
Appendix A
Definitions

Appendix A. Definitions

American National Standards Institute (ANSI) Standards

ANSI is a private, non-profit standards organization that serves as a facilitator for the standardization work of its members in the United States. It accredits standards developing organizations (SDOs) that meet a set of requirements and criteria governing the management of consensus standards development. Accredited SDOs can submit candidate documents to ANSI for consideration and approval as American National Standards (ANS). ANSI's goal is to promote and facilitate voluntary consensus standards and conformity assessment systems and maintain their integrity.

Basal Area

The basal area is the cross-section area of the stem or stems of a plant or of all plants in a stand, generally expressed as square units per unit area.

Cabling/Bracing

Cabling and bracing are processes that restore or improve the structural integrity of a tree that is worth preserving. Individual limbs or the entire tree may be cabled and braced. Fasteners are attached to the weakened limb and the main trunk. Using ropes or chains, tension is applied to the weakened limb. Heavy-duty cables are then prepared and attached to each fastener to provide the correct amount of support for the weakened limb.

Central Leader

The central leader is the topmost vertical stem extending from the trunk.

Certified Arborist

A *Certified Arborist* is an individual who has achieved a level of knowledge in the art and science of tree care through at least three years' experience and who has passed a comprehensive examination developed by some of the nation's leading experts on tree care. A *Certified Arborist* must also continue his/her education to maintain his/her certification. Therefore, he/she should be up-to-date on the latest techniques in arboriculture. Certification is not a measure of standards of practice. Certification can attest to the tree knowledge of an individual, but cannot guarantee or ensure quality performance.

Codominant Leader and Stems

Codominant leaders and stems is a tree condition that occurs when two or more branches, trunks, or leaders of approximately the same size originate in close proximity to one another.

Condition Rating

Rating tree condition involves looking at the tree crown, foliage, trunk, and root characteristics. The condition of each tree is rated according to the following categories:

Excellent

Trees in this class are judged to be exceptional trees possessing the best qualities of their species. They have excellent form and very minor maintenance problems. There are virtually no dead branches, deformities, or nutritional problems. These trees are in an acceptable location and can be expected to achieve a full mature shape and life expectancy.

Good

Trees in this class are judged to be desirable and with proper maintenance can be returned to an excellent classification. They may be interfering with utility lines, planted in an overcrowded location, or have minor insect, pathogen, or nutritional deficiencies.

Fair

Most trees in this category have some or all of the following problems: large dead limbs with as much as one-half of the tree already dead, large cavities in the trunk, major deformities, girdling roots, obvious insect, pathogen, or nutritional problems. Immediate maintenance and proper care may be able to save the tree.

Poor

Trees in this group are in a degraded condition with irreversible problems. They have over 50% dead branches, drastic deformities, and severe insect, pathogen, or nutritional problems. They will have to be removed as soon as possible.

Dead

Trees in this category are either already dead or in such poor condition that removal is required. These trees have over 90% dead branches and have completely succumbed to either insects, pathogens, or nutritional deficiencies. It is important to conduct the installation tree inventory after spring growth has begun. This ensures that a dormant tree is not misidentified as dead.

Coniferous

Coniferous trees are those that are in or related to any order (Coniferales) of mostly evergreen trees and shrubs including forms (as pines) with true cones and others (as yews) with an arillate fruit.

Conservation Easement

A conservation easement is a restriction placed on a piece of property to protect its associated resources. Conservation easements protect land for future generations while allowing owners to retain many private property rights and to live on and use their land, at the same time potentially providing them with tax benefits.

Critical Root Zone

The critical root zone is the soil area around a tree where the roots are located that provides stability and a significant uptake of moisture.

Cultivar

A cultivar is a race or variety of a plant that has been created or selected intentionally and maintained through cultivation.

Diameter at Breast Height (DBH)

The DBH is the internationally accepted method of measuring tree diameter. Measurements are taken on the trunk of the tree 4.5 feet from the ground.

Deciduous

Deciduous trees or other plants lose their leaves at some time during the year and stay leafless during the cold season.

Double Leader

A double leader occurs when two stems compete as leading stems on a tree.

Genus

Genus is a taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

Geographic Information Systems (GIS)

GIS is a technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework.

GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to give you a better understanding of how it all interrelates. You choose what layers to combine based on your purpose.

Global Positioning Systems (GPS)

GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

Grow Space

A tree's grow space is the room needed for a plant's leaves and roots to grow.

Growth Habit

The growth habit of a tree describes its growth form, comprising its size, shape, texture, and orientation.

Integrated Pest Management

Integrated pest management is an approach that relies primarily on non-chemical means (such as controlling climate, food sources, and building entry points) to prevent and manage pest infestation.

Low-impact Development (LID)

Low-impact development is a more environmentally sensitive approach to developing land and managing stormwater runoff. The main objective of low impact development is to help protect aquatic resources, water quality, and the natural hydrology of a watershed as development takes place.

Maintenance Rating

Tree maintenance requirements can be categorized in one of six categories:

Removal—High Priority

Trees categorized as high-priority removals should be removed as soon as possible as their condition and location present risks to persons or property.

Removal—Low Priority

Low-priority removals should be scheduled and accomplished when resources are available after high-priority removals have been accomplished. These trees are generally located away from population areas and facilities.

Pruning—Immediate Priority

Like high-priority removal, trees in the immediate pruning category present safety risks to persons or property. Trees in this category are characterized by dangerous broken branches and large deadwood. Pruning should be accomplished as soon as resources are available. All trees in this category should be examined closely during trimming operations for decay or severe dieback. If, upon closer inspection, these trees are severely decayed, they should be removed.

Pruning—High Priority

Trees requiring high-priority pruning should be attended to as quickly as scheduling will allow, starting with those presenting the greatest safety risks. These trees, like the immediate priority pruning category, have broken branches and areas of deadwood. The dead areas, however, do not present an immediate safety hazard to persons or property. All trees in this category should be examined closely during trimming operations for decay or severe dieback. If, upon closer inspection, these trees are severely decayed, they should be removed.

Routine Pruning

All other trees, except young and recent plantings, fall into the routine pruning category. They require removal of dead, dying, diseased, or obviously weak, heavy, or hazardous branches, and deadwood. Routine, ongoing pruning should be scheduled and programmed to ensure all tree pruning is accomplished on a minimum cycle of five to seven years. It is important to remember that low priority problems can become high priority if they are neglected for an extended period of time. Thinning of tree canopies to reduce crossing or unnecessary branches should be accomplished routinely. This reduces the potential for wind and ice-induced branch breakage and increases sunlight and air circulation within the crown. Thinning of tree canopies reduces substantially the incidence of insect and disease related problems.

Training Pruning

Trees in this category are generally young, recent plantings. Minimum maintenance includes trimming root and trunk suckers, deadwood, crossing, diseased, or weak branches, and staking improvement or removal. Trees in this category need to be scheduled for maintenance and not neglected. Generally, young trees should be pruned to reflect their species' natural growth pattern or to a single leader or a strong central leader to promote the development of strong scaffold limbs. Certain species do not develop single leaders; therefore, the strongest leaders should be selected and allowed to shape the tree canopy. It is important to remember that minor problems can become major if they are neglected for an extended period of time.

Monoculture

A monoculture is a single, homogenous culture of species lacking diversity across a population or area.

Native Species

A native species is one which naturally exists at a given location or in a particular ecosystem, *i.e.*, it has not been moved there by humans.

Non-native Species

Species that occur outside of their native ranges in a given place as a result of actions by humans are non-native species.

Overmature

Trees or stands past the mature stage are overmature.

Residential Cluster Development

Residential cluster development is a means of permanently protecting open space, rural character, and important environmental resources in new housing developments, while still providing homeowners with good housing and landowners with the opportunity to develop their property.

Right-of-Way

The right-of-way is a strip of land over which facilities, such as highways, railroads, or power lines, are built.

Risk Tree

A risk tree has structural defects likely to cause failure of all or part of the tree, which could strike a target.

Routine/Preventive Maintenance

Routine/preventive maintenance work is planned and performed on a routine basis to maintain and preserve the condition of trees.

Species

Species is a fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding. An organism belonging to such a category, represented in binomial nomenclature by an uncapitalized Latin adjective or noun following a capitalized genus name.

Stocking Level

The number of trees in an area as compared to the desirable number of trees for best results, such as maximum wood production.

Tax Increment District (TID)

A TID uses property and/or sales tax revenues in a designated area to enable private development to occur.

Traffic Calming Device

Traffic calming devices are used to calm traffic on residential streets to enhance neighborhood livability. Some examples of these devices are speed humps, stop signs, crosswalks, traffic signals, and enforcing speed limits.

Transplanting

Trees within the urban forest may be affected as the result of proposed construction. In these cases, the choices are to remove or transplant the tree. Trees in good condition under 20 centimeters DBH should be transplanted if expertise, equipment, and funding are available. The long-term benefits of transplanting a quality tree usually outweigh the transplanting costs. Transplanting can be accomplished using a tree spade or by back-hoe and chain. A large, protected root ball and immediate replanting greatly improves transplant success. This will lessen transplant shock and dehydration greatly enhancing survival rates. In most regions, transplanting is most successful when performed in the fall. Transplanted trees must receive constant attention for at least six months or more depending on the season and climate. Extra irrigation, root

stimulators, special fertilizers, and expert pruning contribute to the success and survival of a transplanted tree.

Tree Bank

A tree bank is a special account created to deposit funds from various sources, which are restricted for use by the urban forestry program. The funds in this account are managed by the Town, subject to the annual budget process, and expenditures follow normal purchasing policies and procedures.

Tree Mitigation Site

A tree mitigation site is typically a publicly owned property, such as a school or public park, or a site permanently protected with a conservation easement where a developer can donate and plant the required trees when it is not feasible to plant the required trees within their site's project area.

Urban Forest Canopy Cover

The urban forest canopy cover is a measurement of how much of an urban area is covered by the leaves in the crown of its trees. Communities use this measure to set tree planting goals to ensure green infrastructure is maintained at minimum thresholds, even as the community continues to develop.

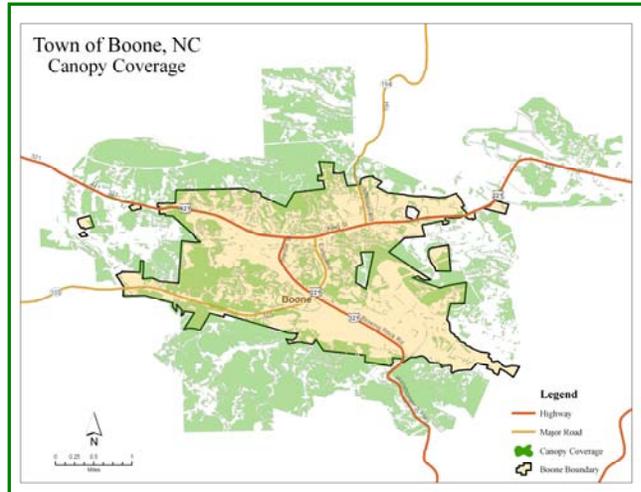
Appendix B
Interview Questions and Project Preview

Urban Forestry Master Management Plan

Town of Boone, North Carolina

Boone has a valuable public and private forest canopy that enhances the ambiance and livability of the Town. The Town recognizes that this urban forest provides a wide variety of benefits including energy savings, increasing property values, improving air quality, and reducing stormwater runoff. Boone is experiencing rapid commercial and residential development that may threaten the quality and size of the urban forest in the near future. The Town also seeks to improve the management of public and private trees and expand its comprehensive urban forest program.

Therefore, the Town has started the process of developing an *Urban Forestry Master Management Plan*. This plan will provide guidance for balancing the built environment with the urban forest, and will discover efficiencies and improvements that can be made to the Town's management practices and operations.



Similar to the Town's process of updating the Land Use Master Plan, the process for developing the Boone *Urban Forestry Master Management Plan* will include fact finding, expert consultant guidance provided by Davey Resource Group, and a collaborative planning process with key stakeholder groups and Town staff. The new plan can then become a compliment to and a component of the Town's newly updated Comprehensive Plan.

Today's action priority is to create the *Urban Forestry Master Management Plan*!

Plan Goals

-  Provide strategies, goals, policies, standards, and actions to protect, enhance, expand, and preserve the tree canopy for the benefit of the community.
-  Coordinate and improve Town tree management in an equitable, economic, and sustainable manner.
-  Provide a valuable strategic planning tool, serve as a roadmap in recovering the loss of tree canopy, and become a part of the town's Comprehensive Plan.



Urban Forestry Master Management Plan, Town of Boone, North Carolina

Proposed Contents of Boone's Urban Forestry Master Management Plan

- A. Executive Summary
- B. Vision Statement
- C. Benefits and Values of the Urban Forest
- D. Management Goals
- E. Limited History
- F. Assessment of Tree Canopy Cover
- G. Review of Existing Regulations
 - 1. Unified Development Ordinance
 - 2. Comprehensive Plan
 - 3. Master Tree Plan
- H. Current Tree Management Structure
 - 1. Planning
 - 2. Public Works
 - 4. State of Public Trees
 - a. Analysis of Tree Inventory
 - b. Way to Maintain Tree Inventory
 - c. Use of GPS
 - d. Health and Structure
- I. Strategies, Goals, Policies, Standards, Actions
 - 1. Management Priorities and Level of Service for Five Program Elements
 - a. Risk Tree Management
 - b. Mature Tree Care
 - c. Young Tree Care
 - d. Tree Planting
 - e. Administration
 - f. Insect and Disease Management
- J. Funding Sources
- K. Tree Preservation for Public and Private Lands
- L. Definitions
- M. Appendices and References

Summary of Tasks to Develop the Plan

Review and analyze urban forestry data, planning policies, development regulations, construction standards, and master plans

Perform on-site assessment of public trees and the Town's urban forest.

Conduct interviews with key stakeholders

Produce a draft of the Plan for review and comment at a public forum

The Plan will address these issues:

- Increased and Prioritized Tree Planting
- Protective Legislation and Policies that Incorporate Smart Growth Principals
- Expanded Education and Public Relations
- Improved Funding and Funding Opportunities
- Improved Urban Forest Management and Maintenance

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For information on existing policy and the draft Town Plan, go to:

<http://www.townofboone.net/> or <http://boone2030.blogspot.com/>

Interviewee:

Position:

Phone:

Interviewer:

Date:

Questions to be answered by all (General):

1. What is **working well** in your urban forestry program?
2. What is **not working** well? What would you like to see changed?
3. What are the biggest **challenges** to your urban forest?
4. Do you have **vision and future goals** for your urban forestry (ignoring current constraints)? How would you put that into words?
5. **What should we see or understand?** Since you are explaining it all to me as an outside consultant, what would be especially important that I get?

QUESTIONS for City Staff:

1. What are the most immediate needs of the Town's tree program?
2. Do you feel that dealing directly with community forestry issues is part of your job responsibilities?
3. How would you prefer the responsibility for urban forestry tasks be organized? Centralized in one department, or decentralized?
4. Do you feel that the Town is adequately staffed to handle all of the community forestry issues that are present? If not, where are you lacking? What positions need to be filled? What existing resources can be tapped? Are there needs for additional training of staff? What about equipment and crew? Does the Town have what it needs in terms of quantity or quality?
5. Would you support a "permit system" for tree planting and maintenance on public trees? Would you support a "permit system" for contractors (plumbers, concrete workers, etc) performing work on streets and sidewalks within the drip line of existing trees?
6. Do you believe that the current ordinances and regulations are adequate to maintain a viable urban forest and canopy cover?
7. What changes, if any, would you propose to the city's ordinances with regard to tree protection?

Questions for Elected Officials

1. Do you believe that the condition and quantity of the public and private urban forest is important for the future quality of life in Boone?
2. How strongly do you think the citizens/voters feel about expanding tree planting, maintenance, and preservation in the Town?
3. By what means do you think the citizens would support increased funding for the urban forestry program?
4. Do you think creating new and stronger development regulations for tree planting and tree preservation during land development would discourage developers and be a detriment to the Town's growth, or be a valuable tool to maintain a good quality of life?

Other Comments:

QUESTIONS for members of Appointed Commissions and Committees:

1. What are the most immediate needs of the Town's tree program?

2. Do you feel that dealing directly with community forestry issues is part of your commission or committee's duties?

3. How would you prefer the responsibility for urban forestry tasks be organized? Centralized in one town department, or decentralized (separate tasks handled by different departments)?

4. Do you feel that the Town is adequately staffed to handle all of the community forestry issues that are present? If not, where are you lacking? What positions need to be filled? What existing resources can be tapped? Are there needs for additional training of staff? What about equipment and crew? Does the Town have what it needs in terms of quantity or quality?

5. Would you support a "permit system" for tree planting and maintenance on public trees? Would you support a "permit system" for contractors (plumbers, concrete workers, etc) performing work on streets and sidewalks within the drip line of existing trees?

6. Do you believe that the current ordinances and regulations are adequate to maintain a viable urban forest and canopy cover?

7. By what means do you think the citizens would support increased funding for the urban forestry program?

QUESTIONS for Citizens / Business Owners (Community Input):

1. Do you believe that the condition and quantity of the public and private urban forest is important for the future quality of life in Boone?

2. What are the most immediate needs of the Town's tree program?

3. How would you prefer the responsibility for urban forestry tasks be organized? Centralized in one town department, or decentralized (separate tasks handled by different departments)?

