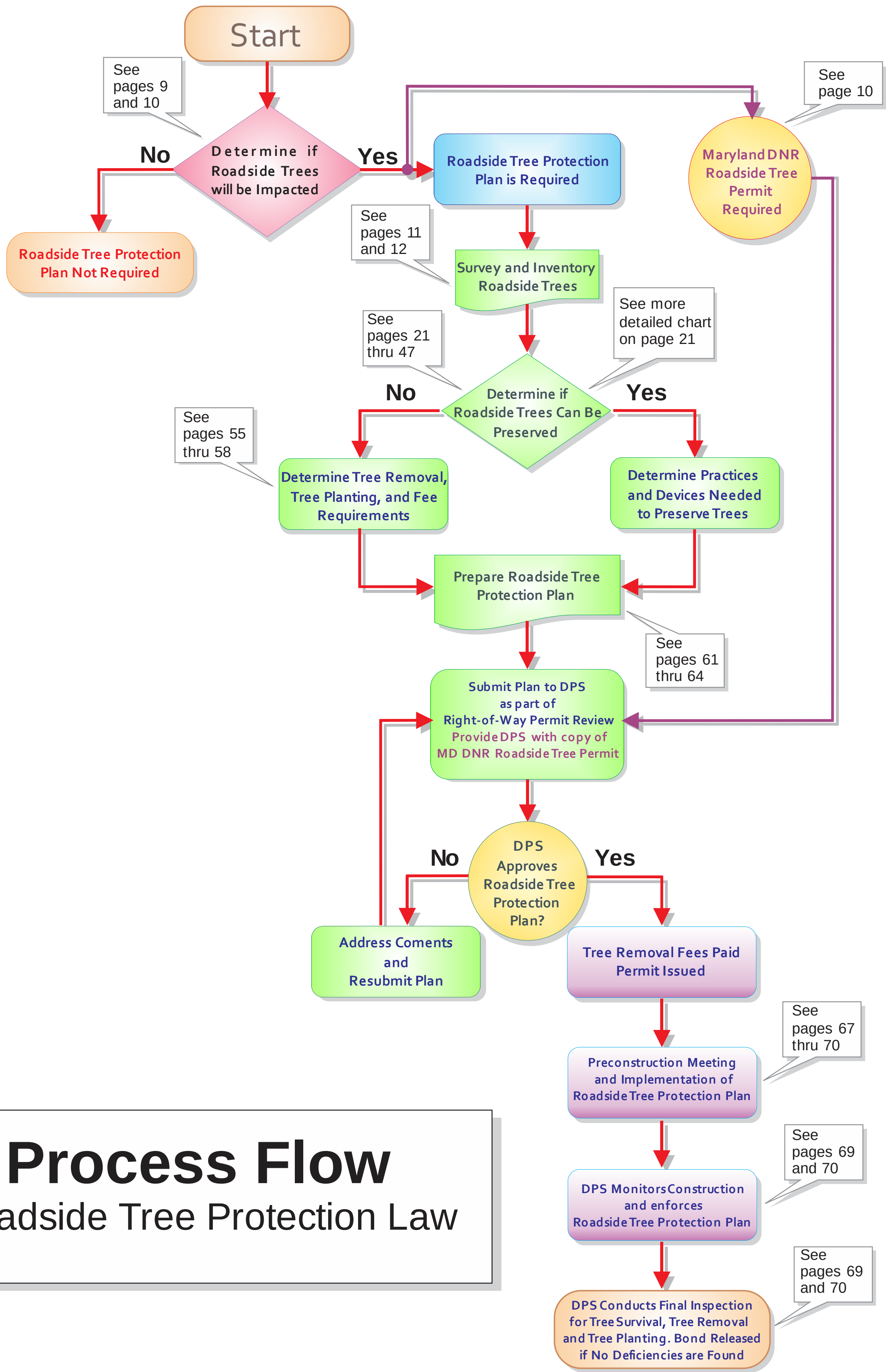

Chart 1

Process Flow

Roadside Tree Protection Law

Chapter 3

Does the Roadside Tree Protection Law Apply to Your Project?

This chapter describes a simple procedure to gauge whether the Roadside Trees Protection Law applies to your project. The procedure can be used to estimate the level of attention that will need to be given to roadside tree issues during the planning stages of projects.

Before using the procedure provided below, be sure to review the activities that are not subject to County roadside tree requirements identified in Appendix 4, *Exempted Activities*. While the procedure will prove useful to a majority of construction projects, more complex projects may require additional steps to estimate the level of impact that construction will have on roadside trees. For these projects, tree locations, critical root zones, and the limit of disturbance may need to be overlaid on engineered site plans before the applicability of roadside tree requirements can be fully determined.

NOTE: The following steps were developed for on-site use!

1. **Determine if roadside trees are present.** Determine if there are trees growing in the County right-of-way and within 50 feet of the subject property. Include trees with trunks that are bisected by right-of-way property lines.
   a. If there are trees meeting this description, then proceed to step 2 below.
   b. If there are no trees meeting this description, then your project will not need to address roadside tree protection requirements. It is advisable to document the absence of roadside trees on permit applications.

2. **Flag the limits of disturbance.** Delineate the outer boundary of areas that will need to be disturbed to construct the project. Surveyor's tape can be used to flag the limits of disturbance (for additional information see Limits of Disturbance on p. 38).

3. **Determine if critical root zones will be impacted.** Using the critical root zone formula on p. 40, flag the circular areas that are proposed to be left undisturbed in order to protect critical tree roots. Compare the outer boundaries of disturbed areas described in step 2 with critical root zones to determine if overlap exists. Overlap indicates that impact

will occur within the critical root zone.

a. **If there will be impacts**: The project will require submission of a Roadside Tree Protection Plan.
b. **If there will be no impacts**: The project will not need to address the Roadside Trees Protection Law.

If the initial analysis indicates there will be impacts (the limits of disturbance and critical root zone overlap), then the next step will be to determine if the site layout can be adjusted to eliminate impacts to the critical root zone. If it appears that the layout cannot be adjusted to eliminate impacts, the next step is to identify which roadside trees will need to be inventoried and depicted on Roadside Tree Protection Plans (see Chapter 4 for more information).

Maryland Roadside Tree Law

In addition to Montgomery County's Roadside Trees Protection Law, publicly owned trees located in County rights-of-ways are protected by the Maryland Roadside Tree Law administered by the Maryland Department of Natural Resources. Maryland State Code requires that before a roadside tree is removed, trimmed, or cared for, a *Roadside Tree Care Permit* must be obtained from the Maryland DNR Forest Service. This permit is also required when construction will impact the root zone of existing roadside trees or when planting trees within the public rights-of-ways. For more information on the Maryland Roadside Tree Law see:

http://sha.maryland.gov/index.aspx?PageId=221

NOTE: Montgomery County's Roadside Tree Protection Law and the Maryland Roadside Tree Law are separate and distinct laws. Although the requirements of these laws are similar, each law must be treated separately when construction projects have potential to impact roadside trees. **Maryland State Code requires permit applicants to provide the Department of Permitting Services with a copy of an approved *Maryland Roadside Tree Permit* before issuing building, right-of-way, and sediment control permits when impacts to roadside trees are anticipated.**

Chapter 4

Roadside Tree Inventory Requirements

This chapter defines which trees are protected by the Montgomery County Roadside Tree Protection Law, and describes three categories of roadside trees and how each category should be inventoried and documented on plans submitted with permit applications.

A *Roadside Tree* is defined as any tree that grows all or in part within a County right-of-way, including trees with trunks that are bisected by the right-of-way property line. Inventories should include roadside trees that are growing within 50 feet of the subject property lines using the criteria listed in categories 1 through 3 below.

Category 1: Any tree that appears to have been intentionally planted within the right-of-way irrespective of trunk diameter (see Example #1 in Appendix 1). These trees are typically located adjacent to sidewalks, curbs, and gutters and are often spaced at regular distances. Use A through E below to inventory trees in this category:

A. Locate the tree trunk
B. Identify the trunk diameter in inches (measured at 4 ½ feet from the highest soil level found around the base of trunk)
C. State the common name of the tree
D. Note if the tree appears to be dead, dying or structurally unsound
E. Show the critical root zone (see p. 38-40 for more information)

Category 2: Naturally occurring trees measuring 6 inches or greater in diameter (see Example #2 in Appendix 1). These trees are normally located in a random fashion within the right-of-way. A significant percentage of trees in this category represent early successional and/or invasive tree species such as red maple, black locust, Virginia pine, red mulberry, Callery pear, or tree of heaven. Use A through E below to inventory trees in this category:

A. Locate the tree trunk
B. Identify the trunk diameter in inches (measured at 4 ½ feet from the highest soil level found around the base of trunk)
C. State the common name of the tree
D. Note if the tree appears to be dead, dying or structurally unsound
E. Show the critical root zone

Category 3: Naturally occurring trees measuring less than 6 inches in diameter (see Example #3 in Appendix 1). These are trees are typically early successional or invasive species that have developed from seed or other natural processes. Use A through C below to inventory trees in this category:

A. You do not need to locate individual trunks or critical root zones
B. Provide a note describing the general nature of any vegetation in this category (example: "small red maple saplings located here" or "small deciduous trees are naturally regenerating in this area")
C. You may delineate the location of this vegetation on the plan by means of shading or a polygon

NOTE: The Department of Permitting Services (DPS) does not recommend the exclusive use of aerial photography or street-view imagery to inventory roadside trees. Taking time to physically visit project sites is necessary to document current tree conditions and other factors that could influence decisions to preserve or remove individual trees.

Suggested Reading

Roadside tree inventory examples:

Photos of typical site conditions and corresponding plan views for all three categories of roadside trees are provided in Appendix 1 (p. 71)

Tree identification references:

George A. Petrides, Janet Wehr. 1998. *A Field Guide to Eastern Trees,* Third Edition, Expanded.
Boston, Massachusetts Houghton Mifflin Harcourt.
ISBN-13: 004-6442904551

National Audubon Society. 1980. *Audubon Society Field Guide to North American Trees: Eastern Region*, New York, New York: Knopf Doubleday Publishing Group.
ISBN-13: 9780394507606

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Chapter 5

Understanding How Construction Damages Trees

This chapter provides basic information needed to make informed decisions regarding roadside trees. This includes information about tree physiology and biology, the importance of root systems, how construction activities damage trees, and the long-term consequences of construction damage.

Managing trees in the roadside environment can be very challenging, even for tree care professionals. Annual growth changes the way that trees interact with their surroundings over time. When provided with adequate volumes of soil, water, and space, newly planted trees have relatively low potential to interact negatively with surrounding objects; however, as trees mature, the potential for negative interaction can increase dramatically. Placing new structures close to existing trees without careful planning increases the potential for property damage, and the development of conditions that can harm people and disrupt traffic.

In order to weigh the significance of these interactions, land developers must cultivate a basic understanding of tree physiology, biology, and growth patterns. They must also understand how construction activities can damage trees, and how trees typically respond to that damage.

Be aware that many roadside trees will have suffered a variety of damages that occurred prior to land development. This includes damage from vehicular collision, storm events, underground utility installation, and pruning for overhead utilities. Although permittees are not held responsible for correcting preexisting conditions, these damages can add considerable complexity to decisions to preserve or remove trees. As a result, some projects will require the involvement of a tree care professional. The challenge for land developers is to recognize when this type of involvement is warranted.

Major Components of Trees and Their Functions

The following illustration identifies major tree components that referenced in this document.

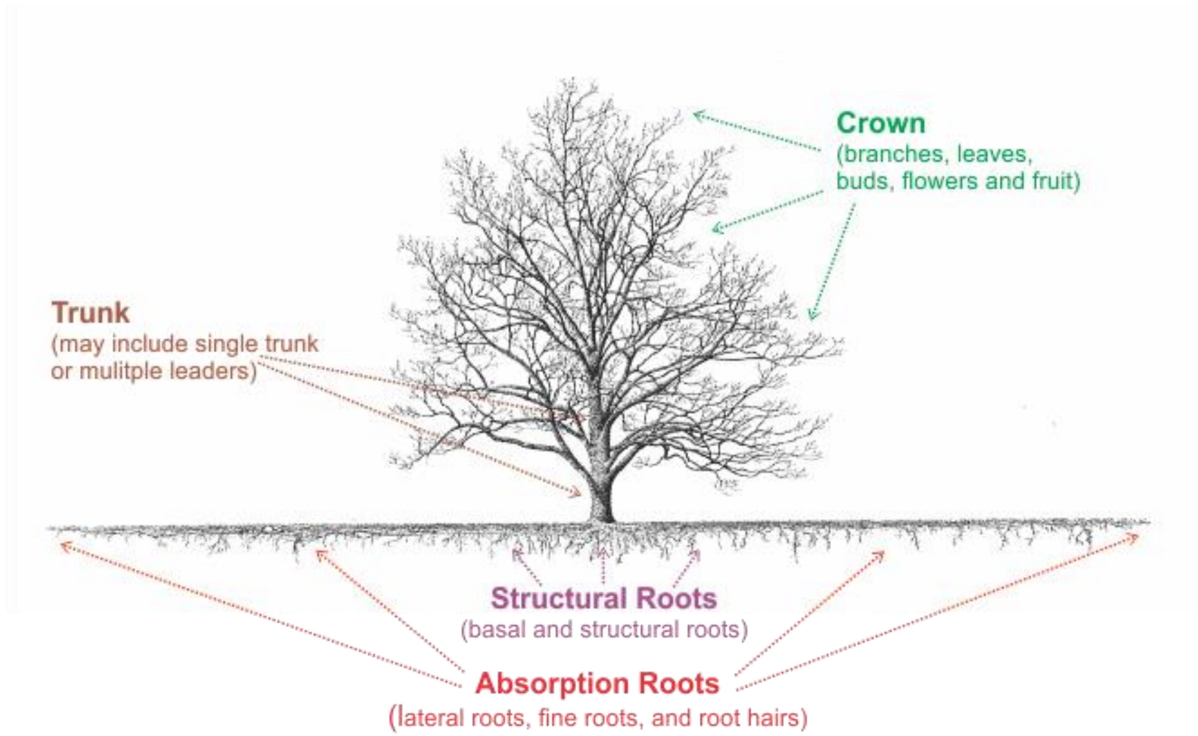


Illustration 2: *The basic physiology of a mature tree in good health and structural condition. Adapted from an illustration published by Morton Arboretum, Lisle Illinois*.

How Trees Grow

One of the central principles of tree biology is that trees must continue to grow in order to survive. Tree health and structural stability is directly related to the quality and quantity of growth that a tree manages to produce each year. Tree growth is dependent on the capacity of trees to carry on the three fundamental processes listed below:

1. **Photosynthesis**: the process of transforming light into chemical potential energy which is stored in the molecular bonds of sugar molecules

2. **Respiration**: the process of releasing stored energy in sugars to yield energy for cell division, reproduction, and other life processes

3. **Transpiration**: the process by which water is pulled from ground and transported throughout the tree. Water is essential to photosynthesis, the transportation of minerals and sugars, and continued cell function and growth

These processes are mutually dependent. Anything that acts to diminish the capacity of one process will act to reduce the capacity of the other two. As an example, the process of photosynthesis produces sugar in the crown; however, the stored energy in the sugars produce by photosynthesis cannot be released and used for growth unless respiration and transpiration occur at sufficient levels in the trunk and roots. The interdependence of these processes underscores why tree preservation efforts must adequately protect all major components of trees in order to be successful. However, from a practical standpoint, the location of roots put this component at greater levels of risk during land disturbance. As a result, the lion's share of tree preservation efforts is focused on protecting root systems.

The protective outer layer of tissue that covers most of the tree contains a thin layer of active tissue called *vascular cambium*. This tissue is responsible for cell division, and it plays a pivotal role in how trees react to physical injury and stress. Vascular cambium generates specialized cells called *xylem* and *phloem*. Xylem tissue grows towards the inside of the tree and provides structural support and acts as a conduit in the upward transportation of water and nutrients from the roots to the leaves to replace water lost during transpiration and photosynthesis. Phloem grows outward from the cambium layer and transports sugars, amino acids and hormones to the rest of the tree including the roots where sugars are stored.

Branches generally lengthen from terminal and lateral buds each year resulting in increased tree height and crown width each year. Roots grow in a similar fashion to branches but tend to retain a horizontal orientation within the top three feet of the surrounding soil. The leaves, buds, and fruit that develop towards the outer extent of branches represent ephemeral growth that occurs on a seasonal basis. In a similar fashion, the fine roots and root hairs that develop towards the outer extent of lateral roots tend to generate and die on a seasonal basis.

Roots play a critical role in the biological processes needed to sustain growth, health, and the structure of trees. They are the primary mechanism through which trees obtain the water and minerals needed to generate new cells, tissues, and phytochemicals. Root growth is dependent on continued access to soil that provides suitable levels of moisture, oxygen, and minerals. Critical biological processes can be impeded when roots are removed or damaged, or when soil conditions are altered in a manner that affects moisture, oxygen, and mineral availability. For these reasons, tree care professionals often use root and/or soil conditions to help forecast the long-term health and longevity of trees.

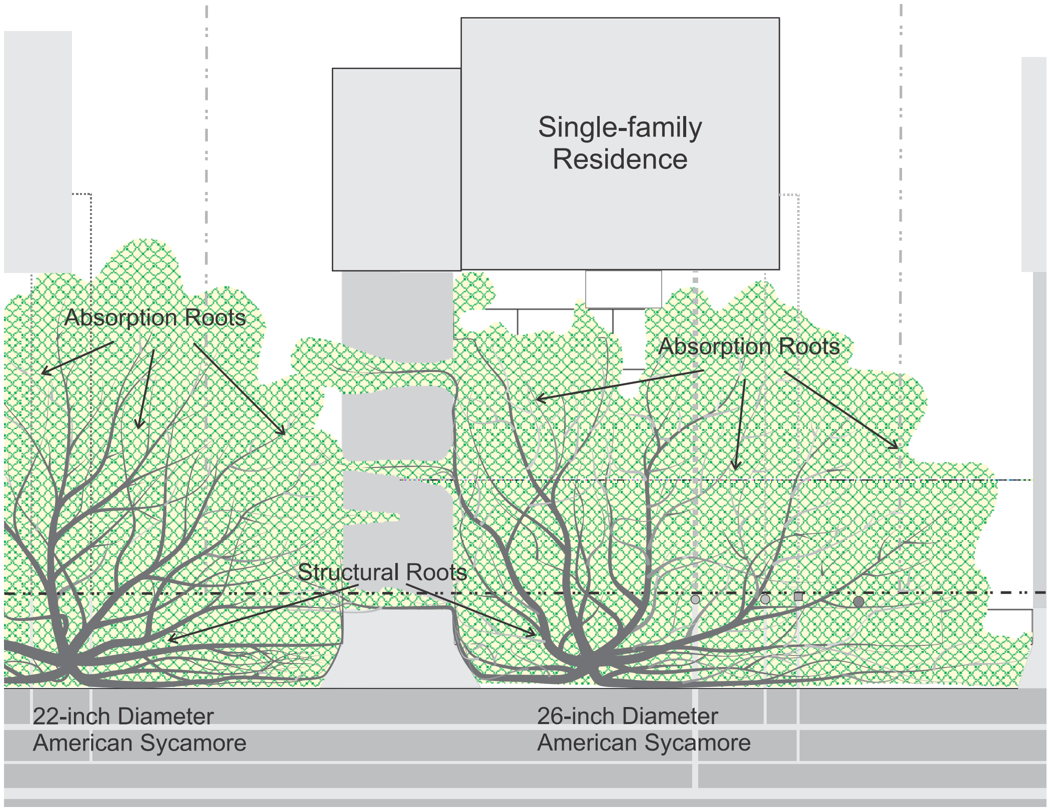


Illustration 3: *The absorption roots of mature roadside trees typically extend beyond the right-of-way and into private property where they can easily be impacted by construction activities. Tree roots do not typically develop in highly compacted soils found under streets and driveway aprons. For this reason, roadside tree roots occur in higher than normal concentrations within the right-of-way and adjacent areas such as front yards.*

How Trees Respond to Construction Damage

A wide variety of construction activities can negatively impact the health and structural condition of trees. The majority of these activities are related to soil disturbance, but other activities such as construction traffic, demolition of structures, and stockpiling of materials often damage trees as well. The impacts of construction-related damage can be categorized as direct and secondary. A single tree can experience cumulative impacts from a series of direct and secondary impacts.

