

URBAN FOREST TECHNICAL MANUAL



February 20, 2006

CITY OF SHENANDOAH
URBAN FOREST TECHNICAL MANUAL



CONTRIBUTING PARTICIPANTS:

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Planning and Zoning Commission
Burditt – Urban Forestry Consultants

February 20, 2006

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INTRODUCTION

Trees provide numerous benefits to quality of life in the urban area, such as beautification, energy conservation, and increased property values. The City of Shenandoah is a peaceful, and comfortable growing community which currently is undergoing an explosion in commercial development. Much of the wooded tracts have been developed or are in the process of being developed. There is a concern for loss of the natural forested areas of the City and the effects on the community as a whole.

Meeting this concern, the City of Shenandoah Code of Ordinances, 2002 Edition (Code), Article IV, Tree Protection and Preservation was completely rewritten in 2005 to preserve the remaining trees on property under development or already developed. This manual will refer to Article IV simply as “the Ordinance”. The Ordinance is the City’s primary regulatory tool to provide for the orderly protection of specified trees, to promote the health, safety, welfare, and quality of life for the residents of the City, to protect property values, and to avoid significant negative impacts on adjacent properties. By assuring preservation and protection through regulations and standards of care, these resources will remain significant contributions to the landscape, streets, and parks, and continue to help define the unique character of Shenandoah.

This *Urban Forest Technical Manual* (the Manual), adopted by resolution by the City Council, is published separately from the Ordinance and is maintained by the City Secretary with distribution by the City Administrator. The Manual provides standards and specifications based on generally accepted practices and provides guidelines for survey, protection, planting, pruning, and irrigation of trees. If there appears to be a conflict in verbiage between the Ordinance and the Manual, the Ordinance will take precedence. The goals of the Manual are intended to provide consistent care and serve as benchmarks to measure achievement in the following areas:

- ❖ Ensure and promote preservation of the remaining tree canopy cover within the City limits
- ❖ Provide standardized presentation of tree survey data required by the City
- ❖ Increase the survivability of trees during and after construction events by providing protection standards and best management practices
- ❖ Provide standards for the replacement of trees that are permitted to be removed
- ❖ Provide standards for new tree planting, tree care, and irrigation
- ❖ Provide guidance on protection, planting, and care of trees in the city’s right-of-way and publicly owned lands
- ❖ Establish criteria for determining when a tree is hazardous and a possible threat to the public health, safety and welfare

PRIMARY SOURCES CONSULTED

Standards and specifications were gathered from various documents listed in Appendix C: Bibliography. The International Society of Arboriculture (ISA) material was used for much of the tree planting, pruning, and general tree care information. The resultant standards in this Manual are based on common practices in the area and the types of soils and trees that exist in Shenandoah.

SECTION 1: TREE SURVEY STANDARDS

1.1. INTRODUCTION

This section describes the format of tree surveys as well as the types of tree identification required in the field. These standards and specifications assure a faster review process as they relate to tree protection and mitigation.

1.2. PROTECTED AND UNPROTECTED TREES

Trees of all species that are at least eight (8) inches in diameter are protected except for Chinese Tallow and exceptions as outlined in Section 98-156 (1) of the Ordinance. For details related to protected trees, refer to the ordinance.

There is one grouping based on size or designation within the protected tree family. The group includes trees with diameters of 8 inches or more.

Trees less than eight (8) inches in diameter are not protected. However, healthy trees (good branching structure, height, and spread similar to nursery grown trees) with diameters of 3 to less than 8 inches may be credited toward replacement trees required as described in Section 98-158 (3) of the Ordinance. The trees selected for mitigation will be indicated on the tree survey and construction plans and will be protected in the same manner as a protected tree. The City Administrator will approve the trees recommended for mitigation.

1.3. TYPES OF TREE SURVEYS

There are two types of tree surveys, partial and full. Elements required in a partial tree survey shall be described by the City Administrator.

1.4. TREE SURVEY CERTIFICATION

All tree surveys shall be certified. The tree survey will be performed by a registered professional land surveyor. Protected trees over eight inches will be surveyed and reflected on the survey graphically and in the legend. Protected species of trees under eight (8) inches used for replacement credit will be illustrated on the survey and legend as well.

If it is found upon field inspection that the survey is inaccurate, the tree survey will not be accepted and reviewed and will be returned for corrections. This will delay the site plan or preliminary plat review process while the tree survey is corrected and approved.

1.5. INFORMATION TO BE GATHERED IN THE FIELD

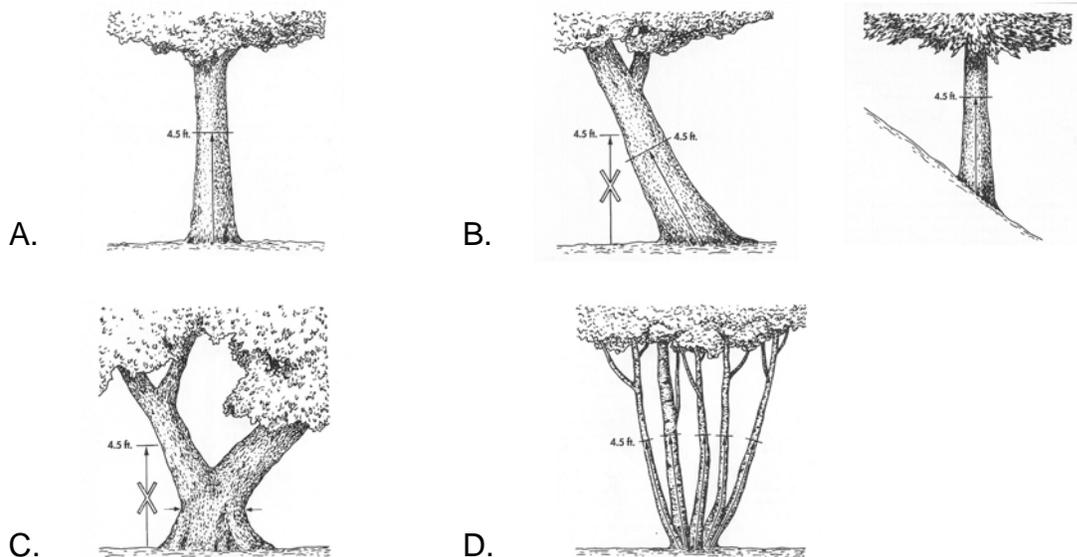
The data required to be collected and illustrated in the site plan include tree locations, diameters, species, limits of construction, and certain tree graphics.

1. **Location** – Tree data submitted must be obtained from a ground survey. A number shall be assigned and a corresponding numbered tag placed on each tree surveyed and provided in the overall tree survey. Tree numbers will remain on the trees until the project has received its certificate of occupancy.

2. **Diameter** – Diameters of existing trees are measured as follows. Diameter measurement should be recorded to the nearest inch. Trees may be measured with a caliper, cruise stick, standard tape measure or diameter tape.

Illustration 1-1: Measurement of trees

From: *Guide For Plant Appraisal, 9th ed.*



- a. **Straight trunk:** Trees with fairly straight, upright trunks should be measured four and a half (4.5) feet above the ground (See illustration 1-1 A.)
 - b. **Trunk on an angle or on a slope:** The trunk is measured at right angles to the trunk four and half (4.5) feet along the center of the trunk axis, so the height is the average of the shortest and the longest sides of the trunk (see illustration 1-1 B).
 - c. **Trunk branching lower than four and a half (4.5) feet from the ground:** When branching begins less than four and a half (4.5) feet from the ground, measure the smallest circumference below the lowest branch. In this example, an alternative would be to add the sum of the cross-sectional areas of the two stems measured about 12 inches above the crotch. Then average the sum of these two branch areas and the smallest cross-sectional area below the branches. This may give a better estimate of the tree size (see illustration 1-1 C).
 - d. **Multi-stemmed tree:** To determine the diameter of a multi-trunk tree, measure all the trunks; add the total diameter of the largest trunk to one-half (1/2) the diameter of each additional trunk (see illustration 1-1 D). A multi-trunked tree is differentiated from individual trees growing from a common root stock if there is a visible connection between the trunks above ground.
3. **Species** – The name of the species, such as Live Oak, Water Oak, or Pine should be accurately reflected. Tree types may be listed by common names or Latin names. Indicating a tree name as “unknown” on a tree survey is not acceptable.

1.6. INFORMATION TO BE PROVIDED ON THE TREE SURVEY

1. **Trunk location** – The trunk location on the plan must represent the center of the trunk at ground level in the field. If the tree leans substantially above the point, show the direction of the lean with an arrow. See the legend under the sample Tree Survey in Illustration 1-2B for an example (Tree #10).
2. **Critical Root Zone (CRZ)** - Trees are to be represented on the tree survey by a concentric circle centered on the trunk location, with a radius equal in feet to the number of inches of the tree's trunk diameter. For example, an oak tree with a trunk diameter measuring fifteen (15) inches would be represented to scale on the tree survey with a circle representing a fifteen (15) foot radius. Trees to be retained will be represented by a solid circle. Trees to be removed are to be represented by a dashed circle. See illustration 1-2B.
3. **Diameters and types of existing trees** – Tree diameters and types shall be shown on the survey through a legend. Tree numbers on the legend will be correlated with the appropriate tree circle drawn on the plan and the trees in the field. Special conditions such as “dead” will be noted.
4. **Tree numbers** – Tree numbers on the plan will correlate with tags assigned to trees during the survey.
5. **Tree survey table** – A table will be included listing all surveyed trees by number, species, sizes, removal status, health conditions, and credit trees under eight inches. It will also include a legend indicating the protection status of the tree. Additionally, it will include calculations of the number of inches of trees to be protected, inches to be removed without mitigation, number of inches equal to or greater than 8 inches, number of inches subject to mitigation, and number of inches credited. See illustration 1-2A for reference.

1.7. ADDITIONAL INFORMATION

There are other types of information related to tree structure and condition which may affect site plan design. The City Administrator may request these types of information. The information will be expressed as a written note on the survey and include the tree number and a description of any of the following:

1. **Crown configuration** – If a tree has a crown which is skewed in one direction, this information would be useful for surveyors to note. Project designers and plan reviewers need such information to more accurately assess design impacts on such trees.
2. **Crown Clearance** – This information is often critical in determining whether a given structure or vehicular use area can practically be placed within the drip line of a tree. If this information is recorded, the surveyor should consider the vertical distance to any major branches.
3. **Condition** – This is one of the principle factors in determining whether a tree should or should not be preserved. Surveyors should not speculate about the condition of all trees unless they have the necessary credentials; however if a tree is obviously in poor condition, it should be noted to prevent unnecessary expense in trying to design around it.

4. **Spot elevation** - Taking an elevation reading near the trunks of some trees will provide valuable information for project designers. Since grade changes are the most destructive impacts on trees, it is important to get the most accurate information possible. If there is more than a six inch change, existing and proposed grade elevation will need to be reflected on the tree survey.

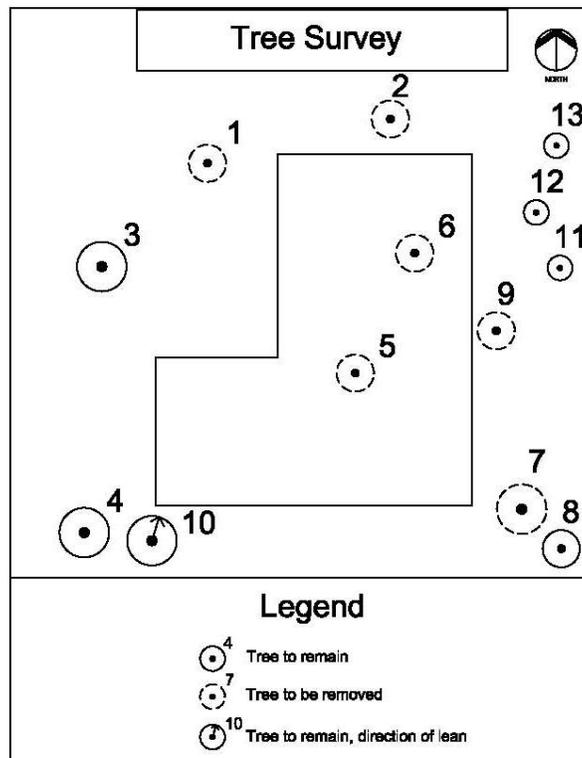
Illustration 1-2: Elements of a Tree Survey

From: Burditt – Urban Forestry Consultants

A.

| TREE SURVEY TABLE | | | |
|--|------|-------------------|-----------------------|
| Tree # | Size | Species | Comments |
| 1 | 8" | Live Oak | Protected |
| 2 | 10" | Tallow | Not protected |
| 3 | 16" | Post Oak | Protected |
| 4 | 36" | Cedar Elm | Protected |
| 5 | 20" | Live Oak | Protected |
| 6 | 20" | Tallow | Not protected |
| 7 | 40" | Live Oak | Dead – Not calculated |
| 8 | 12" | Silver leaf maple | Protected |
| 9 | 12" | Pecan | Protected |
| 10 | 40" | Pecan | Protected |
| 11 | 3" | Pecan | Credit tree |
| 12 | 4" | Bur Oak | Credit tree |
| 13 | 3" | Live Oak | Credit tree |
| Total inches protected trees on site: 144 | | | |
| Total inches that may be removed without replacement: 43 (30%) | | | |
| Trees under 20 inches, total inches removed: 20 | | | |
| Inches subject to replacement (@ 1:1 ratio): 20 | | | |
| Trees 20 + inches, total inches removed: 20 | | | |
| Inches subject to replacement (@ 1:2 ratio): 40 | | | |
| Total tree inches credited: 10 | | | |
| Replacement inches calculation | | | |
| 20 + 40 = 60 to be replaced | | | |
| 60 – 43 = 17 to be replaced without the tree credit | | | |
| 17 – 10 = 7 to be replaced with the tree credit | | | |
| Total inches to be replaced: 7 | | | |

B.