4. Would you support a "permit system" for tree planting and maintenance on public trees? Would you support a "permit system" for contractors (plumbers, concrete workers, etc) performing work on streets and sidewalks within the drip line of existing trees?

5. Do you believe that the current ordinances and regulations are adequate to maintain a viable urban forest and canopy cover?

6. Do you have suggestions that would make it easier for the public and/or business owners to deal with additional regulations, permits, or fees?

7. Would you support increased funding for the urban forestry program (either by generating funds within the program through increased permits, fees, penalties or by increasing taxes)?

Appendix C
Tree Fertilization, Planting, Prune, Removal Specifications

CITY-WIDE STREET TREE PLANTING SPECIFICATIONS

CITY OF _____, _____

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations, and expertise required to deliver, locate, plant, and guarantee for one year, street trees in the City of _____ as specified herein. Contractor has responsibility to:

- A) Furnish, transport, and plant trees;
- B) Reserve workspace along streets;
- C) Excavate in-place soil, plant, and backfill with topsoil approved by City Administrator;
- D) Furnish and place mulch;
- E) Remove excess material and clean up site;
- F) Guarantee trees for one year and make appropriate replacement planting;
- G) Keep work site safe at all times; and
- H) Any work incidental to above.

II. Definitions

- A) Reference is any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.
- B) Specified means specified in the invitation to bid and/or order or contract.
- C) ANSI Z60.1-Standards are American Standard for Nursery Stock.
- D) City Administrator is the city's representative that will administer the technical aspects of this tree planting contract. The City Administrator for this contract is:

- E) Contractor is a company that earns the majority of its annual revenue from planting or maintaining trees and/or shrubbery. Contractor must possess an I.S.A. Certified Arborist License or Certified Landscapers License or Certificate.

III. Materials Specifications

Mention of any product name neither constitutes an endorsement of that product nor excludes the use of similar products meeting specifications.

- A) Nursery Stock - All trees healthy, vigorous, and well-grown, showing evidence of proper root and top pruning, single-trunked, high-branched specimens suitable for use along streets. All trees 1-3/4 inch caliper unless otherwise noted. All trees grown at least one year in a currently active nursery having same climatic conditions as the City of _____. All trees meet ANSI Z60.1-standards for top grade. Label attached to each tree at nursery indicating botanical name and common name. City Administrator will mark trees in the nursery and has final approval of species or variety used and nursery from which trees are obtained.

- B) Root balls and burlap - All trees balled and burlapped with ball shape and size conforming to ANSI Z60.1 standards. Root flare will be easily visible on root balls. Only rottable burlap and rottable rope permitted. Root balls adequately protected at all times from sun, heat, freezing, and drying. City Administrator will reject any cracked or manufactured root balls.
- C) Mulch - Year-old rough wood chips created by local tree service companies during brush chipping operations.

IV. Work Procedures

- A) Source of supply - Contractor submits to City Administrator, within ten (10) days after receipt of notice of award of contract, complete and detailed information concerning the source of supply for each item of plant material specified in the planting list.
- B) Tree location - All planting sites will be identified and marked by the City Administrator before planting begins. The appropriate utilities services will be notified of planting site locations by Contractor immediately after contract has been awarded. Contractor will also be responsible for notifying the appropriate utility authority prior to digging. Contractor will be responsible for any damage to utilities during the planting process. Sites will be marked by a white flag in the grass area and also with a white mark painted on the curb. All trees will be centered between curb and sidewalk, at least two feet from curb line unless otherwise specified by the City Administrator.
- C) Delivery - Trees shall be transported and handled with adequate protection. Trees shall be covered with burlap or tarpaulin during transit or transported in a closed truck to prevent drying out of the tree. Trees in leaf shall be sprayed before shipping with "Wiltpruf" or other anti-desiccant approved by the City Administrator.
- D) Temporary storage - Root balls of trees not immediately planted after delivery must be adequately protected by mulch or heeling-in and watering until planting occurs. Contractor assumes all risk and expense of temporary storage.
- E) Planting holes - Holes may be dug by hand, backhoe, tree spade, or other approved equipment at specified location. An auger is not considered approved equipment. Walls of the planting hole shall be dug so that they are properly sloped and sufficiently loosened to remove the glazing effects of the digging. The planting hole shall be elliptical in shape with the top diameter two times that of the ball. The bottom of the hole shall be rough, flat, and deep enough to have the plant at its original planting depth or slightly higher. Holes shall be ground only on the day the tree is planted. Contractor is responsible to ensure all holes are safe until planted and covered with mulch.
- F) Precautions during digging - When underground utilities are encountered, Contractor immediately calls the controlling agency or company and the City of _____. The Contractor, at his expense, restores to original condition all structures, facilities, and other property damaged by his company's work.
- G) Surplus excavation - Removed and disposed of by Contractor at his own expense.

- H) Planting - Allowed only between the dates of _____ and _____. Planting is only allowed when the soil is not frozen. Balled and burlapped trees are set on tamped backfill, placing tree at same depth as in nursery or up to two (2) inches higher than that level. Planting height may be adjusted if unusual site situations are encountered after approval by City Administrator. Burlap should be pulled back one-third the depth of the root ball and rope or twine should be cut from trunk. Trees with forked top oriented with forked limbs shall be pointed parallel to street and not toward street. Planting is not allowed on days when temperatures fall below 30° F.
- I) Root pruning - Ends of broken or damaged roots more than 1/4 inch in diameter should be pruned with a clean cut, removing only injured portion.
- J) Backfilling - Planting holes shall be backfilled with approved topsoil. Mix soil amendments in mixture prior to filling the hole to prevent stratification. Incorporate a transplant inoculant that contains water-absorbing material such as polymers, root stimulants, and endo- and ecto-mycorrhizal fungi into the backfill. Backfill sides of the tree hole halfway with soil mixture and tamp as the hole is being filled. Cut and remove all rope, twine, burlap, and wires from the top half of the soil ball. Wire baskets should be cut and removed to a two-inch depth below the soil line. Burlap should be pulled back with one-half of the soil ball exposed after plants are properly placed in the planting hole. Shape backfill and mulch in a water ring to facilitate watering.
- K) Top pruning and wound treatment - Pruning to make trees shapely and typical of species shall be done according to recognized horticultural standards and instructions of the City Administrator. Accidental damage during planting not great enough to warrant branch removal or tree replacement should be promptly traced according to recognized horticultural practices. Pruning paint is not necessary.
- L) Mulching - Place rough wood chips loosely around trees within 24 hours after planting to uniform depth of no more than four (4) inches and to a diameter of three (3) feet where possible.
- M) Extra holes - Excess or improperly located planting holes are to be immediately backfilled and seeded with Kentucky Bluegrass, and covered with two (2) inches of straw, at Contractor's expense.
- N) Watering - Thoroughly water to settle backfill when one-half of backfill is in place and again after all backfill is placed. It is highly recommended that watering continue through the first growing season to increase chances of survival after planting.
- O) Wrapping - Trees are not wrapped unless specified by the City Administrator. If wrapping is required, trunk and wrapping shall be treated with a 20 percent Lindane and water spray. Wrapping is crinkle-draft tree wrapping paper tied with rottable twine.
- P) Productivity - Production schedule beginning and ending dates will be agreed upon in writing between the Contractor and the City Administrator.

- Q) Supervision - Contractor is required to consult with the City Administrator concerning details and scheduling of all work. Contractor shall have a competent person in charge of work at all times to whom the City Administrator may issue directions and who is authorized to accept and act upon such directives. Supervisor calls the City Administrator before each day's work begins to provide work locations by street.
- R) Public relations - An information sheet shall be supplied by the City Administrator to Contractor for distribution to property owner.

V. Substitutions

If a species or variety is used as a substitute with the approval of the City Administrator, the per tree price paid by the City is the lowest of:

- A) The per tree price of the species or variety originally bid on; or
- B) The lowest bid price for the substitute species or variety if it is specified elsewhere in this contract.

VI. Inspections

- A) Nursery inspection - The City Administrator, at its discretion, will inspect and mark nursery stock purchased under this contract before digging.
- B) Agency inspection - Federal, state, and other authorities inspect all trees before removal from nursery, as required by local law. Required certificates declaring trees free of all diseases and insects shall accompany each order or shipment of trees.
- C) Planting inspection - The City Administrator, at its discretion, inspects progress of planting or temporarily stored trees to review the progress of the work and condition of trees.
- D) Guarantee period inspection - The City Administrator inspects planting work to verify completion and begin guarantee period. Contractor requests this inspection in writing at least ten (10) days before its scheduled date. After inspection, the City Administrator notifies Contractor in writing of date of beginning of guarantee period or of deficiencies to correct before guarantee period begins.
- E) Correction inspection - Two months before end of guarantee period, the City Administrator inspects work and notifies Contractor of replacement and other corrections required to make work acceptable.
- F) Final inspection - At end of guarantee period, City Administrator inspects trees to determine final acceptance. Contractor requests this inspection in writing at least ten (10) days before the scheduled date.
- G) Stock inspections - The City Administrator reserves right to inspect trees before they are removed from delivery truck at work site. Delivery truck driver or other agent or Contractor should call the City Administrator's office before leaving for work site each day to facilitate these on-truck inspections.
- H) Other inspections - City Administrator reserves right to inspect on-site work at any time without notice. Contractor calls City Administrator on morning of each working day to provide work location.

VII. Guarantee

Contractor guarantees that all trees remain alive and healthy until the end of a one-(1) year guarantee period. Contractor replaces, as specified, and at his expense, any dead trees and any trees, that in the opinion of the City Administrator, have become unhealthy or unsightly or have lost their natural shape due to dead branches, improper pruning or maintenance, or any other cause due to the Contractor's negligence, or weather conditions. Contractor straightens any leaning trees, bearing the entire cost.

VIII. Rejection

Contractor disposes of any tree rejected by the City Administrator at the Contractor's expense.

IX. Items

Each entry (Street name, estimated number of trees and species) within each section is considered a separate item. The City Administrator reserves the right to delete any item or items because of an inability to obtain specified trees or other reasonable cause.

TREE REMOVAL AND PRUNING SPECIFICATIONS

CITY OF _____, _____

I. Scope of Work

To provide all labor, supervision, equipment, services, and expertise necessary to perform urban forestry maintenance work in the City of _____ as specified herein. Since this work is of a potentially dangerous nature, and requires special expertise, it is to be performed by a contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City will require proof of Contractor's involvement in tree service work. The contractor has the responsibility to:

- A. Remove or prune designated trees.
- B. Reserve work space along streets.
- C. Grind out stump when tree is to be removed.
- D. Remove excess material and clean up site.
- E. Guarantee that specifications be met.
- F. Keep work site safe at all times.

II. Definitions

- A. **Reference:** Reference to any other specifications or standards means the latest revision in effect on date of invitation to bid. This set of specifications governs when disagreement with a reference specification occurs.
- B. **Specified:** Means specified in the invitation to bid
- C. **ANSI Z-133:** American Standard of Tree Worker Safety.
- D. **ANSI A300:** Standard Practices for Trees, Shrubs, and Other Woody Plant Maintenance
- E. **City Administrator:** The City's representative that will administer the technical aspects of this tree pruning and removal contract. The City administrator for this contract is: _____
- F. **Contractor:** A company that earns the majority of its annual revenue for pruning, removing, or maintaining trees and/or shrubbery. Contractor must possess an I.S.A. Certified Arborist License.

III. Work Procedures

- A. **Equipment:** All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, devices, chippers, hand tools, aerial and other equipment and supplies which are necessary to perform the work as outlined in these specifications. The City may inspect such equipment or agreements prior to the awarding of a contract.
- B. **Tree Location:** Work limited to trees located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of trees that have been marked with blue paint for priority pruning or red paint if tree is to be removed. All other trees on list are to be pruned for vehicular and pedestrian traffic. The City reserves the right to change, add, or delete areas or quantities to be pruned or removed as it deems to be in its best interest. Pruning and removal operations will commence no later than thirty (30) days after the contract has been awarded and will be completed no later than 90 days after work has begun. The Contractor will be responsible for notifying the appropriate utility authority before removing trees growing in the utility wires. Contractor will be responsible for any damage to utilities during the removal or pruning process.
- C. **Public Relations:** An information sheet will be sent by the City Administrator to the property owners.
- D. **Supervision:** Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks, and writes English competently. Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential personal injury or safety hazards. The City requires a certified arborist on the job site, and requires the arborist's certification number in this bid.
- E. **Inspections:** The City is called at # _____ before 8:30 a.m. on mornings of each working day and told exact location of that day's work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.
- F. **Tree Damage:** Climbing irons, spurs, or spikes are not used on trees to be pruned. Any tree damage caused by contractor is repaired immediately at no additional expense to the satisfaction of the City Administrator. Trees damaged beyond repair, as judged by the City Administrator, are removed at no expense to the City and replaced by a tree of size and species designated by the City Administrator at no additional expense to the City or the dollar value of such damaged trees, as determined by the City Administrator, is deducted from the monies owed the Contractor.

G: Pruning Specifications: Conforms to latest revision of standards of National Arborist Association, ANSI A300. All cuts shall be made as close as possible to the trunk or parent limb, without cutting into the branch collar or leaving a protruding stub. Bark at the edge of all pruning cuts should remain firmly attached. All branches too large to support with one hand shall be pre-cut to avoid splitting or tearing of the bark. Where necessary, ropes or other equipment should be used to lower large branches or stubs to the ground. Treatment of cuts and wounds with wound dressing or paints has not been shown to be effective in preventing or reducing decay and is not generally recommended for this reason. Wound dressing over infected wood may stimulate the decay process. If wounds are painted for cosmetic or other reasons, then material non-toxic to the cambium layer of meristematic tissue must be used.

Care must be taken to apply a thin coating of material only to exposed wood.

Old injuries are to be inspected. Those not closing properly and where the callus growth is not already completely established should be bark traced if the bark appears loose or damaged. Such tracing shall not penetrate the xylem (sapwood), and margins shall be kept rounded.

Equipment that will damage the bark and cambium layer should not be used on or in the trees. For example, the use of climbing spurs (hooks or irons) is not an acceptable work practice for pruning operations on live trees. Sharp tools shall be used so that clean cuts will be made at all times.

All cut limbs shall be removed from the crown upon completion of the pruning. Clean-up of branches, logs, or any other debris resulting from any tree pruning shall be promptly and properly accomplished. The work area shall be kept safe at all times until the clean-up operation is completed. Under no condition shall the accumulation of brush, branches, logs, or other debris be allowed upon a public property in such a manner as to result in a public hazard.

Trees impeding vehicle or pedestrian traffic should be raised up a least 13 feet over streets and 8 feet over sidewalks. Trees obstructing control devices (stop signs, yield signs, and traffic lights) should be trimmed to allow for adequate visibility.

H. Removal Specifications: Removals will include topping and other operations necessary to safely remove the assigned trees. No trees or trunks are felled onto pavement. Work includes removal of basal sprout and brush and weeds within three feet of the trunk. The tree stump will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets, and gutters will be cleaned. Backfill consisting of clean earthen soil should be used to fill the cavity, free of debris, to normal ground level and seeded with an approved seeding mix. Do not backfill with wood chips. All labor, supervision, equipment, materials, and supplies necessary for the execution of this work must be provided for by the contractor at no additional cost to the city. All debris disposal must be provided by the contractor at no additional cost to the city. The chosen contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a contractor is not aware of these standards, copies can be provided by the City of _____.

- I. **Traffic Control:** Is total responsibility of Contractor and is coordinated with the proper department of the City of _____.

The contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades, and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County, and Local highway construction codes.

- J. **Utility Agencies:** Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides a list of principal contacts and telephone numbers for public and private utility organizations.

Tree trimming and removal operations may be conducted in areas where overhead electric, telephone, and cable television facilities exist. The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations.

The Contractor shall make arrangements with the utility for removal of all necessary limbs and branches that may conflict with or create a personal injury hazard in conducting the operations of this contract. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

- K. **Safety:** Work conforms to the latest revision of American National Standards Institute Standard Z-133.1 (Safety Requirement for Pruning, Trimming, Repairing, Maintaining, Removing Trees, and for Cutting Brush).

At the time a contract is entered into, the Contractor shall certify in writing to the City that all Contractor's employees working on this job are either 'Qualified Line Clearance Tree Trimmers' or 'Qualified Line Clearance Tree Trimmer Trainees', as defined in the above ANSI Z-133.1 Standards.

- L. **Clean Up:** Clean-up procedures are completed within two hours after debris have been placed around the site of each tree requiring pruning or removal. The work site is left equal to or cleaner than pre-work conditions. Tree parts dropped or lowered from trees are kept off private property.

It shall be the responsibility of the Contractor to remove and dispose in a proper and acceptable manner all logs, brush, and debris resulting from the tree maintenance operations. Wood may be left for residents, but that not taken must be disposed.

- M. **Damages:** Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

- N. **Insurance:** Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of \$1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of _____.
- O. **Payments:** Partial billings are acceptable, but not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, one-half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.
- P. **Working Hours:** The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.
- Q. **Subcontracts:** The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.
- R. **Execution of Contract:** The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter into contract with the City on forms included within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities, and insurance required hereunder.
- The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.
- S. **Discontinuance of Work:** Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.
- T. **Observance of Laws, Ordinances, and Regulations:** The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State, and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal Statutes, rules, and regulations as they relate to hiring, wages, and other applicable conditions of employment.