Both categories of impact can affect the health and structural condition of trees; however, their effects generally take different amounts of time to become apparent. In addition, direct impacts take place within the immediate vicinity of trees. Secondary impacts can occur close to trees, but they can also result from larger scale changes to the construction site.

- *Direct impacts* are immediate products of physical damage. The initial effects of are often seen as tissue damage quickly followed by disruption of biological processes. The effects on tree health and vigor tend to become discernable shortly after the initial damage occurs. When severe, these impacts cause rapid decline or death, or set the stage for the development of secondary impacts. Examples of direct impacts include:
    - Cutting, tearing, crushing, and removal of roots
    - Hitting and damaging root flares, bark, trunks and branches

- *Secondary impacts* can be triggered by the alteration of environmental conditions on which trees have become dependent for continuation of their fundamental biological processes, or as a result of direct impacts. Secondary impacts tend to be subtle, and as result, more difficult to detect than direct impacts. Examples of these impacts include:
    - Alteration of soil properties
    - Alteration of hydrologic patterns
    - Alteration of light conditions
    - Alteration of microclimate
    - Wood decay resulting from cutting, tearing and crushing of roots and trunks

The manner in which trees respond to both categories will vary depending on factors such as the severity of the initial injury, the influence of individual genetics on longevity, health and vigor, the presence of pest organisms that take advantage of stressed trees, and weather conditions. However, one or more of the following symptoms are often observed on construction damaged trees:

- Leaves, fruit, buds, and branches grow smaller than normal during subsequent growing seasons. (Depending on species these symptoms may be isolated to the upper canopy or dispersed throughout the canopy.)

- Leaves, fruit, buds, and branches are produced in lower numbers during subsequent growing seasons. (Symptoms may occur in the upper canopy or dispersed throughout the entire canopy.)

- A significant percentage of the upper and outer canopy dies but remains connected to living tissue (This condition is often referred to as "stag heading.")

The amount of time necessary for trees to exhibit symptoms of construction impacts varies from weeks to several years. Trees that have sustained low to moderate levels of root damage may generate new roots and recover heath. However, the fight to re-establish the root/crown equilibrium can take several years or more to play out, and the outcome is never certain.

Photo 2 and 3: *These photos show die-back symptoms on mature red oaks three years after construction damage (grading and soil compaction). This symptom is often called "stag heading." Trees that decline in this manner are more prone to dropping large dead branches, especially during storms*.

Even when trees regain health and vigor, construction injuries often leave exposed wounds that can facilitate entry of wood-decaying organisms and cause loss of structural integrity. Trees struggling to maintain biological functionality are more susceptible to disease, pests, and environmental stress than healthy trees. When a large percentage of the absorption root system is removed or damaged, trees may not retain the level of resources needed to respond to the effects of pests and stress. When this occurs, trees can die within a relatively short timeframe (i.e., weeks, months) without exhibiting any of the symptoms previously described.

When the vascular cambium of roots has been damaged, the resulting wounds can allow wood-decaying organisms access to interior wood tissue. Trees that retain sufficient levels of energy can react to these invasions by establishing chemical barriers (or "walls") to contain the spread of wood-decaying organisms. This reaction is called "compartmentalization" and is described by the CODIT model developed by Dr. Alex Shigo of the USDA Forest Service. Compartmentalization can slow and contain the spread of wood-decaying organisms; however, trees under stress tend to be much more susceptible to decay than healthy trees.

Photo 4: *This photo shows the decayed roots and hollowed trunk of a large, white oak that uprooted during and fell across a busy road during heavy traffic. This tree was located a short distance from a drainage swale, trail, and parking lot which were constructed during the prior decade. The wood in the basal roots were extensively decayed and provide only minimal support. These conditions probably played a prominent role in the failure of the tree and may have originated when wood-decaying organisms entered the roots though construction-related wounds.*

When compartmentalization fails, pathogens break free of chemical barriers and penetrate unaffected tissue where they gain access to stored chemical energy and nutrients. In turn, trees can gradually lose structural integrity and their capacity to transport and release energy for biological processes. Photo 4 above shows a large tree that lost its battle with wood-decaying pathogens and underscores why it is important to minimize root wounding during construction.

Suggested Reading

Smith, Kevin, Shortle Walter.1998. *A First Look at Tree Decay. An Introduction to How Injury and Decay Affect Trees.* (Northeastern Research Station, USDA Forest Service). NA-PR-02-98 http://na.fs.fed.us/pubs/misc/decay/first_look_decay.pdf

Matheny, Nelda, and Clark, James R. Clark. 1998. *Trees and Development: A Technical Guide to Preservation of Trees During Land Development* (Champaign, IL; International Society of Arboriculture). See: Primer on Tree Biology 11-23. ISBN: 1-881956-20-2

Chapter 6

Determining if Roadside Trees Should Be Preserved or Removed

This chapter discusses issues that need to be considered when deciding to preserve or remove roadside trees, and methods used to forecast how trees will respond to construction impacts.

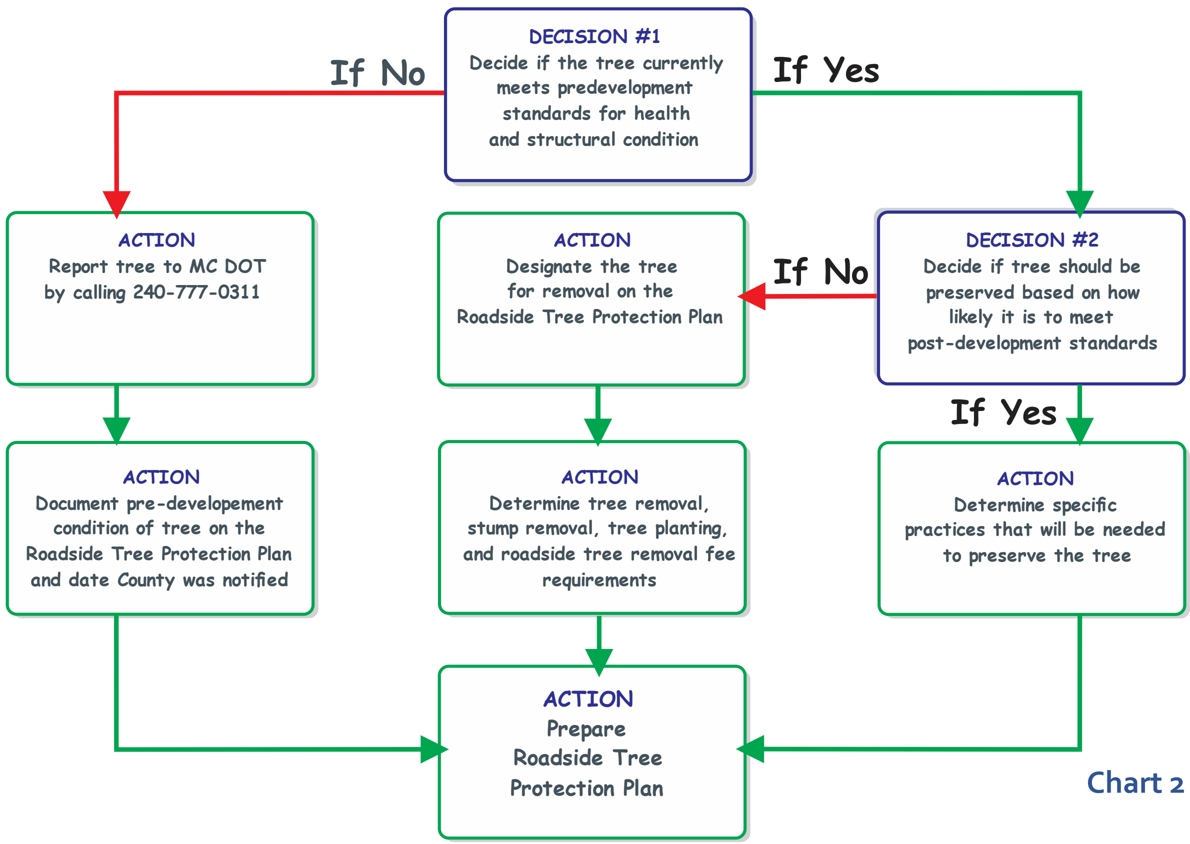


Chart 2

Decisions to preserve or remove roadside trees provide the foundation for Roadside Tree Protection Plans. Land developers should be familiar with the basic process used to guide these decisions. Chart 2 above depicts the sequence of decisions and actions that should take place in order to determine the content of roadside tree protection plans. The sequence begins with an assessment of the current health and structural condition of trees. If trees do not meet predevelopment standards for these attributes, then the process is directed towards tree replacement. If trees meet these standards, then the next step in the process is to gauge the level of impact the proposed construction will have on trees, and if those trees are likely to meet or exceed postdevelopment standards.

Predevelopment Standards for Health and Structure: Roadside trees that are being considered for preservation should meet the following criteria for health, vigor, and structural stability at time of permit application review. Trees that are good candidates for preservation should exhibit the following characteristics:

- Good health, vigor, and structural condition
- Growth rates that are similar to those of trees of the same species and age that are growing in a similar environment
- Structurally sound trunks that support strong branch attachments
- Roots that are firmly anchored in the soil, and do not girdle other roots or the main trunk

In addition, roadside trees that are proposed to be preserved should be free of the conditions listed below unless the permittee can demonstrate that, if present, such conditions can be mitigated by means of accepted arboricultural practice, and DPS agrees that such conditions will not increase the likelihood that roadside trees will not meet the postdevelopment standards listed on p. 23. These conditions include:

- Significant die-back that includes, large broken, or dead co-dominant leaders and scaffold branches
- Exaggerated leans or unbalanced crown weight
- Lightning damage, large exposed wounds, included bark, pockets of decay, cavities, and cankers
- Symptoms of disease or insect populations that are causing significant levels of defoliation, die-back, or wood decay
- Visible disorders caused by herbicides, pesticides, fertilizers, petroleum-based chemicals, or other abiotic agents
- Symptoms of nutrient deficiency or water stress due to insufficient root space, compacted soil, nutrient depleted soil, and poor drainage
- Other conditions that pose a significant threat to the health or structural condition of roots, trunks, and scaffold branches

Pre-existing Tree Conditions: Roadside trees that fail to meet standards identified above before the start of construction activities (including any utility disconnect and demolition work) should be reported to Montgomery County by calling 240-777-0311. Staff from the Montgomery County Department of Transportation (MCDOT) will evaluate such trees and decide if remedial action is necessary and the responsibility of Montgomery County.

Permittees that wish to accelerate the removal of trees and stumps that have already been evaluated and scheduled for removal by MCDOT staff have the option of carrying out such work at their own expense. In order to exercise this option, permittees must receive prior approval by DPS staff. All tree and stump removal work must be accomplished by a Maryland Licensed Tree Expert. The permittee must submit a report to DPS within one week after the work is completed. The report must be prepared by the Maryland Licensed Tree Expert and must state that the tree and stump removal work was necessary to remove a tree that was already dead, or posed a threat to people or property. In addition, the report must document the date that MCDOT evaluated and scheduled the tree/stump for removal.

NOTE: Permittees may be required to remove roadside trees that have been rendered unsafe as the result of construction activities, even when such trees have pre-exiting defects, are dead, or are in an advanced state of decline.

Postdevelopment Standards for Roadside Trees: DPS expects all trees that are designated for preservation on roadside tree protection plans will survive and meet the following standards after construction has ended. Roadside trees are expected to:

- Retain a significant degree of their predevelopment health and structural condition
- Survive at least five years after construction has taken place
- Be compatible with right-of-way infrastructure, transportation activity, and standards for public safety

Trees that are not likely to meet these standards should be proposed to be removed and replaced in Roadside Tree Protection Plans. It is important to note that if DPS determines that trees do not meet these standards by the time of final inspection, the permittee may be required to complete additional work in order to fully satisfy permit conditions.

Factors that May Be Used to Justify Preservation or Removal of Roadside Trees

One or more of the following factors may be used to justify proposals to preserve or remove roadside trees within Roadside Tree Protection Plans. An overview of each of these factors is provided below.

- Predevelopment health (p. 24)
- Predevelopment structural condition (p. 25 - 32)
- Predevelopment disease and insect activity (p. 33 - 34)

- Relative age and species life expectancy (p. 35 – 37)
- Species tolerance to construction damage (p. 37)
- Anticipated impacts to root systems (p 38 – 45)
- Anticipated changes to soil and hydrologic conditions (p. 45 - 46)
- Anticipated impacts to aboveground components (p. 46)
- Anticipated compatibility with right-of-way functionality and safety (p. 47)

The primary objective when using these factors is to predict if the severity of the last four factors (*anticipated* impacts to trees and their surroundings) is likely to prevent trees from meeting postdevelopment standards given how they are rated in the first four factors (predevelopment tree conditions and characteristic responses of the species and age group to construction).

Predevelopment Health: *Tree health* is a measure of a tree's capacity to carry on fundamental biological processes. The term *vigor* is used to describe the relative capacity of trees to survive and grow, especially after sustaining a significant injury. Tree care professionals use observable characteristics such as leaf size and color, bud size, internodal distance, crown density, branch mortality, flower production, and the presence or lack of diseases and pests as measures of health. A value (usually numerical) is assigned to these characteristics based on a comparison of other trees of the same species that are growing in a similar environment. In turn, the values are used to assign an overall health rating which is typically communicated in broad categories such as "Excellent," "Good," "Fair," "Poor," and "Dead."

Predevelopment health is a strong indicator how well trees will respond to future construction impacts. As a rule of thumb, the healthier a tree is before construction, the more likely it is to survive construction. Trees that are unhealthy prior to construction may not have the vigor to withstand heightened stress levels associated with construction impacts.

NOTE: When possible, conduct tree evaluations when foliage is green and fully developed; or if delay is not possible, hire a tree care professional to evaluate trees during dormant periods.

Questions to ask:

- How does the major physical characteristics of the tree (trunk, branches, leaves, buds, fruit, etc.) compare with those found on trees of the same species that grow nearby?
- How would you classify the overall health of the tree?
- Does the tree appear to be dead, dying, struggling, or healthy?
- Is there any reason that a tree care professional should evaluate the health of the tree?

Predevelopment Structural Condition: The terms *condition* and *health* are often used interchangeably to describe the state of trees. Although, this usage may be appropriate for casual discussion, it is important to treat these terms as two distinct areas of concern in the context of construction damage assessment. The fact that trees can appear to be very healthy, and yet contain conditions that represent serious threats to their structural integrity and stability underscores the need to understand how these terms differ.

This publication uses the term *structural condition* to describe the mechanical characteristics of trees, such as strength, flexibility, attachment, stability, and orientation. Structural condition is an important consideration in construction damage assessment because of the potential for roadside trees to cause negative impacts to public safety and/or right-of-way functionality.

As a class, roadside trees are located in manner that increases the likelihood that tree failure will result in human injuries and/or property damage. This potential heightens the need to inspect roadside trees thoroughly prior to construction for *structural defects* that represent unacceptable levels of risk; and, to evaluate the potential of these existing defects to further deteriorate once trees are subjected to construction impacts.

A structural defect (defect) is defined as any injury, growth pattern, wood decay, or other physical condition that threatens to decrease the structural strength or stability of a tree. A thorough examination of all tree components (i.e., crown, trunk, branches and roots) is required to detect and evaluate the significance of defects. Some defects will be difficult to observe and evaluate using a basic, ground-level, visual assessment. In these cases, a tree care professional may need to use advanced assessment techniques to determine their significance.

Defects located in trunks and crowns can be significant because they have potential to affect wood strength, branch attachment, and structural stability of trunks. However, some conditions, such as seams, ribs, and bulges may not represent significant defects, but rather “response growth” that trees produce to improve their structural stability in reaction to environmental stress or physical injury. Defects that are commonly found in the aboveground portions of trees include:

- Dead, dying, or broken branches
- V-shaped branch union (branches with U-shaped unions tend to be stronger than those with V-shaped unions. Included bark often forms at the bottom of the V-shape and provides a natural splitting point at the branch union)

- Included bark (bark that is embedded between a branch and parent stem or between co-dominant leaders and decreases the strength of branch and leader attachment and increases the chance that one of the branches or leaders will fail)
- Trunk defects (pruning wounds, branch stubs, lightning scars, dead and missing bark, and wounds caused by mechanical, animal, or insect injury)
- Seams and cracks (a separation of wood fibers that can increase potential for trunk and branch failure. Surface oriented cracks are usually harmless, but those that extend deeply, or completely, through the stem may indicate that excessive amounts of compression, tension, or torsion forces are being applied to that tree component. Deep cracks should be investigated by a tree care professional)
- Ribs and bulges (pronounced areas of response growth whose shape does not match adjoining sections of the trunk or branch on which they occur. They normally form in response to internal decay, wounds or cracks)
- Cankers (areas of dead or dying wood, cambium, or bark caused by disease or repeated mechanical injury)
- Leaning trees (trees that can be unstable because of uneven weight distribution. Leans can develop for multiple reasons. A *self-corrected lean* may remain stable for a long period of time, especially if the tree has developed response growth in reaction to the lean, and has redirected new branch growth in a vertical fashion. **NOTE:** Recently developed leans, and leans that are accompanied with lifting or cracking soil close to the base of the tree, or within its structural root zone (See p. 45) can indicate an imminent failure of the tree. This condition should be reported immediately by calling 240-777-0311)
- Unbalanced or asymmetric crown development (a condition that can predispose trees to failure because of unbalanced weight distribution and load. Asymmetric crown development may have resulted from utility line clearance or branch failure)
- Multiple branches (a cluster of branches that originate from the same point on a trunk or branch. This condition decreases the strength of branch attachment and may result from previous damage or pruning)
- Overextended branches (branches that have exceeded normal branch length and are more apt to failure due to increased exposure to the effects of wind, rain, snow, and ice)

Structural defects in roots can be significant because they have potential to affect wood strength, and the stability of the entire tree. These defects may, or may not, be associated with wood decay. Defects that are commonly found in roots include:

- Wounds on surface roots
- Pockets of decay in surface roots
- Cavities visible in surface roots
- Adventitious, or short-lived roots
- Girdling roots (roots with a circular and/or inward growth pattern that suppresses health and growth through damage to the lower trunk and basal flare)
- Larger than normal root flares
- Fused or flattened roots

Wood decay (decay) is the biological process by which cellulose and lignin tissue is damaged or destroyed. The starting point for decay in living trees is a wound, however, the causal agent is almost always a wood-decay fungus. This process can lead to wood strength loss, or to the development of internal voids that provide no structural support. Decay is considered to be a defect of *particular significance* because it can affect the strength, flexibility, attachment, and stability of trunks, branches, and roots. Several conditions that may be detected using basic, ground-level, visual assessment techniques are considered *definitive indicators* of decay in trees. These conditions include:

- Cavities and other voids or openings through which the interior of the tree can be viewed
- Wildlife nesting holes
- Bee hives
- Carpenter ants
- Termite emergence from internal nests
- Fungal fruiting bodies such as mushrooms, conks, or brackets

Another group of conditions that may be detected using basic ground-level assessment techniques are considered *potential indicators* of decay. These conditions include:

- Old wounds or branch stubs
- Swelling, bulges, or ridges on trunks and branches
- Cracks and seams
- Oozing fluid from bark
- Dead or loose bark
- Bark with abnormal patterns or colors
- Sunken areas of bark

Photo 5*: Girdling roots on a young Zelkova. The circular roots that wrap around the base of the trunk will eventually expand into the basal flare of the trunk and damage its outer vascular tissue. This condition can easily be corrected when the tree is planted but becomes more problematic as the tree matures.*

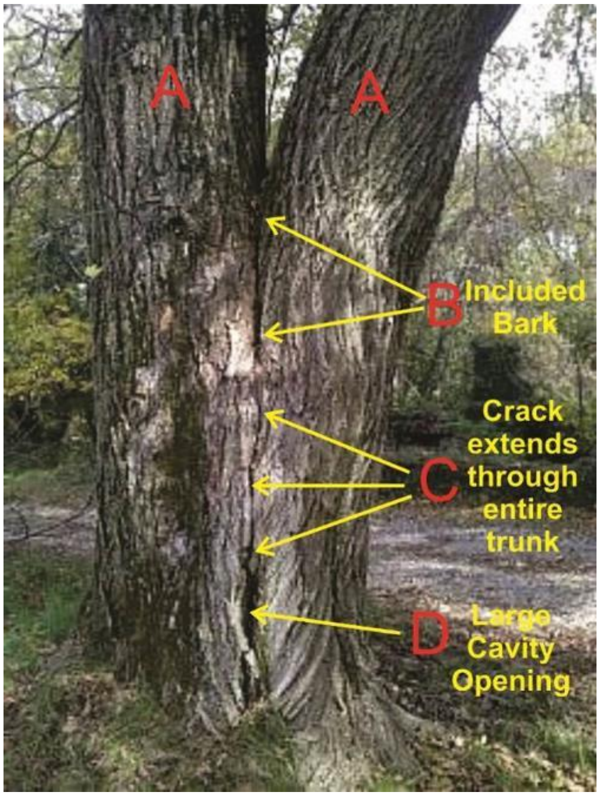


Photo 6: *An American elm with co-dominant leaders (A) that are weakly attached to the trunk. Note the location of included bark (B), crack (C) and cavity opening (D) at its base. B, C, and D represent potential indicators of internal decay and strength loss, and good examples of defects that should be evaluated by a tree care professional before deciding to preserve or remove trees.*

Photo 7: *This white oak has a large crack that extends from the soil line well into the main trunk. Note the torn wood tissue along the edges of the crack. Cracks represent serious structural defects that should be evaluated by a tree care professional as soon as possible.*

NOTE: *It may be necessary to restrict human and vehicular traffic from accessing the "hazard zone" of the tree while waiting for a tree care professional to assess the level of risk posed by the tree. The circular area of the hazard zone is defined by a radius that is equal to 1.5 times the height of the tree, plus any additional area that might be needed to account for potential non-tree hazards such as electrical lines that the tree could potentially pull down.*

Photo 7

Photo 8

Photo 7 and 8 show two sweetgums trees from opposite angles. The large basal wounds and cavities (i.e., defects) that are plainly visible in Photo 8 cannot be detected in Photo 7 are not evident unless the trees are viewed from multiple angles. Variations in light conditions, branch and leaf distribution, and distance from observer are factors that can make it difficult to detect and assess defects; therefore, it is important to evaluate trees from as many angles, distances, and heights as practical. Binoculars may be needed to observe conditions present in the mid- and upper canopy of large trees.