SECTION 2: TREE PROTECTION STANDARDS

2.1. INTRODUCTION

The tree protection section of the Ordinance and the standards in this section are provided to ensure that appropriate practices will be implemented in the field to eliminate undesirable consequences that may result from uninformed or careless acts, and preserve both trees and property values. Construction projects are required to implement the protective practices described in this section.

Typical negative impacts that may occur during construction include:

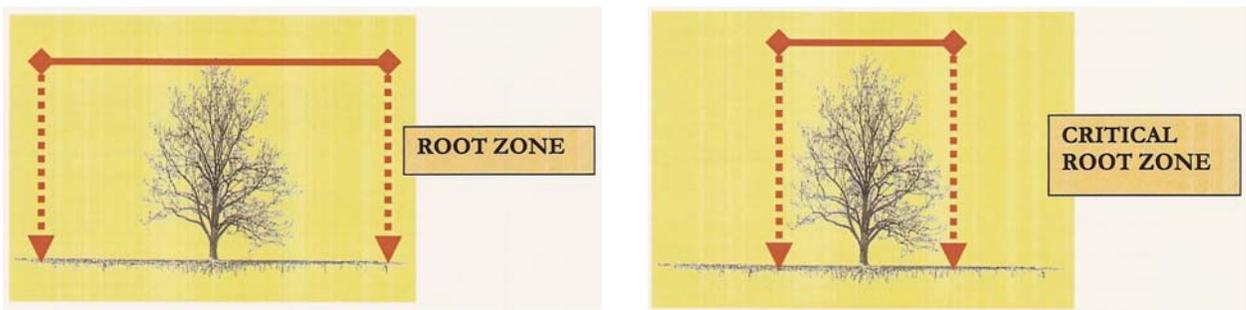
- ❖ Mechanical injury to roots, trunk or branches
- ❖ Compaction of soil, which degrades the functioning roots and inhibits the development of new ones and restricts drainage, which desiccates roots and enables water mold fungi to develop
- ❖ Changes in existing grade which can cut or suffocate roots
- ❖ Alteration of the water table – either raising or lowering
- ❖ Microclimate change, exposing sheltered trees to sun or wind
- ❖ Sterile soil conditions, associated with stripping off topsoil

2.2. CRITICAL ROOT ZONE (CRZ)

Each tree to be retained shall have a designated CRZ identifying the area sufficiently large enough to protect the tree and roots from disturbance. The CRZ is defined as a radius equal in feet to the number of inches of the tree's trunk diameter. The CRZ shall be shown on all tree surveys, tree replacement plans, and construction plans. Improvements or activities such as paving, utility and irrigation trenching and other activities shall occur outside the CRZ, unless authorized by the City Administrator. Unless otherwise specified, the protective fencing shall define the CRZ.

Illustration 2-1: Root zone vs. Critical root zone (CRZ)

From: Urban Forest Management Plan.



Activities prohibited within the CRZ include:

- Storage or parking vehicles, building materials, refuse, excavated spoils or dumping of poisonous materials on or around tree and roots. Poisonous materials include, but are not limited to, paint, petroleum products, concrete or stucco mix, dirty water or any other material which may be harmful to tree health
- The use of tree trunks as a winch support, anchorage, temporary power pole, sign posts or other similar function

- Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches and other miscellaneous excavation without prior approval of the City Administrator
- Soil disturbance or grade change
- Impervious paving
- Vehicular traffic
- Drainage changes

Activities permitted or required within the CRZ include:

- Mulching. During construction, mulch may be spread within the CRZ. The mulch may be removed if improvements or other landscaping is required. Where there are areas of unprotected root zones in the CRZ, those areas shall be covered with four (4) inches of organic mulch to minimize soil compaction. See Chapter 3 of this Manual for a more thorough discussion on mulching.
- Irrigation, aeration, fertilizing or other beneficial practices that have been specifically approved for use within the CRZ and as defined by the City Administrator.

Erosion Control. If a tree is adjacent to or in the immediate proximity to a grade requiring erosion control, then approved erosion control or silt barriers shall be installed outside the CRZ to prevent siltation and/or erosion within the CRZ.

2.3. TREE PROTECTION AND PRESERVATION PLAN & PRE-CONSTRUCTION REQUIREMENTS

Prior to the start of any development project, the property owner shall have prepared and submitted for review a Tree Protection Plan for all protected trees. The Tree Protection Plan will consist of three elements: (1) illustrations showing options in tree fencing and protection (see illustrations in this section related to fencing and protection), (2) notes as listed in section 2.3.2 of this Manual, and (3) tree protection symbols on the tree protection plan as discussed in section 2.3.1 and illustrated in illustration 2-2 of this Manual. The plan will be reviewed by the City Administrator. The following elements will be addressed in the Tree Protection Plan prior to construction:

2.3.1. *Site Plan Reflecting Critical Root Zones*

In addition to the requirements described in the Tree Survey Standards, the CRZ to be enclosed with the specified tree fencing will be indicated on the Tree Replacement Plan and all construction plans as a bold line with x's evenly spread along the line (see illustration 2-2).

2.3.2. *Tree Protection Notes*

The Construction Plan and Site Plan will reflect the following tree protection notes. The following notes must be shown on plans accompanied by the tree protection details as illustrated on pages 2-12 and 2-13.

1. All trees not located within the limits of construction and outside of disturbed areas shall be preserved.
2. All trees shown on this plan to be retained shall be protected during construction with fencing.
3. Tree protection fences shall be erected according to city standards for tree protection, including types of fencing and signage.

4. Tree protection fences shall be installed prior to the commencement of any site preparation work (clearing, grubbing, or grading) and shall be maintained throughout all phases of the construction project.
5. Erosion and sedimentation control barriers shall be installed or maintained in a manner which does not result in soil build-up within tree driplines or root damage.
6. Fences shall completely surround the tree or clusters of trees, located at the outermost limits of the tree branches (dripline) or CRZ, whichever is greater; and shall be maintained throughout the construction project in order to prevent the following:
 - a. Soil compaction in root zone area resulting from vehicular traffic or storage of equipment or material.
 - b. Root zone disturbances due to grade changes (greater than 3 inches cut or fill) or trenching not reviewed and authorized by the City Administrator.
 - c. Wounds to exposed roots, trunk, or limbs by mechanical equipment.
 - d. Other activities detrimental to trees such as chemical storage, concrete truck cleaning, fires, and anchoring to tree trunk.
7. Exceptions to installing tree fences at the tree driplines or CRZ, whichever is greater, may be permitted in the following cases:
 - a. Where there is to be an approved grade change, impermeable paving surface, or tree well;
 - b. Where trees are close to proposed buildings, erect the fence no closer than 8 feet to the building.
8. Where any of the above exceptions result in a fence that is closer than 5 feet to a tree trunk, protect the trunk with strapped-on planking to a height of 8 feet (or to the limits of lower branching) in addition to the reduced fencing provided.
9. Where any of the above exception result in areas of unprotected root zones under the dripline or CRZ, whichever is greater, those areas shall be covered with 4 inches of organic mulch to minimize soil compaction.
10. All grading within protected root zone areas shall be done by hand or with small equipment to minimize root damage. Prior to grading, relocate protective fencing to 2 feet behind the grade change area.
11. Any roots exposed by construction activity shall be pruned flush with the soil. Backfill root areas with good quality light top soil within 24 hours. IF exposed root areas are not backfilled within 24 hours, cover them with organic material in a manner which reduces soil temperature and minimized water loss due to evaporation.
12. Prior to excavation or grade cutting within tree driplines, a clean cut shall be made between the disturbed and undisturbed root zones with a trenching machine or similar equipment to minimize damage to remaining roots.
13. All trees impacted by construction activities will be watered deeply once a week during periods of hot, dry weather. Tree crowns are to be sprayed with water periodically to reduce dust accumulation on leaves.
14. When installing concrete adjacent to the root zone of the tree use a plastic vapor barrier behind the concrete to prohibit leaching of lime into the root zone.
15. Any trenching required for the installation of landscape irrigation within the CRZ of protected trees shall be installed by hand digging with no root over 1" in diameter being cut.
16. No landscape topsoil dressing greater than (3) inches shall be permitted within the dripline or CRZ, whichever is greater, of trees. No topsoil or mulch is permitted on root flares of any tree.

17. Pruning to provide clearance for structures, vehicular traffic, and construction equipment shall take place before construction begins. All pruning must be done according to standards as outlined in American National Standard for Tree Care Operation – Tree Shrub and Other Woody Plant Maintenance – Standard Practice (ANSI R300-1995).
18. The City Administrator has the authority to require additional tree protection before or during construction.
19. Trees approved for removal shall be removed in a manner which does not impact trees to be preserved. Refer to the City of Shenandoah *Tree Technical Manual* for appropriate removal methods.
20. Prior to construction all lower tree limbs over roadways must be pruned to a height of 14 feet height using the techniques described in the City of Shenandoah *Tree Technical Manual*.
21. Deviations from the above notes may be considered ordinance violations if there is substantial noncompliance or if a tree sustains damage as a result.

2.3.3. Pre-construction meeting

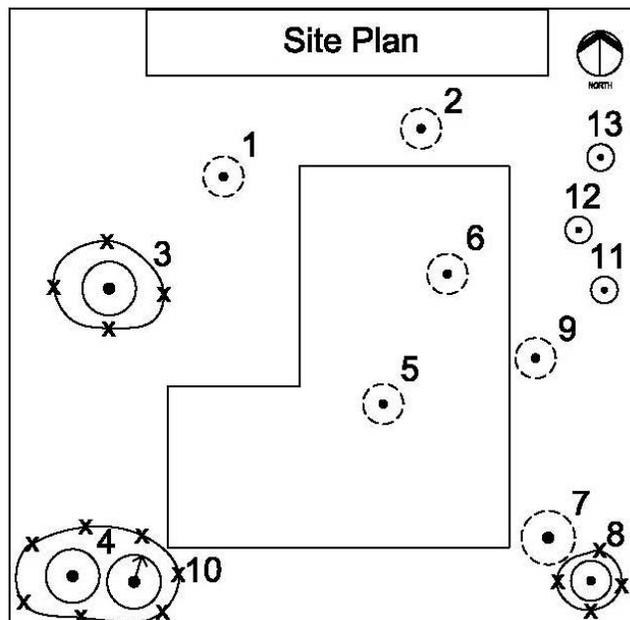
The demolition, grading and underground contractors, construction superintendent and other pertinent personnel are required to meet with the City Administrator or his designee prior to beginning work to review procedures, tree protection measures and to establish haul routes, staging areas, contacts, watering, etc.

2.3.4. Verification of tree protection

The project Urban Forester, landscape architect or contractor shall verify, in writing, that all preconstruction conditions have been met (tree fencing, erosion control, pruning, etc.) and are in place. Written verification must be submitted to and approved by the City Administrator before demolition or grading begins.

Illustration 2-2: Site plan with tree protection fence illustrated as below. Circles illustrate the Critical Root Zone.