- U. **Supervision:** This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.
- V. **Bidding Specification and Contractual Terms:** Tree maintenance work done under the direction of this contract shall be bid on forms as provided by the City.
- W. **References:** Municipal tree pruning and removal experience is required. The bidder will provide a list of municipal governments that it has serviced in the past five years with a contact person listed.
- X. **Award:** For a bid to be considered, prices must be quoted for the entire pruning and removal project.
- Y. **Contract Termination:** The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:
- i. Previous unknown circumstances arise making it desirable in the public interest to void the contract;
 - ii. The Contractor is not adequately complying with the specifications;
 - iii. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;
 - iv. The Contractor refuses, neglects, or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;
 - v. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;
 - vi. The Contractor refuses to proceed with work when as directed by the City; or
 - vii. The Contractor abandons the work.
- Z. **Indemnification:** I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage, or expense arising out of contact with the City's trees by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such trees.

STUMP REMOVAL SPECIFICATIONS
FOR DEPARTMENT OF PUBLIC SERVICE
CITY OF _____, _____

I. Scope of Work

To provide all labor, supervision, equipment, services, and expertise necessary for grinding of stumps, disposal of grindings and debris, and backfilling of stump holes in the City of _____ as specified herein. Since the work is potentially dangerous, and requires special expertise, it is to be performed by a Contractor that derives a majority of its annual income from arboricultural work and whose employees are highly trained and skilled in all phases of tree service work. Contractors must have been in business for at least five years. The City may require proof of the Contractor's involvement in tree service work.

The Contractor has the responsibility to:

- A. Reserve work space along streets;
- B. Grind out designated stumps;
- C. Remove excess material and clean up the work site;
- D. Guarantee the specifications will be met; and
- E. Keep work site safe at all times.

All bidders must have in their possession or available to them by formal agreement at the time of bidding: trucks, stump grinders, hand tools, and other equipment and supplies that are necessary to perform the work as outlined in these specifications.

II. Location

Work is limited to stumps located on all public rights-of-way and City-owned property. All work under this contract shall be assigned by supplying the Contractor with a list of stumps that have been marked with the diameter of the stump.

The City reserves the right to change, add, or delete areas or quantities of stumps to be removed as it deems necessary. Stumping operations will commence no later than five (5) days after the contract has been awarded and will be completed no later than _____.

III. Supervision

Contractor consults with the City concerning details of scheduling of all work. Contractor has a competent person in charge of his work at all times to whom the City may issue directives and who shall accept and act upon such directives, and who reads, speaks, and writes English competently.

Failure for the supervisor to act on said directives shall be sufficient cause to give notice that the Contractor is in default of contract unless such directives would create potential personal injury or safety hazards. The City requires a certified arborist on the job site, and requires the arborist's certification number in this bid.

IV. Inspections

The City is called at # _____ before 8:30 a.m. on mornings of each working day and told exact location of that day's work. The City inspects work at its discretion and is requested by letter, five days in advance of the completion of this contract, to provide a final inspection.

V. Stump Grinding

The tree stumps will be ground out to a depth of six (6) inches below the normal surface level including all surface roots. Immediately after grinding each stump, the grindings must be removed from the work area. Adjacent sidewalks, lawns, streets, and gutters will be cleaned. Holes are not to be left open overnight. Backfill consisting of clean earthen soil should be used to fill in the cavity, free of debris, to four (4) inches above the existing lawn grade surrounding the stump site (to allow for settling) and seeded with an approved seeding mix. Do not backfill with wood chips.

All labor, supervision, equipment, material, and supplies necessary for the execution of the work must be provided for by the Contractor at no additional cost to the City. All debris disposal must be provided by the Contractor at no additional cost to the City.

The chosen Contractor will be required to follow the ANSI Z-133 Standards for tree worker safety. If a Contractor is not aware of these standards, copies can be provided by the City of _____.

VI. Traffic Control

Is total responsibility of Contractor and is coordinated with the proper department of the City of _____.

The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall provide the necessary warning devices, barricades, and personnel needed to give safety, protection, and warning to persons and vehicular traffic within the area.

Blocking of public streets shall not be permitted unless prior arrangements have been made with the City and is coordinated with the appropriate departments. Traffic control is the responsibility of the Contractor and shall be accomplished in conformance with State, County, and Local highway construction codes.

VII. Utility Agencies

Are contacted by Contractor any time assistance is needed to work safely around overhead or underground installations. The City provides list of principal contacts and telephone numbers for public and private utility organizations.

The Contractor shall protect all utilities from damage, shall immediately contact the appropriate utility if damage should occur, and shall be responsible for all claims for damage due to his operations. It is left to the Contractor's discretion to notify the appropriate utility authority before stump removal begins. If the Contractor has properly contacted the utility in sufficient time to arrange for the required work by the utility, delays encountered by the Contractor in waiting for the utility to complete its work will not be the responsibility of the Contractor.

VIII. Damages

Done by the Contractor to any person or property, public or private, are the total responsibility of the Contractor and are repaired or compensated for by the Contractor to the satisfaction of both injured party and the City at no cost to the City.

IX. Insurance

Contractor shall be fully insured as specified and shall be completely covered by State Workers' Compensation during the life of this contract. The Contractor shall have liability insurance in the amount of \$1,000,000.00 for each occurrence and shall name the City as an additional insured on its policy for the work being performed in the City of _____.

X. Payments

Partial billings are acceptable, not more frequently than every two weeks. Payment is made according to actual number of stumps removed. Ten percent (10%) of each invoice is withheld until Contractor's work is completed to the satisfaction of the City. Billing for work along any street may not be made until Contractor completes all work on that street. At the discretion of the city, one-half of the ten percent (10%) retainer may be held until spring if enough snow is on the ground that a proper inspection of sites cannot be conducted. When an inspection is done and the Contractor, as directed by the City, corrects any problem that may occur, the remainder of the retainer will be paid.

XI. Working Hours

The Contractor will schedule work between the hours of 7:00 a.m. and 6:00 p.m. Monday through Friday unless authorized by the City to do otherwise.

XII. Subcontracts

The Contractor will not be allowed to subcontract work under this contract unless written approval is granted by the City. The Subcontractor, as approved, shall be bound by the conditions of the contract between the City and the Contractor. The authorization of a Subcontractor is to perform in accordance with all terms of the contract and specifications. All directions given to the Subcontractor in the field shall bind the Contractors as if the notice had been given directly to the Contractor.

XIII. Execution of Contract

The successful Bidder shall, within five (5) calendar days of the mailing of written notice of selection as the successful bidder, enter into contract with the City on forms included within the bidding documents for the performance of work awarded him and shall simultaneously provide the appropriate bonds, indemnities, and insurance required hereunder. The contract, when executed, shall be deemed to include the entire agreement between the parties; the Contractor shall not base any claim for modification of the contract upon any prior representation or promises made by representatives of the City, or other persons.

XIV. Discontinuance of Work

Any practice obviously hazardous as determined by the City shall be immediately discontinued by the Contractor upon receipt of either written or oral notice to discontinue such practice.

XV. Observance of Laws, Ordinances, and Regulations

The Contractor, at all times during the term of this contract, shall observe and abide by all Federal, State, and Local laws which in any way affect the conduct of the work and shall comply with all decrees and orders of courts and competent jurisdiction. The Contractor shall comply fully and completely with any and all applicable State and Federal Statutes, rules, and regulations as they relate to hiring, wages, and other applicable conditions of employment.

XVI. Supervision

This contract will be under the direct supervision of the City or its authorized representatives. Any alteration or modifications of the work performed under this contract shall be made only in written agreement between the Contractor and the City-authorized representative and shall be made prior to commencement of the altered or modified work. No claims for extra work or materials shall be allowed unless covered by written agreement.

XVII. Bidding Specification and Contractual Terms

Stump work done under the direction of this contract shall be bid on forms as provided by the City.

XVIII. Award

For a bid to be considered, prices must be quoted for the entire stump removal project.

XIX. Contract Termination

The City shall have the right to terminate a contract or a part thereof before the work is completed in the event:

- A. Previous unknown circumstances arise making it desirable in the public interest to void the contract;
- B. The Contractor is not adequately complying with the specifications;
- C. Proper arboricultural techniques are not being followed after warning notification by the City or its authorized representatives;
- D. The Contractor refuses, neglects, or fails to supply properly trained or skilled supervisory personnel and/or workers or proper equipment of the specified quality and quantity;
- E. The Contractor in the judgment of the City is unnecessarily or willfully delaying the performance and completion of the work;
- F. The Contractor refuses to proceed with work when as directed by the City; or
- G. The Contractor abandons the work.

XX. Indemnification

I, the Contractor, agree to indemnify, hold harmless, and defend the City from and against any and all loss, damage, or expense which the City may suffer or for which the City may be liable by reason of any injury (including death) or damage to any property arising out of negligence on the part of the Contractor in the execution of the work to be performed hereunder.

This indemnity provision shall not apply in cases where the Contractor has not been provided with timely notice, nor shall the Contractor be liable to the City for any settlement of any complaint affected without the prior written consent of the Contractor. This indemnity provision also specifically does not apply to loss, damage, or expense arising out of contact with the City's stumps by persons (other than employees of the Contractor engaged in the work contemplated by this agreement) who are around such stumps.

CITY WIDE STREET TREE FERTILIZATION SPECIFICATIONS

CITY OF _____, _____

I. Scope of Work

To provide all supervision, material, labor, equipment, service operations, and expertise required to fertilize street trees in the City of _____ as specified herein. Contractor has responsibility to:

- A) Furnish, transport, and apply water-soluble fertilizer;
- B) Reserve work space along streets;
- C) Use hydraulic sprayer and soil probe or lance at 100-200 PSI;
- D) Remove excess material and clean up site;
- E) Keep work site safe at all times; and
- F) Any work incidental to above.

II. Material Specifications

Section A: Types of Fertilizer to be Used

1. Inorganic Fertilizer (Chemical) - Is that derived from chemical sources. These nutrients are readily available in the soil and are rapidly soluble, with a short residual period.
2. Soluble Fertilizer - Is mixed with water and applied in liquid form. Soluble fertilizers may be applied via the deep root feeding method. Soluble fertilizers are usually inorganic and readily available. Materials with a limited solubility that dissolve slowly are often listed on fertilizer labels as water-insoluble nitrogen (WIN).

Section B: Fertilizer Analysis

1. Established Plantings - use fertilizers with N-P-K ratios of 3-1-2 or 3-1-1 for best response. These formulations may have slight variations.
2. Inorganic (water-soluble) nitrogen should be supplemented with synthetic or organic nitrogen (WIN) for the slow availability characteristics of the insoluble form of the material.

Section C: Rates of Application

1. For optimum plant growth, apply 4-6 lbs. of actual nitrogen per 1,000 sq. ft. every two years.
2. Diameter at Breast Height (DBH) - Measure the trunk diameter at 4.5 feet above grade. Generally for optimum growth, apply 1/4 lb. actual nitrogen per inch DBH to trees under 6 inches in diameter. The rate can be increased to 1/2 lb. N per inch DBH for most trees over 6 inches DBH. The majority of the trees to be fertilized in this project will be 2 - 4 inch DBH. Using a 3-inch DBH tree and fertilizing with 1/4 lb. actual N per inch DBH would require 4.2 lbs of an 18-5-11 complete fertilizer:

$$3 \text{ inches (dia)} \times 0.25 \text{ lb/inch (rate)} = 0.75 \text{ lb. (amount of N).}$$

$$0.75 \text{ lb. (amount of N)} / 0.18 \text{ (%N in 18-5-11)} = 4.166 \text{ lbs of 18-5-11.}$$

3. Liquid application - Diluted fertilizer solutions should be applied at the rate recommended by the manufacturer according to operating pressure and flow rate of the equipment to be used. Apply sufficient liquid mixture to supply the required rate of fertilizer as determined by the surface area of DBH method. It is suggested that one apply 150 gallons to each 2,000 sq. ft. of surface area. Inject approximately 1/2 gallon of fertilizer solution per injection at 2.5 ft. spacings.

Section D: Timing of Fertilizer Applications

Early spring before bud break is the recommended time for fertilizing. Fertilizing should not be done after leaves have fully expanded.

Section E: Method of Fertilizer Application

Liquid Injection - Injections using a soil probe or lance should be 2.5 feet apart, and 6-12 inches deep for trees. Begin lance injection 2-3 feet from the tree trunk and work out about 8 feet beyond the trunk or to the sidewalk or other hardscape obstacle, whichever is farthest. Use a hydraulic sprayer at 100-200 lbs. pressure and soil lance designed for liquid fertilizer with a manual shut-off valve and three or four horizontal discharge holes at 90 degrees in its point. Inject one-half a gallon of fertilizer solution into each hole. The addition of water to dry soil as occurs during the liquid injection process is an excellent side-benefit.

Section F: Additional Guidelines

1. Undesirable tree species that could be found on tree lawns or on public rights-of-way should not be fertilized. These are: silver maple, boxelder, alder, birch, catalpa, redbud, Russian-olive, osage-orange, apple, mulberry, poplar, cottonwood, cherry plum, black cherry, black locust, sassafras, willow, and elm.
2. Be aware that overfertilizing small trees such as flowering crabapple can result in excessive succulent growth. Succulent growth is more prone to fireblight symptoms on susceptible plants such as pear, crabapple, and mountain ash.
3. Fertilize in moist soils - Fertilizer should always be applied in moist soils to enhance fertilizer uptake and reduce fertilizer injury to plants and aid in soil injection treatment. If soils are not moist, irrigation should precede fertilization to moisten the plant root zone area. The liquid injection method of fertilizing trees will help moisten the soil in the root zone while applying desired nutrients.
4. Fertilizing Excessively Wet Soils - Avoid fertilizing trees growing in soil that is excessively wet. The roots in wet soil are often damaged from lack of oxygen caused by the accumulation of toxic gases. Adding fertilizer in any form may contribute to root injury.
5. Read the Label - Read the entire label of any fertilizer product before application and apply per label recommendations.

Appendix D
Tree Planting and Pruning Guidelines

Planting Guidelines

The following guidelines to tree planting will help reduce transplanting shock and ensure that trees adapt to the new site. Keep in mind that spring and fall are the best times of the year to plant trees, but some trees do better when transplanted in spring rather than fall, and vice versa. Check with your nursery when planning tree-planting operations.

Site Conditions

A frequent cause of new tree failure is poor acclimation to site conditions. This includes not only the planting site, but also the climate conditions at the nursery and the similarity in the new tree location. For example, a tree raised in a nursery farther south than the planting site may have more difficulty in adapting than a tree grown in more similar climate conditions. Furthermore, the soil conditions of the site (pH, moisture, oxygen, and nutrient availability) should be sufficient to meet the specific requirements of the tree. It is more cost-effective to choose the right tree for a site than to modify the site after the tree has been planted or to have high maintenance costs because a poorly established tree is unhealthy.

Tree Selection

In addition to selecting trees that are tolerant of existing site conditions, select trees that show normal growth and are free of serious insect and disease problems. The trees should exhibit good vitality, appearing undamaged with a healthy root mass. Trees should have good leaf color, annual twig growth, and bud appearance. Careful nursery selection is essential.

Single-stemmed trees should not have the appearance of clumped foliage arising from the same point on the stem. Such a condition, while providing an initial tree form, will ultimately cause branching problems, such as weak crotches, and should be avoided. Trees with good potential for lower maintenance when mature will have a scaffold or ladder appearance with branch angles greater than forty-five degrees. Some trees have this form naturally, while others need to be pruned when young to encourage such form.

Stock Type

Trees are delivered from the nursery in one of three states of preparation: balled-and-burlapped trees, with soil surrounding the root system; bare-root trees, without soil; and containerized trees, generally grown in the container in which they are delivered.

Bare-root is the least expensive and allows roots to be in contact with the native soil. However, care must be taken to keep the roots protected and moist before planting, as the fine roots can dry rapidly.

Balled-and-burlapped tree roots are slower to dry out than bare-root trees, as the roots are inside a soil ball. However, the burlap may cover dead or poorly pruned roots and should be inspected before planting. The type of soil surrounding the roots should not be too different from the soil on the site or the tree roots may not extend sufficiently into the surrounding soil from the root ball. In such a case, the backfill soil should be amended to provide a transition between the two types of soil.

Container-grown trees have an undisturbed root system and can be planted with the intact root system. If the tree has been in the container for too long; however, the tree may be pot-bound with the roots encircling the inside perimeter of the pot. The roots should be sliced or partially separated in order to improve the ability of the tree to extend the roots into the surrounding soil.

Tree Planting

The tree should be planted to the same depth or slightly higher than it was growing at the nursery. A high mound should be avoided as the soil can dry out quickly in the summer and freeze in the winter.

The hole should be dug shallow and wide. It should not be any deeper than the root ball but should be a wide hole, allowing for amendments, if necessary, or for loosening heavy clay soil to allow for improved oxygen availability and root penetration.

The backfill soil should be added gradually and watered carefully to settle the soil but not to saturate it. Balled-and-burlapped trees should have any untreated burlap pulled away from the top of the root ball and cut away—not buried—so that none of the burlap is exposed at the soil surface. Otherwise, the burlap can wick moisture away from the roots of the freshly planted tree.