Photo 9: *Wounds and/or visible separation of trees roots from surrounding sidewalks, gutters, and soil may indicate movement of the structural root plate during periods of high winds and storms. This condition may also reflect the aftermath of root pruning that was carried out when a section of sidewalk or gutter was replaced.*

The full array of defects that have potential to affect tree health and structural condition is extensive and requires specialized training to recognize. Virtually all trees contain defects. The presence of one or more defect does not necessarily indicate that a tree is unhealthy or represents an unacceptable level of risk; however, defects should not be ignored. A basic set of diagnostic questions is provided below to help guide a preliminary assessment of defects and structural condition. If you are uncertain how to answer any of the following questions, you are advised to hire a tree care professional to exam the defect or condition in question.

Questions to ask:

- Does the tree appear to contain any of the conditions, defects or injuries described on p. 26-27?
- Does the tree appear to have developed new wood tissue in response to defects or injuries?
- Do any of the defects appear to weaken the stability of the tree?
- Do any of the defects appear to pose a danger to people, traffic, or surrounding property? If so, call 240-777-0311 to report the condition*.
- Does the tree appear to be firmly attached to the surrounding soil? Can you detect any heaving, cracking, or lifting of soil or large roots within the structural root zone?
- In your opinion, will the tree remain structurally sound and stable during the full range of weather conditions that typically occur at the site?
- Are there any conditions or defects that you suspect could deteriorate further as the result of proposed construction impacts?
- If this tree grew near your residence, how would you feel about it? Would you consider it an asset or liability?
- Are there any defects or conditions that should be evaluated by a tree care professional?

***Roadside trees that are suspected of containing serious defects should be reported to the MCDOT for further evaluation. You can report these trees by calling 240-777-0311.**

Suggested Reading

How to Recognize Hazardous Defects in Trees, 1996. USDA Forest Service. NA-FR-01-96
http://na.fs.fed.us/spfo/pubs/howtos/ht_haz/ht_haz.PDF

Hayes, Ed 2001. *Evaluating Tree Defects*, *Field Guide*, Second Edition.
(Champaign, IL; International Society of Arboriculture) ISBN-13: 9780971412804

Shortle, W., Dudzik,, K. 2011. Wood decay in Living and Dead Trees: A Pictorial View. USDA Forest Service. General Technical Report, NRS-97.
http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs97.pdf

Predevelopment Disease and Insect Activity: This factor is closely related to tree health and structural condition. As previously discussed, the roadside environment places trees under considerable stress. Chronic stress lowers the ability of trees to resist invasion by wood-decay fungi, bacteria, viruses and insects (pests). Consequently, it is important to examine trees for signs of existing pests, and, if present, to assess their effect on current tree health and vigor, along with their potential to affect a tree's ability to tolerate construction impacts.

Keep in mind that it is possible to find evidence of pests on virtually all trees. The presence of pests may not be significant unless their effect on tree health is apparent, or construction impacts will be severe enough to allow opportunistic pests to take advantage of stress conditions. The scenarios below track this progression, along with the relative influence of pest activity on tree survival:

- Evidence of pest activity can be found but is isolated to one or two locations on the tree. The tree appears to be tolerating the pest and exhibits little or no decline in health. Although possible in cases involving severe impacts, pests are not likely to play a significant role in tree decline. If identified as "to be preserved," a roadside tree that exhibits this level of pest activity does not need to be targeted for pest management practices.

- Pest activity is visible in several areas of the tree, but the effect of this activity on tree health does not appear to be significant. Because pests are present and active, they have potential to take advantage of declining health that may result from construction activities. If identified "to be preserved," a roadside tree exhibiting this level of activity may need to be targeted for pest management practices.

- Pest activity is widespread, and the health of the tree is visibly affected as a result of that activity. A roadside tree that is declining in health as a result of pests is not likely to be a good candidate for preservation. However, it may be possible to treat the pest. If identified "to be preserved," any roadside tree exhibiting this level of pest activity <u>must</u> be targeted for pest management practices.

Invasion by wood-decay fungi is a particular concern during land development because this category of fungi gains access to the interior of trees through the type of bark and root wounding that is associated with excavation, tunneling, and grading activities. The decay associated with these organisms can lead to loss of strength in structural roots and trunks, and, in turn, can contribute to the failure of the entire tree.

Photo 10: *Evidence of "shoestring" root rot can often be found under dead bark along the edges of basal root flares and along the soil line of infected trees. The shoestring-like structure (hyphae) shown being held are a part of the fungal body. This species often produces clusters of golden-colored mushrooms in the late summer or autumn. The mushrooms tend to be more abundant during moist periods. This fungus attacks trees that are under stress, and if detected, should be examined by a tree care professional*.

It is beyond the scope of this publication to provide comprehensive information on the diseases and insects that can affect tree health and structural condition. Fortunately, a wealth of information on these subjects is available from tree care professionals, local extension service agents, and the USDA Forest Service. Some of these resources are listed below.

Suggested Reading

Sinclair, Wayne A., Lyon, Howard H., and Johnston, Warren T. 1987-07. *Diseases of Trees and Shrubs* - Second Edition., Cornell University Press. ISBN-13: 9780801415173

Sinclair, Wayne A., Lyon, Howard H. 1991. *Insects That Feed on Trees and Shrubs*. Second Revised Edition. Cornell University Press. ISBN-13: 9780801426025

"Diseases-Trees," © 2016. University of Maryland Extension, College of Agriculture and Natural Resources. https://extension.umd.edu/hgic/trees-shrubs/diseases-trees

Relative Age and Species Life Expectancy: The following temporal aspects of trees should be considered when deciding to preserve or to remove roadside trees:

- The relative age of trees
- The average life span of the species
- The “service life” of roadside trees that serve as street trees in urbanized areas
- The potential of construction impacts to reduce the life expectancy of roadside trees

Approximating age is very useful when estimating how long roadside trees are likely to retain their current level of health and vigor, how they are likely to react construction stress, and how long they are likely to live after construction activities take place. Tree care professionals do not typically attempt to identify an exact age when assessing construction impacts. Instead, a relative category of age is assign to trees that generally describes how their current age compares to the average life span for their species. Young,” “mature,” and “overmature” are terms commonly used for this purpose as follows:

- Young: Beginning stages marked by rapid growth. Trees in this category devote most of their resources towards building tissue that supports vertical crown and root expansion.
- Mature: Trees in this category produce regular growth, but have reached most of their potential for height and spread. In addition to measured amounts of growth, this group devotes considerable resources towards the production of flowers, fruit, and seeds.
- Overmature: Trees in this group are approaching their maximum potential for age. They are still capable of producing new growth, but at a much reduced rate. The capacity to supply adequate levels of carbohydrates, water, and nutrients is often compromised in this group. Consequently, they are more likely to exhibit visible signs of decline, stress, and disease.

The following attributes generally apply to these age categories:

- Young trees can tolerate higher levels of construction impacts than older trees.
- Young trees tend to tolerate environmental changes better than mature and overmature trees.
- Mature and overmature trees tend to require larger areas of undisturbed soil and root system.
- Mature and overmature trees tend to require more stringent tree protection measures and more frequent monitoring than younger trees.
- Relatively small changes to surrounding environmental conditions can trigger a decline in the health and condition of overmature trees.
- Mature and overmature trees are more likely to have developed significant structural

defects than younger trees.

- Risk levels tends to increase as trees age. Older trees require higher levels of scrutiny to ensure that they will not develop into public safety concerns during and after construction.

Life spans of tree species vary significantly. Some species may live several hundred years, while others, especially those that dominate early successional forest communities may live only three or four decades. These variations reflect different “life strategies” that act to ensure survival of the species over time. The following examples demonstrate life span variation between four commonly found roadside tree species:

- Green ash - maximum life span of 175 years, and an average life span of 120 years
- Pin oak - maximum life span of 150 years, and an average lifespan of 100 years
- Red maple - maximum life span of 300 years, and an average lifespan of 130 years
- White oak - maximum life span of 460 years, and an average lifespan of 300 years

The maximum life span of tree species is largely determined by genes that influence the life strategies of species; however, environment plays a role in how long individual trees will live within that span. The vast majority of trees do not reach their potential for age, size, and vigor due to limitations imposed by external conditions and events.

The majority of tree species that grow in County rights-of-ways are relatively long-lived and have well-adapted life strategies to overcome the effects of disease, insects, and mechanical wounding. However, the roadside environment presents multiple challenges to these strategies. Consequently, the life span of most roadside trees, especially those planted as street trees, is considerably shorter than the average for the species. When assessing naturally occurring roadside trees that are growing in open/rural settings, use the average life span for the tree species as a reference.

The life span of street trees planted in urban/suburban settings has been described as “service life.” Service life equates to the typical length of time that occurs between tree planting and tree removal. The average service life for roadside trees planted along residential streets is estimated at 50 to 60 years. It may be even less for street trees planted in commercial business districts that provide very small planting spaces with limited soil volume.

Questions to ask:

- What is the estimated age of the tree?
- Where does the estimated age generally fall within the average life span for the species, or the service life if the tree is a street tree?
- Would you classify the tree as young, mature, or overmature?
- How does the tree's environment affect its life expectancy? Is the environment stressful, tree-friendly, or somewhere in between?
- How well does the species tolerate construction?
- Are construction impacts likely to reduce the life expectancy of the tree?
- How likely is the tree to survive five years or more after construction?

Suggested Reading

"Average and Maximum Lifespan of Virginia Trees" © 2012. Virginia Polytechnic Institute and State University. http://bigtree.cnre.vt.edu/TreeAge.htm

Species Tolerance to Construction Damage: Individual trees tend to react to construction damage in a similar fashion as their species. This allows individual trees to be rated for construction tolerance based on how the species typically reacts. Tolerance ratings can be used in combination with age categories to refine estimates of critical root zone size and location. Appendix 2 (p. 75) identifies the construction damage tolerance of most tree species found in County rights-of-ways. Keep in mind that these ratings are relative. A high tolerance rating does not indicate that the species is immune to construction damage, but that individuals within that species tend to survive higher levels of damage than species rated medium or poor.

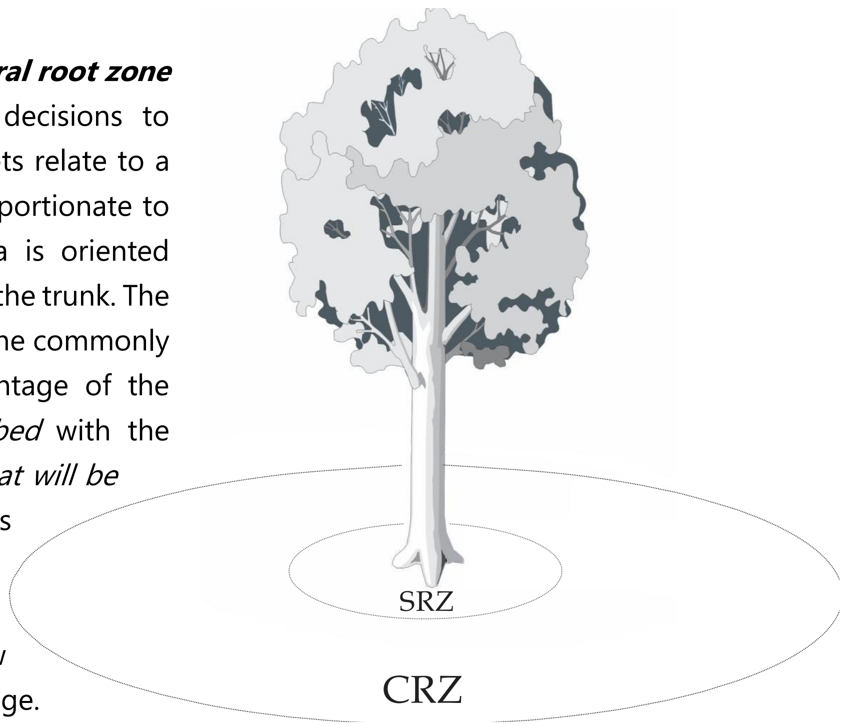
Questions to ask:

- What percent of the critical root zone is likely to be impacted by construction, and how well does this species typically tolerate that level of damage?
- Does the construction tolerance rating indicate the tree can be preserved, or should be removed?
- Does the construction tolerance rating indicate a need to adjust the size of the critical root zone?

Anticipated Impacts to Root Systems: Since roots are the primary tree component damaged by construction, decisions to preserve or remove trees are often centered around the magnitude of root system impact that is anticipated to occur. The following plan elements can be used to gauge the magnitude of root system impact that is likely to occur.

- **Critical root zone**
- **Structural root zone**
- **Limit of disturbance**

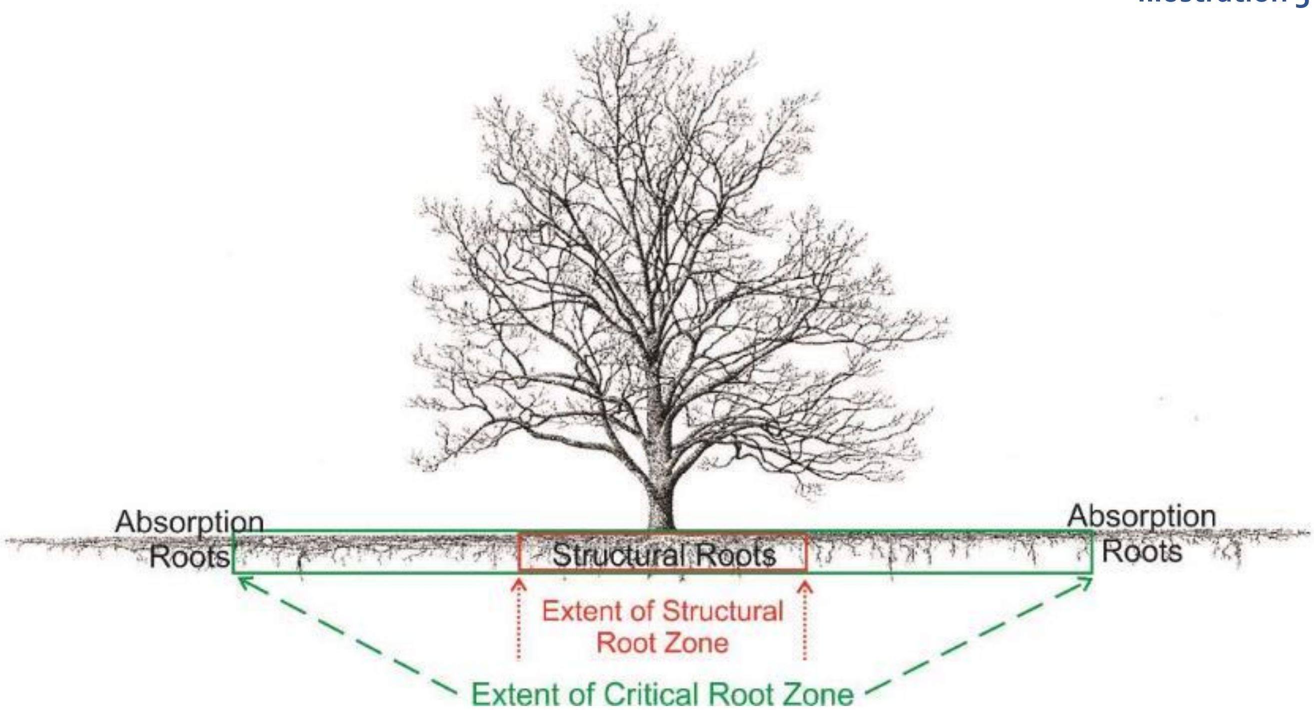
Illustration 4



The ***critical root* zone** and ***structural root zone*** are key concepts that are used in decisions to preserve or remove trees. Both concepts relate to a circular area of root system that is proportionate to trunk diameter size. The circular area is oriented horizontally and radiates outward from the trunk. The critical root zone concept is central to the commonly used method of weighing the percentage of the critical root zone *that will be disturbed* with the percentage of the critical root zone *that will be left undisturbed.* This relationship has been described in shorthand as "*% of CRZ impact*." Tree care professionals use this method to quickly gauge how trees will respond to construction damage. In addition, this chapter describes the use of the "structural root zone" formula (p. 45) to delineate the minimal area of roots that need to be protected in order to ensure structural stability of the entire tree.

The ***limit of disturbance*** is a graphical element that is required on various plans to depict the boundary between areas that will be disturbed, and areas that will be left undisturbed by construction. This feature can be used in combination with critical and structural root zones to gauge the level of impact that soil disturbance will have on the root systems of individual trees. All three of these features are required on Roadside Tree Protection Plans

Illustration 5

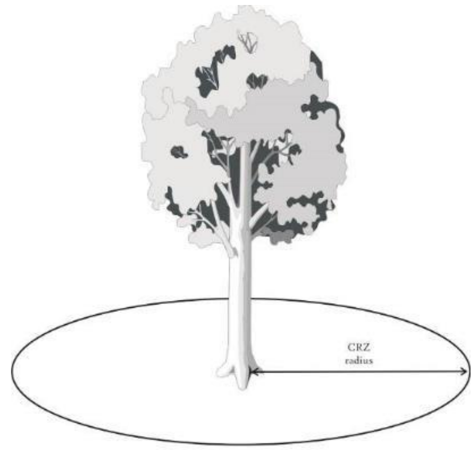


The Importance of the Critical Root Zone: As previously discussed, this concept is used to project the area of soil that contains the structural, lateral, and absorption roots that must be protected in order for trees to sustain critical biological functions and survive construction impacts. The outer edge of the critical root zone circle coincides with the location of smaller diameter roots that absorb water and nutrients from the soil. Absorption roots are fine, non-woody and short-lived roots that fan out from lateral roots. The outer tissues of these roots are often inhabited by beneficial microorganisms that greatly increase a tree's capacity to absorb nutrients and water.