From: Burditt – Urban Forestry Consultants



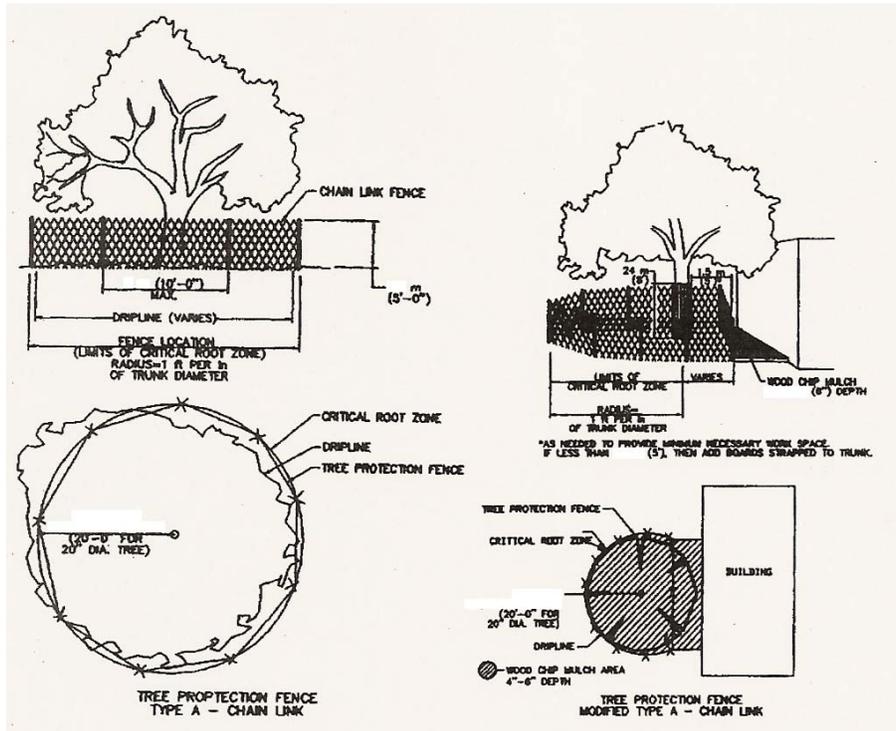
2.3.5. Tree fencing for protected trees

Fenced enclosures shall be installed at the CRZ or the dripline, whichever is greater, to achieve three primary goals:

1. To keep the foliage crowns and branching structure clear from contact by equipment, materials and activities
2. To preserve roots and soil conditions in an intact and non-compacted state
3. To identify the Critical Root Zone (CRZ) in which no soil disturbance is permitted and activities are restricted, unless otherwise approved.

Illustration 2-3: Examples of tree protection fencing surrounding the Critical Root Zone – Chain link fencing, without and with adjacent obstruction

From: City of Austin



a. Exceptions to fencing along the CRZ

1. Where aeration paving is to be installed, erect the fence at the outer limits of the aeration area
2. Where trees are close to proposed buildings, erect the fence no closer than eight (8) feet to the building
3. Where there are severe space constraints due to tract size, or other special requirements, contact the City Administrator

b. Size and type of fence

Chain Link:

Chain link fences around protected trees shall be a minimum of five (5) feet high. Fences are to be mounted on two inch diameter galvanized iron posts, driven

into the ground to a depth of at least 1-foot at no more than 10-foot spacing. This detail shall appear on grading, demolition and improvement plans.

Plastic:

Plastic fence will consist of 4' tall plastic mesh fence supported by 6' tall iron T-bar posts driven 2' into ground on no more than 10' centers. Fence is attached to posts with 16 gauge wire ties spaced on 24" centers.

c. Area to be fenced

1. Type I Tree Protection

Tree fences shall enclose the entire area under the **dripline or CRZ**, whichever is larger, of the tree(s) to be saved throughout the life of the project, or until final improvement work within the area is required, typically near the end of the project.

Parking Areas: If the fencing must be located on paving or sidewalk that will not be demolished, the posts may be supported by an appropriate grade level concrete base.

2. Type II Tree Protection

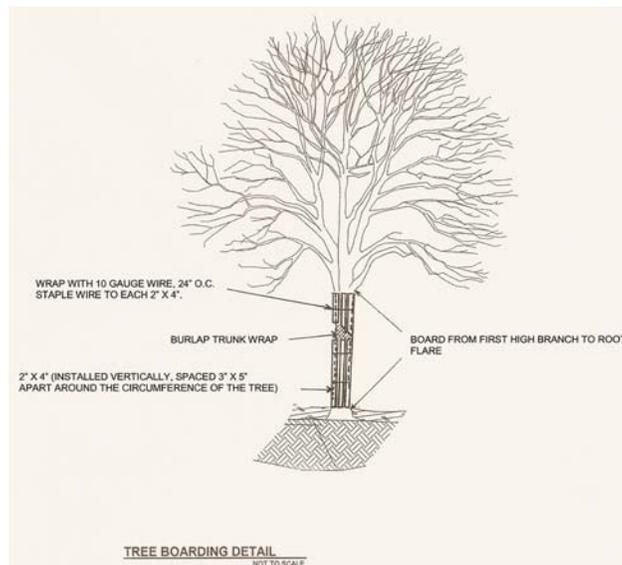
For trees situated within a **narrow planting strip**, only the planting strip shall be enclosed with the required chain link or wood protective fencing in order to keep the sidewalk and street open for public use. For trees **situated near buildings**, partial fencing may be necessary.

3. Type III Tree Protection

Trees situated in a small tree well or **sidewalk planter pit**, or when construction will come within five (5) feet of a trunk, shall have the trunk protected with strapped-on planking to a height of eight (8) feet or to the limits of lower branches. During installation of the wood slats, caution shall be used to avoid damaging any bark or branches. Major scaffold limbs may also need protection as directed by the City Administrator.

Illustration 2-4: Example of trunk protection – done when CRZ is less than an 8 foot diameter, upon approval by the City Administrator.

From: Burditt – Urban Forestry Consultants



d. Duration

Tree fencing shall be erected before demolition, grading, or construction begins and remain in place until the certificate of occupancy has been granted. Removal of the fence during construction must be approved by the City Administrator. **Fence removal without the approval of the City Administrator will result in a stop work order.**

e. 'Warning' sign

A warning sign shall be posted on each section of fence or every one hundred (100') feet of fence and state in both English and Spanish the following: 'TREE PROTECTION ZONE – NO ACCESS BY ORDER OF THE CITY OF SHENANDOAH ADMINISTRATOR'. Durable signs are recommended with a minimum size of 8"x11".

2.4. TREE PRUNING, TREE SURGERY, AND REMOVAL PRIOR TO CONSTRUCTION

2.4.1. Pruning

Prior to construction, various trees may require that branches be pruned clear from structures, activities, building encroachment or may need to be strengthened by means of mechanical support or surgery per approval of City Administrator. The most compelling reason to prune is to develop a strong, safe framework and tree structure. Cosmetic pruning is left to the discretion of the owner. Consult an urban forester or landscape architect for best practices if cosmetic pruning is desired. However, practices such as limbing up should be avoided.

Heavy pruning just after the spring growth flush should be avoided. This is when trees have just expanded a great deal of energy to produce foliage and early shoot growth. Removal of a large percentage of foliage at this time can stress the tree.

a. All trees except oak (Recommended):

Most routine pruning to remove weak, diseased, or dead limbs can be accomplished at any time during the year with little effect on the tree. As a rule, growth is maximized and wound closure is fastest if pruning takes place between November and March in the Southeast Texas Area.

b. Pruning limitations:

1. **Minimum Pruning** – If the project urban forester or landscape architect recommends that trees be pruned, and the type of pruning is left unspecified, the standard pruning shall consist of 'crown cleaning' as described below. Trees shall be pruned to reduce hazards and develop a strong, safe framework.
2. **Maximum Pruning** – Maximum pruning should only occur in the rarest situation and be approved by the City Administrator. No more than one fourth (25 percent) of the functioning leaf and stem area may be removed within one calendar year of any protected tree. It must be recognized that trees are individual in form and structure, and that pruning needs may not always fit strict rules. The project urban forester or landscape architect shall assume all responsibility

for special practices that vary from the standards outlined in this manual.

3. **Tree Workers** – Pruning shall not be attempted by construction or contractor personnel, but shall be performed by a certified arborist.
4. **Types of Pruning – (See Illustration 2-5)**
 - i. **Cleaning:**

The removal of dead, dying, diseased, crowded, weakly attached, and low-vigor branches from the crown of a tree.
 - ii. **Thinning:**

The selective removal of branches to increase light penetration and air movement through the own. Thinning opens the foliage of a tree, reduces weight on heavy limbs, and helps retain the tree's natural shape.
 - iii. **Raising:**

Removes the lower branches from a tree in order to provide clearance for building, vehicles, pedestrians, and vistas.
 - iv. **Reduction:**

Reduces the size of a tree, often for clearance for utility lines. Reducing the height or spread of a tree is best accomplished by pruning back the leaders and branch terminals to lateral branches that are large enough to assume the terminal roles (at least 1/3 the diameter of the cut stem). Compared to topping, this helps maintain the form and structural integrity of the tree.
5. **Making Proper Pruning Cuts**
 - Tree topping is prohibited and may result in tree replacement.
 - Stub cuts are prohibited.
 - Cuts will be made just beyond the outer edge of the collar of live wood. See illustration 2-6 for an example.
 - To reduce potential of oak wilt infections, all pruning cuts on oak trees during the months of April, May or June shall be covered with a thin coat of water-based black paint.
 - If a large limb is to be removed, its weight should first be reduced. This is done by making an undercut about 12-18 inches from the limb's point of attachment. A second cut is made from the top, directly above or a few inches further out on the limb. This removes the limb leaving the 12-18 inch stub. The stub is removed by cutting back to the branch collar. This technique reduces the possibility of tearing the bark.

Illustration 2-5: Types of crown pruning
 From: *International Society of Arboriculture*

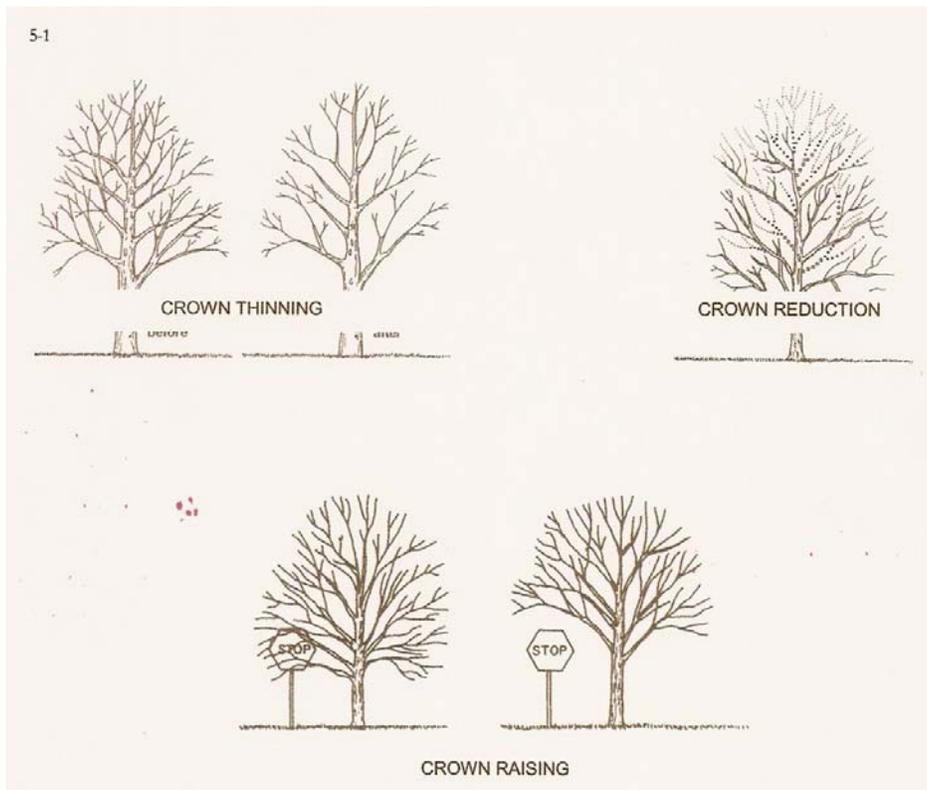
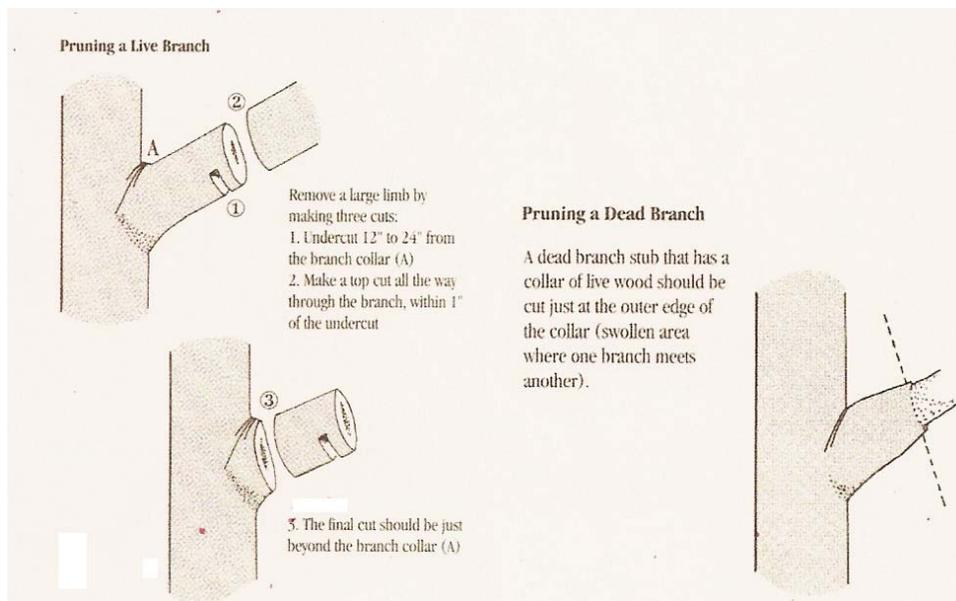