Tree Staking

Stakes should only be used to support trees on windy sites or for smaller trees with weak trunks. The stakes should be placed before the backfill is added to avoid damaging any large roots. A stake is meant to provide a temporary support and should be removed within a year to allow the tree to develop trunk strength and to limit the potential for physical damage from the stakes and support ties.

Wooden stakes, metal pipe, fence stakes, and metal reinforcing bars may all be used for support. Anything used for a tie should have a flat, smooth surface and be somewhat elastic to allow for slight movement for the tree. Suitable materials include rubber strips or webbing and belting. Wire covered with hose or tubing **should not** be used.

Tree Irrigation

Because a newly transplanted tree may have lost much of its root system, watering is critical for successful establishment. Initial watering at planting should be followed with weekly watering, particularly during dry periods. A newly planted tree will benefit from at least an inch of water a week.

Mulching

Newly planted trees respond well to mulch placed around the tree. This reduces initial root competition with turf and limits the possibility of physical damage by mowers. These factors contribute to the health of the trees and increase the likelihood of survival.

The mulch should **not** be piled (mulch ‘volcanoes’) around the tree and should not actually touch the tree trunk. No more than a 2- to 3-inch depth of mulch should be added, with it being no more than ½ inch deep closest to the tree.

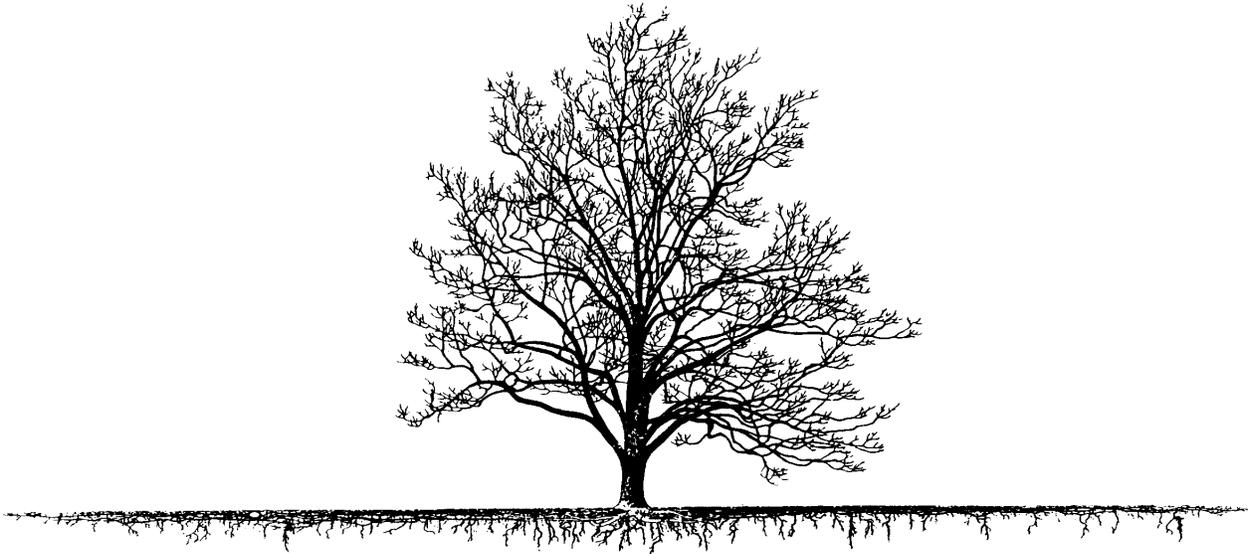
Pruning

When planting a tree, only dead or broken branches should be removed. All living branches should be left on the tree to help promote tree establishment. Once the tree has been established on the site, training pruning can be done to promote good branching patterns, but no more than 1/4 of the branches should be removed at any one time.

Fertilizing

Fertilizer is not generally necessary at the time of planting and, indeed, if placed improperly in the planting hole can injure roots. The addition of nitrogen, in a slow-release form, however, can benefit a newly planted tree, and it may be efficient to apply at the time of planting.

Tree Pruning Guidelines



Introduction

Pruning consists of *selectively* removing branches (living and dead) from woody plants, ranging from pinching off a bud at the end of a twig to removing large limbs.

Proper pruning benefits trees, shrubs, and vines, and the associates of woody plants (including humans). Pruning branches can be one of the most beneficial or the most damaging practices arborists do to trees.

A basic principle of pruning is that the removal of any live stems, branches, twigs, and buds affects growth of the plant. Proper pruning prevents and corrects defective form that could result in branch or stem failure. Thus, knowledge of plant biology is essential for the correct methods of Davey pruning.

Most tree species evolved in competitive forest communities. Consequently, trees developed efficient branching systems to capture the energy of available light for photosynthesis.

Woody plants also evolved the ability to get rid of inefficient energy resources by *shedding* shaded branches (cladaptosis). A branch is naturally shed from its base. As natural shedding occurs, the wood tissue around the branch core within the stem protects against decay. Davey's limb removal cuts imitate natural branch shedding (natural target pruning).

Many people equate woody plant pruning to amputation, but there should be no fear of wise and careful use of pruning equipment. A properly pruned tree, shrub, or vine is a combination of art, science, and skill.

Davey Tree surgeons adhere to Davey and industry pruning standards. In the arboriculture industry, the current standard approved by the ISA and the NAA is *The American National Standards Institute (ANSI) A300* issued in 1995. Davey Residential Operations adheres to the National Arborist Association (NAA) *Pruning Standards for Shade Trees* (revised 1988) where four classes of pruning are defined. The NAA classes appear in a condensed version on the back of the Davey Plant Health Care quote/work order forms printed before 1996.

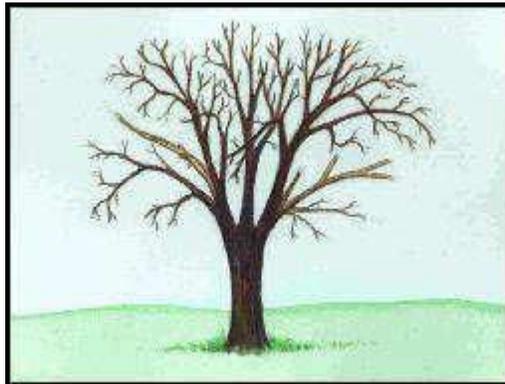
Reasons for Pruning

The first rule in pruning is **do not cut without a reason**. Too often arborists tend to over-prune to meet client expectations. Proper pruning is an effort to *direct* new growth rather than 'control' growth.

Most pruning cuts are of a *preventive* or a *corrective* nature to be beneficial to woody plant health.

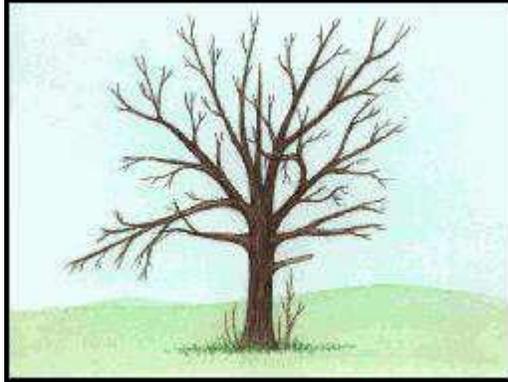
Health

- *Sanitation* by removing dead, broken, decayed, diseased or insect-infested wood (crown cleaning).
- *Thinning* to improve penetration of light and air, and to reduce wind resistance and potential storm damage.
- Reduction of the number of poorly attached *epicormic branches*.
- *Girdling root* removal.
- Correct and/or redirect *structural growth* that may cause future problems (weak crotches, branches growing out of proportion, etc.).



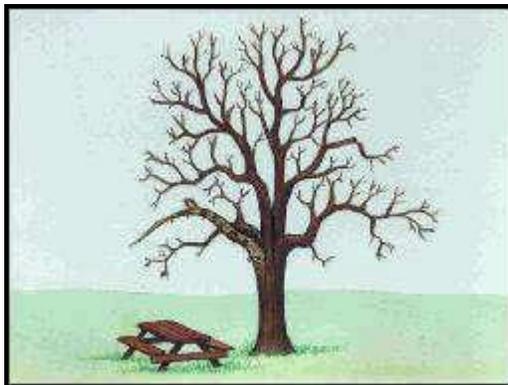
Appearance

- Shape for aesthetic purpose, natural forms, growth habit (training).
- Influence flowering, fruiting, promotion of shoots, canes, bark color.
- Direct new growth and/or correct improper prior pruning (crown restoration).



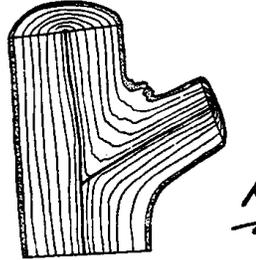
Convenience or Safety of Property and People

- Correct or modify storm-damaged, neglected, or poorly pruned woody plants.
- Identify and remove potential hazard limbs, stems, and deadwood (hazard reduction pruning).
- Line clearance (directional pruning).
- Raise or lower obstructive canopies over or near roads, sidewalks, playgrounds, buildings, pools, satellite dishes, etc. by removing interfering limbs (crown reduction and/or crown raising).
- Provide access to more light for understory plants and turf (crown thinning).
- Vista pruning (alter crowns to allow views of something beyond tree screens).



Pruning Methods and Techniques

Branch Attachment to Stems



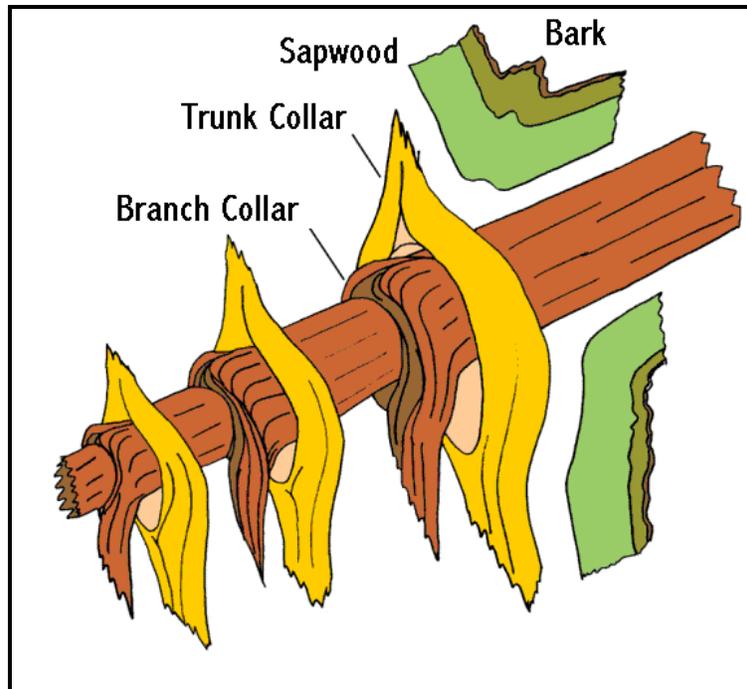
New branch tissues generated by the vascular cambium usually start growth before trunk tissues. As current-year branch tissue develops from branch ends toward the trunk, it turns abruptly downward at the branch base to form a *collar*.

Trunk branch tissues grow later and form a trunk collar over the branch collar (trunk collars and branch collars are collectively called the *branch collar*).

The collar is where wood and bark of the branch and the trunk come together, like an overlapping tissue 'switching zone'. All true branches on woody plants have branch collars.

The *branch bark ridge* (BBR) is raised bark developing in the branch crotch and shows the angle of the branch core in the tree.

If a branch dies or is removed, the trunk collar continues to grow over the thin belt of branch tissue below the collar junction. The wood core of the branch is walled off (compartmentalized) in the trunk.



Proper Pruning Cuts (Natural Target Pruning)

Location of *branch bark ridges* and *branch collars* determines the location of a pruning cut. Cuts must be made *outside* of the branch bark ridge, angling away from the trunk outward as close as possible to the collar.

- There is no set or standard angle for a proper collar cut.
- The proper angle depends on the shape of the collar.
- Conifers often have flat collars where a straight cut close to the collar is correct.
- Sometimes the angle of the cut will necessitate an *upstroke* cut with a handsaw or chainsaw.

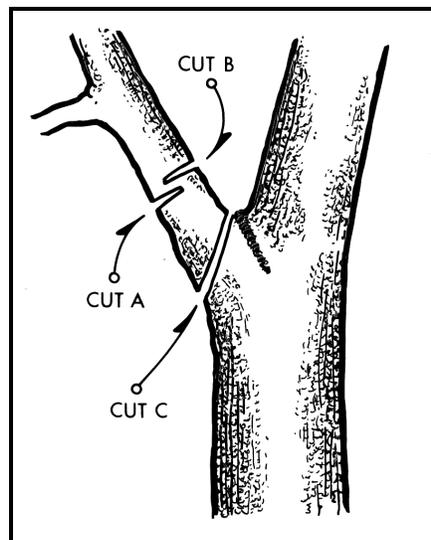
Do not cut into the collar to stimulate callus production and rapid closure. Although closure is desirable for appearance, such a cut promotes decay and future hazards. Never put a pruning tool behind the branch bark ridge.

Whether a branch collar is obvious or not, the position of the final or finish cut should:

- Minimize the branch stub that is an entryway for decay fungi.
- Retain the natural decay protection present in the branch core. The intact branch collar is the first line of defense in preventing decay within the trunk.
- Minimize the overall size of the pruning wound and direct damage to the stem.

Always **stub cut** the branch first. Limbs that cannot be controlled must be removed using at least **three** cuts. Roping of limbs may be necessary to prevent damage to other parts of the tree if they cannot be controlled by hand.

1. The first cut (Cut A) **undercuts** the limb one or two feet out from the parent branch or trunk. A properly made undercut will eliminate the chance of the branch 'peeling' or tearing bark as it is removed.
2. The second cut (Cut B) is the **top cut** which is usually made slightly further out on the limb than the undercut. This allows the limb to drop smoothly when the weight is released.
3. The third cut (Cut C) or **finish cut** is to remove the stub.



Each finish cut should be made carefully, outside of the branch bark ridge and the evident collar, leaving a smooth surface with no jagged edges or torn bark.

There are some situations where the cambium dies back beneath a branch collar after a correct cut:

- The trunk collar did not join the branch collar directly below the branch. Sunken spots under branches are a sign of this condition.
- Winter cuts may result in undercollar dieback.
- Problem tends to increase with size of branches removed.

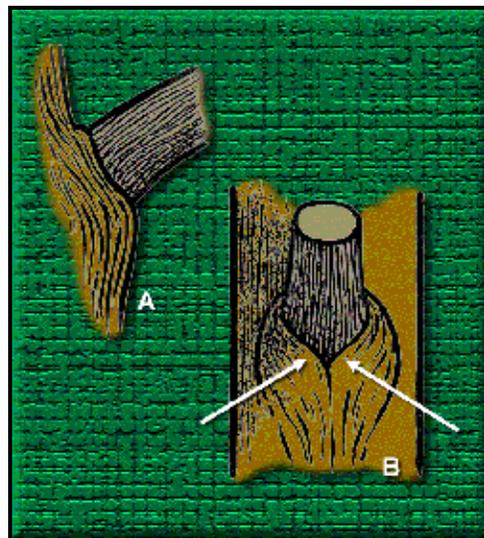
Callus and Woundwood

Callus is undifferentiated meristematic tissue that forms at wound margins from the cambium.

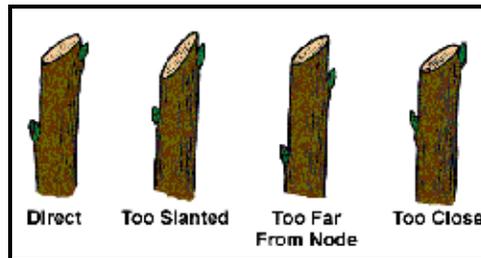
Callus differentiates into *woundwood* over time. Woundwood is 'new wood' and has the different cell components of periderm, cambium, phloem, and xylem.

A *complete* ring of callus and subsequent woundwood will develop around and eventually over proper cuts. Woundwood forms only to the sides of improper cuts (flush cuts), which means the collar and branch protection zone is damaged and the trunk is wounded.

A proper pruning cut results in a smaller wound area, and more rapid callus and woundwood movement over the wound. Cuts on dead limbs that have trunk collars moving up the dead branch wood must also be made just outside of the evident collar.



- Appropriate only for small woody plants or one- to two-year-old branches (twigs, branchlets) on trees.
- Cut back to a bud (lateral bud) or lateral branchlet, slanting at a 45° angle above the bud *node* on alternately arranged branches and stems.
- Two or more buds at a node (opposite, whorled) require a *transverse* cut just above the bud tips or a 45° angle cut, removing one of the buds and leaving the other(s) to elongate in a desired direction.
- Cut 1/8" higher above the bud tips when pruning in cold weather to prevent winter injury to the bud (tissue around a winter cut is more vulnerable to desiccation).



- Leaving a majority of *inward* facing buds produces growth towards center.
- Leaving a majority of *outward* facing buds results in more open growth.

Pruning Tools

Use **well-sharpened** tools for both your safety and to help reduce tearing of wood and cambial tissues. Wear specified protective equipment.