Absorption root health and function is dependent on continuation of the soil conditions that the tree originally developed in. For this reason, the critical root zone area represents both the minimal area of undisturbed *soil* needed to protect conditions that favor healthy and functional roots, and the minimal amount of *absorption roots* needed to ensure tree survival. Absorption roots are more likely to develop in soils with low to moderate compaction rates than in those that are highly compacted. Conditions that support the uptake of adequate macro- and micronutrient levels are associated with favorable soil pH, moderate moisture levels, and the exchange of oxygen and other gases between roots and soil.

How to Identify Critical Root Zones. Tree care professionals use a basic formula to calculate the area of the critical root zone. Although variable factors may be used in the formula, the "zone" it identifies is always circular and radiates outward from the trunk. The outer edge of the circle typically extends well beyond the "dripline" of the tree's canopy. The formula is applied in the following manner:

1. Start by measuring trunk diameter at 4 ½ feet above the soil line
2. Multiply the diameter in inches by a factor of 1.5
3. The resulting number is equal to the radius (in feet) that is used to define the circular area surrounding the tree that should be left undisturbed



Critical Root Zone Formula
=
for each inch of trunk diameter
(measured @ 4.5 feet from soil)
provide
1.5 feet of Critical Root Zone radius

Illustration 6

Example:

Tree trunk diameter measured @ 4 1/2 feet = 12 inches

12 x 1.5 = 18

18 feet = size of radius used to define circular critical root zone

Application and Limitation of the Critical Root Zone Concept: Up this point in the publication, the "critical root zone" concept has been applied in two contexts, which were (1) determining applicability of the Roadside Tree Protection Law, and (2) depicting roadside trees graphically on plans. In both of these applications the critical root zone formula is set by County Code. In this chapter, the critical root zone concept is discussed as a tool that can be modified based on tree and site conditions, and used to help determine how roadside trees will be treated in Roadside Tree Protection Plans.

Estimating % of CRZ impact is the primary method used to predict how trees will react to construction impacts (i.e., a construction impact assessment), and by extension, if they should be preserved or removed when impacted by construction. This methodology is popular with tree care professionals because it is easy to use, easy to communicate to clients, can be applied quickly to a large number of trees, and is reasonably accurate. Despite its widespread use, it is important to recognize that the underlying concept of the critical root zone does not take into account other important factors that influence tree biology. Consequently, predictions that are based solely on this method should not be regarded as absolutely conclusive. When high levels of accuracy are required, tree care professionals refine construction impact assessments by considering additional factors such as those listed below.

Adjusting the size of the Critical Root Zone: Table 1 below identifies a range of radius lengths (column 3) that have been adjusted for species tolerance to construction (column 1), and relative tree age (column 2). The following subheadings provide an overview of several factors that can be used to adjust the size of critical root zones.

Species Tolerance to Construction Damage (see Appendix 2)	Relative Tree Age (See age definitions on p. 35 and 36	Length of the critical root zone radius (feet per inch of trunk diameter measured at 4.5 feet from soil line)
High	Young	0.50
	Mature	0.75
	Overmature	1.00
Medium	Young	0.75
	Mature	1.00
	Overmature	1.25
Low	Young	1.00
	Mature	1.25
	Overmature	1.50

Table 1. *The information provided in this table may be used to justify refinement of the critical root zone area. Note: The critical root zone formula used to determine the need to submit Roadside Tree Protection Plans must remain as it was set by law and is based on 1.5 feet of critical root zone radius for every inch of tree diameter at 4 ½ feet from the soil line.*

Adjusting for Construction Tolerance: Tree care professionals take this factor into account by adjusting the size of the critical root zone downward for species that exhibit "good" to "good/moderate" tolerance, and upwards for species that exhibit "moderate/poor" to "poor" tolerance. These adjustments are typically applied in conjunction with adjustments for tree age. Appendix 2 contains a list of tree species that occur in Montgomery County and categorizes their tolerance to construction in the gradients described above.

Adjusting for Tree Age: Young trees tend to tolerate greater levels of impact than mature and overmature trees. Tree care professionals take tree age into account by adjusting the size of the critical root zone downward for younger trees and upward for older trees. Table 1 was adopted from guidelines for determining tree protection zones (*i.e.,* critical root zones) provided in "*Best Management Practices: Managing Trees During Construction.*" Kelby Fite and E Thomas Smiley. Companion publication for ANSI A300 Part 5: Management of Trees and

Shrubs during Site Development and Construction. International Society of Arboriculture. ISBN: 1-881956-67-9.

Excluding Areas that Lack Roots: When estimating the critical root zone, it is important to examine the site for existing features that inhibit root development. These features typically include streets, parking lots, concrete driveways, and building foundations. Including areas that are physically blocked or inhibited by such features in critical root zones will likely result in overestimating the size of the zone, and conversely, underestimating the percentage of the zone that will be impacted by construction.

The majority of features that should be excluded from critical root zones are paved. The capacity of a paved surface to inhibit root development is linked to its thickness, and the compaction rate required for its subbase materials. Although, roots can be found growing along the expansion joints and cracks of paved surfaces, they do not penetrate or function in highly compacted soils with a bulk density higher than 1.6 g/cm3 (see illustration 7 on p. 43). Building foundations and walls also act to inhibit root development and should be treated the same as the paved surfaces described above.

It is important to note that relatively thin, load-bearing pavements that require lower subgrade compaction such as sidewalks, asphalt paths, patios, asphalt driveways, and similar surfaces may actually encourage root development, especially where surrounding soil moisture levels tend to be low. Fine absorption roots, larger scaffold roots, and lateral roots will grow and easily pass underneath theses surfaces. These types of areas should be included within the critical root zone (see photo 11 on p. 44).

NOTE: Although the adjustments identified above are useful when deciding to remove or preserve roadside trees, the critical root zone formula that is used to determine the applicability of the Roadside Tree Protection Law (see Chapter 3, p. 9 and 10) is set by County Code, and is not negotiable. That formula must remain based on 1.5 feet of critical root zone radius for every inch of tree diameter measured at 4 ½ from the soil line.

Assessing Construction Impacts after Critical Root Zone Adjustments: There are no quantitative methods to compute when trees have reach a critical level of root damage. However, as a general rule, roadside trees that have 30 percent or more of their *adjusted* critical root zone damaged have significantly less chance of meeting postdevelopment standards (see p.23) than those that sustain lower levels of damage. Again for reasons already stated, the % of CRZ impact method should not be treated as a be-all and end-all, but as an important starting point for further investigation and analysis.

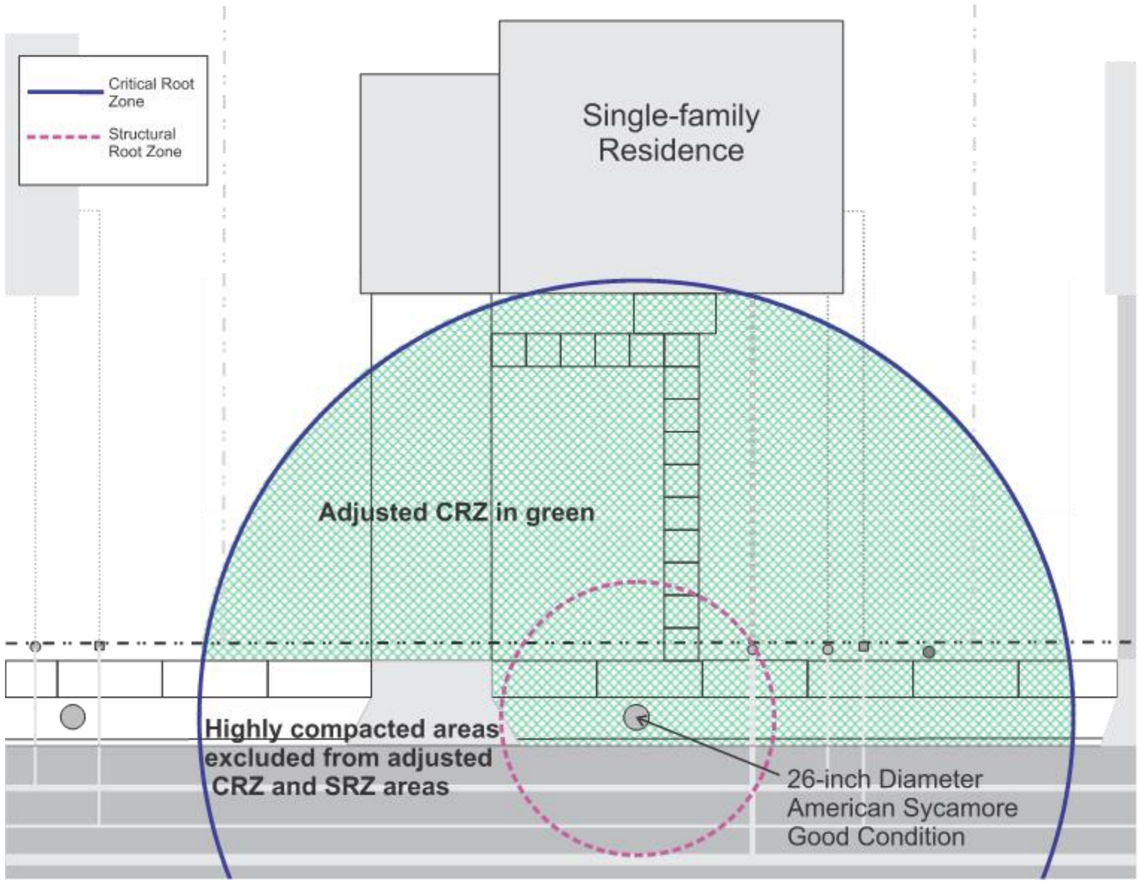


Illustration 7: *It may be necessary to adjust the critical root zone so it excludes surfaces or structures built on highly compacted subbase materials installed 12 inches or more into the soil profile. In this example, the area of the street and driveway apron has been subtracted from the critical root zone along with a small section of the right-of-way to the left of the driveway apron. The green area represents the "adjusted" the area of the critical root zone, which is approximately 45% of the total theoretical critical root zone.*

Photo 11: *This photo shows the density of roots that can occur underneath sidewalks in the roadside environment. These roots were exposed by means of a supersonic air spade immediately after several sections of concrete sidewalk were removed.*

Suggested Reading

Fite, Kelby and Smiley, Thomas E. 2008. *Best Management Practices: Managing Trees During Construction. Companion publication for ANSI A300 Part 5: Management of Trees and Shrubs during Site Development and Construction*. (Champaign, IL; International Society of Arboriculture) See "Defining the Tree Protection Zone," 11-14. ISBN: 1-8811956-67-9

Matheny, Nelda, and Clark, James R. Clark. 1998. *Trees and Development: A Technical Guide to Preservation of Trees During Land Development* (Champaign, IL; International Society of Arboriculture). See: "Identifying a Tree Protection Zone" 72-75. ISBN: 1-881956-20-2

The Structural Root Zone: The structural root zone (a.k.a., "zone of rapid taper," "structural root plate", and SRZ) contains the larger diameter roots that radiate outward from the basal flare of the tree trunk. This zone includes the basal, scaffold, and large lateral roots. Structural roots act as a conduit in the transportation of water, nutrients, and hormones to the crown and, conversely, in the transportation of carbohydrates and phytochemicals to the root system. Structural roots also anchor and support aboveground components. It is especially important to protect structural roots from trenching, root pruning, boring, and soil cutting activities.

How to Identify Structural Root Zones: Tree care professionals use a formula that is similar to that used to identify critical root zones to identify the area of structural roots that should be left undisturbed. The structural root zone formula is applied in the following manner:

1. Start by measuring the trunk diameter at 4 ½ feet above the soil line
2. Multiply that diameter in inches by a factor of .5
3. The resulting number is equal to the size of a radius (in feet) that is used to define the circular area of structural roots

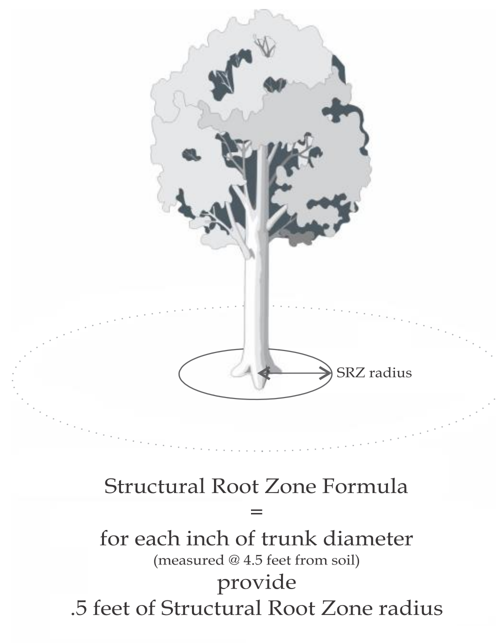


Illustration 8

Example:

Tree trunk diameter measured @ 4 1/2 feet = 12 inches

12 x .5 = 6

6 feet = size of radius used to define circular structural root zone

Anticipated Changes to Soil and Hydrologic Conditions: As previous described, trees are highly dependent on a seasonal supply of water and nutrients from the surrounding` soil for continued growth. Soil structure, composition, pH, and moisture holding capacity influence the ability of trees to carry on respiration and transpiration processes. The growth rate and health of trees can be negatively affected when soil and hydrologic conditions are altered through construction.

The primary manner that construction impacts soil is through increased compaction. High compaction rates are associated with reduced soil oxygen levels and restricted water movement. Both of these substances are integral to the biological processes that control energy production and use. Compaction decreases the number and size of the pores that exist between soil particles. When this occurs oxygen becomes less available for photosynthesis and gas exchange that occurs during root respiration.

Soil saturation may result when alterations to topography divert water into the critical root zone at increased levels, or when the soil within the zone is compacted in a manner that prohibits percolation and/or lateral movement of water through soil. Although it may seem paradoxical, trees often have difficulty extracting moisture and nutrients from saturated soil. Reverse osmosis may occur when soil is oversaturated, and can cause desiccation. Saturated soil can also encourage the growth of organisms that cause decay in roots and trunks. When present, these organisms may enter into xylem and phloem tissues through root wounds.

Questions to ask:

- Will grading or changes to topography result in higher compaction rates within critical root zones?
- How will proposed grade changes influence existing drainage patterns? Are such changes likely to increase, or decrease the availability of soil moisture?
- What are the moisture requirements for the species?

Anticipated Impacts to Aboveground Components: Roadside Tree Protection Plans should address how trunk flares, trunks, and branches of roadside trees will be protected. In addition to assessing impacts to root systems, aboveground components should also be assessed. Construction traffic, staging, and stockpiling of materials are activities that often inflict mechanical wounds to aboveground components. If these types of impacts are likely to occur, then an attempt should be made to relocate, resize, or eliminate the feature(s) causing the impact. If adjustments are not feasible, then mitigation practices such as “trunk armoring,” or pruning should be considered.

Photo 12: *This photograph shows the effect of hitting a tree trunk with construction equipment several years after the initial injury. Mechanical injuries may take a year or more to become visible. The resulting wounds expose internal wood tissue to invasion by wood-decaying organisms. The presence of wood decay can eventually lead to a loss of structural integrity at the site of the wound and beyond.*

Anticipated Compatibility with Right-of-Way Functionality and Safety: Roadside trees that are preserved along roads and streets should complement the functionality and safety of County rights-of-ways. In order to minimize potential conflicts, land developers should consider the potential for existing roadside trees to cause negative impacts to proposed transportation infrastructure if they are preserved.

Questions to ask:

- What are the mature dimensions and growth habits of the tree species?
- What are the fruiting habits of the species and could its fruit cause unsafe conditions along streets and roads?
- Does the species produce low-hanging branches that could impede pedestrian traffic or create sight-distance problems?
- What is the potential for the tree to cause conflicts with traffic?
- Can the location of proposes features (e.g., proposed buildings, driveways, stormwater practices) be adjusted to facilitate preservation of the tree?

Chapter 7

Minimizing Construction Impacts

This chapter describes practices that can be used to minimize physical impacts to roadside trees to increase their survival chance, and describes methods that can be used to ensure that Roadside Tree Protection Plans are prepared efficiently and effectively.

The key to minimizing roadside tree damage is simple: keep construction outside of the critical root zone. In practice, this is easier said than done. Land developers must juggle roadside trees with site-specific constraints and their client's needs. Fortunately, there are several practices that can be used to minimize, and, in some cases, avoid construction impacts. The following information describes practices that have proved useful to a wide range of construction projects.

Incorporate Roadside Trees into Planning and Design Efforts: Examining roadside trees requirements as early as possible in project planning and design stages is critical. Waiting to look at tree preservation opportunities until after the design has been finalized limits site layout flexibility and options to mitigate construction impacts.

Minimize Soil Disturbance: Always take time to examine if proposed site layouts can be "tweaked" to minimize the level of soil disturbance that will occur within critical root zones. This includes looking for opportunities to shift the location of grading and excavation activities, stormwater infrastructure, underground utilities, proposed buildings, and driveways. These types of adjustments do not always need to be large in order to prove beneficial. In some cases, reducing critical root zone impacts as little as five percent may significantly increase the chance of tree survival.

Keep Constructability in Mind: Although this practice may seem counter intuitive to the concept of minimizing on-site disturbance, land developers should take steps to ensure that soil disturbance is realistically sized to facilitate construction. An area of disturbance that has been adequately sized for construction is more likely to be honored over the entire project timeline than one that needs to be resized to gain additional space.

Use caution when placing sediment control devices: Keep in mind that absorption roots tend to located in the top 12 to 18 inches of soil, and structural roots in the top 36 inches. Sediment control devices that require trenching can damage and sever roots of all sizes. Trenching within the structural root zone is of special concern because of the potential to cut or damage larger roots that anchor trees to the surrounding soil. Place sediment control devices as far away from critical and structural root zone as possible. Where appropriate, consider using alternative devices that do not require trenching.

NOTE: Do not place silt fence or super silt fence at property lines unless it is needed to control movement of sediment off the property!

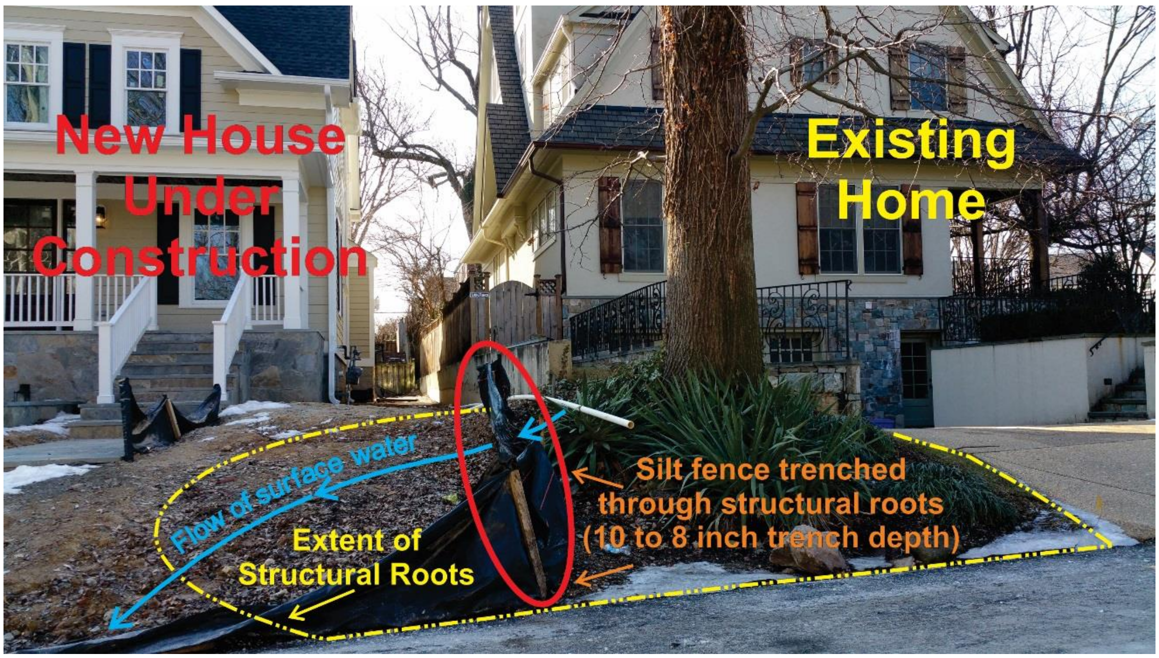


Photo 13: *This photograph shows a section of silt control fence (circled in red) that is not controlling silt from the construction site and has probably damaged roots in the critical and structural root zone when it was installed. The practice of installing silt controls arbitrarily at property lines can result in extensive and unnecessary damage to roadside trees.*

Minimize Trenching: Trenching for underground utilities can cause considerable damage to absorption and structural roots. Where feasible, directional boring should be used so that utilities paths can be routed beneath root systems. This practice can minimize the level of root loss and damage that is typically associated with utility installation. For more information, see the “Minimum Distances for Boring Under Tree Roots” technical detail on p. 83.