Illustration 2-6: Proper tree cuts
 From: *International Society of Arboriculture*



2.4.2. Tree Surgery

If it is necessary to promote health and prolong useful life or the structural characteristics, trees shall be provided the appropriate treatments (e.g. cavity screening, bark tracing, wound treat, cables, rods or pole supports) as specified by the project urban forester or landscape architect.

2.4.3. Tree Removal Adjacent to Protected Trees

When trees are removed and adjacent trees must be protected (as shown on the approved site plans), then the following tree removal practices apply:

- a. **Tree Removal** – Removal of trees that extend into the branches or roots of protected trees shall not be attempted by demolition or construction personnel, grading or other heavy equipment. A certified arborist or tree worker shall remove the tree carefully in a manner that causes no damage above or below ground to trees that remain.
- b. **Stump Removal** – Before performing stump extraction, the developer shall first consider whether or not roots may be entangled with trees that are to remain. If so, these stumps shall have their roots severed before extracting the stump. Removal shall include the grinding of stump and roots to a minimum depth of 12-inches.

2.5. ACTIVITIES DURING CONSTRUCTION & DEMOLITION NEAR TREES

Soil disturbance or other injurious and detrimental activity within the CRZ is prohibited unless approved by the City Administrator. If an injurious event inadvertently occurs, or soil disturbance has been specifically conditioned for project approval, then the following mitigation is required:

2.5.1. Soil compaction

If compaction of the soil occurs, it shall be mitigated as outlined in Section 2.5.5.

2.5.2. Grading limitations within the Critical Root Zone

- Grade changes within the CRZ are not normally permitted.
- If grading within the CRZ is approved, grading shall be done by hand or with small equipment to minimize root damage.
- Grade changes outside the CRZ shall not significantly alter drainage to the tree.
- Grade changes under specifically approved circumstances shall not allow more than three (3) inches of fill soil added or allow more than three (3) inches of existing soil to be removed from natural grade unless mitigated.
- Grade fills over three (3) inches or impervious overlay shall incorporate an approved permanent aeration system, or other approved mitigation.
- Grade cuts exceeding three (3) inches shall incorporate retaining walls or an appropriate transition equivalent.

Illustration 2-7: Options in tree preservation due to grade change
 From: *City of Austin*

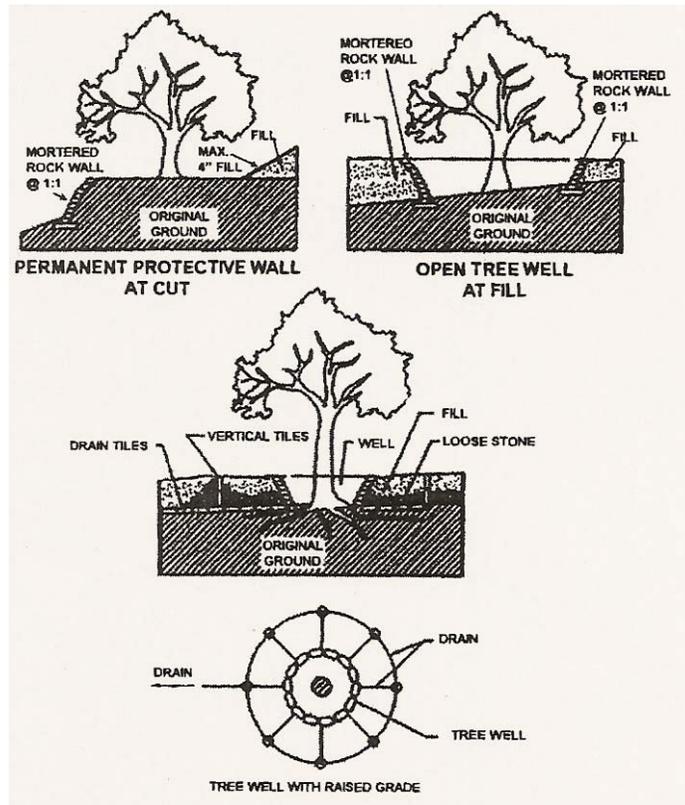


Illustration 2-8: Changing grade around tree trunk by grading or fill. Trees which have too high or a grade during or after construction will lack the root flare.
 From: *A Guide to Preserving Trees in Development Projects*

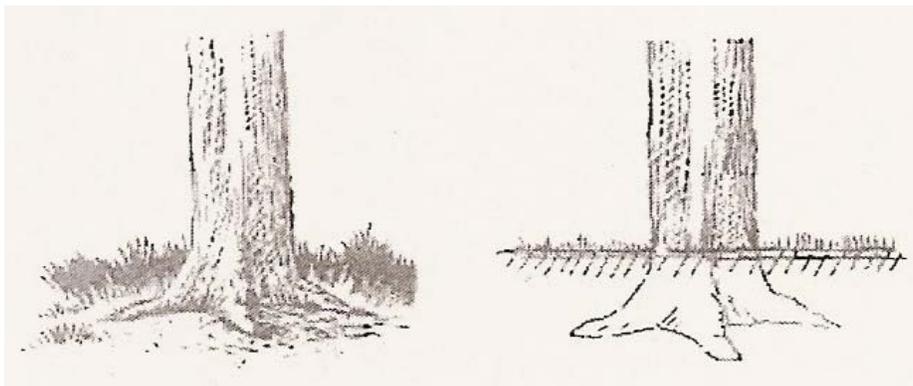
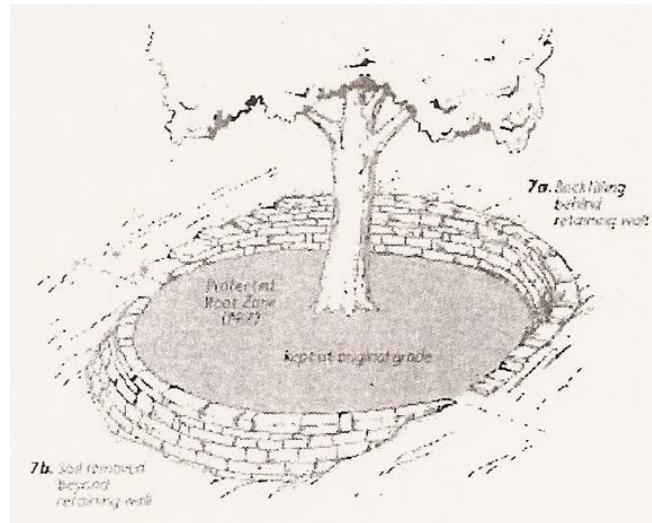


Illustration 2-9: Using retaining walls when natural grade must be raised or lowered.

From: *Building Greener Neighborhoods*



2.5.3. Trenching, excavation and equipment use

Normally, trenching is allowed outside of the CRZ. Trenching, excavation or boring activity within the CRZ is restricted to the following activities, conditions and requirements if approved by the City Administrator. Mitigating measures shall include prior notification to and direct supervision by the project urban forester or landscape architect.

- a. Notification. Contractor shall notify the project urban forester or landscape architect a minimum of 24 hours in advance of the activity in the CRZ. As noted above, the project urban forester or landscape architect must notify the City Administrator before any work begins in the CRZ.
- b. Root Severance. Roots that are encountered shall be pruned flush with the soil. Backfill root areas with good quality top soil within the same day. If exposed root areas are not backfilled within the same day, cover them with organic material in a manner which reduces soil temperatures and minimizes water loss due to evaporation.
- c. Excavation. Any approved excavation, demolition or extraction of material shall be performed with equipment sitting outside the CRZ. Methods permitted are by hand digging, hydraulic air excavation technology.

If excavation or trenching for drainage, utilities, irrigation lines, etc., it is the duty of the contractor to tunnel under any roots 1-inches in diameter and greater.

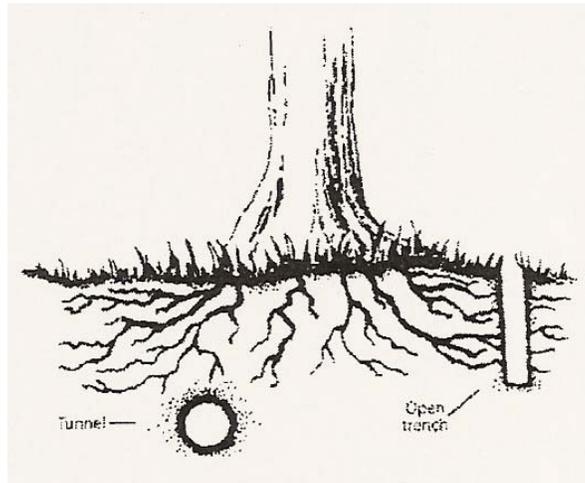
Prior to excavation for foundation/footings/walls, grading or trenching within the CRZ, roots shall first be severed cleanly one (1) foot outside the CRZ and to the depth of the future excavation. The trench must then be hand dug and roots pruned with a saw, narrow trencher with sharp blades or other approved root pruning equipment.

- d. Heavy Equipment. Use of backhoes, steel tread tractors or any heavy vehicles within the CRZ, plans shall specify a design or special foundation, footing, walls, concrete slab or pavement designs subject to City

Administrator approval. Discontinuous foundations such as concrete pier and structural grade beam must maintain natural grade (not to exceed a 3-inch cut), to minimize root loss and allow the tree to use the existing soil.

Basement excavations shall be designed outside the CRZ of all protected trees and shall not be harmful to other mature or neighboring property trees.

Illustration 2-10: Trenching and boring options illustrated.
 From: *Conserving Wooded Areas in Developing Communities*



2.5.4. Tunneling and directional drilling

If tunneling or pipe installation has been approved within the CRZ, the trench shall be either cut by hand, air-spade, hydraulic vac-on excavation, or by mechanically boring the tunnel under the roots with a horizontal directional drill and hydraulic or pneumatic air excavation technology. In all cases, install the utility pipe immediately, backfill with soil and soak with water within the same day. Installation of private utility improvements shall be tunnel bored beneath the tree and roots per Trenching Tunneling and Distance Table in Illustration 2-11.

Emergency utility repairs shall be exempt from the above restriction zones within the CRZ. The City Administrator shall be contacted after any such repairs that may result in significant tree damage or removal.