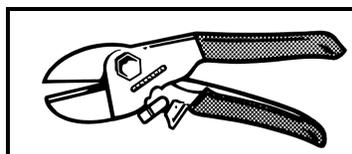
Pruning Shears

Hand shears, secateurs, hand pruners, one-hand shears:

- Remove branches, stems up to 1/2" diameter.
- By-pass (hook and blade, scissors, drop-forged, curve blade): make closer cuts than anvil-type.



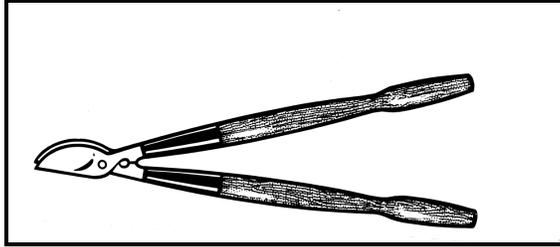
- Anvil (straight-blade): good for only soft-tissued wood; will crush harder wood (inappropriate per A300 standards).



Lopping shears

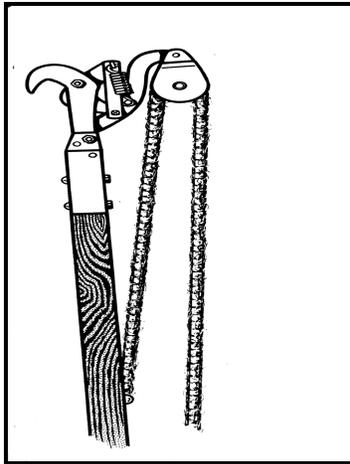
Two-hand shears:

- Remove branches, stems up to 1-3/4" diameter.
- Most useful in rejuvenation.
- By-pass, hook and blade, etc.
- Anvil, straight-blade.
- Ratcheting.



Pole Pruners

- Wood and insulated poles (round and squared).
- Cut like by-pass shears.
- Important to keep blade side in toward the cut.



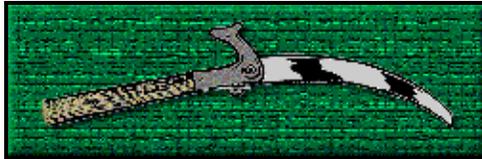
Cut at the outer side of the branch bark ridge at a slightly outward angle so as not to injure or remove the branch collar. Hook the pruner head around the limb to be cut with the blade side against the lateral branch or stem to remain. The arborist must be in a safe working position and the pruner handle positioned so the blade will not jam in the wood. You should not cut off a limb directly above yourself if there is any chance that it could fall and hit you.

Change your working position before completing the cut; place the hook so you have a straight pull on the rope and the lever arm can move far enough to complete the cut. An experienced tree surgeon can give a limb a flip with the side of the pruner head, just as the cut is completed, so that the limb will fall in the desired direction.

Saws

Pole saws:

- Hook cast onto pole-head.
- Wood poles (round and squared).
- Insulated poles (foam core).
- Difficult to make clean, accurate cuts.



Fine-tooth saw blades (more points per inch):

- On folding, rigid, and grip handles.
- *Needlepoint* teeth.
- Razor-tooth, Japanese, or *tri-edge*-style teeth (*Fanno*TM 1311, *Felco*TM, *Corona*TM); narrow, curved blades facilitate getting into tight spots.



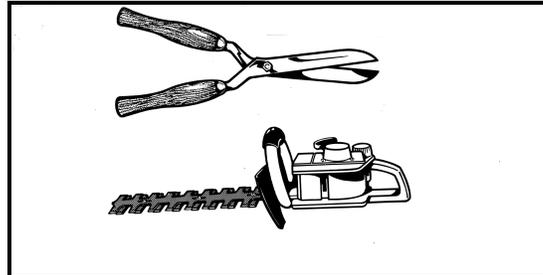
Arborist saws cut on the *pull* stroke:

- Davey-issue speed saw.
- Raker and gullet saws.
- Needle-tooth saws *Fanno*TM series.
- Scabbards, blade lengths.
- Pole saw blades now available with *tri-edge* teeth.

Hedge Shears

Clippers/trimmers:

- Manual (sometimes called 'pruning' shears)



- Powered (electric, gasoline)
- Cut off growth 'in line' with no regard for node locations or branch bark ridges.
- Provide time and labor savings at expense of overall plant health.
- Dull blades compound problems and make you work harder!

Crown Thinning and Cleaning

A proper thinning cut removes a branch at its point of attachment, or back to a lateral branch large enough to assume a terminal role.

Learn to foresee the need for removing live branches while they are small. Avoid large cuts. Direction can be influenced by removal of short portions of growth or even by removal of individual buds.

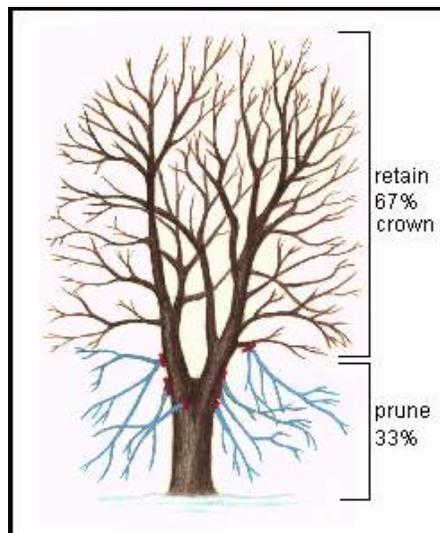
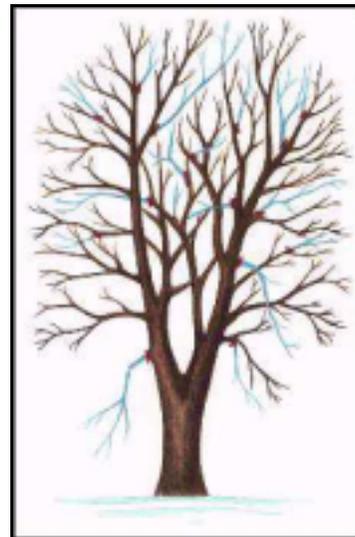
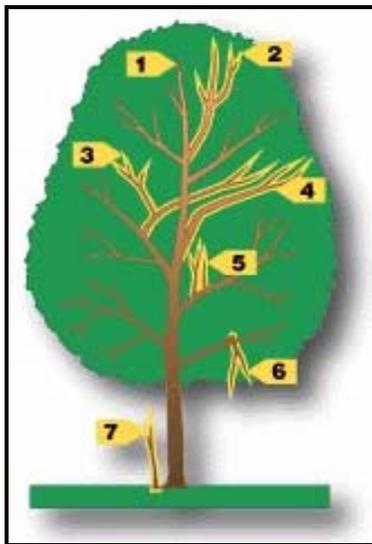
Thinning of lower branches can 'raise' a limb. If, after crown raising, the remaining leaf material is insufficient for limb size, consider complete removal. The client's opinion is important.

Never perform excessive thinning, which is stressful, especially on thin-barked or young trees prone to sunscald.

Avoid removing more than 1/4 of the live branches on a tree. Older or overmature trees should have an absolute minimum of living branches removed.

Always avoid 'skinning' or 'hollowing' out the center of a tree's canopy. The majority of thinning cuts should be made along the outer crown. Proper thinning requires a good deal of limb-walking and deft use of a pole-pruner when and where aerial lifts are not used.

When thinning laterals from a limb, maintain well-spaced inner branches to achieve more distribution of foliage along the branch.



Caution must be taken to avoid creating an effect known as *lion-tailing*:

- Caused by removing all of the inner laterals and foliage.
- Displaces foliar weight to the ends of the branches.
- May result in sunburned bark tissue, renewed and excessive epicormic branches, weakened branch structure and breakage.
- Wind whippage.



Lion-tailing

Removal of Diseased or Insect-Infested Branches

Sanitation or 'eradivative' pruning (crown cleaning):

- Cut out diseased limbs back to collars, appropriate lateral branches, or a scaffold branch at least one foot below infected portion.
- Disinfect tools *during or after* pruning diseased branches with bleach solution (1 part bleach to 10 parts water) or Lysol.
- Do not use any form of alcohol to sterilize pruning tools *during* the work. Use alcohol to disinfect auger-bits, injection tees, or pruning tools *after* the job, especially plants with wetwood or fireblight bacterial infections.

Removal of Weak, Rubbing, or Competing Stems

Remove, if possible, but avoid large holes in the canopy.

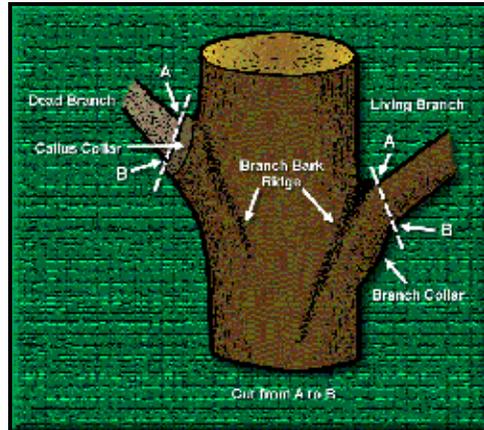
The life of large limbs, weakened by decay or cracks, can often be extended by "shortening" or weight removal using highly selective thinning cuts. Cabling and/or rigid bracing may be required to secure limbs or codominant stems if removal is not possible.

Deadwood Removal

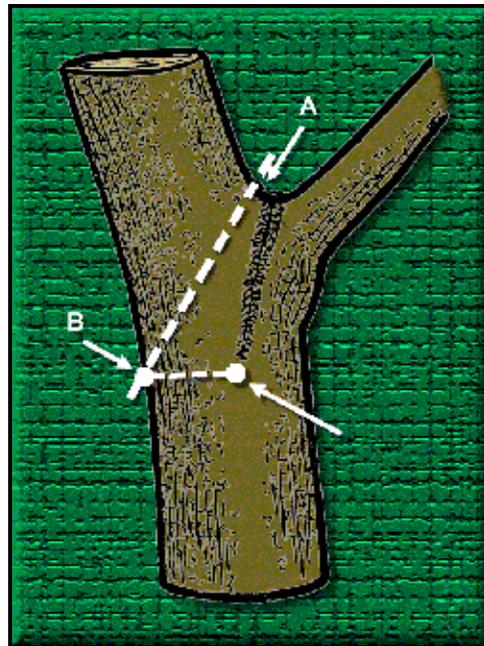
Sanitation and hazard reduction pruning:

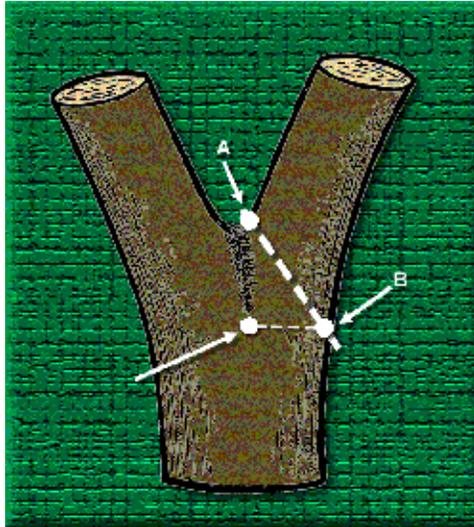
- Dead branches and stubs are an energy source (cellulose, glucose).
- Decay fungi.
- Boring insects.

Again, do not remove the branch collar around dead branches. Cut as close as possible to the collar of good wood surrounding the branch base.



Locate Target Points





Codominant Stem or Branch Removal

Always *stub cut* the stem to be removed, and then make the *finish* cut with care.

Some defect (discoloration) will develop in the remnant stem 'core' in the main stem:

- Usually not attached like a true branch with protective collar.
- Barrier zone should develop and confine defect if correct cut is performed.

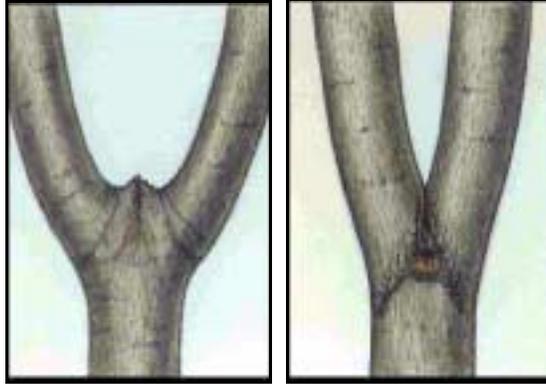
Never remove both stems!

When the bark plates on the stem bark ridge turn upward, the union of the stems is usually *strong*.

When the bark between the stems turns inward, the union of the stems is *weak*.

It is the *union* of the stems or upright branches more than the *angle* that determines whether attachment is weak or strong.

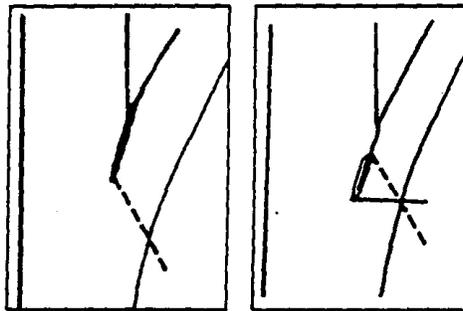
The stems have *included bark* squeezed or embedded *between* them.



Remedies:

To *remove*, stub cut the stem first and then cut where the dotted line is with care; avoid cutting into the remaining stem.

If the saw cannot complete this cut, tap a small wedge into the kerf and cut the remainder of the wood with a flat chisel and mallet.



To *strengthen* stem on older trees, a cable can be attached; place at a point approximately two-thirds of the distance from the crotch to the ends of the stems.

When a cable is used to strengthen stems, the cable and hardware must be checked regularly. When the risk of stem fracture becomes high, the weaker stem should be removed.

Davey Residential Operations employs four general classes of pruning. Classes 1, 2, and 3 are classified as maintenance pruning, which is recommended when the primary objective is to maintain or improve tree health and structure, including hazard reduction pruning:

- Class #1 - *Fine Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches (crown cleaning), as well as selective thinning to lessen wind resistance. Some deadwood up to ½ inch in diameter may remain within the main leaf area where it is not practical to remove such. Girdling roots will be monitored and removed where possible.

- Class #2 - *Medium Pruning*: consists of the removal of dead, dying, diseased, interfering, objectionable, and weak branches (crown cleaning). Some deadwood up to one inch in diameter may remain within the leaf canopy.
- Class #3 - *Hazard reduction*: pruning is recommended when the primary objective is to reduce the danger to a specific target, caused by visibly defined hazards in a tree, by removing dead, diseased, or obviously weak branches two inches in diameter or greater.
- Class #4 - *Crown Reduction Pruning*: consists of reducing canopy tops, sides, under branches, or individual limbs at appropriate lateral limbs and stems for purposes of clearance of storm damage repair. Some crown reduction pruning incorporates hazard reduction pruning.

Epicormic Branches

Epicormic branches may be needed to fill in the canopy where trees have been excessively thinned or storm damage has occurred (crown restoration).

Epicormic branches (shoots, watersprouts, suckers) arise from two types of "buds":

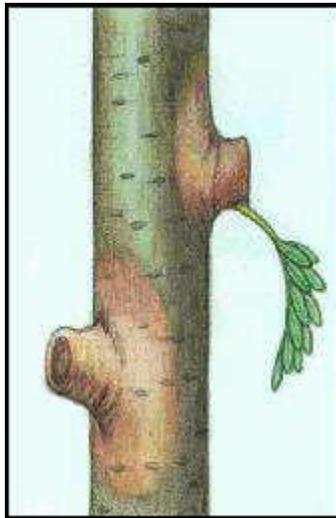
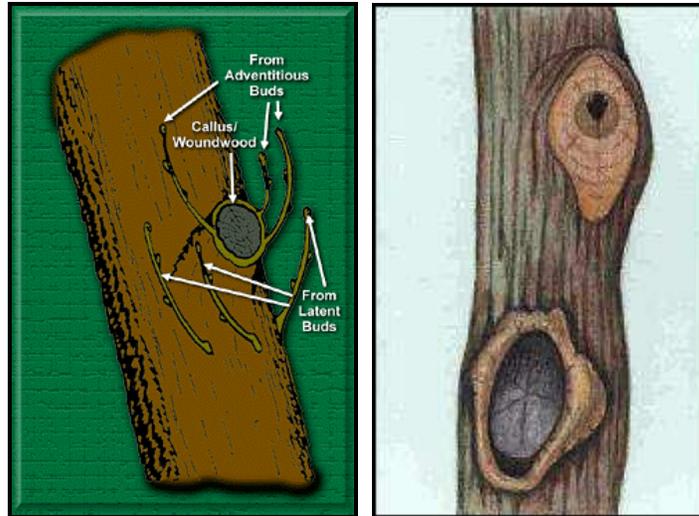
- Adventitious buds.
- Latent (dormant) buds or meristematic points.

Adventitious epicormics come from meristematic tissue generated anew by the cambium. Most adventitious buds develop from callus tissues moving over a wound, or from root tissue.

Latent (dormant) buds or *meristematic points* are formed at an earlier time in the life of a woody plant but do not 'release' or grow. Latent buds are 'carried along' in rays in the cambial zone year after year, as the tree increases girth, and are usually released upon injury or stress. Epicormic sprouts from latent meristematic points are often found in the vicinity of pruning cuts, usually below the wound.

Epicormic branches are *stimulated* on a much larger scale by winter or early spring pruning rather than by late spring-summer pruning (desirable in shrub renewal or rejuvenation).