Avoid Soil Compaction: Managing storage and construction traffic on small construction sites is often difficult. Although these temporary activities may not directly destroy or remove roots, they can adversely affect root functionality by squeezing oxygen out of the upper soil profile. Several practices can be used to mitigate soil compaction associated with temporary uses. See the "Temporary Soil and Root Protection Practices" technical detail on p. 84 for more information. These practices should be described in detail on Roadside Tree Protection Plans. **NOTE:** Compaction mitigation must not conflict with the functionality of sediment control practices.

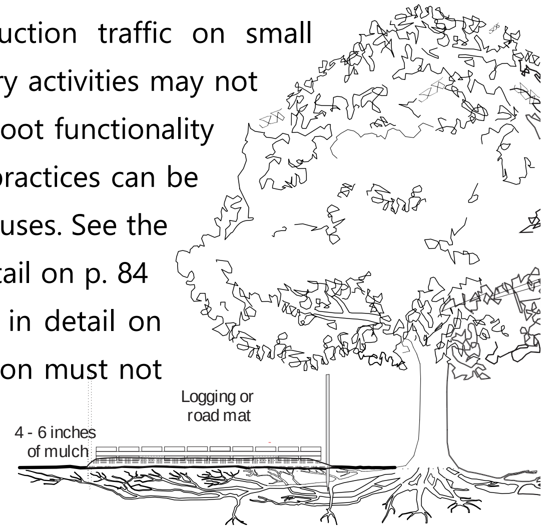
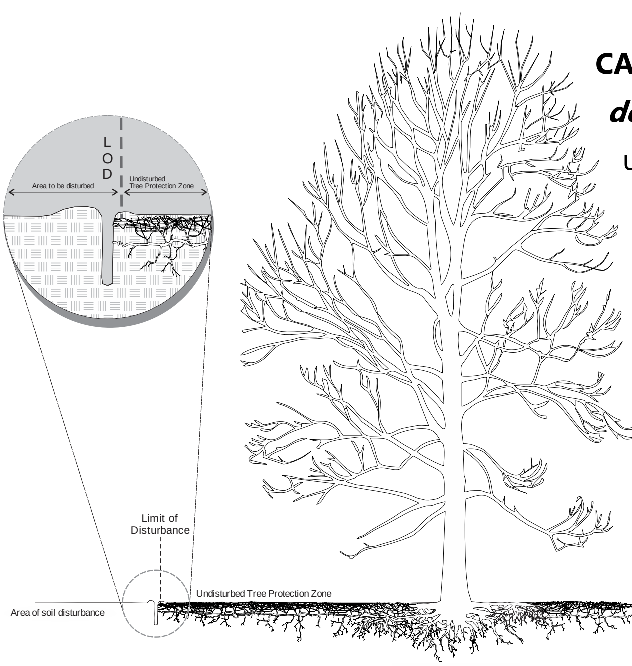


Illustration 9

Use Retaining Walls: Grading and addition of soil is often used to direct surface drainage away from new buildings. These activities often must occur in areas that overlap with the critical root zones of roadside trees. Retaining walls can be used to minimize the area of grading needed to tie into existing topography. When located properly, this practice can eliminate or decrease the area of soil disturbance that must occur within critical root zones.

Use Root Pruning where appropriate. Root pruning is a widespread practice used to sever roots in a "clean" fashion. This practice limits the amount of interior wood tissue that is exposed to wood-decaying organisms when roots are severed.



CAUTION! ***Cutting structural roots can destabilize trees.*** Root pruning should not be used within the structural root zone of roadside trees without prior approval from DPS. See "Root Pruning and Structural Root Zone Formula" technical detail on p. 79 for more information.

Illustration 10

Water Trees Before and After the Start of Construction: Roadside trees must have adequate water to remain healthy. A mature tree can lose several hundred gallons of water through its foliage on hot, dry days. The majority of water that enters through the root system is lost to evaporation in the crown, but the tree retains about 10% of the water that it absorbs for photosynthesis and other processes that maintain health and growth.

Absorption root loss and soil compaction can significantly reduce the amount of water that was previously available to roadside trees before construction. This condition may place trees under considerable stress and can trigger decline or death if not addressed. Two practices are recommended:

- Irrigation prior to soil disturbance. This practice is highly recommended if construction will begin during hot, dry periods. Water roadside trees overnight within the critical root zone one week prior to any soil disturbance on the construction site (this includes utility disconnections and demolition activities). Then repeat overnight irrigation again, one or two days prior to soil disturbance.

- Supplemental irrigation during and after soil disturbance. This practice is recommended during hot, dry periods. Water should be applied heavily within the critical root zone at weekly intervals.

Use of soaker hoses is recommended to minimize water loss from evaporation. Placing soaker hoses within the critical root zone overnight will usually provide sufficient irrigation for both the practices listed above. Where feasible, apply two to four inches of shredded wood mulch within the critical root zone to help retain moisture, and to moderate soil temperature between irrigations,

Business Practices that Facilitate Approval of Roadside Tree Protection Plans

In addition to using design and on-site practices to minimize construction impacts to roadside trees, land developers should consider implementing the following business practices to help ensure that Roadside Tree Protection Plans are approved in a timely and efficient manner.

Hire a Tree Care Professional: Although Maryland LTE inspections can introduce additional expense to projects, their services have potential to offset resources that might otherwise be needed to address permit application deficiencies or to correct on-site violations to the County Roadside Tree Protection Law. When hiring a Maryland LTE, it is advisable to select an individual or a company that has previous experience assessing potential construction impacts, monitoring and protecting trees during construction, and assessing tree health and structural condition after construction has occurred.

In addition to being a Maryland LTE, many tree care professionals have earned professional certifications and qualifications that add depth their knowledge of tree preservation and planting practices:

- **Certified Arborist** (administered by International Society of Arboriculture)

- **Tree Risk Assessment Qualification** (administered by International Society of Arboriculture)

- **Registered Consulting Arborist** (administered by the American Society of Consulting Arborists)

Make Sure that Roadside Tree Requirements Have Been Addressed in All Permit Applications: Delays can be introduced into the land development process when roadside tree requirements have not been addressed within certain permit applications. These requirements are frequently overlooked in sediment control and building permits applications. Land developers should take steps to ensure that roadside tree requirements have been addressed in demolition, right-of-way, sediment control and building permits.

Communicate Roadside Tree Protection Plans with Clients: Discuss roadside tree issues with clients as early as possible in the development process so they have a thorough understanding of County and State requirements and what their obligations will be once permits are issued. Be sure to disclose any roadside tree removal fees that are due to DPS. These type of discussions can help expedite the time that is takes to issue of permits, and may help your clients save time and money during the active construction phases of their project and again at final release of the permit.

Suggested Reading

Matheny, Nelda, and Clark, James R. Clark. 1998. *Trees and Development: A Technical Guide to Preservation of Trees During Land Development* (Champaign, IL; International Society of Arboriculture). See: *Minimizing Impacts and Preparing Specifications*. 95-114. ISBN: 1-881956-20-2

Fite, Kelby and Smiley, Thomas E. 2008. *Best Management Practices: Managing Trees During Construction. Companion publication for ANSI A300 Part 5: Management of Trees and Shrubs during Site Development and Construction*. (Champaign, IL; International Society of Arboriculture) ISBN: 1-8811956-67-9

Fraedrich, B. R., *Preventing and Mitigating Construction Damage to Trees.* Bartlett Tree Research Laboratories Technical Report.

Maryland Tree Expert List. © Copyright 1995-2010 Maryland Department of Natural Resources
http://www.dnr.state.md.us/forests/tree_expert_search.asp

"Why Hire and Arborist?" ©2011, International Society of Arboriculture
http://www.treesaregood.org/treecare/resources/hire_arborist.pdf

"Find an Arborist" website ©International Society of Arboriculture 2009-2016
http://www.treesaregood.org/findanarborist/arboristsearch.asp

Chapter 8

Selecting Replacement Trees

This chapter provides information on how to select and locate trees so they will thrive and complement the roadside environment, how to present tree planting requirements in Roadside Tree Protection Plans, and how to calculate roadside tree removal fees.

Tree preservation is the primary focus of the Roadside Tree Protection Law; however, removing existing trees and replacing these with new trees may be the only viable option available to some projects. Although naturally occurring roadside trees can replenish their numbers through natural seeding, planting nursery-grown trees is the only practical way to replenish the County's street tree canopy over time. For these reasons tree planting represents the future of the resource.

In addition to replenishing the roadside tree population, tree planting provides an opportunity to:

- Increase the level environmental and socioeconomic services provided by roadside trees, while minimizing the frequency and severity of undesirable impacts they can cause.
- Improve the capacity of the roadside tree population to tolerate harsh urban conditions and the effects of diseases and pests.

Land developers are encouraged to use the following guiding principle when selecting and locating trees in County rights-of-way:

Right Tree, Right Place!

This is a variation on the time-honored concept *Right Plant, Right Place* which captures the idea of selecting plant species based on the opportunities and constraints presented by the environment in which they will be located. When this principle is kept in mind, trees have a better chance of thriving in the roadside environment. Unfortunately, it is not difficult to spot examples of *Wrong Tree, Wrong Place* along our streets and roads. A prime example can be found where tall-growing trees have been planted directly under or very close to overhead power lines. Another example is where large tree species have been planted in very small planting spaces that lack sufficient soil volume to support long-term health and growth. Choosing an inappropriate species and/or planting it in the wrong place can contribute to one or more of the following consequences:

- Increased utility line clearance operations and costs
- Increased tree maintenance and removal costs
- Increased number of traffic delays due to tree blockages
- Increased infrastructure repair costs.

Planting Space Guidelines: MCDOT provides a list of approved tree species that can be planted in the right-of-way. The list separates trees into "minor" and "major" categories that reflect the relative size of the species at maturity. Species in the major tree category represent large deciduous shade trees. Use of this category of tree should be limited to planting spaces that:

- Are not obstructed by overhead utility lines (center of tree should have at least 10 feet of horizontal space from edged of nearest utility wire.)
- Provide access to 800 cubic feet or more of unrestricted and unshared soil space, that is capable of supporting adequate levels of root growth
- Provide soil depth of 36 inches or more below the soil surface adjacent to the basal flare of tree
- Provide a minimum of 2 feet of unrestricted space (measured horizontally from the edge of the trunk to any aboveground physical restriction)
- Provide a minimum of 24 square feet of surface area with no dimension less than four feet

NOTE: Major tree species may be used in planting areas that cannot meet 800 cubic feet of contiguous soil volume, if the primary planting space is connected to addition soil volume via trenches, root paths, break out zones, structural cells, or other technology that provides tree roots with access to soil that is conducive to good root development and function. In these cases, Roadside Tree Protection Plans should demonstrate how minimum soil volume requirements for planting spaces will be met. See p. 42 for more information on conditions that favor and discourage root development.

Species in the minor tree category represent small to medium-sized deciduous trees. Use of these trees should be limited to planting spaces that:

- Are not obstructed by overhead utility lines that are less than 25 feet in height
- Provide access to 300 cubic feet or more of unrestricted and unshared soil space that is capable of supporting adequate levels of root growth

- Provide soil depth of 36 inches or more below the soil surface adjacent to the basal flare of tree
- Provide a minimum of 1.5 feet of unrestricted space (measured horizontally from the edge of the trunk to any aboveground physical restriction)
- Provide a minimum of 12 square feet of surface area with no dimension less than two feet

In addition to the planting space standards provided above, both minor and major trees must be located in a manner that meets MCDOT requirements for tree spacing and minimal clearances as follows:

- Minor trees should be planted no closer than 30 feet (+/-5 feet) from each other.
- Major trees should be planted no closer than 50 feet (+/- 5 feet) from each other.
- Trees should be located a minimum of 5 feet from water mains.
- Trees should be located a minimum of 5 feet from gas boxes.
- Trees should be located a minimum of 5 feet from storm drain inlets or manhole covers.
- Trees should be located a minimum of 10 feet from fire hydrants.
- Trees should be located a minimum of 15 feet from street lights.
- No tree shall be planted in a manner that limits ability to sight traffic at intersections.
- (see MC 700.01 and MC 701.01 standards for more information).

Land developers should identify the mature physical attributes, environmental tolerances, horticultural requirements of the tree species (or cultivar) they are interested in planting, and compare these characteristics with the physical environment present at the planting site.

Physical Attributes:

- Height and crown spread at maturity
- Overall crown shape
- Branch orientation
- Resistance or susceptibility to damage by storms
- Objectionable characteristics of seeds, fruit and bark

Environmental and Cultural Requirements:

- Light requirements (shade, partial sun, full sun)
- Drought tolerance
- Moisture and drainage requirements
- Soil pH and nutrient requirements
- Soil structure and compaction

NOTE: DPS recommends inquiring if the trees being considered for use are likely to be available from local nurseries in the planting sizes and numbers needed to support the project.

Tree Planting Plan Submission Requirements

Roadside Tree Protection Plans involving tree planting should provide the following information:

- The exact location of the main trunk
- The name of the species and/or variety of tree that will be planted (common names and/or botanical names can be used)
- The number of each species that will be planted
- Planting sizes (caliper and height)
- Staking and guying that might be needed to secure trees in place
- The DPS Tree Planting Detail (p. 80)

Roadside Tree Removal Fees

The Roadside Tree Protection Law requires DPS to collect a tree removal fee when any roadside tree is removed that is designated on a MCDOT street tree inventory or is equal to or greater than 6 inches in diameter (measured at 4½ feet above soil line). This fee may be waived if DPS determines that the roadside tree in question is already dead, or poses a danger to persons or property. The fee must be paid to DPS prior to issuance of related right-of-way permits. Roadside Tree Protection Plans should capture the amount of fees that are owed for tree removal as follows:

- $500 for each roadside tree that will be removed.
- A $250 fee should be added to the $500 fee identified above for each roadside tree that will be removed, if DPS determines that is not feasible to plant a replacement tree in a near-by location within the right-of-way.

Photo 13: *This photo shows a typical planting environment for roadside trees. What constraints are present that might affect the ability of the tree in the foreground to thrive?*

What physical characteristics do you think a tree species should have in order to complement the surrounding infrastructure?

Suggested Reading

An online list of trees that can be planted in County rights-of-way
http://www.montgomerycountymd.gov/dot-highway/tree/TreePlant.html
Montgomery County Department of Transportation

Montgomery County Department of Transportation *Standards for Tree Locations*
http://www.montgomerycountymd.gov/DOT-DTE/Resources/Files/Design/mc-700_01.pdf

Montgomery County Department of Transportation *Standards for Tree Locations*
http://www.montgomerycountymd.gov/DOT-DTE/Resources/Files/Design/mc-701_01.pdf

"How to Plant Trees" © 2012, Casey Tree Foundation
http://caseytrees.org/resources/howto/plant/

"How to Plant your Trees" © 2016 Arbor Day Foundation
https://www.arborday.org/trees/planting/

"New Tree Planting" ©2011. International Society of Arboriculture.
http://www.treesaregood.org/treecare/resources/New_TreePlanting.pdf

"Soil Volume Minimums for Street Trees Organized by State/Province" © 2014 Green Infrastructure
http://www.deeproot.com/blog/blog-entries/soil-volume-minimums-organized-by-stateprovince

"Tree Space Design: Growing the Tree out of the Box" © 2008 Casey Trees
http://caseytrees.org/wp-content/uploads/2012/02/tree-space-design-report-2008-tsd.pdf

Urban, James. 2008. *Up By Roots: Healthy Soils and Trees in the Built Environment.* Champaign, Illinois: International Society of Arboriculture.

Chapter 9

Roadside Tree Protection Plan Submission Requirements

This chapter provides guidance on how to determine the correct plan submission requirements for Roadside Tree Protection Plans.

Submission requirements for roadside tree protection can vary considerably depending on site conditions; however, all projects need to provide the minimal information identified in Table 2 below. Projects involving significant impacts to roadside trees may need to address more advanced practices.

The ability to visualize impacts to critical and structural root zones is greatly enhanced when the information identified in Table 2 is overlaid on a backdrop of existing and proposed features (see sample Roadside Tree Protection Plan provided on p. 64). Examples of existing features to include on Roadside Tree Protection Plans are property lines, topographic contours, building locations, sidewalks, driveways, aprons, streets, underground and overhead utilities, and stormwater management facilities. Examples of proposed features include new buildings, driveways, sidewalks, underground utilities, and stormwater management devices.

The limit of disturbance plan element is useful in determining the percentage of a critical and structural root zones that will be impacted by construction. The area defined by the limit of disturbance should be premised on the minimal area of disturbance needed to implement the entire range of engineering and construction practices utilized to construct the project. The limit of disturbance should be depicted at the intersection of existing and proposed topographic contours, or, where there are no proposed changes to grade, the area of soil that will need to be disturbed to facilitate construction. For an example of how the limit of disturbance appears on a site plan, see Illustration 11 on the following page.

Determining Submission Requirements Based on Levels of Impact

The best approach to determining which features and information are needed on Roadside Tree Protection Plans starts with gauging the level of construction impact on roadside trees. If it has not already been used, the procedure identified in Chapter 3 (p. 9-10) provides a simple and fairly accurate method for gauging construction impacts on individual trees.