Illustration 2-11: Trenching and boring distances.
 From: *Tree Technical Manual Standards and Specifications*

| TRENCHING DISTANCE | |
|--------------------------------|--|
| ↔↔ | |
| Tree diameter at 54 inches is: | Trenching will be replaced with boring if the CRZ is being encroached. |
| | CRZ |
| 8-19" | 8'-19' |
| 20"+ | 20'+ |
| DEPTH OF TUNNELING | |
| ⊖⊖ | |
| Tree Diameter | Depth of Tunneling |
| 9" or less | 2.5' |
| 10-14" | 3' |
| 15-19" | 3.5' |
| More than 19" | 4.0' |

2.5.5. Construction impact mitigation

A mitigation program is required if the approved development will cause drought stress, dust accumulation, or soil compaction to trees that are to be saved. To help reduce impact injury, one or more of the following mitigation measures shall be implemented and supervised by the project arborist or landscape architect as follows:

- a. Irrigation program – Irrigate or water weekly or as scheduled by City Administration with 10-gallons of water per diameter inch within the CRZ. Duration shall be until project completion or when seasonal rainfall begins.
- b. Dust control program – During periods of extended drought, wind or grading, spray wash trunk, limbs and foliage to remove accumulated construction dust.
- c. Soil compaction damage – Compaction of the soil is the largest killer of trees on construction sites due to suffocation of roots and ensuing decline of tree health. If compaction occurs to the upper 12-inches of soil within the CRZ by any means, then one or more of the following mitigation measures shall be implemented.
 - i. Type I Mitigation. IF an approved paving, hardscape, or other compromising material encroaches within the CRZ, an aeration system shall be designed by the project urban forester and landscape architect and used within this area (subject to approval by the City Administrator).
 - ii. Type II Mitigation. IF inadvertent compaction of the soil has occurred within the CRZ, the soil shall be loosened by one or more of the following methods to promote favorable root conditions: vertical mulching, soil fracturing, core-venting, radial trenching or other method approved by the City Administrator.

2.6. DAMAGE TO TREES

2.6.1. Reporting

Any damage or injury to trees shall be reported the same day to the project urban forester, landscape architect, job superintendent or City Administrator so that mitigation can take place. All mechanical or chemical injury to branches, trunk or roots over 1-inch in diameter shall be reported. In the event of injury, the following mitigation and damage control measures shall apply:

- a. Root injury: If trenches are cut and tree roots 1-inch or larger are damaged they must be cleanly cut back to a sound wood lateral root. The end of the root shall be sawed off with a clean cut. All exposed root areas within the CRZ shall be backfilled or covered the same day. Exposed roots may be kept from drying out by temporarily covering the roots and draping layered burlap or carpeting over the upper 2-feet of trench walls.
- b. Bark or trunk wounding: Current bark tracing and treatment methods shall be performed by a certified arborist tree care specialist within 24 hours.

- c. Scaffold branch or leaf canopy injury: Remove broken or torn branches back to an appropriate branch capable of resuming terminal growth within five days. If leaves are heat scorched from equipment exhaust pipes, consult the project urban forester or landscape architect the same day.

2.6.2. *Penalty for damage to protected trees*

In the event that protected trees or their roots have been damaged, replacement may be required if the City Administrator deems that the trees need to be replaced. Damaged trees will be replaced according to Section 3.1109 of the Ordinance.

2.7. PAVEMENT AND HARDSCAPE CONFLICTS WITH TREE ROOTS

Conflicts may occur when tree roots grow adjacent to paving, foundations, sidewalks or curbs (hardscape). Improper or careless extraction of these elements can cause severe injury to the roots and instability or even death of the trees. The following alternatives must first be considered before root pruning within the CRZ of a protected tree.

2.7.1. *Removal and replacement of pavement or sidewalk*

- a. Removal of existing pavement over tree roots shall include the following precautions: Break hardscape into manageable pieces with a jackhammer or pick and hand load the pieces onto a loader. The loader must remain on undisturbed pavement or off exposed roots. Do not remove base rock that has been exploited by established absorbing roots. Apply untreated wood chips over the exposed area within one hour, then wet the chips and base rock and keep moist until overlay surface is applied.
- b. Replacement of pavement or sidewalk: An alternative to the severance of roots greater than 1 – inch in diameter should be considered before cutting roots. If an alternative is not feasible, remove the sidewalk and grind roots only as approved by the City Administrator. Use a wire mesh reinforcement if within 10-feet of the trunk of a protected tree.

2.7.2. *Alternative methods to prevent root cutting (Recommended)*

The following remedies should be considered before cutting tree roots that may result in tree instability or decline:

- a. Grinding a raised sidewalk edge.
- b. Ramping the walking surface over the roots or lifted slab with pliable paving.
- c. Routing the sidewalk around the tree roots.
- d. Inflexible paving or rubberized sections.
- e. On private property, new sidewalk or driveway design should offer alternatives to conventional pavement and sidewalk materials. Substitute permeable materials for typical asphalt or concrete overlay, sub-base or footings to consider are: permeable paving materials, interlocking pavers, flexible paving, wooden walkways, porches elevated on posts and brick or flagstone walkways on sand foundations.

2.7.3. *Avoiding conflict (Recommended)*

Conflicts and associated costs can be avoided or reduced by the following planting practices:

- Plant deep rooted trees that are proven to be non-invasive.
- Over soil that shrinks and swells, install a sidewalk with higher strength that has wire mesh and/or expansion slip joint dowel reinforcement.
- Follow soil loosening planting techniques to promote deep rooting.
- Install root barrier only along the hardscape area of the tree (but allow roots to use open lawn or planter strip areas).

2.7.4. Alternative base course materials (Recommended)

When designing hardscape areas near trees, the project architect or engineer should consider the use of recommended base course material such as an engineered structural soil mix. Structural soil mix will allow a long term cost effective tree and infrastructure compatibility that is particularly suited for the following types of development project: repair or replacement of sidewalk greater than 40-feet in length; subdivisions with new street tree plantings; planting areas that are designed over structures or parking garages; confined parking lot median and islands or other specialized conditions as warranted.

SECTION 3: TREE REMOVAL, REPLACEMENT, PLANTING, AND MAINTENANCE STANDARDS

3.1. INTRODUCTION

A protected tree may not be removed without City review and approval, except in certain emergencies. The purpose of City review is to verify that the removal is allowed under the Ordinance, and to prevent unnecessary tree removal. This section discusses conditions for tree removal, replacement or protected trees, planting and pruning of replacement trees, and maintenance.

3.2. TREE REMOVAL

3.2.1. *Allowable removal*

Tree removal is approved as part of the subdivision and site plan process, or in the case of individual trees, through the tree removal permit process. These three processes are defined in the Ordinance. ***A tree removal must be granted, or a site or subdivision plan with a tree survey and replacement plan approved, before removing a protected tree regardless of the condition of the tree.***

3.2.2. *Protected Tree Removal Permit Application*

Tree removal applications are available at the City of Shenandoah City Administration Office. The form is required ONLY when a request for tree removal originates with an owner of fully developed land, including a single family house under construction. All other requests for removal of protected trees take place during the subdivision and site development processes as defined in the Ordinance.

An application for a Protected Tree Removal Permit shall be processed within fifteen (15) working days from the date the application is received.

3.3. TREE REPLACEMENT PLAN

Replacement requirements are defined in the Ordinance, and are limited to protected trees. It is important to note that tree replacements during the site plan process will be addressed in both the Tree Protection Ordinance and the Landscape Ordinance. Whichever ordinance requires the greatest number of tree replacement inches, that is the ordinance which will be followed in terms of the number of inches to be replaced. The tree requirements of both ordinances will not be added up. See Section 98-157 of the Ordinance for the types of replacements that are required dependent on lot size and development status.

In selecting trees to be replaced, the types of trees removed will be replaced with the same or similar species. Each replacement tree shall be a minimum of three inches (3") caliper, a minimum of ten feet (10') in height, and a minimum of five (5) feet in spread when planted. Illustration 3-1 shows the type of information required on a tree replacement plan.

The Tree Replacement Plan will include four elements: (1) a table including the common or Latin name; tree size in caliper inches, height, and spread; tree symbols; quantity; and if the tree is considered large, medium, or small; (2) a tree planting plan (may be combined with the Landscape Plan); (3) proper tree planting details including planting hole, tree planting, staking, and mulching; and, (4) notes on proper tree planting as described in section 3.7 of this Manual.

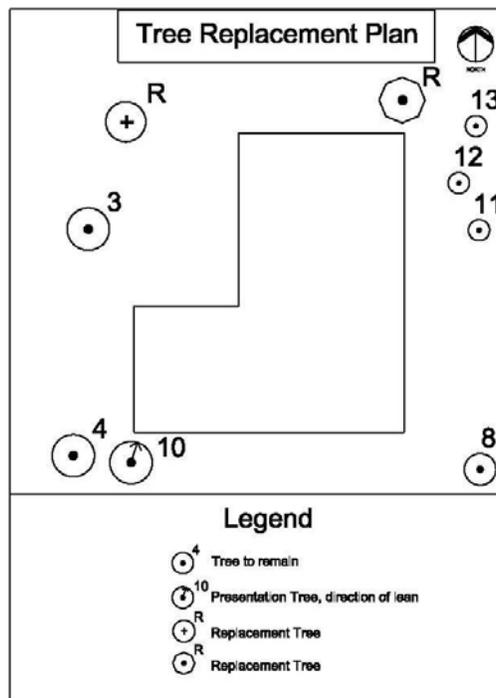
Illustration 3-1 shows the type of information required on a tree replacement plan.

Illustration 3-1: Tree replacement plan

From: Burditt – Urban Forestry Consultants

| Symbol | # of Trees | Species | Size |
|---|------------|---------------------------------------|---|
|  | 1 | Pecan <i>Caraya illinoensis</i> | 3" caliper 10'-12' high 5' spread |
|  | 1 | Live Oak <i>Quercur virginiana</i> | 4" caliper 10'-12' high 5' spread |

Required Replacement: 7 inches
 Total provided replacement:
 2 trees (1-3" cal + 1-4" cal.) = 7 inches
 Designed with (R)



3.4. TREE PLANTING REQUIREMENTS

3.4.1. Species

The replacement trees shall be the same or similar species unless the City Administration determines that another species would be more suitable for the location or if there is a need to promote diversity of species. Factors to be considered include the long term health of the tree in the location and its compatibility with adjacent uses as well as design considerations.

If the City Administration deems it necessary to plant species other than those that were removed, the following issues will be considered.

Street trees: On any four hundred foot (400') length of street, a single species of tree may be planted. On a length of street greater than four hundred feet (400'), no more than twenty percent (20%) of the total number of trees shall be of one species.

Non-street areas: For plantings in non-street areas (parking lots for example), no more than 20 percent (20%) of the total number of trees planted may be of one species. Exceptions must be approved by the City Administration.

The above restrictions are designed to avoid creating monocultures, or areas of plantings made up of only one species of trees. Monocultures are undesirable because if a certain species is prone to a particular disease or is more susceptible to storm damage or temperature extremes, then it is likely the entire stand could die or be destroyed by a single disease or weather event. Creating planting areas of several species creates a more diverse, and therefore more resistant, urban forest.

Chinese Tallow shall not be planted along city streets due to damaging surface roots and the possibility of causing damage to sidewalks, utilities and curbs. These trees also have short lifespans, weak wood, and susceptibility to disease and insects.

With the exceptions noted above, other species shall be chosen from the City of Shenandoah approved tree list provided in Appendix B of this Manual.

3.4.2. *Planting distances/spacing requirements:*

- a. Minimum distance between newly planted trees
Large sized trees: 40 ft;
Medium sized trees: 30 ft; and,
Small sized trees: 20 ft
- b. Minimum distance from any underground utility, water meter boxes, and fire hydrant: 10 feet
- c. Distance from trees to curb, sidewalk, or driveway: Minimum 10 feet.
- d. Planting strips should be a minimum of 10 ft wide or as indicated for corner lots in Landscape Ordinance Section 98-118(4).
- e. Minimum distance from buildings and similar structures:
Large size tree: 30 ft;
Medium size tree: 20 ft; and,
Small size tree: 10 ft
- f. Minimum distance from overhead utility lines. Trees cannot be planted under utility lines. In order to avoid future interference of limbs, planting may take place as follows:
Large trees: 30 feet from line;
Medium trees: 20 feet from line; and,
Small trees: 10 feet from line
- g. From curb line of an intersection: 25 feet, or by Code, which ever is greater.

- h. Minimum distance from stop or yield signs: 20 feet or by Code, which ever is greater.
- i. Distance from directional traffic sign: 10 feet or by Code, which ever is greater.
- j. Distance from street lights: 25 feet, or by Code, which ever is greater.

Tree selection shall take into consideration ordinance requirements for height clearances as defined in the Code. As they grow, trees will need to be pruned to provide pedestrian clearance of at least 8 feet over sidewalks, and vehicular clearance of 14 feet over streets.