A *watersprout* is an epicormic branch growing from branch and stem parts, or above a graft union.



A *sucker* is an epicormic branch growing from root tissue or below a graft union.

Apical Dominance and Control

Woody plant natural shapes, forms, or habits are governed by species' inherent (genetic) determination of:

- Leaf and flower bud locations.
- Bud-break patterns along stems.
- Branching angles.
- How buds and branches elongate.

Apical dominance = terminal bud(s) suppress lateral buds along an elongating shoot

Excurrent and *decurrent* branching patterns:

- Decurrent woody plants have overall weak apical control, but strong apical dominance while shoots are elongating.
- Random-branching excurrent plants have weak apical dominance and overall strong apical control.
- Whorl-branching excurrent trees have both strong apical dominance and control.



Decurrent



Excurrent

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases, these chemicals either increase or decrease normal growth, flowering, and/or fruiting of plants.

Selective growth control and/or branch release by natural growth regulators:

- Auxins
- Abscisic acid (ABA)
- Cytokinins
- Gibberellins (gibberellic acid = GA)
- Ethylene

Branch terminals – auxin source

Roots – cytokinin source

Low auxin = axillary bud release,
High cytokinin energy storage drain

High auxin = bud suppression,
Low cytokinin initiate new roots

Plant growth regulators are substances that enhance or alter the growth and development process of a plant. In most cases, these chemicals either increase or decrease normal growth, flowering, and/or fruiting of plants.

Utility arborists use synthetic growth regulators to *control* the growth of trees and other vegetation beneath utility lines. Growth *inhibitors* can be:

- Sprayed on the foliage.
- Painted on pruning wounds.
- Banded on the bark.
- Soil applied.
- Injected into trees.

Antigibberellins are growth regulators that counter the effects of naturally occurring *cell-elongation* hormones (gibberellin). Ideal formulations are being sought that would minimize phytotoxicity while reducing utilities' pruning expenses.

Another use of growth inhibitors is to suppress epicormic branch production on trees:

- Not yet widely used by arborists.
- Must be applied annually.
- Client concern over the use of chemicals.
- Applicator safety concerns.
- Epicormic branch growth can be minimized with proper cuts.
- Retarded woundwood development.

Painting of Cuts

Proper cuts negate the "need" for wound dressings. Wound dressings will not *prevent* decay; wound dressings have been evaluated to often *promote* wood decay or cause cambium damage.

Cuts or wounds in certain species during the growing season may attract insects that carry diseases or allow fungus invasion. Native oaks or elms and European elms should be pruned during dormant periods in regions where wilt disease conditions are known to exist.

If pruned in summer, pruning wounds on wilt-susceptible oaks and elms should be treated with the current wound dressing recommended by The Davey Institute.

Pruning Phenology

The ideal or optimal times to prune most woody plants are:

- Late in the dormant season.
- After leaves are fully formed and expanded.

Client concerns with excessive *sap flow* (birches, maples):

- Avoid pruning during height of sap flow (just before growing season) if possible.
- Sap flow may be unsightly but does not cause definite injury.
- Prune immediately after leaves are fully expanded if client cannot be convinced.

Avoid pruning birches after leaf expansion, as the wounds may be attractive to boring insects.

Dead, broken, or weak limbs may be removed at any time with little effect, except in wilt-susceptible oaks and elms.

Pruning before the spring leaf bud-break period can enhance stimulated growth and rapid wound closure. Pruning during the period after leaf expansion will result in suppressed growth and maximum 'dwarfing'.

Avoid pruning those woody plants undergoing bud break and early leaf expansion, especially in the period where bark 'slips' (cambial development of unligified wood).

Flowering can be reduced or enhanced by pruning at the appropriate time of the year. Woody plants that bloom on current season's growth ('summer-flowering' such as crapemyrtle or butterfly-bush) are best pruned to enhance flowering:

- During the dormant season.
- Just prior to or immediately after leaf expansion.
- In late summer (post-bloom).

Plants that bloom on last season's wood ('spring-flowering') should be pruned *just after bloom*.

- Fruit trees are often pruned during the dormant season to enhance structure and distribute fruiting wood, and after bloom to thin fruit-load.

Pruning Selection

Ideal pruning technique begins with planting the right tree in the right place (PHC selection).

Maintaining tree size or allowing for limited crown growth is possible with a regular pruning schedule begun early in the tree's life.

- Consider the extent of mature branches and crown.
- Select good stock with proper growth form.
- Imagine how form will continue to develop; there is no way to turn a large tree back into a small tree.
- Don't expect to improve form with future prunings.

Avoid obtaining saplings with included bark; the stem union becomes weaker rather than stronger as the plant grows. Failure of one or both stems of the fork frequently occurs when the tree is mature, especially during snow and ice storms (loading events).

Structural Pruning

Structural pruning principles are used when training young woody plants or working with a tree that has not been pruned in many years. Properly trained shrubs and young trees will develop into structurally strong plants that should require little corrective pruning as they mature.

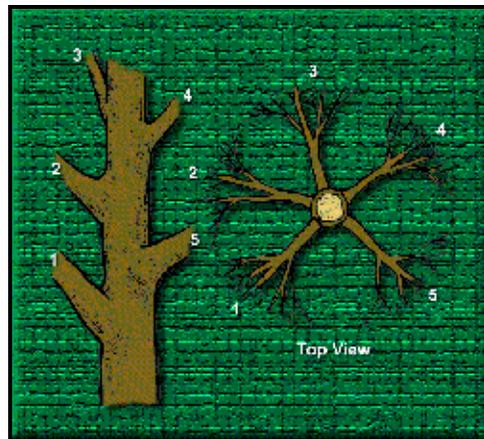
Trees that will be large at maturity should have a sturdy, tapered trunk, with well-spaced branches smaller in diameter than the trunk.

If two branches develop from apical buds at the tip of the same stem, they will form *codominant* branches or, eventually, codominant stems. Each codominant branch is a direct extension of the stem. It is best if one is removed when the tree is young.

Branches with narrow angles of attachment and codominant branches may tend to break if there is *included bark* that gets enclosed inside the crotch as the two branches develop girth and length.

The relative *size* of a branch in relation to the trunk is usually more important for strength of branch attachment than is the *angle* of attachment. Scaffold branches' diameters should not be more than 1/2 the stem or trunk diameter.

Select main branches to give *radial distribution*. Discourage branches growing directly over another unless spaced well apart.



On large-growing trees, except whorl-branching conifers, branches that are more than 1/3 the diameter of the trunk in size should be well spaced along the trunk (at least 18 inches apart).

Maintain one-half the foliage on branches arising in the lower 2/3 of younger trees.

- Increases trunk taper.
- More uniformly distributes weight and wind stress along the trunk.

This rule of thumb also holds true for an individual limb:

- Leave lower and inside branches along the limb.
- Limb can develop taper and strength.
- Stress and weight can be evenly distributed along the length.

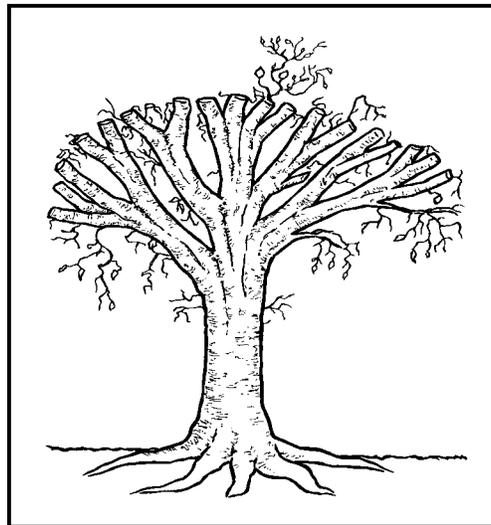
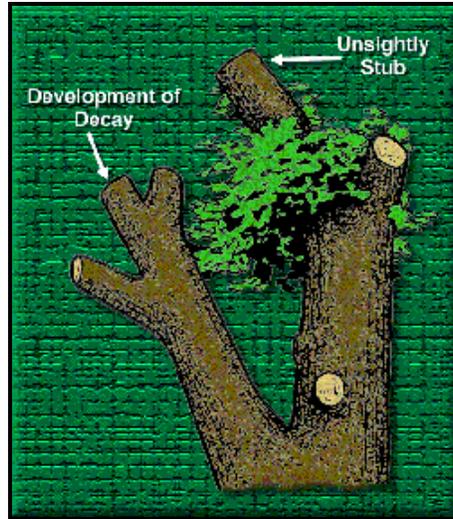
The height of the lowest scaffold branch will depend on the intended function of the tree: screen an unsightly view, provide a windbreak, shade a patio, installed as a walkway or street tree.

Pruning at Planting

For years, the conventional wisdom was that trees should be severely pruned at time of transplant to compensate for root loss and to "balance" the crown with the root system (especially bareroot trees). This practice has since been discovered to prolong *transplant shock*.

- Transplant pruning should be limited to removal of dead, broken, diseased, or interfering branches.
- Leave small shoots along the trunk for later removal.
- Protect the trunk from 'sunburn'.
- Aid in development of proper trunk taper.
- Leave as many terminal buds as possible.
- Stimulate root growth triggered by hormones in these buds.

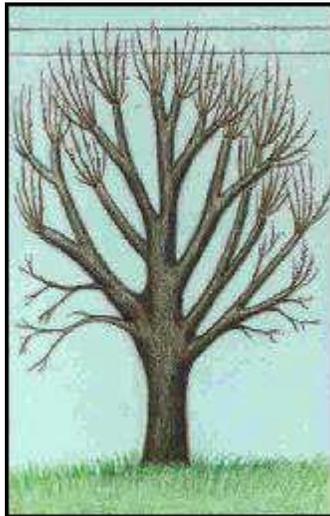
Topping, Tipping, and Roundover



Topping: cutting vertical branches and stems back to inadequate nodes (heading) or to internodes (stubbing).



Tipping: heading side or horizontal branches to stubs or weak laterals.



Roundover: topping + tipping.

Many people have the misconception that cutting or heading the main branches of a tree back to stubs to ‘reduce the height’ is the proper way to prune.

Apparently, a short tree is thought to be safer and healthier than a tall tree regardless of how the result is attained. Heading back to stubs or inadequate laterals permanently disfigures and weakens a tree. Topping is one of the worst things humans do to trees.

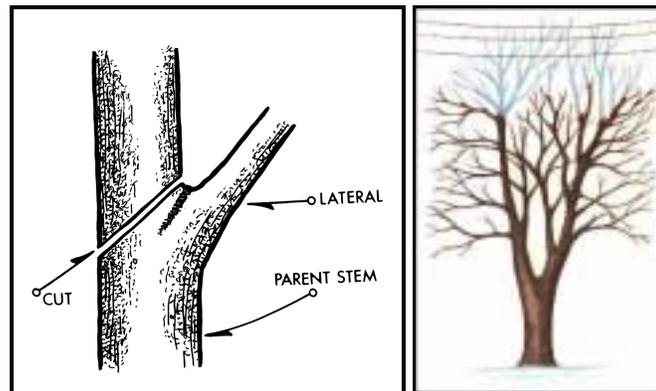
The International Society of Arboriculture (ISA) and the National Arborist Association (NAA) consider heading-back to stubs an unacceptable arboricultural practice. Modern pruning standards do not include heading-back as any sort of a recommended technique.

- Topping removes a major portion of a tree's leaves that are necessary for the production of carbohydrates.
- Stimulation of epicormic branches at or just below an internodal stub cut causes a topped tree to grow back to its original height faster and denser than a properly pruned tree. The sprouts are weakly attached and easily broken off in storms.
- Bark within the canopy can become scalded by sudden exposure to direct sunlight.
- Stubs attract wood-boring insects and sustain wood decay organisms.
- Topping, tipping, and roundover cuts permanently disfigure a tree.

Crown Reduction, Restoration, and Raising

If the height or width of a tree has to be reduced because of storm damage or interference with structures or utility lines, it is performed correctly by a method called *crown reduction* or *drop-crotch* pruning (NAA Class IV Crown Reduction). This procedure involves the removal of a main leader, scaffold, or branch at its point of attachment with a lateral branch large enough to assume a terminal or leader role.

The final cut should begin or end somewhat *parallel* to the remaining lateral branch and offset slightly above the branch bark ridge (without cutting into the bark ridge). The remaining lateral branch must be at least one-half to one-third the diameter of the branch or leader that is being removed.



If a tree has been topped previously and now has epicormic sprouts, *crown restoration* can improve its structure and appearance. Decayed, rotting stubs and tipped branches are cut back to appropriate laterals or entirely removed. One to three sprouts on main branch stubs are retained to become permanent branches and reform a more natural appearing crown. Selected epicormic branches may need to be thinned to a lateral to control length and ensure adequate attachment for the size of the sprout. Restoration usually requires several prunings over a number of years.

Trees in urban and landscape settings may need to have lower limbs removed. *Crown raising* or elevating removes the lower branches of a tree in order to provide clearance for buildings, vehicles, pedestrians, and vistas. Excessive removal of lower limbs should be avoided so that the development of trunk taper is not affected and structural stability is maintained.

Definitions of Arboricultural Terms

Anvil-Type Pruning Tool – Pruning tool that has a straight sharp blade that cuts against a flat metal cutting surface (see *hook and blade-type pruning tool*).

Arborist – A professional who possesses the technical competence through experience and related training to provide for or supervise the management of trees and other woody plants in the residential, commercial, and public landscape.

Boundary Reaction Zone – A separating boundary between wood present at the time of wounding and wood that continues to form after wounding.

Branch – A secondary shoot or stem arising from one of the main axes (i.e. trunk or leader) of a tree or woody plant.

Branch Collar – Trunk tissue that forms around the base of a branch between the main stem and the branch or a branch and a lateral. As a branch decreases in vigor or begins to die, the branch collar becomes more pronounced.

Branch Bark Ridge – Raised area of bark in the branch crotch that marks where the branch wood and trunk wood meet.

Callus – Undifferentiated tissue formed by the cambium layer around a wound.

Cambium – Dividing layer of cells that forms sapwood (xylem) to the inside and bark (phloem) to the outside.

Climbing Spurs – Sharp, pointed devices affixed to the climber's leg used to assist in climbing trees (also known as *gaffs, hooks, spurs, spikes, climbers*).

Closure – The process of woundwood covering a cut or other tree injury.

Crotch – The angle formed at the attachment between a branch and another branch, leader, or trunk of a woody plant.

Crown – The leaves and branches of a tree or shrub; the upper portion of a tree from the lowest branch on the trunk to the top.

Crown Cleaning – The removal of dead, dying, diseased, crowded, weakly attached, low-vigor branches, and watersprouts from a tree's crown.

Crown Raising – The removal of the lower branches of a tree in order to provide clearance.

Crown Reduction – The reduction of the top, sides, or individual limbs by the means of removal of the leader or longest portion of a limb to a lateral no less than one-third of the total diameter of the original limb removing no more than one-quarter of the leaf surface.

Crown Thinning – The selective removal of branches to increase light penetration and air movement, and to reduce weight.

Cut – The exposed wood area resulting from the removal of a branch or portion thereof.

Decay – Degradation of woody tissue caused by biological organisms.

Espalier Pruning – A combination of cutting and training branches that are oriented in one plane, formally or informally arranged, and usually supported on a wall, fence, or trellis. The patterns can be simple or complex, but the cutting and training is precise. Ties should be replaced every few years to prevent girdling the branches at the attachment site.

Facility – Equipment or structure used to deliver or provide protection for the delivery of an essential service such as electricity.

Girdling Roots – Roots located above or below ground whose circular growth around the base of the trunk or over individual roots applies pressure to the bark area, ultimately restricting sap flow and trunk/root growth. Frequently results in reduced vitality or stability of the plant.

Heading – Cutting a currently growing or one-year-old shoot back to a bud, or cutting an older branch or stem back to a stub or lateral branch not sufficiently large enough to assume the terminal role. Heading should rarely be used on mature trees.

Heartwood – The inactive xylem (wood) toward the center of a stem or root that provides structural support.

Hook and Blade Pruning Tool – A hand pruner that has a curved, sharpened blade that overlaps a supporting hook (in contrast to an *anvil-type pruning tool*).

Horizontal Plane (palms) – An imaginary level line that begins at the base of live frond petioles.

Lateral – A branch or twig growing from a parent branch or stem.

Leader – A dominant upright stem, usually the main trunk. There can be several leaders in one tree.

Limb – Same as *Branch*, but larger and more prominent.

Lopping – See *Heading*.

Mycellum – Growth mass of fungus tissue found under bark or in rotted wood.

Obstructing – To hinder, block, close off, or be in the way of; to hinder or retard a desired effect or shape.

Parent Branch or Stem – The tree trunk or a large limb from which lateral branches grow.

Petiole – The stalk of a leaf.

Phloem – Inner bark tissue through which primarily carbohydrates and other organic compounds move from regions of high concentration to low.

Pollarding – Pollarding is a training system used on some large-growing deciduous trees that are severely headed annually or every few years to hold them to modest size or to give them and the landscape a formal appearance. Pollarding is not synonymous with topping, lopping, or stubbing. Pollarding is severely heading some and removing other vigorous water sprouts back to a definite head or knob of latent buds at the branch ends.