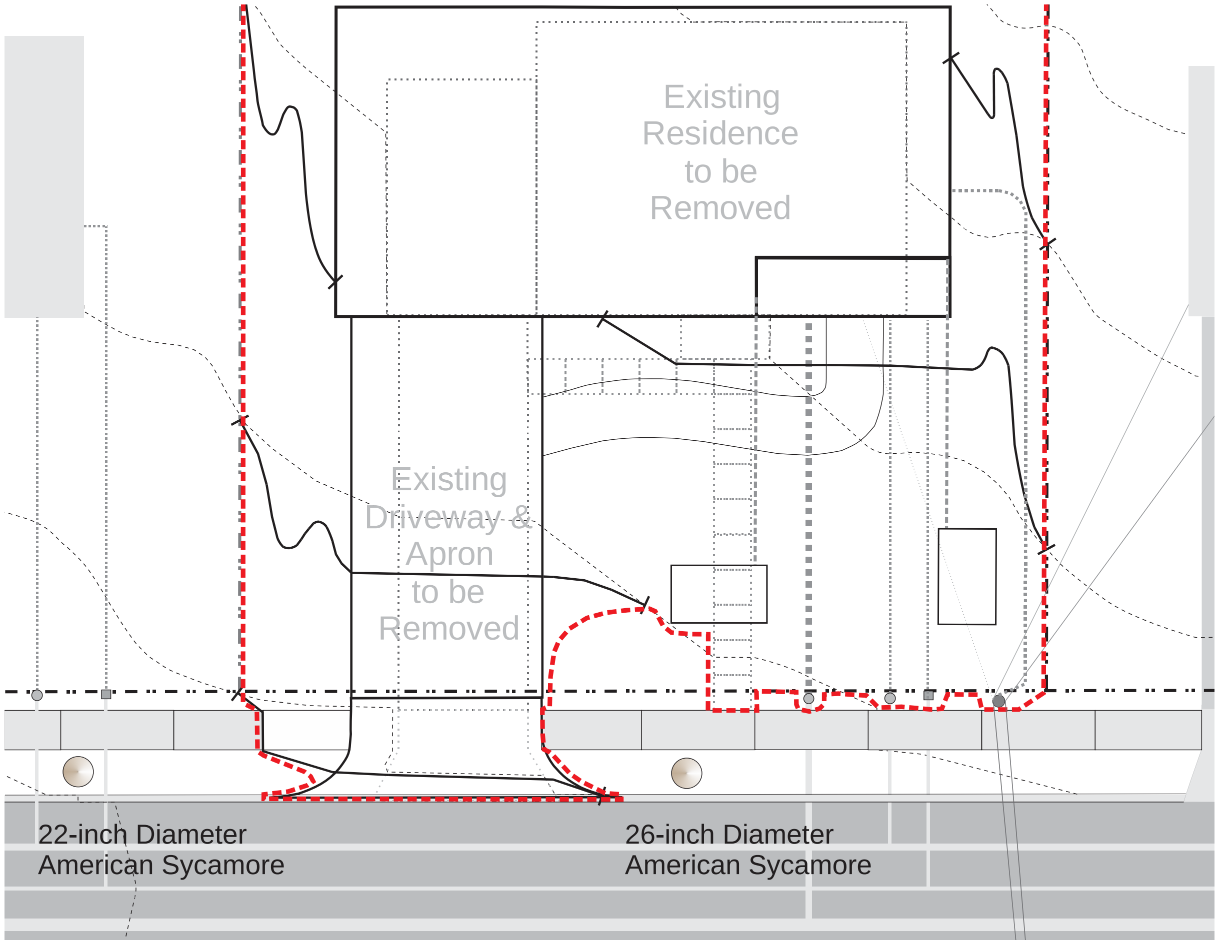


Illustration 11: *Example of plan elements that facilitate the design and review of roadside tree requirements. This example includes a limit of disturbance (in red); existing and proposed topography contours; existing house, walkway, driveway, and concrete apron locations; underground and overhead utility locations, and, proposed drywell locations.*

The following process assumes that there will be impact (as determined using the procedure in Chapter 3), and divides that impact into two categories - marginal and significant. Then the submission requirements typically needed to address each level of impact are described.

Marginal Impacts: If construction activities are anticipated to cause marginal impacts (i.e., a % of CRZ impact of 10 percent or less) the tree protection requirements for the project will likely to be limited to the minimum requirements listed in Table 2 below.

Table 2: Minimum Roadside Tree Protection Plan Submission Requirements

Location of roadside tree trunks	See "Roadside Tree Inventory Requirements" p. 11-12
Common name of tree	
Tree diameter measured at 4 ½ feet	
Location of dead or dying roadside trees	
Critical root zone	See p. 38-40
Limit of disturbance	See p. 39
Tree protection fence (only needed if there will be impacts inside critical root zone)	See p. 78
Tree protection signs (only needed if there will be impacts inside critical root zone)	See p. 81-82

Significant Impacts: When construction activities are anticipated to cause significant damage (i.e., a % of CRZ impact greater than 10 percent) then a more comprehensive Roadside Tree Protection Plan will be required. In these cases, the plan will need to address the minimum requirements listed in the table above, plus any advanced tree preservation practices that may be appropriate.

Advanced tree protection may involve one or more of the following practices:

- Root pruning
- Directional boring
- Root Investigation/mapping
- Mulching to mitigate soil and root damage
- Soil management and modification
- Use of geocomposite materials
- Use of root aeration mat systems
- Use of growth regulators
- Use of pruning practices to minimize structural failure and to mitigate conflicts with new structures and to allow access to construction areas
- Use of pruning practices to create vertical clearance and/or sight distance

Advanced practices such as those listed above are required to be implemented by a **Maryland Licensed Tree Expert (**Maryland LTE)**.** The Roadside Tree Protection Law requires Roadside Tree Protection Plans to identify a Maryland LTE who will implement the specific tree care practices and treatments identified in the plan. Although civil engineers, landscape architects, and land surveyors may prepare and submit Roadside Tree Preservation Plans, DPS highly recommends that a tree care professional generate the technical content, especially where proposed construction is likely to cause significant damage to trees, or where the predevelopment health or structural condition is in question.

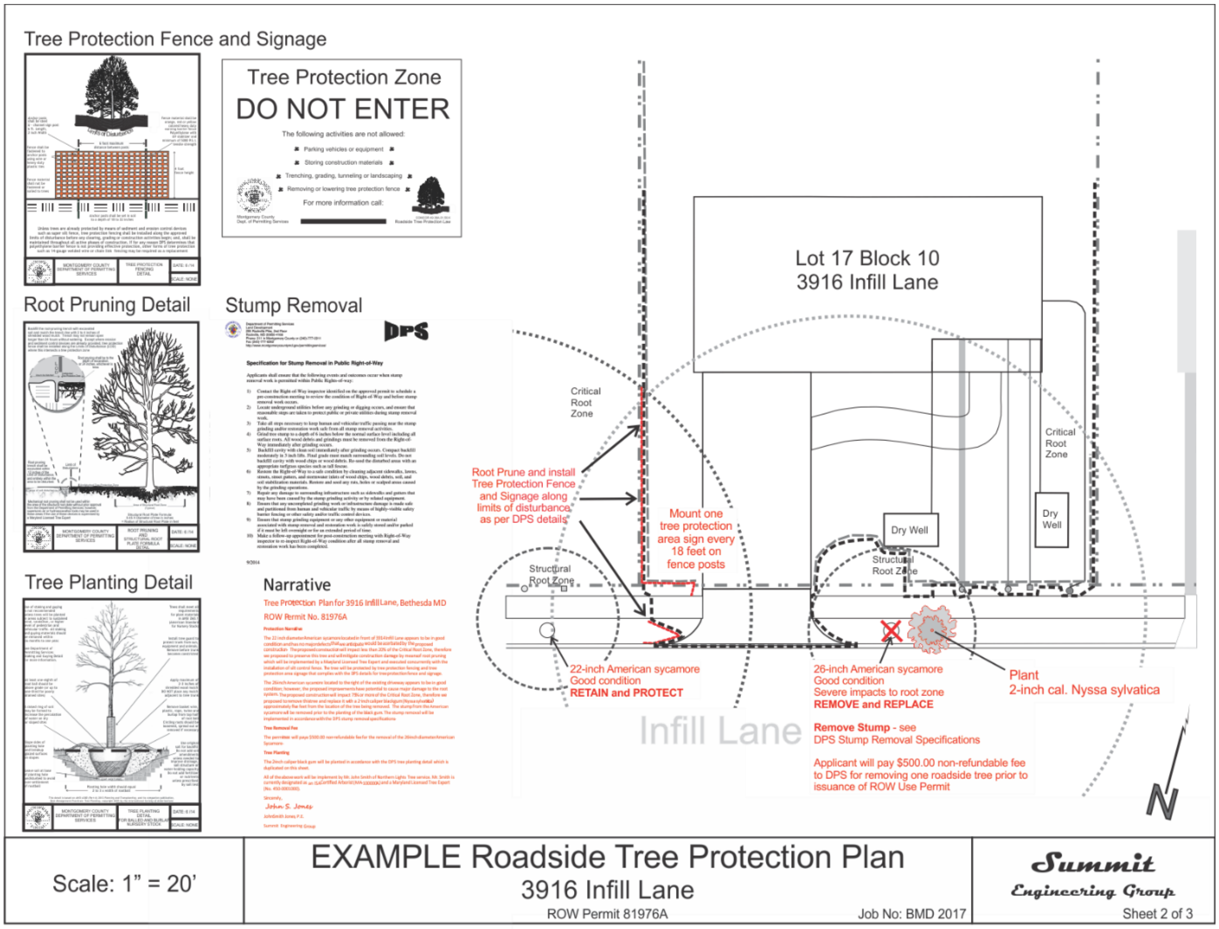


Illustration 12: *This illustration depicts tree protection specifications and plan submission features that are required on a typical Roadside Tree Protection Plan. Do not submit this information separately. Roadside Tree Protection Plan sheets should be included as part of the plan set submitted in conjunction with right-of-way permit applications. This sample is reproduced at a larger size in Appendix 3: Technical Specifications and Samples.*

Chapter 10

Sustaining Commitment Once Construction Begins

The time and energy that goes into preparing Roadside Tree Protection Plans can be wasted if applicants do not take steps to sustain commitment to roadside trees when projects are constructed. This chapter suggests methods that can be used to ensure that Roadside Tree Protection Plans are implemented correctly and honored throughout the construction phase.

Since roadside trees are not usually the focal point of construction projects, tree-related tasks may sink to the bottom of the priority list once actual demolition or construction works begins. If this occurs, tree protection measures such as fencing and signage may fall into disrepair and become ineffective, and time-sensitive features of Roadside Tree Protection Plans may not be implemented in a timely or effective fashion.

One way to help sustain attention to roadside tree matters is to have the designated Maryland LTE participate in preconstruction meetings. During these meetings the Maryland LTE can review the contents and sequence of Roadside Tree Protection Plans with the project superintendent, other on-site personnel, and DPS inspection staff.

This review can help encourage open communication and establish a spirit of teamwork that will ensure that roadside tree issues are given necessary attention throughout projects. Discussion that take place during pre-construction meetings will vary from site to site but may include one or more of the following topics:

- Location of the approved limit of disturbance
- Installation of tree protection fencing and signage
- Location and depth of trenching needed for sediment control devices
- Potential impacts to roots from trenching
- How tree protection zones will be treated and maintained
- Locations of tree-friendly areas for on-site storage and parking
- Timing and logistics needed to implement Roadside Tree Protection Plans

A well-conceived Roadside Tree Protection Plan can be undermined by one uninformed subcontractor. In order to sustain awareness, DPS suggests that a Maryland LTE conduct periodic site inspections to ensure that tree preservation practices are implemented on time and maintained throughout the project timeline. These inspections can help keep roadside tree protection efforts fresh in the minds of construction personnel and subcontractors. The need and frequency of these inspections will vary depending on site-specific conditions such as the number of trees designated for protection, the complexity of tree preservation practices, and, on-site spatial constraints.

Photo 14: *This photo shows a roadside tree that is protected by means of 14-gauge welded wire fencing mounted on steel posts and tee protection signs. Note the use of fiber logs as a silt control practice. Where appropriate, the use of fiber logs can minimize the trenching that is needed to install silt control fencing. Do you think this roadside tree has been adequately protected? If not, what steps would you take to increase the likelihood that this tree would survive construction?*

Chapter 11

Implementing Roadside Tree Protection Plans

The information in this chapter is provided to help land developers understand their obligation to implement and honor Roadside Tree Protection Plans during the construction phase.

Timing

DPS expects that tree protection practices such as the installation of tree protection fence and tree protection zone signs will be completed before any land disturbance occurs in the County rights-of-way or on the subject property identified on approved permits. Deviating from this requirement is prohibited unless the approved Roadside Tree Protection Plan narrative identifies a different timing for these actions.

Permittees (or their representative) are expected to be ready to demonstrate on-site compliance with applicable Roadside Tree Protection Plan requirements at the time of preconstruction meetings. The content of Roadside Tree Protection Plans should be discussed during preconstruction meetings so that permittees, contractors and county inspectors have a common understanding concerning the timing of specific practices and actions contained in the plan.

DPS expects the Maryland LTE who is identified as responsible for implementing tree protection plan practices to participate in preconstruction meetings. Unless stated as a timing requirement in Roadside Tree Protection Plan narratives, DPS expects all work required by the plan to be completed by time of final inspection.

Adherence to Plan Content

DPS expects permittees to fully implement all features of approved Roadside Tree Protection Plans. This includes adhering to the following components:

- Honoring the limit of disturbance depicted on approved plans
- Installation of fencing and signage
- All treatments and timings identified in the Roadside Tree Protection Plan

- Tree removals
- Stump removals
- Tree planting
- Removal of planting stakes and guying materials

DPS expects the Maryland LTE identified on approved Roadside Tree Protection Plans to implement all tree preservation and arboricultural practices identified on such plans with the exception of installing tree protection fencing and signs. If for some reason the Maryland LTE designated on the Roadside Tree Protection plan cannot be used, then another Maryland LTE may be used to implement the plan.

DPS expects all roadside tree requirements identified on site plans submitted in conjunction with right-of-way, demolition, sediment control and building permits to be fully implemented regardless of how such site plans are titled or identified.

Maintenance of Tree Protection Devices and Tree Protection Zones

DPS expects permittees to monitor the condition of tree protection devices and to take steps to maintain these before they fall into a state of disrepair or neglect.

DPS expects permittees to monitor the effectiveness of tree protection devices and to take steps to replace these with more effective devices if these devices are not effective in protecting roadside trees or tree protection zones as depicted on approved plans.

DPS expects permittees to communicate the need to protect roadside trees and tree protection zones to contractors, subcontractors and utility companies that will carry out work on the site.

DPS expects permittees to install tree protection zone signs in languages that can be understood by the contractors and subcontractors that will work at the project site. See p. 81 and 82 for examples of English and Spanish tree protection zone signs. One tree protection zone sign should be posted for every 20 linear feet of tree protection fence.

Tree Protection Zones

DPS expects permittees to keep all construction, storage, parking, and land disturbance activities out of tree protection zones identified on Roadside Tree Protection Plans. This requirement applies to all areas outside of the approved Limits of Disturbance regardless if they are labelled as Tree Protection Zones or not.

DPS expects permittees to protect tree protection zones and to honor the approved Limits of Disturbance throughout the life of the project until the final inspection for all permits is completed.

Photo 15: *This photo shows tree protection and silt control fence that is being maintained property*.

Completion of Roadside Tree Protection Plans

DPS will periodically monitor construction sites to ensure that work identified on approved Roadside Tree Protection Plans is being successfully implemented. DPS will evaluate the effectiveness of tree protection, tree removal, stump removal and tree planting efforts during final inspection of the project. DPS will not release bonds collected to ensure the protection of right-of-way features until all Roadside Tree Protection Plan work has been deemed complete.

If roadside trees that are designated to be protected are determined by DPS to be dead, dying, or to represent an unacceptable level of risk to right-of-way safety and functionality, DPS will direct the Permittee to remove such trees and their stumps. In addition, DPS will direct the Permittee to replace such trees with acceptable species and to pay applicable roadside tree removal fees. DPS will inspect all stump removal work for compliance with the County's stump removal specifications (p. 87-88).

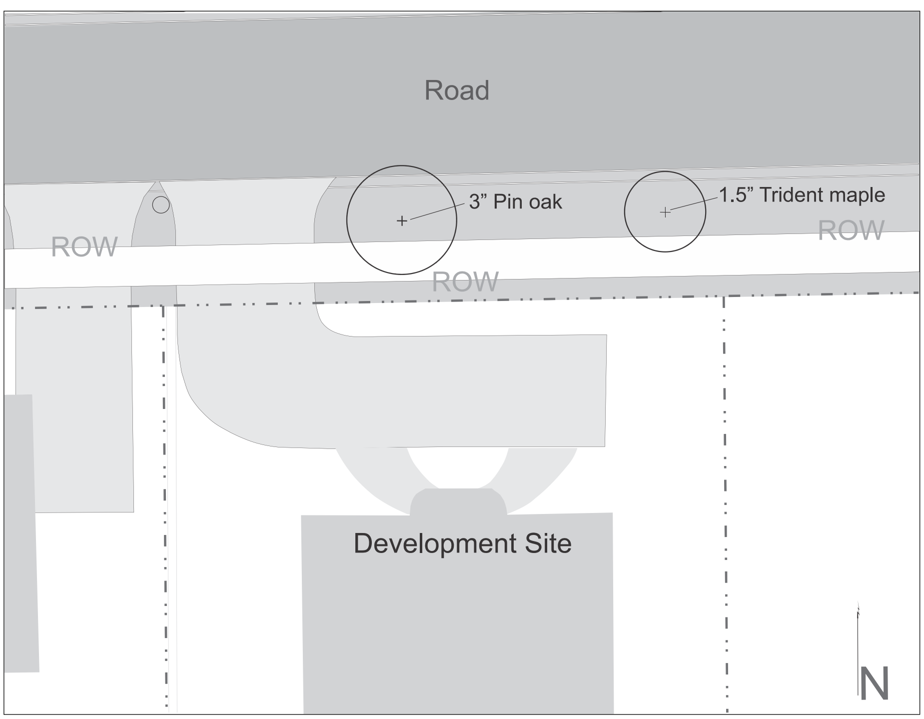
If DPS determines that trees planted to satisfy the Roadside Trees Protection requirements do not meet standards for size, health, and placement within the right-of-way, DPS will direct the permittee to replant such trees until they are deemed to meet such standards.

Appendix 1: *Roadside Tree Inventory Examples*

Category 1. Any tree that appears to have been intentionally planted within the right-of-way irrespective of trunk diameter size.

Typical Site Conditions

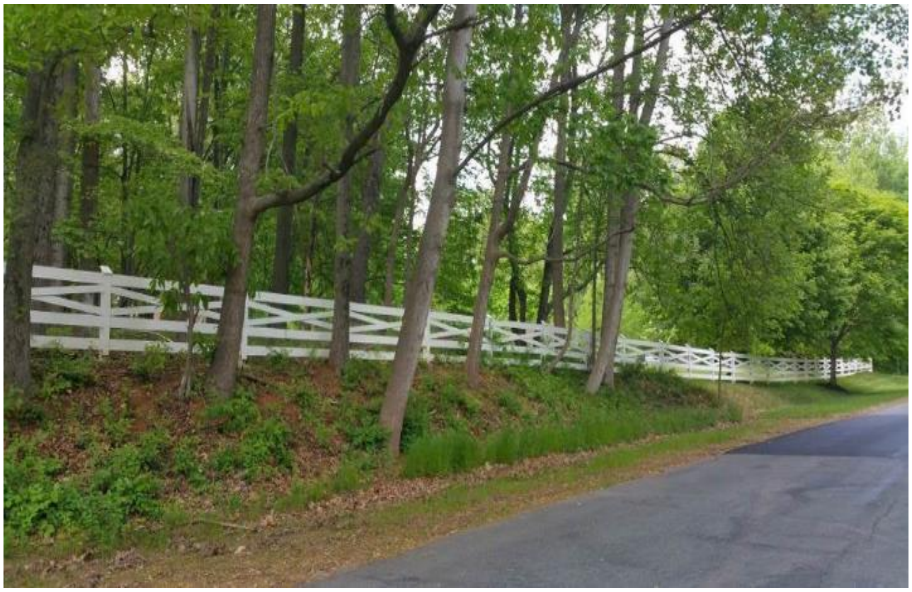
Category 1 roadside trees are typically found adjacent to sidewalks, curbs, and gutters, and planted at regular distances.



Corresponding Plan View

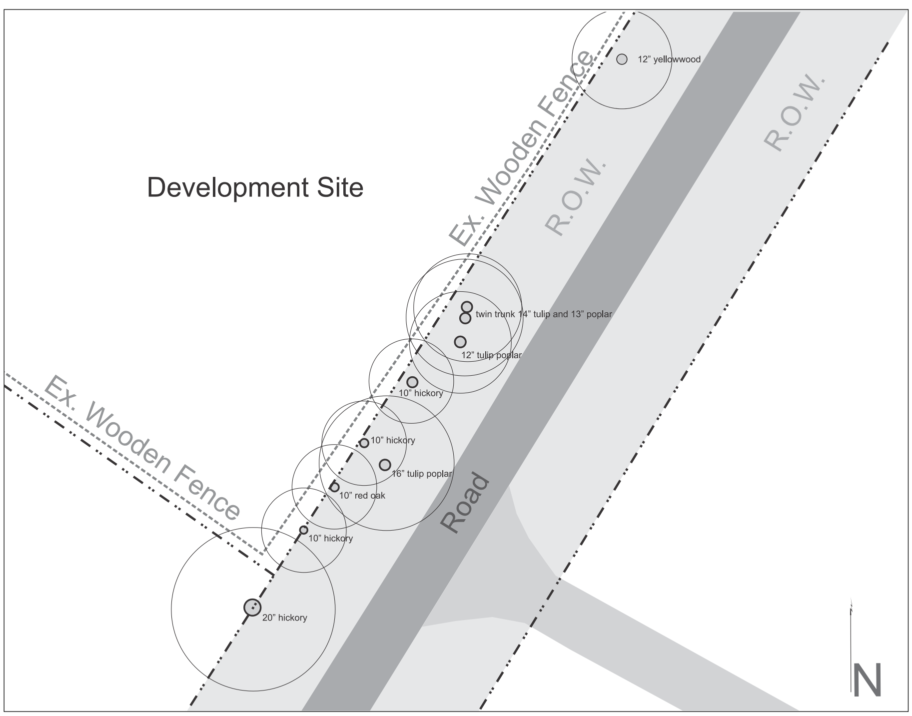
A. Locate the trunk
B. Identify the trunk diameter in inches (measured at 4 ½ feet from the highest soil level)
C. Identify the common name of the tree
D. Note if the tree appears to be dead, dying, or structurally unsound
E. Identify the critical root zone

Category 2. Naturally occurring trees 6-inches or greater in diameter.