Variations from requirements listed above must be approved by the City Administration.

3.5. TREE STOCK AND MATERIALS

3.5.1. Quality

It is the contractor's responsibility to supply tree stock that meets ANSI 760.1-1996 and any other standards addressed in this Manual.

- All trees installed within the City of Shenandoah shall conform with the *American Standard for Nursery Stock*.
- Trees shall be sound, healthy, vigorous, and free of plant disease and insect pests or their damage.
- Container grown trees shall be grown for a least 8-months in containers in which delivered and shall not be root bound or have girdling roots. The root ball will be moist and the roots will be contained within the container.
- Trees shall not have been topped or headed.
- The tree will have healthy leaves if it is the time of year for trees to have leaves.
- There will be no weeds growing out of the container.
- If the tree is multi-stemmed, the stems will not be squeezing against each other or the trunk of the tree.
- Trees with broken tops, branches, injured trunks, poor structure, low branching, poor vigor, and apparent poor quality shall be rejected and the City Administration has the right to reject them if they do not meet the quality standards.

3.5.2. Container grown/ball and burlapped trees

Trees can be effectively planted that are container grown or balled and burlapped (B & B). The advantage to planting container grown trees is that they can be planted year round, provided there is good follow up care. B & B trees require planting during the dormant season (November to April).

Recommendations: Regardless, due to the advantages of container trees, it is recommended that container grown trees be used during all times of the year.

3.5.3. Miscellaneous materials

The following materials shall be used unless otherwise specified:

- Tree stakes. Metal T-posts shall be used.
- Tree Ties. Tree ties may include one of two types. The first is a 10 gauge wire, cushioned with a rubber hose around the trunk. The wire should not touch the trunk. The second is a plastic chain lock, also called twist brace.
- Mulch. All newly planted trees should be mulched with 2-4 inches of organic mulch. Mulch should never be placed against the trunk of a tree. There should be a space of 1-2 inches between the trunk and mulch. Mulch should cover the entire tree planting hole. No volcano mulching is allowed.
- Tee guards. For trees in turf areas requiring regular mowing and/or weed eating, the tree trunk shall be protected with TreeGuard or equivalent.
- Tree gates. Where sidewalk width is less than 8-feet and new trees will be installed in a tree well, metal tree grates may be used and approved by the City Administration. Minimum size grates shall be 4' x 4' unless specified otherwise. All tree grates shall be mounted in frames, frames inset into a concrete foundation within the sidewalk or surface material, and shall be flush with the surrounding surface.

3.6. PLANTING SITE PREPARATION

3.6.1. *Soil preparation and conditioning*

All debris, wood chips, pavement, concrete and rocks over 2-inches in diameter shall be removed from the planting pit to a minimum of 24-inch depth, unless specified otherwise.

3.6.2. *Planter pit preparation*

- *Trees in a confined planter pit or sidewalk area:* The planting hole shall be excavated to a minimum of 30-inches deep x the width of the exposed area. Scarify the sides of the pit. Soil beneath the rootball shall be compacted to prevent settling.
- *Trees in all other areas*
 - a. Mark out a planting area 2 to 5 times wider than the rootball diameter (the wider the better). Loosen this area to about an 8" depth. This will enable your tree to extend a dense mat of tiny roots well out into the soil in the first one to ten weeks in the ground.
 - b. Remove all soil from on top of the root flare before planting so the root flare is visible. The top of the root ball should be several inches above surrounding soil or approximately 10% of the root ball is above the landscape grade. This prevents roots from being planted too deep (root flare remains above ground) and aids in establishment, even if the root ball should settle. The handle of a shovel can be used to gauge appropriate planting height.

3.6.3. *Drainage*

Adequate drainage must be provided to the surrounding soil for the planting of new trees. If the trees are to be planted in impermeable or infertile soil and water infiltration rates are less than two (2) inches an hour, then one of the following drainage systems or other approved measures must be implemented:

- French drain, a minimum of three feet in depth

- Drain tiles or lines beneath the trees
- Auger six drain holes at the bottom perimeter of the planting pit, at a minimum of four (4) inches in diameter, twenty-four (24) inches deep and filled with medium sand or fine gravel

3.6.4. **Aeration tubes for trees**

- Trees planted in sidewalk planter pits, planting strip, parking islands, or medians shall use 4-inch diameter perforated aeration piping (rigid or flexible), circling the bottom of the planter connected to a 'T' fitting to two riser tubes with grated caps with filter fabric. This detail shall be shown on the approved landscape plans.

3.7. PLANTING THE TREE

After the hole has been prepared as described in Section 3.6 above, the tree is ready to be planted.

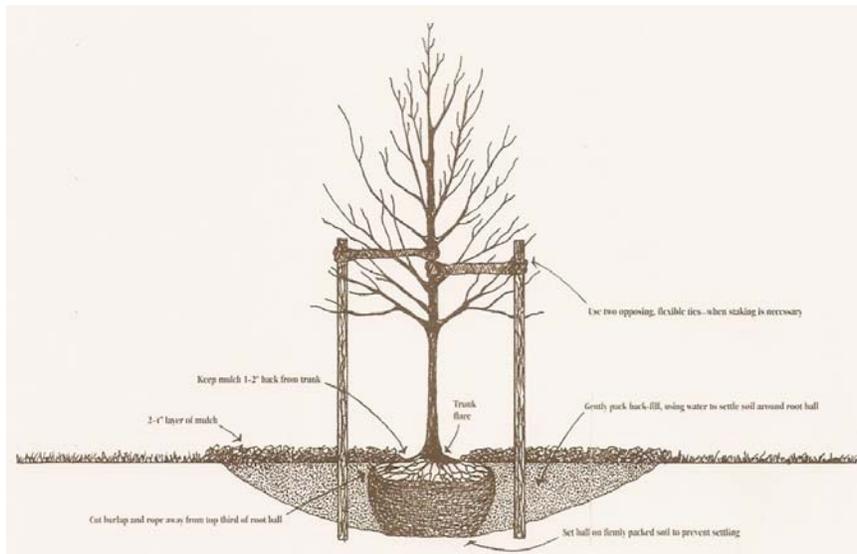
3.7.1. **Container grown tree**

Pull the container away from the root ball. Don't pull the tree out by its trunk. Container grown trees often have circling or girdling roots running along the edge of the rootball. If they exist in this area, cut them and spread them apart. Place the root ball in the center of the hole and adjust the tree so it is straight and at the proper level. Make any adjustments prior to filling the hole with dirt.

3.7.2. **Ball and burlapped tree**

Rest the root ball in the center of the hole, and reshape the hole so the tree will be straight and at the proper level. After adjusting the tree, pull the burlap and any other material away from the sides and top of the root ball. Do not remove the burlap from the bottom. If you adjust or lift the tree after the burlap has been removed you run the risk of damaging the root system.

Illustration 3-2: Tree planting detail graphic



3.7.3. Backfill soil, amended soil

Backfill with the original soil unless the original soil has been removed or the soil is poor. If soil must be amended, consult with a landscape architect or urban forester in identifying the most appropriate soil mix.

3.7.4. Filling the hole

Fill until the hole is half full. Flood the hole with a slow hose or tamp gently with your foot to firm the soil. Repeat until the hole is full. Do not press too firmly-only firm enough to hold the tree upright. Backfilling with soil and water or gently tamping will remove large air pockets.

3.7.5. Constructing a berm

A berm should be construction from soil or mulch to hold water ONLY IF the tree will be watered with a hose or other high volume device. If irrigation will be from a low volume system or if little or no irrigation will be applied, do not bother with the berm. No more water will reach the root ball under these circumstances if a berm is present. The potential downsides of the berm include cutting off rainwater and oxygen when personnel later push the berm over the rootball.

3.7.6. Mulching

Cover the entire loosened area of soil with 2 to 3 inches of mulch composed of shredded wood or bark in the entire planting area. Mulch will be placed one to two inches away from the trunk of the tree.

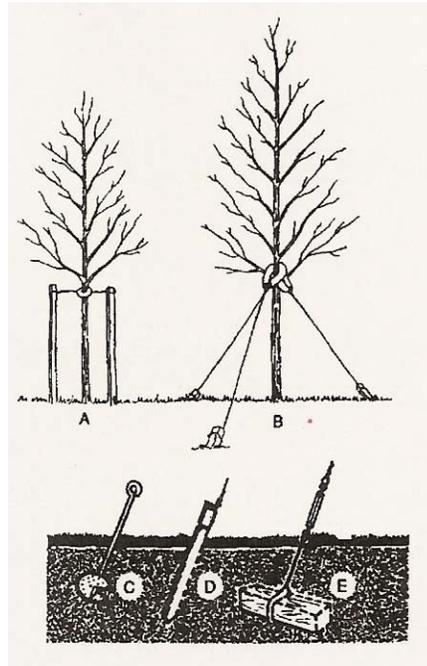
3.7.7. Staking or guying

Stake trees only if necessary, and remove staking as soon as is possible. Staking or guying is to prevent movement of the lower trunk and root system. Movement of the top is desirable and will strengthen the tree. The stakes will be installed 12-18 inches in undisturbed soil outside of the planting hole. Depending on height and size of the tree, stakes shall be six, eight, or ten feet tall. Trees shall be staked with 3 metal T-posts. Metal stakes will not rub against tree trunks. Tree ties will be located near the lowest main branch on the tree. Check a staked or guyed tree monthly during the growing season and after storms or strong wind. Use wide strips attached loosely around the trunk. Do not stake a tree any longer than necessary. One or two growing seasons is all that is needed.

Illustration 3-2 and 3-3 show the proper staking and guying techniques. In Illustration 3-3 A, trees 3-4 inches in diameter are supported by three stakes. Branches should not rub against the stakes. For trees over four (4) inches, guy wires should be used, with a minimum of three guys. Cable or wire is attached to the tree by running wires through a piece of hose or by using lag hooks on large trees. The guys should be secured to arrowhead-shaped land anchors (C), wooden stakes (D), or deadmen buried in the soil (E).

Illustration 3-3: Staking and Guying Trees

From: *Principles and Practice of Planting Trees and Shrubs*



3.8. PRUNING NEWLY PLANTED TREES

Young trees are pruned to allow for proper growth through the years. If the tree is of high quality, it should need little pruning. If is no longer common practice to automatically trim a certain percentage of limbs from a newly planted tree. The tree needs as much foliage as can be available to assure rapid growth and solid leaf structure. This includes refraining from “limbing up” and topping.

3.8.1. Prohibitions

Topping trees – tree replacement may be required if this is done
Limbing up trees (the practice of cutting the lowest branches to a desired height)

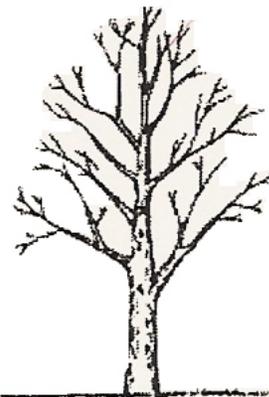
3.8.2. Pruning guidelines (Recommended)

Scaffolding / permanent branches. Identify the scaffolding/permanent branches. The lowest permanent branch should have a diameter of one-half or less of the trunk diameter where the branch attaches to the trunk. The vertical spacing of permanent scaffold branches should equal a distance equal to 3% of the tree’s eventual height. Thus, a tree that will be 50 feet tall should have permanent scaffold branches spaced about 18 inches apart along the trunk. Avoid allowing two scaffold branches to arise one above the other on the same side of the tree. Maintain radial balance with branches growing outward in each direction.

3.8.3. *Limb removal (Recommended)*

The following may be removed.

- a. Torn, damaged, dead branches. Remove the branch just outside of the branch collar. See Illustration 2-6.
- b. Double Leaders: Maintain a dominant trunk for at least six to eight feet without a major fork. If the trunk divides into two or more relatively equal stems, favor one strong stem and remove the others. Cut one stem back to a lateral branch.
- c. Rubbing Branches: Eliminate branches that are rubbing or will soon rub against another branch.
- d. Crowding: Give each branch room to grow with minimal competition for sunlight. When possible, have major lateral branches evenly spaced eight to ten inches apart along the trunk. If the tree by its nature would lose too much foliage in the process of eliminating crowding, maintain at least half the foliage on branches in the lower 2/3 of the tree.
- e. Narrow Branch Angles/Included Bark: Remove one branch if the angle is 40% or narrower or if it appears that the bark from the branch is becoming pinched between the branch and the trunk.
- f. Sprouts and Suckers. Remove sprouts and suckers.
- g. Temporary Branches: Leave temporary branches that are not competing with permanent, scaffolding branches.