Precut or Precutting – The two-step process to remove a branch before the finished cut is made so as to prevent splitting or bark tearing into the parent stem. The branch is first undercut, and then cut from the top before the final cut.

Pruning – Removal of plant parts.

Qualified Line Clearance Tree Trimmer – A tree worker who, through related training and on-the-job experience, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. This qualified person may or may not be currently employed by a line clearance contractor.

Qualified Line Clearance Tree Trimmer Trainee – Any worker undergoing line-clearance tree trimming training, who, in the course of such training, is familiar with the techniques in line clearance and has demonstrated his/her ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Qualified Person or Personnel – Workers who, through related training or on-the-job experience, or both, are familiar with the techniques and hazards of arboriculture work including training, trimming, maintaining, repairing, or removing trees, and the equipment used in such operations.

Qualified Tree Worker, Person, or Personnel – A person who, through related training and on-the-job experience, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees and with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved.

Qualified Tree Worker Trainee – Any worker undergoing on-the-job training who, in the course of such training, is familiar with the hazards of pruning, trimming, repairing, maintaining, or removing trees, with the equipment used in such operations and has demonstrated ability in the performance of the special techniques involved. Such trainees shall be under the direct supervision of qualified personnel.

Remote/Rural – Areas associated with very little human activity, land improvement, or development.

Sapwood – The active xylem (wood) that stores water and carbohydrates, and transports water and nutrients; a wood layer of variable thickness found immediately inside the cambium, comprised of water-conducting vessels or tracheids and living plant cells.

Shall – As used in this standard, denotes a mandatory requirement.

Should – As used in this standard, denotes an advisory recommendation.

Stub – An undesirable short length of a branch remaining after a break or incorrect pruning cut is made.

Stubbing – See *Heading*.

Target – A person, structure, or object that could sustain damage from the failure of a tree or portion of a tree.

Terminal Role – Branch that assumes the dominant vertical position on the top of a tree.

Thinning – The removal of a lateral branch at its point of origin or the shortening of a branch or stem by cutting to a lateral large enough to assume the terminal role.

Throwline – A small, lightweight line with a weighted end used to position a climber's rope in a tree.

Topping – See *Heading*.

Tracing – Shaping a wound by removing loose bark from in and around a wound.

Urban/Residential – Locations normally associated with human activity such as populated areas including public and private property.

Utility – An entity that delivers a public service such as electricity or communication.

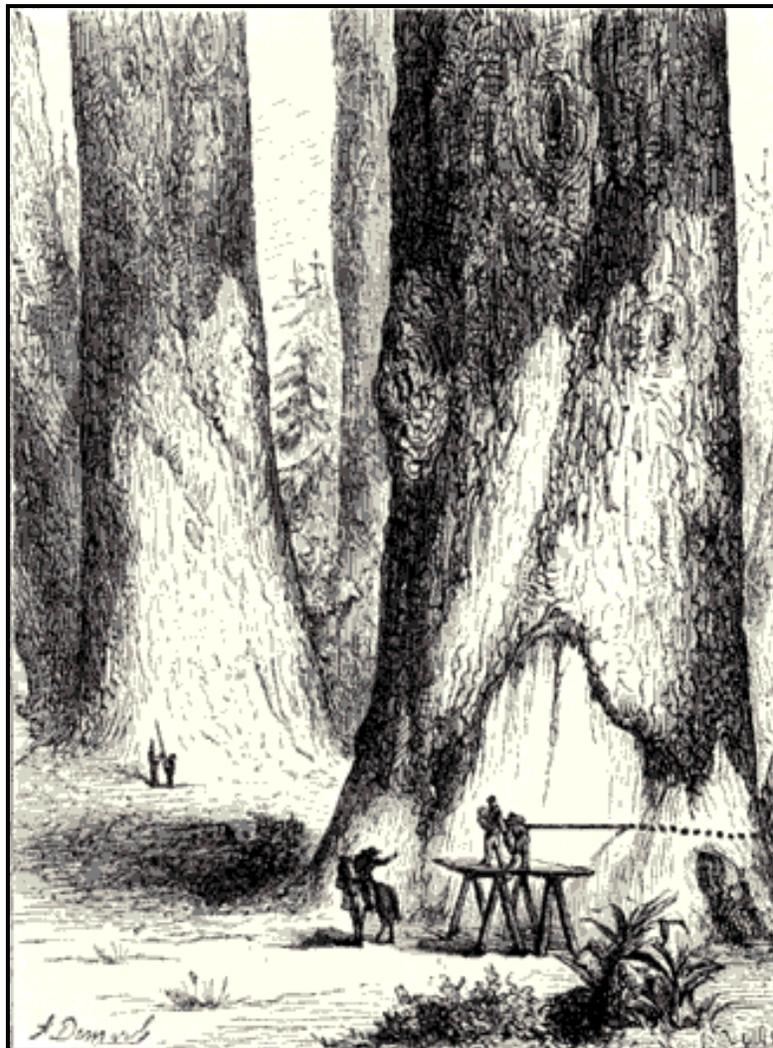
Utility Space – The physical area occupied by the utility's facilities and the additional space required ensuring its operation.

Wound – An opening that is created any time the tree's protective bark covering is penetrated, cut, or removed, injuring or destroying living tissue. Pruning a live branch creates a wound, even when the cut is properly made.

Woundwood – Differentiated woody tissue that forms after the initial callus has formed around the margins of a wound. Wounds are closed primarily by woundwood.

Xylem – Wood tissue; active xylem is called *sapwood* and inactive xylem is called *heartwood*.

Young Tree – A tree young in age or a newly installed tree.



Appendix E
Tree Emergency Manual for Public Officials

TREE EMERGENCY MANUAL

for

Public Officials



Developed by
Community Forestry Education Project
Cornell Cooperative Extension of Monroe County
Rochester, NY

supported by a grant from
USDA Forest Service, Northeastern Region

through the
Northeast Center for Urban and Community Forestry
Amherst, MA

August 2000

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INTRODUCTION

This *Emergency Tree Manual* is designed to be a practical short **guide** to managing disastrous tree damage, accompanied by a set of critical documents and standards called the *Tree Emergency Compendium*. Its focus is upon urban forests in the public realm, where questions of safety and cost are critical, and its target audience is public tree managers. To facilitate access to and speed through the document, it has been written in outline form. For more detail or explanation, readers are referred to publications listed under Printed Resources.

The *Manual* and the *Compendium* will be stored at the USDA Forest Service's Northeast Center for Urban and Community Forestry in Amherst MA, at offices of participating state urban and community forestry coordinators, and at the FEMA Region 1 and Region 2 offices in Boston and New York. Both documents will also be posted on the web site of the Northeast Center for Urban and Community Forestry, where they will be updated periodically as needed.

Funding for this *Manual* was provided by the USDA Forest Service, Northeastern Area, with special monies appropriated by Congress after 1998 ice storm in northern New York and New England. Grant definition, award, and administration were carried out through the USDA Northeast Center for Urban and Community Forestry.

This document was produced by personnel of the Community Forestry Education Project, located at Cornell Cooperative Extension of Monroe County, 249 Highland Ave, Rochester NY 14620-3036. Primary responsibility lies with Jerry Bond, Community Forester, whose work was made much easier by the creative and unfailing support of Frances Tucker, Program Assistant.

PROJECT COOPERATORS

- USDA Forest Service, Northeastern Area
- USDA Forest Service, Northeast Center for Urban and Community Forestry
- Cornell University, Cornell Cooperative Extension
- State of Maine, Department of Conservation
- State of New Hampshire, Division of Forests and Lands, Urban Forestry Center
- State of Vermont, Agency of Natural Resources, Division of Forests
- State of New York, Department of Environmental Conservation

EXPLANATIONS OF SYMBOLS USED IN THIS TEXT



Indicates that a document referred to in the text is included in the companion volume, the *Tree Emergency Compendium*.



Indicates that a technical term underlined in the text is defined in the Glossary at the end of this document.

ACKNOWLEDGMENTS

Various hands contributed to this work. It began as a request from the state urban and community forestry coordinators of New York and New England after a disastrous 1998 ice storm to Dave Bloniarz of the USDA Northeast Center for Urban and Community Forestry in Amherst MA. That request was itself an attempt to respond to emergency needs in the field and at FEMA offices. Without the initial concept and ongoing support of the state coordinators, this document would never have appeared.

The basis and benchmark was laid by *Storms over the urban forest* (2nd ed., 1994) by John Andresen and Lisa Burban. That carefully written classic provided the inspiration for this *Manual*, even if our approach differs from theirs in having a more technical orientation, a somewhat different audience (public tree managers), and outline form. Resources have been updated from that book, with special attention paid to web-based materials and computer applications, since much has emerged in those realms since the earlier text was written.

Many readers have taken the time to read drafts of this manual along the way: Dave Bloniarz (Northeast Center for Urban and Community Forestry in Amherst MA), tish carr (urban and community forestry coordinator, Maine), J. B. Cullen (urban and community forestry coordinator, New Hampshire), Jim Donovan (FEMA, Region 1), Peter Frank (urban and community forestry coordinator, New York), Doug Long (DPW Superintendent, Albion NY), Chris J. Luley (Davey Resource Group), Andy Pleninger (former City Forester, Rochester NY), Steve Sinclair (urban and community forestry coordinator, Vermont), Sue Sisinni (USDA Forest Service Research Unit in Syracuse NY), and Warren Spinner (City Arborist, Burlington VT). We are grateful for their time and effort--their contribution has been invaluable.

ILLUSTRATIONS

Unless otherwise indicated, images of trees are taken from the collection of the Community Forestry Education Project. We are grateful to Dr. Alex Shigo (Shigo & Trees, Associates, Durham NH) for permission to include three slides--as indicated in the text--from the excellent sets he has produced. Also, we appreciate receiving permission from the Press-Republican (Plattsburgh NY) and the Democrat and Chronicle (Rochester NY) to reproduce some of the extraordinary photographs taken by their staff.



Source: Mike Dowd, The Press-Republican (Plattsburgh NY)

THE PROBLEM

View down a street in Plattsburgh NY after the ice storm of January 1998. The important questions after such a disaster are what to do, and how do it. Later come questions such as how to recover, and how to minimize damage in the future.

I. EMERGENCY RESPONSE

A. First steps

Basic Point: *Tree emergency response should proceed in an orderly and prepared manner for maximum safety and minimum cost.*

- **Locate and consult Emergency Plans, Debris Removal Plan, and Contact Lists.**
- **Identify live electric wires** in, on, or under trees. Block public access to them, and report them to appropriate utility officials.
 - Only trained arborists should work around live wires, and the work should conform to ANSI standards Z133.1 and A300.
 - OSHA 1910.269 and other safety standards may also be relevant.
Resources: Contact offices of ANSI, OSHA, and FEMA.
- **Response Phase I, "Debris clearance"** (FEMA 1999)*
 - **Clear priority traffic lanes and culverts**, beginning with main routes, roads to hospitals, etc.
 - **Push debris simply to the side** in this first phase, without attempting at removal or disposal.
 - **Clear at least one lane** on each arterial, major highway, and secondary road as soon as possible.
 - **Open major walkways** to provide access to critical buildings, as well as other locations you think important under emergency conditions.



Source: Press-Republican (Plattsburgh NY) staff photo

Rig with a long-armed rotary saw clearing a country road during Phase I response after an ice storm in northern New York during early January 1998.

*References in parentheses and smaller font are listed in detail at the end of this document under "Resources"

- **Response Phase II, "Debris removal and disposal"** (FEMA 1999)
 - Use **established routes and methods** for clearing tree debris. Hopefully, these were already set up before the disaster; if not, try adopting routes used for trash pickup or snow removal.
 - In larger communities, it is often easiest to set up temporary collection points (malls, playgrounds, etc.) around the community, then clear those after things calm down.
 - Debris removal is usually reported as the most difficult tree disaster problem for communities and individuals.
 - In general, removal of debris from public property is eligible for FEMA assistance (FEMA 1999) when a Federal Disaster has been declared and when it constitutes an immediate threat to life, public safety, or improved property. See II B, below.

B. Communication

Basic Point: Communication is critical to surviving disasters. If you do not actively manage information during tree emergencies, things have a way of quickly getting out of hand and complicating your work.

- **Set up clear communication channels among emergency agencies and personnel.**
- **Establish and publicize a phone number and staff person for public contact.**
- **Work with the media early and often.**
 - Take the time to get accurate information out--it will be well spent.
 - Be frank about the extent of damage and the estimated time needed for recovery.
 - Useful tree disaster media releases can be downloaded from the web at <http://www.arboday.org/storm> Here is one example from that site:



Trees & Storms: Others Have Recovered

Trees are often like good friends--not fully appreciated until they are gone or hurt. So, to anyone who anguished when a favorite tree was severely damaged in the recent storm, here's encouragement from The National Arbor Day Foundation and foresters in other cities: Don't despair--given time, the community's trees can come back.

"Trees are amazingly resilient," says John Rosenow, president of The National Arbor Day Foundation. "It may take several years, but many of the trees damaged by a storm will recover as they grow."

Rosenow also notes that damaged trees may need human assistance in the recovery process. "They need our help and our patience, and they need our care. The experience of other communities has shown that with proper care of damaged trees and planting of new trees to replace those toppled or mortally wounded by a storm, once-devastated neighborhoods can come back."

In one Miami neighborhood, more than 1,600 homes were destroyed, and photos taken immediately after the storm show most trees down or severely damaged. But five years after Hurricane Andrew, the powers of recovery from both human and tree loss were amazingly evident in follow-up newspaper stories. The homes had been rebuilt, the surviving trees had regrown and were in full leaf, and life had returned to normal. Eliot Kleinberg, writing for the Palm Beach Post, summed up the recovery in his community in these words: "The birds have returned. The trees have grown back. The walls are back up. Unless you look closely, you might never know."

- **Deliver important messages to the community:**
 - Stay safe (watch for hangers, leaning trees, downed wires, chainsaw injury, etc.). → **G**
 - Stay calm--it may not be as bad as it seems, and panic only makes it worse. → **G**
 - Get help from arborists who are insured and, if possible, certified or registered. → **G**
 - Take your time in deciding tree removals, as long as no hazard is present. → **G**

- **Indicate how the public can help:**
 - Placing debris at the curbside
 - Keeping debris away from fire hydrants and valves
 - Segregating recyclable and flammable materials

Resource: FEMA 1999

- **Emphasize the need for careful professional damage assessment.**
 - People often tend to become radical about trees after a disaster, wanting either to “kill” or to “save” them all, and they need to hear voices of reason from officials.
 - Trees can recover from substantial damage, and what looks awful at first to an amateur may be judged as much less serious by an experienced professional.

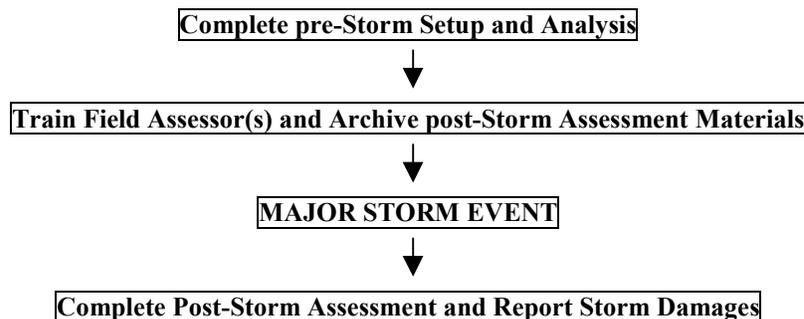
C. Records

Basic Point: It will be infinitely easier later if you start your paperwork at the beginning, and keep it up as you go along. It is very hard to recreate records after an emergency.

- **Complete an accurate damage assessment, and estimate associated costs**
 - Use any method that will give you quick and reliable results. If your community is large, sample a random selection of streets that makes up at least 2% of street miles.
 - Accurate damage assessment is vastly easier if you already have a pre-storm survey in place.
 - You will need an accurate damage assessment for local officials, as well as for state and other emergency officials.
 - Estimate hours of labor and equipment that will be required for:
 - standing tree removals
 - hazard pruning
 - debris removal
 - Multiply hours by costs to obtain job cost, or determine a lump sum for the job if relevant.

Resource: FEMA 1999, Bloniarz et al *Initial*

Overview: Storm Damage Assessment Protocol



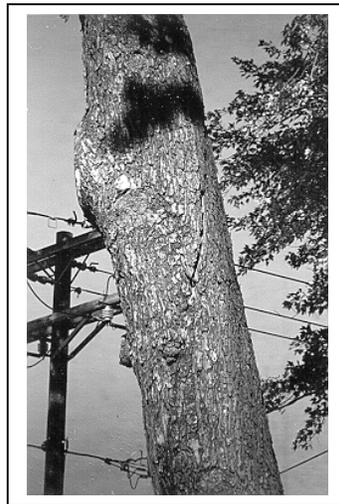
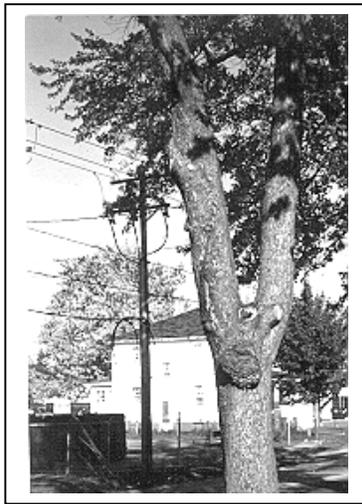
Source: Bloniarz et al *Initial*

- **Maintain good records from the beginning**
 - Keep track of date, personnel, job, equipment, location, and hours.
 - Basic FEMA forms can be found inside the back cover of this manual.
 - Others forms available on the FEMA web site (<http://www.fema.gov>), or in the *Applicant Handbook* for public assistance available from your regional FEMA office.