Typical Site Conditions

A substantial number of Category 2 roadside trees are early successional or invasive species that have developed from seed or other natural processes.



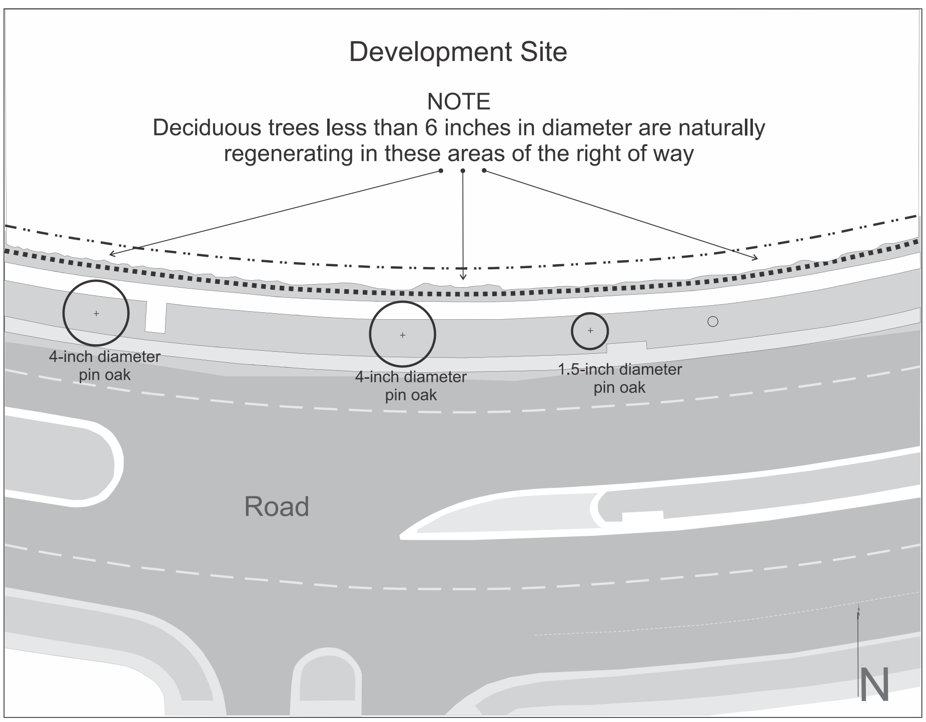
Corresponding Plan View

A. Locate the trunk
B. Identify the trunk diameter in inches (measured at 4 ½ feet from the highest soil level)
C. Identify the common name of the tree
D. Note if the tree appears to be dead, dying, or structurally unsound
E. Identify the critical root zone

Category 3. Naturally occurring trees less than 6 inches in diameter

Typical Site Conditions

Roadside trees in this category are typically pioneer species that have developed as part of an early successional plant community, or invasive species that have taken advantage of recent clearing and grading. Trees in this category typically develop from seed or other natural processes, and are less than 6 inches in diameter.



Corresponding Plan View

A. You do not need to locate individual trunks or critical root zones

B. Provide a note describing the general nature of any vegetation in this category (example: "small red maple saplings located here" or "small deciduous trees are naturally regenerating in this area")

C. You may delineate the location of this vegetation on the plan by means of shading or a polygon

Appendix 2. *Tree Species Tolerance to Construction*

This appendix identifies tree species found in rights-of-ways along with three gradients of construction tolerance which the species is typically associated with.

Trees with High Tolerance to Construction Damage

Hackberry, *Celtis occidentalis*

Persimmon, *Diospyros virginiana*

Green ash, *Fraxinus pennsylvanica*

Ginkgo, *Ginkgo biloba*

Honey locust, *Gleditsia triacanthos*

Eastern red cedar, *Juniperus virginiana*

Red mulberry, *Morus rubra*

Blackgum, *Nyssa sylvatica*

Austrian pine, *Pinus nigra*

White oak, *Quercus alba*

Black locust, *Robinia pseudoacacia*

Sassafras, *Sassafras albidum*

Bald cypress, *Taxodium distichum*

Siberian elm, *Ulmus pumila*

Trees with Medium Tolerance to Construction Damage

(MH = Medium High, M = Medium, ML = Medium Low)

Norway maple, *Acer plataniodes* (MH)

Red maple, *Acer rubrum* (MH)

Silver maple, *Acer saccharinum* (ML)

Sugar maple, *Acer saccharum* (ML)

Ironwood, *Carpinus caroliniana* (M)

Pignut hickory, *Carya glabra* (M)

Mockernut hickory, *Carya tomentosa* (MH)

Southern and Northern catalpa, *Catalpa spp*. (MH)

Katsura-tree, *Cercidiphyllum japonicum* (ML)

Redbud, *Cercis canadensis* (MH)

Fringetree, *Chionanthus virginicus* (M)

White ash, *Fraxinus americana* (MH)

Black walnut, *Juglans nigra* (ML)

Sweetgum, *Liquidambar styraciflua* (M)

Trees with Medium Tolerance to Construction Damage (continued)

(MH = Medium High, M = Medium, ML = Medium Low)

Tulip poplar, *Liriodendron tulipifera* (ML)

Cucumber tree, *Magnolia acuminate* (M)

Southern magnolia, *Magnolia grandiflora* (M)

Crabapple, *Malus angustifolia* (M)

Sourwood, *Oxydendron arboretum* (ML)

Norway spruce, *Picea abies* (M)

Colorado blue spruce, *Picea pungens* (M)

Loblolly pine, *Pinus taeda* (MH)

Virginia pine, *Pinus virginiana* (ML)

London plane, *Platanus x acerfolia* (M)

Sycamore, *Platanus occidentalis* (M)

Cottonwood, *Populus deltoids* (MH)

Bigtooth Aspen, *Populus grandidentata* (ML)

Callery pear, *Pyrus calleryana* (M)

Southern red oak, *Quercus falcate* (MH)

Pin oak, *Quercus palustrus* (MH)

Willow oak, *Quercus phellos* (MH)

Red oak, *Quercus rubra* (MH)

Post oak, *Quercus stellate* (M)

Black oak, *Quercus velutina* (MH)

Willow, *Salix spp*. (MH)

Littleleaf linden, *Tilia cordata* (MH)

American elm, *Ulmus americana* (M)

Slippery elm, *Ulmus rubra* (MH)

Trees with Poor Tolerance to Construction Damage

Yellowwood, *Cladrastis lutea*

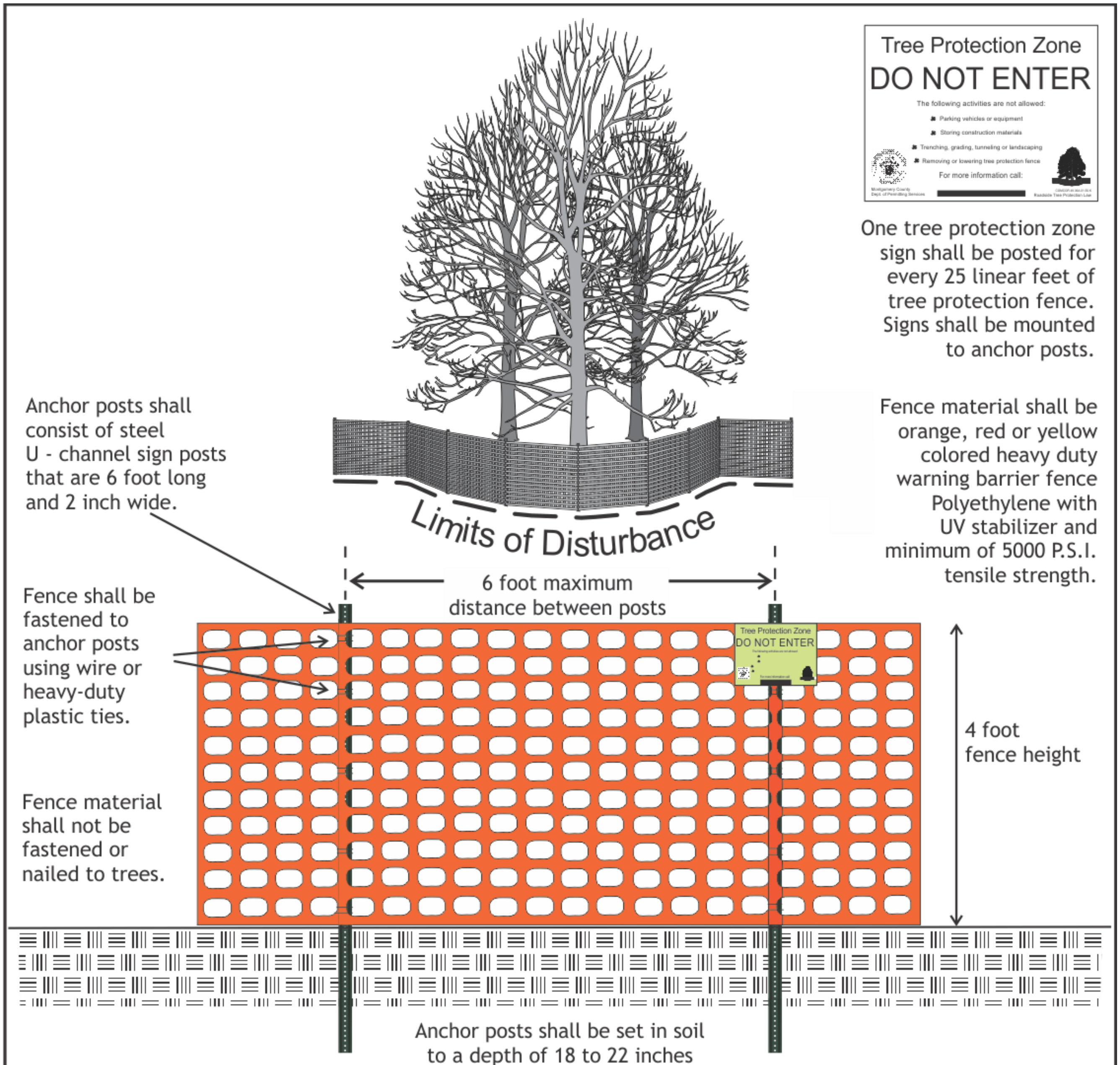
Flowering dogwood, *Cornus florida*

American beech, *Fagus grandifolia*

Black cherry, *Prunus serotina*

Basswood, *Tilia americana*

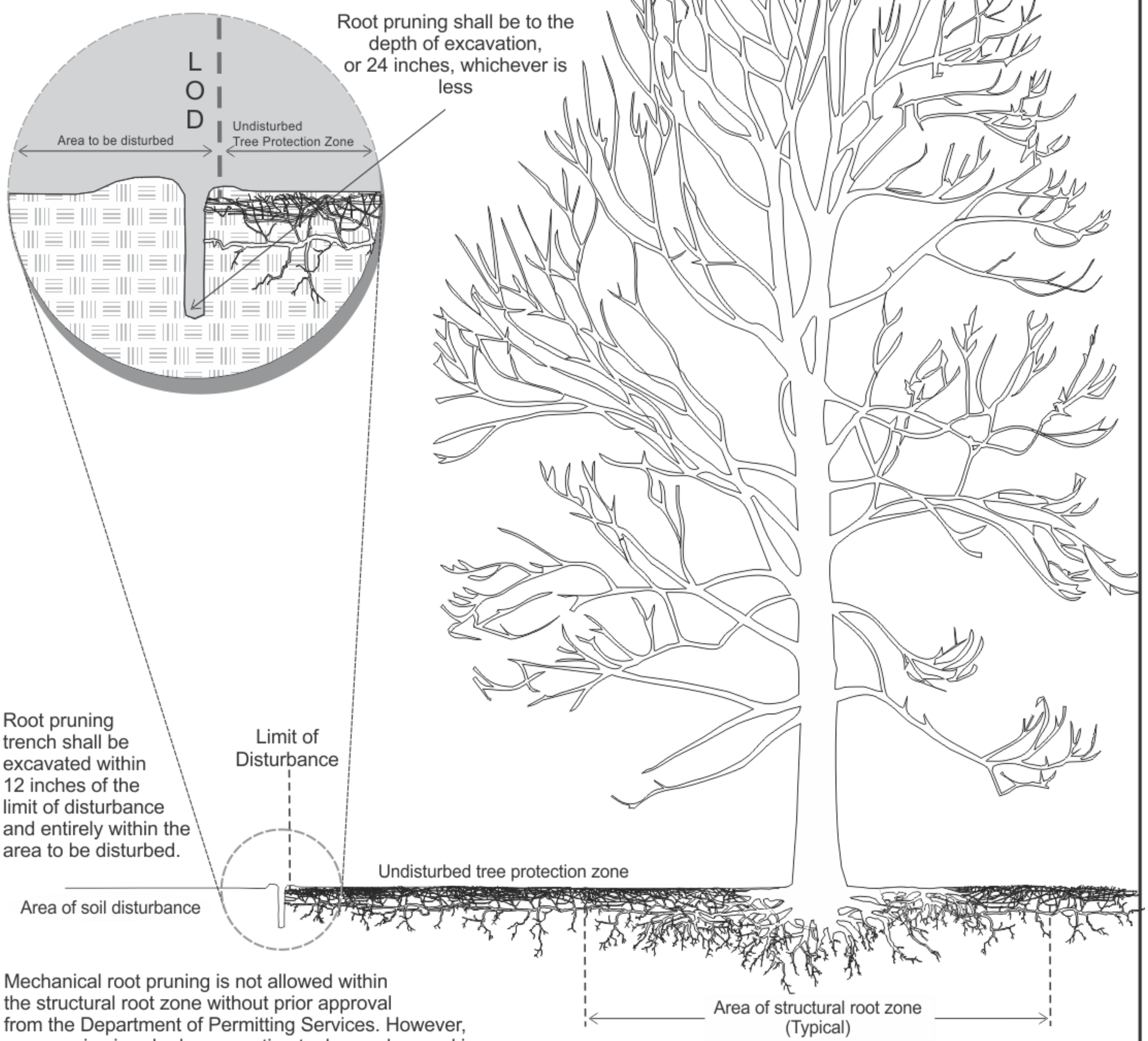
Appendix 3: *Technical Specifications and Samples*



Tree protection fence shall be installed along the approved limit of disturbance before any clearing, grading, or construction activities begin, and shall be maintained throughout the entire project. If for any reason DPS determines that polyethylene fence is not effective, other forms of tree protection, such as 14-gauge welded wire or chain link fence, may be required as a replacement. Silt fence may serve as tree protection if specified for this use on the approved sediment control plan. NOTE: Silt fence and super silt fence shall not be installed within the structural root zone of roadside trees without prior approval from DPS.

MONTGOMERY COUNTY MARYLAND 1776	MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES	TREE PROTECTION FENCING DETAIL	DATE: 5 /16
			SCALE: NONE

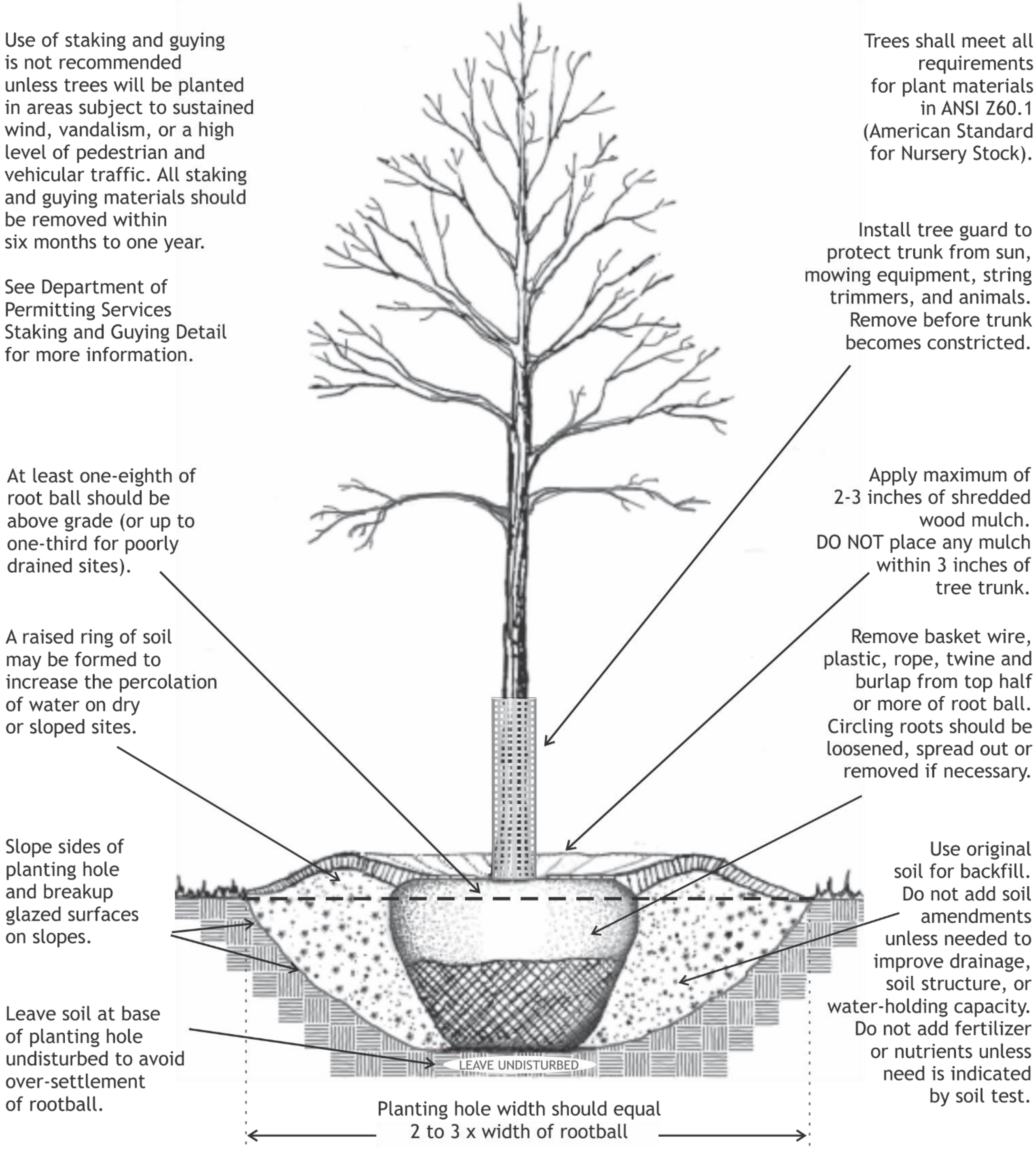
Backfill the root-pruning trench with excavated soil and mulch the trench line with 2 to 4 inches of shredded wood mulch. Trench may not remain open longer than 24 hours without watering. Except where erosion and sediment control devices are already provided, tree protection fence shall be installed along the limits of disturbance where this intersects a tree protection zone. Root pruning shall be executed by a Maryland Licensed Tree Expert.



Mechanical root pruning is not allowed within the structural root zone without prior approval from the Department of Permitting Services. However, supersonic air or hydroexcavation tools may be used in these areas without prior permission if these activities are implemented by a Maryland Licensed Tree Expert.