Select strong permanent scaffold branches that are spaced 12-18 inches apart.

3.9. TRANSPLANTING TREES

Transplanting large trees is difficult, expensive, and requires expertise and equipment. Pre-approval from the City Administration and periodic inspections will be required for the transplanting of a protected tree. Such trees will be under warranty as if it is a new tree, and will need to follow replacement requirements should the tree die or severely decline. When transplanting protected trees eight (8) inches and larger from existing landscapes it is important to select healthy, vigorous trees, dig an appropriate size root ball, select a site that is consistent with the tree's cultural needs, provide a saucer shaped planting hole approximately three times the root ball width, and then protect the root ball, trunk, and crown during lifting, transportation, and storage. The most important and hardest part in tree transplanting is creating and implementing a multi-year aftercare program, providing adequate moisture to the root ball.

When a tree is dug for transplanting, as much as 90% of its root system is left behind, severed in the process of digging for transplanting. The tree has a hard time relying on 5-10 percent of its root system doing the work of the 90 percent that was lost. Until it is well established, the root system will have difficulty supplying enough water to the leaves. This stress impacts vigor of the tree and also exposes the tree to the risk of being vulnerable to pests and diseases, as well as less able to adapt to or withstand drought, extreme cold, and drying winds.

The following issues should assist in providing a successful transplanting. Considering the size of the protected trees being transplanted, a professional arborist is required to assist in the process.

- **Site** – Before transplanting make sure the tree is a good match for the new site.
- **Timing** – Recommended timing for transplanting trees is during the dormant season, when the tree is not trying to support its leafy crown.
- **Health of tree** – Select a tree that is in good health and shape and has no major defects in its trunk branch structure.
- **Success rate** – Different species have different success rates in transplanting. Consult with your urban forester on the success rate of the tree you want to transplant.
- **Tree size** – Most commonly transplanted trees range in size from 4-12 diameter inches.

Transplanting process –

Digging up the tree –

Dig up a wide root ball with appropriate depth and wrap burlap material with wire and twine to save as much of root ball as you can intact.

A rule of thumb for trees over six inches in diameter is that a root ball = 10 inches in diameter for every tree trunk diameter measured at 4 ½ feet above the ground (see Chapter 2 for a discussion on measuring the tree diameter in unusual situations). In other words, a 10 inch tree should have a 100 inch diameter. Likewise, the ball depth should be about 60% of the ball diameter. The same 10 inch tree should have a 60 inch depth.

While smaller trees can be transplanted using a tree spade or other specialty equipment/techniques, larger trees will require mechanical digging equipment and appropriate hoists and heavy equipment for moving the tree.

Transporting the tree –

During transportation the tree crown should always be covered with tarp to protect the tree from drying out and windburn.

After transplanting –

Keep the root ball moist at all time.

Anticipate watering three times a week, or in every hot weather every day.

Continued watering will be required for several years.

Do not prune newly transplanted trees to reduce crown and compensate for root loss. That will only further weaken the tree.

Mulch the transplanted tree with 2-4 inches of organic mulch to cover root ball.

The process of regenerating a normal root system will take several years, especially for large trees. Immediately after transplanting, the tree will be susceptible to extreme stress. Moisture is a critical factor in new root growth. Compacted soils and soil temperature also impact the growth of roots.

(Abridged from "Transplanting Trees", by Patrice Peitier and Gary W. Watson. *Arbor Age*, January-March 2000.)

3.10. IRRIGATION PLAN

COMMERCIAL PROPERTIES:

The following requirements are mandatory for all tree replacement plantings.

An automatic irrigation system will be installed or a watering schedule approved by the City Administration. Tree irrigation shall not share the same irrigation zone, including valves and circuits, as shrubs and plants due to different watering requirements. A minimum of one (1) bubbler or sprayer each shall be provided for all newly planted trees. Trees larger than 4 inches in caliper shall have 2 bubblers or sprayers. Bubblers or sprayers shall be located between 1-2 feet from the trunk.

All automatic irrigation systems shall be equipped with an electronic controller capable of dual or multiple programming. Controller(s) shall have multiple cycle start capacity and a flexible calendar program, including the capability of being set to water every five days. All automatic irrigation systems shall be equipped with a rain and freeze sensor shut-off device.

The irrigation system must be designed and sealed by a licensed irrigator.

Watering schedule and methods

Newly planted trees will be watered weekly for the first two years. Ten (1) gallons per caliper inch will be applied weekly. During June-September trees will be watered more frequently, or at least during each permitted watering day (every five days).

Irrigation plans need to be submitted prior to final inspection.

RESIDENTIAL PROPERTIES (RECOMMENDED):

Trees placed on residential properties are not required to have irrigation systems. When irrigation systems do not exist, trees need to be hand watered.

- Keep the soil moist but no soaked. Water trees at least once a week at the rate of 10 gallons per caliper inch, unless it has rained, and more frequently during hot weather. When the soil is dry below the surface of the mulch, it is time to water. Continue watering weekly during the winter if there is no rain. Continue watering newly planted trees for two years in this manner.
- Water the area within the dripline. A soaker hose is ideal as it can water a greater area at one time and does not need to be moved as often.

3.11. MAINTENANCE

All newly planted trees shall be maintained by the owner. Maintenance practices shall consist of all regular and normal maintenance of trees, including but not limited to irrigation, pruning, and disease control. Plant material that exhibits severe levels of insect or pest infestation, disease and/or damage, shall be approximately treated, and all dead trees shall be removed and replaced with living trees where required according to the city approved Tree Replacement Plan for the site.

Failure to replace dead or diseased trees within thirty (30) days of written notification by the City shall constitute a violation of the Ordinance.

SECTION 4: ADMINISTRATION, INSPECTION, AND ENFORCEMENT

4.1. ADMINISTRATION

The Ordinance and the standards in this Manual will be administered and updated by the City Administration. Refer to Section 98-161 of the Ordinance for more information.

4.2. INSPECTION

4.2.1. *Inspection by owner*

The project urban forester or landscape architect retained by the applicant shall conduct the following required inspections of construction sites containing protected trees. Inspections shall verify that the type of tree protection and/or plantings are consistent with the standards outlined within this Manual. For each required inspection or meeting, a written summary of the changing tree related conditions and actions taken shall be provided to the City Administration.

- a. Construction Meeting. Prior to commencement of construction, the applicant or contractor shall conduct a pre-construction meeting to discuss tree protection with the job site superintendent, grading equipment operators, project urban forester or landscape architect, and City Administration. At this time all tree protection fencing approved in the permit plans must be installed correctly.
- b. Inspection of Rough Grading. The project urban forester or landscape architect shall perform an inspection during the course of rough grading adjacent to the CRZ to ensure trees will not be injured by compaction, cut or fill, drainage and trenching, and if required, inspect aeration systems, tree wells, drains and special paving. The contractor shall provide the City Administration at least 48 hours advance notice of such activity.
- c. Monthly Inspections. The project urban forester or landscape architect shall perform monthly inspections to monitor changing conditions and tree health. The City Administration shall be in receipt of an inspection summary if there are any changes to the approved plans, tree health conditions, or protection measures. If the City Administration is not in receipt of inspection summaries prior to final inspection, he will assume that no change in tree conditions have occurred in the field during construction.
- d. Special activity within the Critical Root Zone. Work in this area (CRZ) requires that direct onsite supervision of the project urban forester or landscape architect.
- e. Landscape Architect Inspection. Prior to the issuing of the certificate of occupancy, the applicant or contractor shall contact the landscape architect to perform on site inspection of all plant stock, quality of the materials and planting and that the irrigation is functioning consistent with the approved construction plans. The City shall be in receipt of a letter of compliance from the landscape architect prior to scheduling the final inspection, unless otherwise approved.

4.2.2. *Inspection by city representative*

There are four inspections performed by the City Administration as described in Section 3.1112 (2) of the Ordinance. They include the following:

- a. Site inspection at the site development plan or preliminary plat submittal.
- b. Tree fencing inspection and other tree preservation measures.
- c. Unscheduled site visits during construction.
- d. Final inspection.

4.3. ENFORCEMENT

The Ordinance and the standards in this Manual are enforced by the City Administration. Enforcement is described in Section 98-161 of the Ordinance.

APPENDIX A: DEFINITIONS

For the purposes of this Manual the following definitions apply. Additional definitions may be found in the Ordinance.

Certified Arborist is an individual who has demonstrated knowledge and competency through obtainment of the current International Society of Arboriculture arborist certification, or who is a member of the American Society of Consulting Arborists.

Compaction means compression of the soil structure or texture by any means that creates an upper layer that is impermeable. Compaction is injurious to roots and the health of a tree.

Dangerous tree see Hazardous tree.

Dead Tree means a tree that is dead or that has been damaged beyond repair or is in an advanced state of decline (where an insufficient amount of live tissue, green leaves, limbs or branches, exist to sustain life) and has been determined to be such by a certified arborist. If the tree has been determined to be dead, removal is permitted as defined in the ordinance.

Disturbance refers to all of the various activities from construction or development that may damage trees.

Excessive Pruning means removing in excess, one-fourth (25 percent) or greater, of the functioning leaf, stem or root area. Pruning in excess of 25 percent is injurious to the tree and is a prohibited act. Excessive pruning typically results in the tree appearing as a 'bonsai', 'lion's-tailed', 'lolly-popped', or overly thinned.

Unbalanced Crown. Excessive pruning also includes removal of the leaf or stem area predominantly on one side, topping, or excessive tree canopy or crown raising. Exceptions are when clearance from overhead utilities or public improvements is required or to abate a hazardous condition or a public nuisance.

Roots. Excessive pruning may include the cutting of any root two (1) inch or greater in diameter and/or severing in excess of 25 percent of the roots.

Hazardous Tree refers to a tree that possesses a structural defect which poses an imminent risk if the tree or part of the tree that would fall on someone or something of value (target). Structural defect means any structural weakness or deformity of a tree or its parts. A tree with a structural defect can be verified to be hazardous by a urban forester and confirmed as such by the City Administration. The City Administration retains discretionary right to approve or amend a hazardous rating, in writing, and recommend any action that may reduce the condition to a less-than significant level of hazard. If the tree has been determined to be hazardous, removal of the tree is permitted as provided for in the Ordinance.

Injury means a wound resulting from any activity, including but not limited to 'excessive pruning', cutting, trenching, excavating, altering the grade, paving or compaction within the tree protection zone of a tree. Injury shall include bruising, scaring, tearing or breaking of roots, bark, trunk, branches or foliage, herbicide or poisoning, or any other action foreseeably leading to the death or permanent damage to tree health.

Manual means this Tree Technical Manual: Standards and Specifications.

Project Urban Forester means a consultant retained by a property owner or development applicant for the purpose of overseeing on-site activity involving the welfare of the trees to be retained. The project urban forester shall be responsible for all reports, appraisals, tree preservation plans, or inspections as required.

Protective Tree Fencing means a temporary enclosure erected around a tree to be protected at the boundary of the tree protection zone. The fence serves three primary functions: (1) to keep the foliage crown, branch structure and trunk clear from direct contact and damage by equipment, materials, or disturbances; (2) to preserve roots and soil in an intact and non-compacted state; and (3) to identify the tree protection zone in which no soil disturbance is permitted and activities are restricted.

Root Buffer means a temporary layer of material to protect the soil texture and roots. The buffer shall consist of a base course of tree chips or mulch spread over the root area to a minimum of 6-inch depth.

Site Plan means a set of drawings (e.g. preliminary drawings, site plan, grading, demolition, building, utilities, landscape, irrigation, tree survey, etc.) that show existing site conditions and proposed landscape improvements, including trees to be removed, relocated or to be retained. Site plans shall include the following minimum information that may impact trees:

- Surveyed tree location, species, size, dripline area (including trees located on neighboring property that overhang the project site) and protected trees within 30-feet of the project site.
- Paving, concrete, trenching and grade change located within the tree protection zone.
- Existing and proposed utility pathways.
- Surface and subsurface drainage and aeration systems to be used.
- Walls, tree wells, retaining walls and grade change barriers, both temporary and permanent.
- Landscaping, irrigation and lighting within dripline of trees, including all lines, valves, etc.
- Location of other landscaping and significant features.
- All of the final approved site plan sheets shall reference tree protection instructions.