Structural Root Zone Formula:
0.5 X Diameter of tree in inches
= Radius of Structural Root Zone in feet

MONTGOMERY COUNTY MARYLAND 1776	MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES	ROOT PRUNING AND STRUCTURAL ROOT ZONE FORMULA	DATE: 6 /14 SCALE: NONE



This detail is based on *ANSI A300 (Part 6) 2012 Planting and Transplanting*, and its companion publication, *Best Management Practices: Tree Planting*, copyright 2005 by *the International Society of Arboriculture*

MONTGOMERY COUNTY MARYLAND 1776	MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES	TREE PLANTING DETAIL FOR BALLED AND BURLAP NURSERY STOCK	DATE: 6 /14
			SCALE: NONE

Tree Protection Zone

DO NOT ENTER

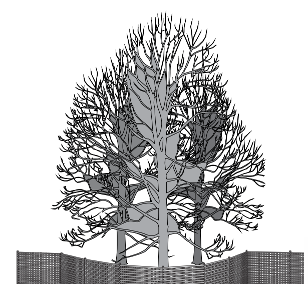
The following activities are not allowed:

- Parking vehicles or equipment
- Storing construction materials
- Trenching, grading, tunneling or landscaping
- Removing or lowering tree protection fence

For more information call:

____

Montgomery County
Dept. of Permitting Services



COMCOR 49.36A.01.50.K
Roadside Tree Protection Law

Zona de Protección de Arboles

NO ENTRE

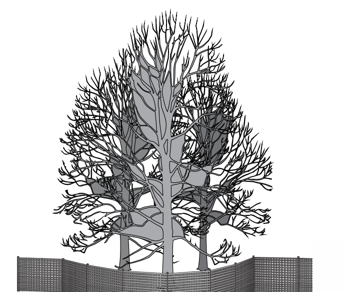
Las siguientes actividades no están permitidas:

- Parqueo de Vehículos o equipos de construcción
- Almacenamiento de materiales de construcción
- Hacer Trincheras, nivelación de tierra, túneles, o jardinería
- Remover o bajar la cerca de protección de arboles

Para más información llamar a:

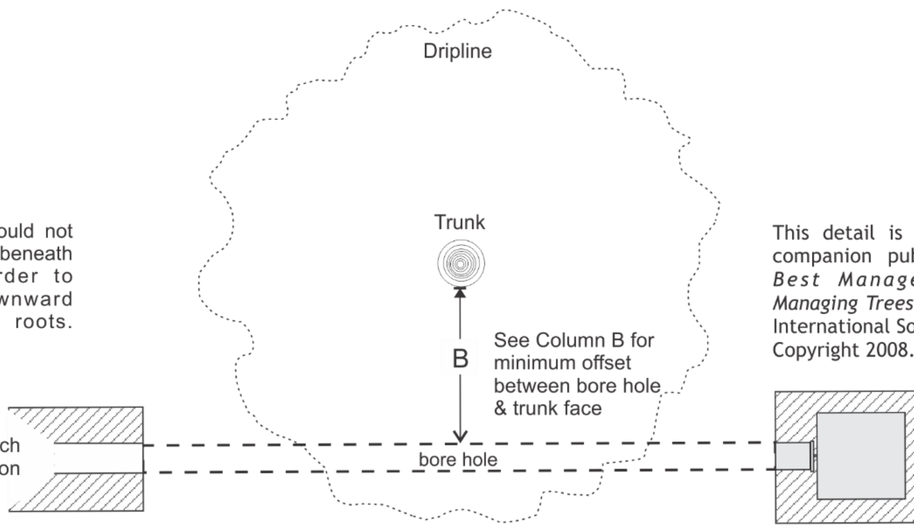
____

Montgomery County
Dept. of Permitting Services



COMCOR 49.36A.01.50.K
Roadside Tree Protection Law

The bore hole should not be located directly beneath the trunk in order to avoid large downward growing oblique roots.



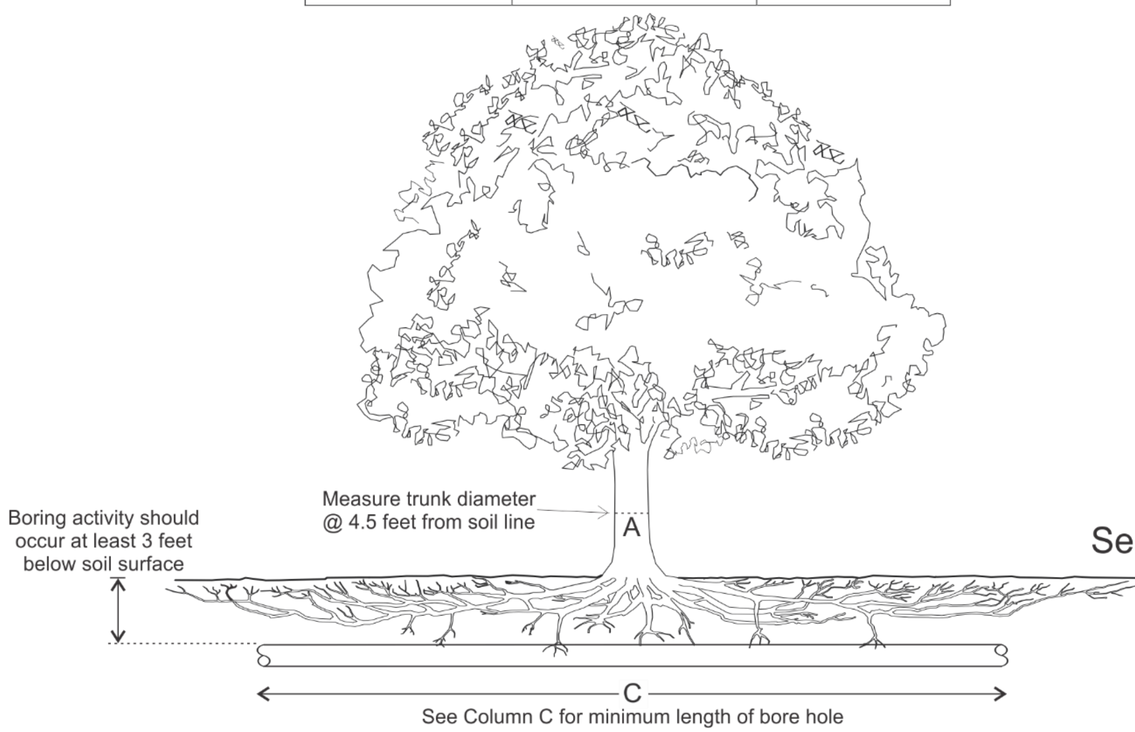
This detail is based on ANSI A300 companion publication to Part 5: *Best Management Practices, Managing Trees During Construction.* International Society of Arboriculture Copyright 2008.

Plan View

Adherence to the dimensions provided in Columns B and C will help to enure that most, if not all, structurally important roots will remain undamaged by boring activities.

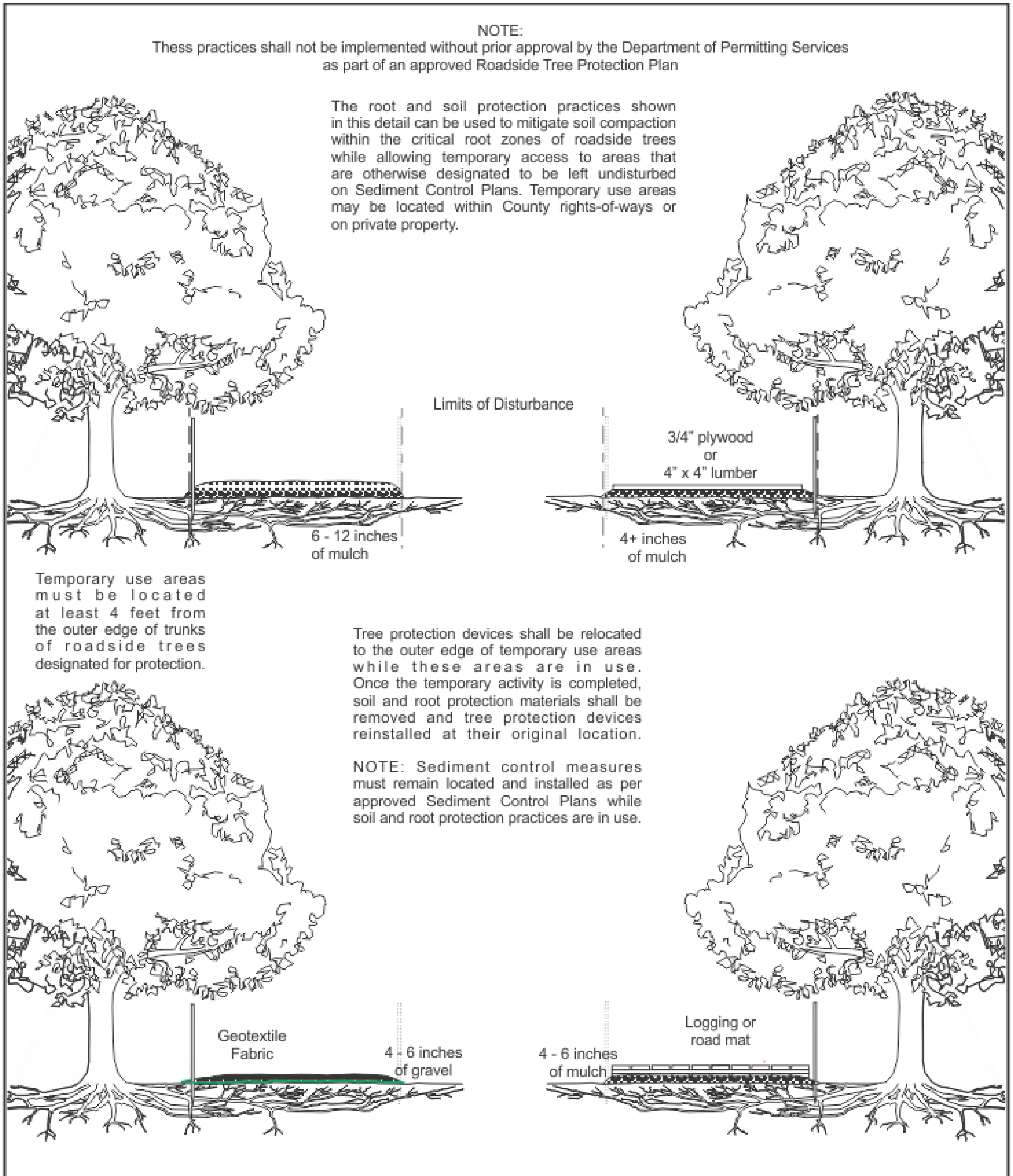
A Tree Diameter Measure at 4 ½ feet from soil	**B** Minimum Offset Distance from Trunk Face to Edge of Bore Hole	**C** Minimum Length of Bore Hole (centered on trunk)
inches	feet	feet
2	1	2
3	2	3
5	5	5
10	10	10
15	12	15
20	15	20

Use matrix to correlate trunk diameter (A) to the minimum offset distance from trunk to edge of bore hole (B), and the minumum length of the bore hole (C).

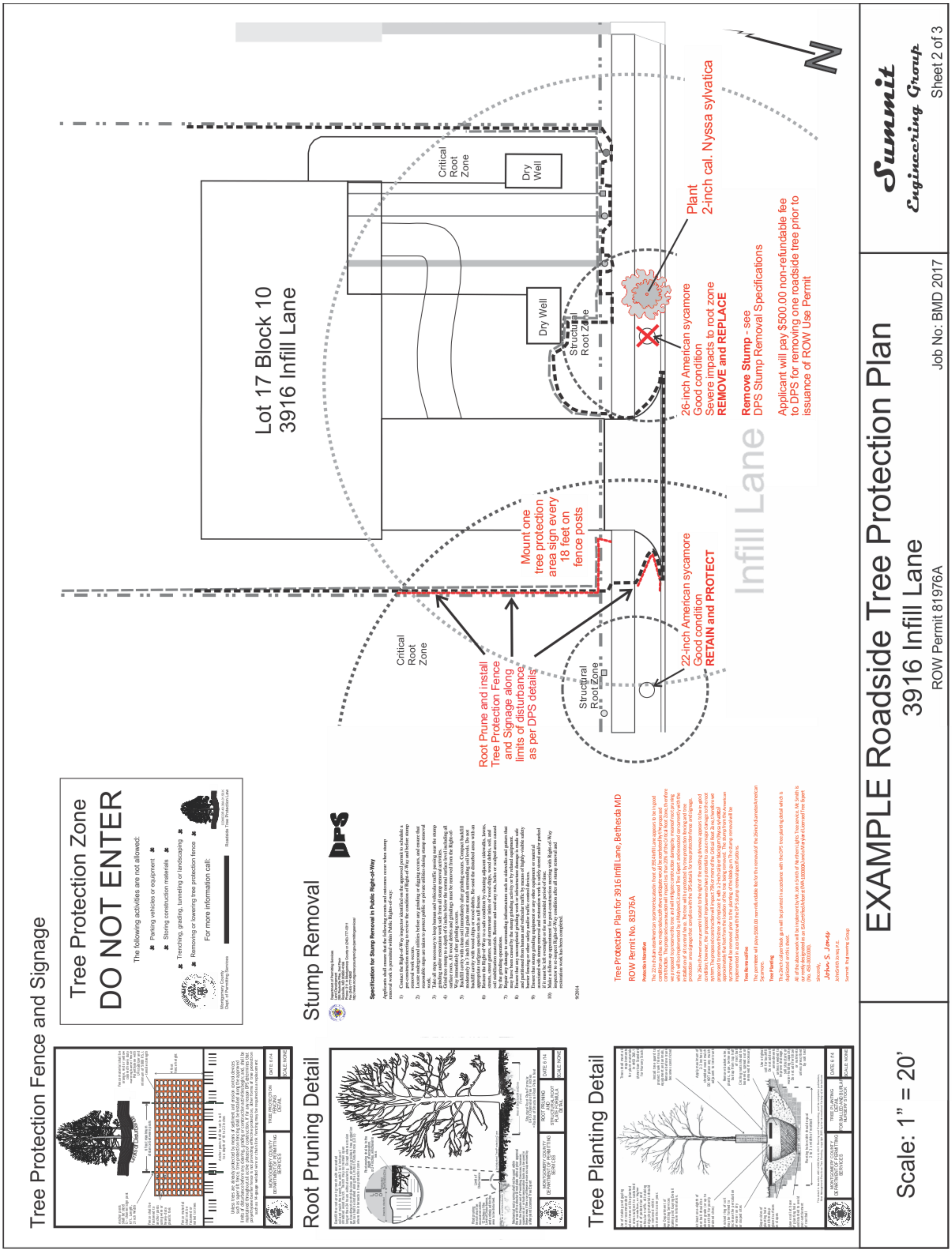


Section View

MONTGOMERY COUNTY MARYLAND 1776	MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES	MINIMUM DISTANCES FOR BORING UNDER TREE ROOTS	DATE: 2 /16 SCALE: NONE



	MONTGOMERY COUNTY DEPARTMENT OF PERMITTING SERVICES	Temporary Soil and Root Protection Practices	DATE: 5 /16
			SCALE: NONE


Tree Protection Fence and Signage
Tree Protection Zone
DO NOT ENTER
The following activities are not allowed:
Parking vehicles or equipment
Storing construction materials
Trenching, grading, tunneling or landscaping
Removing or lowering tree protection fence
For more information call:
Montgomery County Dept. of Permitting Services
Root Pruning Detail
Stump Removal
Specification for Stump Removal in Public Right-of-Way
Tree Planting Detail
Tree Protection Plan for 3916 Infill Lane, Bethesda MD
ROW Permit No. 81976A
Lot 17 Block 10
3916 Infill Lane
Critical Root Zone
Dry Well
Structural Root Zone
Root Prune and install Tree Protection Fence and Signage along limits of disturbance as per DPS details
Mount one tree protection area sign every 18 feet on fence posts
22-inch American sycamore
Good condition
RETAIN and PROTECT
26-inch American sycamore
Good condition
Severe impacts to root zone
REMOVE and REPLACE
Remove Stump - see DPS Stump Removal Specifications
Applicant will pay $500.00 non-refundable fee to DPS for removing one roadside tree prior to issuance of ROW Use Permit
Plant
2-inch cal. Nyssa sylvatica
Infill Lane
N
Scale: 1" = 20'
EXAMPLE Roadside Tree Protection Plan
3916 Infill Lane
ROW Permit 81976A
Job No: BMD 2017
Summit
Engineering Group
Sheet 2 of 3

Stump Removal Specification
Montgomery County Department of Permitting Services

The Permittee shall ensure that a visual inspection of stumps will take place prior to excavation, and shall contact "Miss Utility" to ensure that the locations of underground utilities are marked prior to any excavation.

The Permittee shall take all steps necessary to keep human and vehicular traffic passing near the stump grinding and/or restoration work safe from all stump removal activities.

The Permittee shall take steps to ensure that stump grinding equipment or any other equipment or material associated with stump removal and restoration work is safely stored and/or parked if it must be left overnight or for an extended period of time.

The Permittee shall perform stump removal and complete restoration of the right-of-way in accord with the following specifications:

- Stumps shall be ground to full depth.
- All exposed surface roots extending from the stump are to be ground out until there are no longer any exposed roots visible.
- Stump chips are to be removed from the right-of-way.
- Chip piles shall not be left in the right-of-way overnight. Sufficient chips may be left in the excavated area to maintain a level grade until the backfilling operation is completed.
- All excavated areas must be backfilled, graded, and seeded within 48 hours of excavation.
- Any open, excavated holes will be properly barricaded whenever the Permittee or their contractor is not on the site so as to prevent accidental entry by the public. This shall include areas of excavation that need to be left unattended overnight. Appropriate warning signs shall be posted in conjunction with barricades.
- The excavated area is to be filled with certified screened topsoil and free of debris, chips, or stones larger than one-half (1/2) inch diameter.
- The backfill topsoil is to be lightly tamped for compaction with a crown slope of one-half (1/2) inch per foot left to allow for settlement. All wood chips must be removed from the excavation prior to backfilling with topsoil.
- The finished grade will be raked, fertilized and seeded in accordance with professional trade practices. Fertilizer will be a 10-6-4 formulation applied at a rate of ½ lb. fertilizer

per 50 square feet of excavated area.

- Seed shall be a lawn mixture of 40% Kentucky Bluegrass, 40% Fescue, and 20% Annual/Perennial Ryegrass (or equivalent mix) applied at a rate of ½ lb. seed mix per 50 square feet of excavated area. The seeded area is to be mulched with straw or other suitable mulching material.
- The Permittee shall assume responsibility to repair or replace any lead walks, slate or flagstone, sprinkler systems, or other improvements that have been damaged as result of stump grinding activities. This includes damages to both private and public property.
- The Permittee shall take steps to contact residents prior to stump removal to request relocation of parked vehicles or other objects which may be damaged as a result of stump removal activities.

Appendix 4: *Exempted Activities*

Verbatim text from Montgomery County Code:

Chapter 49, Streets and Roads

Article 3, ROAD DESIGN AND CONSTRUCTION CODE

Sec. 49-36A. Roadside tree work.

(b) *Applicability; exceptions*.

(2) The following activities are not subject to this Section (except subsection (f)) and do not require a right-of-way permit:

(A) cutting or clearing a public utility right-of-way or land for an electric generating station licensed under Sections 7-204, 7-205, 7-207, or 7-208 of the Public Utilities Article of the Maryland Code, or any successor provision, if:

(i) any required certificate of public convenience and necessity has been issued under Section 5-1603(f) of the Natural Resources Article of the Maryland Code or any successor provision; and

(ii) the cutting or clearing is conducted in a way that minimizes the loss of forest;

(B) routine maintenance of a public utility right-of-way, and cutting or clearing any tree by a public utility as necessary to comply with applicable vegetation management requirements or to maintain, repair, replace, or upgrade any public utility transmission or distribution line; or

(C) cutting or clearing a public utility right-of-way or land for a new transmission or distribution line.

DPS | Montgomery County Department of Permitting Services