Soil Compaction means the compression of soil particles that may result from the movement of heavy machinery and trucks, storage of construction materials, structures, paving, etc. within the tree protection zone. Soil compaction can result in atrophy of roots and potential death of the tree, with symptoms often taking 3 to 10-years to manifest.

Soil Fracturing means the loosening of hard or compacted soil around a tree by means of a pneumatic soil probe that delivers sudden bursts of air to crack, loosen or expand the soil to improve the root growing environment.

Target is a term used to include people, vehicles, structures or something subject to damage by a tree.

Note: A tree may not be a hazard if a “target” is absent within the falling distance of a tree or its parts (e.g., a defective tree in a non-populated area away from pathways may not be considered a hazard)

Trenching means any excavation to provide irrigation, install foundations, utility lines, services, pipe, drainage or other property improvements below grade. Trenching within the CRZ is injurious to roots and tree health and is prohibited, unless approved. If trenching is approved within the CRZ, it must be in accordance with instructions and table outlined in this Manual.

Verification of Tree Protection means the project urban forester shall verify, in writing, that all pre-construction conditions have been met (tree fencing, erosion control, pruning, etc.) and are in place. An initial inspection of protective fencing and written verification must be submitted to the City Administration prior to demolition, grading or building permit issuance.

Vertical Mulching means augering, hydraulic or air excavation of vertical holes within a tree’s root zone to loosen and aerate the soil, typically to mitigate compacted soil. Holes are typically

penetrated 4- to 6- feet on center, 2- to 3- feet deep, 2- to 6-inches in diameter and backfilled with either perlite, vermiculite, peat moss or a mixture thereof.

APPENDIX B: TREE LIST

LIST OF APPROVED TREES FOR PLANTING IN THE CITY OF SHENANDOAH

LARGE TREES – EVERGREEN (50' + HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|-------------------|-----------------------------|-------------------------------|------------------|
| Southern Magnolia | <i>Magnolia grandiflora</i> | 3" – 6" Caliper | Accent |
| Loblolly Pine | <i>Pinus taeda</i> | 3" – 6" Caliper | Group planting |
| Live Oak | <i>Quercus virginiana</i> | 3" – 6" Caliper | Group planting |

MEDIUM TREES – EVERGREEN (25' – 50' HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|--------------------|-------------------------------|-------------------------------|------------------|
| Dahoon Holly | <i>Ilex cassine</i> | 3" – 4" Caliper | Accent |
| American Holly | <i>Ilex opaca</i> | 3" – 4" Caliper | Accent |
| East Palatka Holly | <i>Ilex x attenuata</i> | 3" – 4" Caliper | Accent |
| Savannah Holly | <i>Ilex opaca x attenuata</i> | 3" – 4" Caliper | Accent |
| Eastern Redcedar | <i>Juniperus virginiana</i> | 3" – 4" Caliper | Screen |
| Cherry Laurel | <i>Prunus caroliniana</i> | 3" – 4" Caliper | Screen |

SMALL TREES – EVERGREEN (Under 25' HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|-----------------------|---|-------------------------------|------------------|
| Youpon Holly | <i>Illex yomitoria</i> | 3" – 4" Caliper | Screen |
| Southern Wax Myrtle | <i>Myrica ceirfera</i> | 3" – 4" Caliper | Screen |
| Loquat | <i>Eriobotrya japonica</i> | 3" – 4" Caliper | Accent |
| Little Gem Magnolia | <i>Magnolia grandiflora</i> 'Little Gem' | 3" – 4" Caliper | Accent |
| Texas Mountain Laurel | <i>Sophora secundiflora</i> | 3" – 4" Caliper | Accent |

LARGE TREES – DECIDUOUS (50' + HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|-------------------|--------------------------------|-------------------------------|----------------------------|
| Pecan | <i>Carya illinoensis</i> | 3" – 4" Caliper | Street |
| Bald Cypress | <i>Taxodium distichum</i> | 3" – 6" Caliper | Specimen, Groups |
| Sweetgum | <i>Liquidambar styraciflua</i> | 3" – 6" Caliper | Street, Fall color |
| Mexican Sycamore | <i>Platanus mexicana</i> | 3" – 6" Caliper | Plaza, Street, Parking lot |
| Southern Red Oak | <i>Quercus falcata</i> | 3" – 6" Caliper | Fall color, Street |
| Water Oak | <i>Quercus nigra</i> | 3" – 6" Caliper | Street, Parking lot |
| Willow Oak | <i>Quercus phellos</i> | 3" – 6" Caliper | Plazas |
| Shumard Oak | <i>Quercus shumardi</i> | 3" – 5" Caliper | Groups, Fall color |
| Bur Oak | <i>Quercus macrocarpa</i> | 3" – 6" Caliper | Street |
| Chinquapin Oak | <i>Quercus muehlenbergii</i> | 3" – 6" Caliper | Specimen |
| Cedar Elm | <i>Ulmus crassifolia</i> | 3" – 6" Caliper | Group planting |
| Chinese Pistache | <i>Pistacia chinensis</i> | 3" – 6" Caliper | Accent |
| Chinese Elm | <i>Ulmus parvifolia</i> | 3" – 6" Caliper | Accent |
| Montezuma Cypress | <i>Taxodium mucronatum</i> | 3" – 6" Caliper | Accent |

| | | | |
|---------------|-------------------------------|-----------------|--------|
| Red Maple | <i>Acer rubrum</i> | 3" – 6" Caliper | Accent |
| Green Ash | <i>Fraxinus pennsylvanica</i> | 3" – 6" Caliper | Accent |
| White Oak | <i>Quercus alba</i> | 3" – 6" Caliper | Accent |
| Sawtooth Oak | <i>Quercus acutissima</i> | 3" – 6" Caliper | Accent |
| Laurel Oak | <i>Quercus laurifolia</i> | 3" – 6" Caliper | Accent |
| Overcup Oak | <i>Quercus lyrata</i> | 3" – 6" Caliper | Accent |
| Nuttall Oak | <i>Quercus nutallii</i> | 3" – 6" Caliper | Accent |
| Monterrey Oak | <i>Quercus polymorpha</i> | 3" – 6" Caliper | Accent |

MEDIUM TREES – DECIDUOUS (25' – 50' HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|---------------------------|--------------------------------|-------------------------------|------------------|
| River Birch | <i>Betula nigra</i> | 3" – 6" Caliper | Accent |
| Brandford Pear | <i>Pyrus calleryana</i> | 3" – 6" Caliper | Accent |
| Aristocrat Flowering Pear | <i>Pyrus calleryana</i> | 3" – 6" Caliper | Accent |
| 'Aristocract' | | | |
| Golden-Rain Tree | <i>Koelreuffria paniculata</i> | 3" – 6" Caliper | Accent |

SMALL TREES – DECIDUOUS (Under 25' HT.)

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|------------------|-------------------------------|-------------------------------|------------------|
| Redbud | <i>Cercis canadensis</i> | 3" – 4" Caliper | Accent |
| Fringe Tree | <i>Chionanthus virginicus</i> | 3" – 4" Caliper | Accent |
| Dogwood | <i>Cornus florida</i> | 3" – 4" Caliper | Accent |
| Parsley Hawthorn | <i>Crataegus marshalli</i> | 3" – 4" Caliper | Accent |
| Crape Myrtle | <i>Lagerstroemia spp.</i> | 6' – 10' HT. | Grouping |
| Mexican Plum | <i>Prunus mexicana</i> | 3" – 4" Caliper | Accent |
| Purple Leaf Plum | <i>Prunus cerasifera</i> | 3" – 4" Caliper | Accent |
| Saucer Magnolia | <i>Magnolia soulangiana</i> | 3" – 4" Caliper | Accent |

SHRUBS – LARGE

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|------------------------|--------------------------------|-------------------------------|------------------|
| Mediterranean Fan Palm | <i>Chamaerops humilis</i> | 14 gal. – box | Accent plant |
| Laurel-leaf Cocculus | <i>Cocculus laurifolius</i> | 2 gal. – 5 gal. | Group |
| Pampas Grass | <i>Cortaderia sellonna</i> | 5 gal. – B&B | Accent – groups |
| Waxleaf Ligustrum | <i>Ligustrum texanum</i> | 30" – 48" HT. | Screen |
| Banana Shrub | <i>Michelia figo</i> | 5 gal. B&B | Accent |
| Oleander | <i>Nerium oleander</i> | 2 gal. – 5 gal. | Screen |
| Rodtip Photinia | <i>Photinia x fraseri</i> | 5 gal. | Screen |
| Chinese Photinia | <i>Photinia serratifolia</i> | 5 gal. B&B | Accent – screen |
| Pittosporum | <i>Pittosporum tobira</i> | 2 gal. B&B | Screen |
| Yew Podocarpus | <i>Podocarpus macrophyllus</i> | 3' – 6' HT. | Accent – screen |
| Japanese Viburnum | <i>Viburnum japonicum</i> | 5 gal. | Screen |
| Sandankwa | <i>Viburnum suspensum</i> | 2 gal. – 5 gal. | Screen |
| Suspensum | | | |
| Shiny Xylosma | <i>Xylosma congestum</i> | 2 gal. – 5 gal. | Screen |

SHRUBS – MEDIUM AND SMALL

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|-----------------------------|---|-------------------------------|------------------------|
| Cleyera | <i>Cleyera japonica</i> | 2 gal. – B&B | Accent, screen |
| Sago Cycad | <i>Cycas revoluta</i> | 1 gal. – B&B | Accent |
| Dwarf Chinese Holly | <i>Ilex cornuta</i> 'Dwarf Chinese' | 1 gal. – 5 gal. | Mass grouping, borders |
| Dwarf Yaupon Holly | <i>Ilex vomitoria</i> 'Nana' | 1 gal. – 5 gal. | Mass grouping, borders |
| Primrose Jasmine | <i>Jasminum mesnyi</i> | 1 gal. – B&B | Screening |
| Italian Jasmine | <i>Jasminum humile</i> | 1 gal. – B&B | Mass grouping |
| Dwarf Crape Myrtle | <i>Lagerstroemia indica</i> 'Petite Snow' | 1 gal. – 5 gal. | Mass grouping |
| Heavenly Bamboo | <i>Nandina domestica</i> 'Compacta' | 1 gal. | Mass grouping, borders |
| Dwarf Oleander | <i>Nerium oleander</i> 'Dwarf Pink' | 1 gal. – 5 gal. | Protected areas |
| Dwarf Pittosporum | <i>Pittosporum tobira</i> 'Wheelers Dwarf' | 1 gal. – 2 gal. | Mass grouping |
| Indian Hawthorne | <i>Raphiolepis indica</i> | 1 gal. – 2 gal. | Mass grouping, accent |
| Azalea | <i>Rhododendron spp.</i> | 1 gal. – 5 gal. | Mass grouping |
| Andorra Creeping Juniper | <i>Juniperus horizontalis</i> 'Andorra' | 1 gal. – B&B | Mass grouping |
| Cast Iron Plant | <i>Aspidistra elatior</i> | 1 gal. | FS |

GROUNDCOVER AND VINES

| Common Name | Scientific Name | Recommended Size Min - Max | Recommended Uses |
|--------------------------------|---|-------------------------------|------------------|
| Carpet Bugleweed | <i>Ajuga reptans var.</i> | 6" pot | SS, groundcover |
| Sprenger Fern | <i>Asparagus sprengeri</i> | 4" pot – 1 gal. | FP |
| Madam Galen Trumpet Creeper | <i>Campsis taglihuana</i> | 1 gal. – 5 gal. | Vine |
| Holly Fern | <i>Crytomium falcatum</i> | 1 gal. | SS, groundcover |
| Fatshedera | <i>Fatsyendera lixei x</i> | 1 gal. – 5 gal. | SS, accent |
| Aralia | <i>Fatsia japonica</i> | 5 gal. | SS, accent |
| Carolina Jessamine | <i>Gelsemium sempervirens</i> | 1 gal. | DS, vine |
| Algerian Ivy | <i>Hedera canariensis</i> | 4" pot – 1 gal. | SS, groundcover |
| Liriope | <i>Liriope muscari</i> | 4" pot – 1 gal. | SS, groundcover |
| Asian Jasmine | <i>Trachelospermum asiaticum</i> | 4" pot – 1 gal. | SS, groundcover |
| Dwarf Mondograss | <i>Ophiopogon japonicus</i> 'Nanaus' | 4" pot – 1 gal. | SS, groundcover |

APPENDIX C: BIBLIOGRAPHY

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