D. Survey of immediate threats

Basic Point: *In addition to clearing trees and limbs on the ground, you need to examine and manage those that are still upright from the standpoint of public safety.*

- **Identify immediate threats**, and make Priority 1 (danger of immediate failure) decisions about removals and pruning.
- **Determine Priority 1 Removal**
 - Systematically search for public trees that are:
 - *uprooted*
 - *split in half*
 - *undermined*



This silver maple leader over a busy city street was split by rotational forces during a windstorm. It took binoculars to spot the crack. Once seen, it makes the tree an obvious Priority 1 Removal.

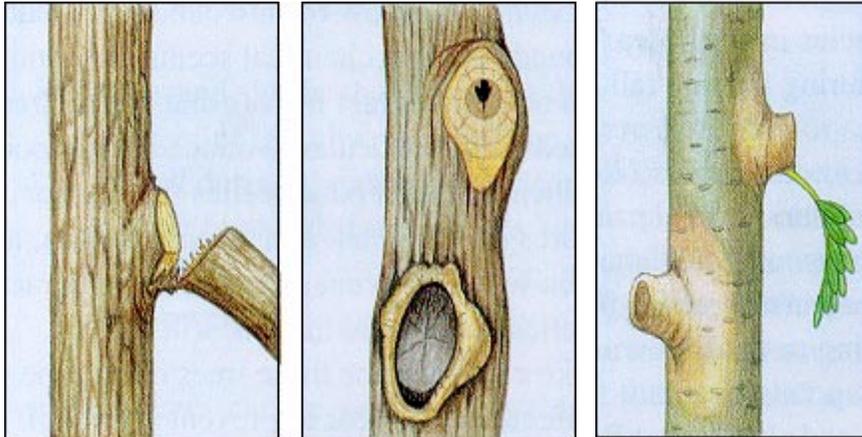
- Select such trees for immediate removal if they have a building, sidewalk, major electric wires, road, or other important structure as a likely target.
- Distribute work orders for the immediate removal of these hazardous trees.
- **Determine Priority 1 Pruning**
 - Systematically conduct high priority pruning street by street, taking out limbs over 2" in diameter that are *hanging, broken, or cracked*.
 - Select these trees for immediate pruning if they have a building, sidewalk, electric wire, road, or other important structure as a likely target.
 - Contracting out the work for these steps is often easy and cost-effective. This frees up staff for other emergency needs.
- **Hire professionals** whose work matches standards (ANSI A300) and whose costs are appropriate to the work. Include the phrase :*"all work to be carried out according to ANSI A300 standards."*
 - Let professionals know you are aware of the standards before they start.
 - Expect a reasonable markup for emergency work, but try to keep it under 20-25%.

■ **Inspect the work** before you sign off on payment.

○ Look for *errors*:

- rips, flush cuts, and stubs (see below)
- cuts through the branch collar or branch ridge
- cuts back to a lateral branch that is too small ($< 1/3$ main branch diameter)
- follow-through cuts into healthy wood

→ G



Source: USDA, 1995, *How to prune trees*

○ Look for *omissions*:

- dead branches $> 2''$, both attached and free
 - cracked limbs
 - trees with a new lean
- Follow standard contract procedures when errors and omissions are found

■ **Estimate % crown loss**

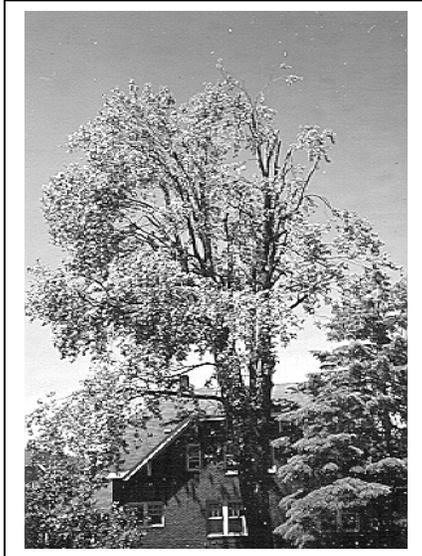
- Be sure not to confuse overall "% crown missing" (which includes earlier loss, pruning, etc.) from "% crown loss" caused by the event that led to your tree emergency
- **There is a good correlation between the amount of crown a tree loses and its survivability**
 - With 50% or less crown loss, a tree has a good chance of surviving
 - With 50-75% crown loss, many trees will still survive, though with varying degrees of internal decay and growth suppression
 - **Over 75% crown loss means trees generally have a low chance of survival**
- The further outward the breaks occur, the less decay will occur
- Weaker trees are less likely to survive than stronger trees
- In declared Disaster Areas, FEMA usually covers removals of street trees above 50% crown loss where the tree's death is imminent and the dead trunk would become a threat to life, public safety, and/or improved property.

Resource: USDA FS 1998

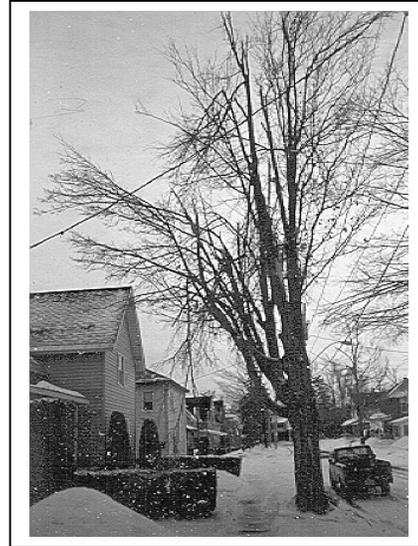
■ **Vigorous and healthy individuals may recover in spite of crown loss $> 75\%$**

- *If there is no hazard situation, and if you can wait from a budget standpoint*, postpone making removal decisions on vigorous healthy trees for a couple of years, to see how recovery progresses.
- For instance, individual green ash, Callery pear, and honey locust trees have been known to recover well from complete or nearly complete canopy loss in urban locations.

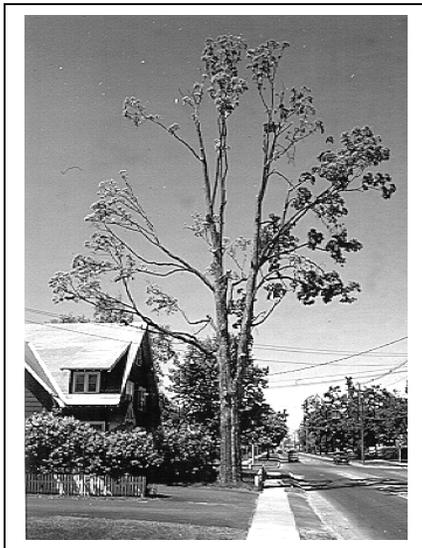
■ These images will help you estimate % crown loss in deciduous trees.



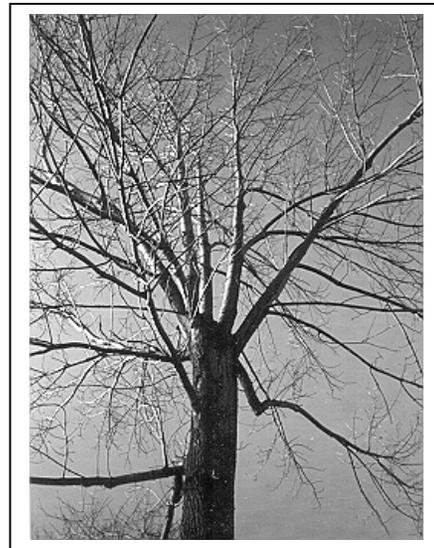
This silver maple lost only about 20% of its crown. Depending on other health factors, it should recover well.



It is harder to estimate % crown loss in the winter on deciduous trees. This sugar maple lost about 30% , below the critical level.



Here, the easiest way to estimate loss is to add up loss in each half of the crown. The total is probably near 65% (40 left + 25 right) on this sugar maple.



This young (11" DBH) green ash in a park resprouted a full crown in the 8 years after it lost 90% in an ice storm. Most trees can not tolerate such loss, and will die.

II. AFTER THE DUST SETTLES

A. Assessment and Planning

Basic Point: *Once the immediate tree emergency has been remedied, you will need to turn to long-term decisions and actions.*

■ Inventory/Survey

- Make a survey of the complete forest.
- If you already have a survey or inventory, you need to revise it now:
 - to update data
 - to establish damage, safety problems, work, and cost

■ Tree Inspection: systematically inspect each tree for *maintenance needs* and *site information*.

- For speed, you will probably want to conduct a windshield survey, but recognize that it takes a ground survey to see and evaluate more subtle problems such as decay.
- *Maintenance needs* include pruning, removal, cabling, mulching, etc.
- *Site information* includes presence of wires, width of planting area, soil texture, etc.
- Include potential *planting sites*, if not already noted in your inventory. Check local criteria for planting sites, including spacing from other trees and traffic objects.

■ Policies. This is a good time to get in place—or review—standard tree documents such as:

- up-to-date *specifications* for selecting, buying, planting, pruning, and removal
- a Tree Ordinance

Resource: Bernhardt and Swiecki 1991, on the web at <http://www2.champaign.isa-arbor.com/tree-ord/ordintro.htm>, and the "Sample Brief Tree Ordinance" at www.cce.cornell.edu/monroe/cfep

■ Education. Work again with the media, now that you have a plan.

- Publicize your next actions and decisions. People get most upset when they do not know what is going to happen, or when.
- Notify homeowners from now on before doing work on any public tree they might consider "theirs". Use letters, postcards, door hangers, or any other means that works.
- Get out good information on replanting and tree care. For example, excellent consumer brochures are available from the International Society of Arboriculture.

B. Working with FEMA and other reimbursement sources

Basic Point: *A little bit of care and attention on the front end can save a lot of pain on the back end!*

■ Records, records, records! Know what is needed, and keep track of it from the start.

■ To be eligible for FEMA reimbursement, work must be:

- overtime
- required as the result of a major disaster event
- located within a designated disaster area
- the legal responsibility of an eligible applicant

- **Understand the "disaster area" declaration process** (Resource: Andresen/Burban 1994, pp. 61-65)
 - Initial emergency response occurs at the local level.
 - Local officials can decide to contact their State Emergency Management Agency (SEMA) for assistance.
 - SEMA determines whether the affected area should be declared a disaster by the Governor.
 - The governor can request that the situation be declared a "major disaster" by the President.
 - If approved, the Federal Emergency Management Agency names a Federal Coordinating Officer who oversees the determination of what type of relief is needed.
 - Local, state, and federal representatives work together to develop the Damage Survey Report, which provides an estimated budget.
 - Tree removal and pruning in natural forest systems are excluded from FEMA reimbursement, unless the trees directly impact public safety of persons using a maintained public facility.
 - Hazard mitigation funding is also possible to reduce future damage, though it is much more limited.

- **Inform yourself about reimbursement requirements:**
 - Get a copy of your state's Emergency materials.
 - Understand FEMA and its role (current info on the web at www.fema.gov/about/)
 - **Get a copy of FEMA's *Applicant Handbook*** (FEMA 323).
 - Interactive application forms that can be filled out on the computer are available on the web at <http://www.fema.gov/r-n-r/pa/appfrm1.htm>
 - Directions for those forms can be found in the *Applicant Handbook*, and on the same web site as the forms.
 - Find out what will be reimbursed before you contract out work.
 - Public tree removal necessitated by a disaster in a declared area is usually reimbursed, stump grinding is not unless a clear threat to life and public safety can be identified.
 - Tree replacement is usually not covered by federal and state emergency management offices, unless it is a component of an otherwise eligible FEMA project.
 - **Only overtime emergency labor is eligible** for FEMA reimbursement.

- **Individual tree valuation may become necessary** in some instances for establishing the value of a specimen tree.
 - Tree valuation is difficult and often disputed, and for this reason is best carried out by a certified or registered consulting arborist trained and experienced in the technique.
 - There are two standard guidelines for doing this (ISA):
 - *Trunk formula method*: used for large trees
 - *Replacement cost method*: used for smaller, replaceable trees

Resource: ISA, *Guide for Plant Appraisal*

$$\text{Appraised Value} = \text{Basic Value} \times \text{Condition} \times \text{Location}$$

where

$$\text{Basic Value} = \text{Replacement Cost} + (\text{Basic Price} \times [\text{TA}_A - \text{TA}_R] \times \text{Species})$$

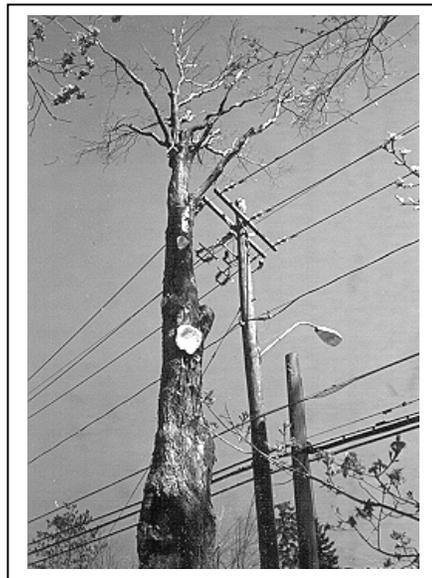
Source: ISA Guide

General formulas for deriving a guideline value for a specimen tree according to the "Trunk Formula Method"

C. Reducing delayed threats to public safety

Basic Point: *Disasters weaken surviving trees, leaving future safety and cost questions.*

- **Priority 2 Removal.** Priority 2 trees have no danger of immediate death and failure, but they are expected to decline and fail over the next 5-10 years. *Making decisions about Priority 2 Removals is probably the hardest and most controversial step in managing a storm-damaged forest.*
 - Decide which trees should come down now to remove a likely source of future hazards, and to be more cost-effective. Use your inventory/survey to set priorities.
 - Consider factors such as safety, looks, neighborhood effect, cost, age, vigor, crown loss, balance, heartwood damage, and species.
 - Good candidates for Priority 2 removal:
 - low-vigor trees with 50% or more of the crown destroyed or heavily damaged, → G
especially when the loss is mostly on one side
 - trees with leaders broken back into the trunk
 - split or tipped trees that were not removed as Priority 1
 - FEMA usually does not reimburse communities for non-hazardous tree removal.
 - Consider closely those trees that have a high hazard potential by virtue of species. In the Northeast, these typically include:
 - basswood (American linden)
 - black locust
 - willows
 - boxelder (ash-leaf maple)
 - silver maple
 - cottonwood, quaking aspen, and other poplars
 - tree-of-heaven



This old sugar maple lost about 75% of its crown in an ice storm, and has a restricted rooting volume between the street and a new sidewalk. Sugar maple is a species that is unable to resprout lost crown.

Finally, its failure would impact the busy street intersection, as well as significant utility fixtures.

For these reasons, this tree is a Priority 2 Removal candidate.

- Get help if possible, using knowledgeable tree professionals who have little or no monetary stake in the outcome. Check with your state forestry or Cooperative Extension office for suggestions.

■ **Priority 2 Pruning.**

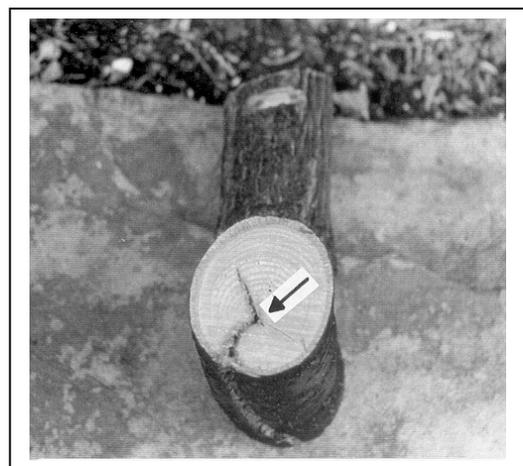
- Use your inventory to locate trees with a high hazard rating that need to be pruned.
- Prune off stubs or broken branches, and begin rotational maintenance pruning to reduce future hazards. FEMA usually does *not* pay for non-hazardous pruning. → **G**
- Identify vigorous trees that will need crown restoration.
 - Hold off any restoration work until the tree has resumed normal growth.
 - When many sprouts emerge after severe loss, it often helps to select a new scaffold limb structure by reducing competing limbs to the strongest.
- Many communities have found it often more cost-effective to clean and repair Priority 2 trees than to remove them and replant.

■ **Delayed storm response**

- After winter storms, be ready for new failures of split trunks and limbs when leaves come out in the spring. The leaf surfaces catch extra air and rain, increasing the load on the damaged tree parts.
- Trees flooded when they are actively growing (especially just after the first flush of growth) will often have their roots weakened or killed, rendering them susceptible to later incidents of insects, disease, and windthrow.
- All storm-damaged trees are weakened trees, and significant problems routinely emerge much later.

A radial shake in a linden that had gone through a severe ice storm, showing tri-part rupture through bark and wood on the outer surface. The radial shake weakens the limb, making it susceptible to later failure.

Source: Miller 1991

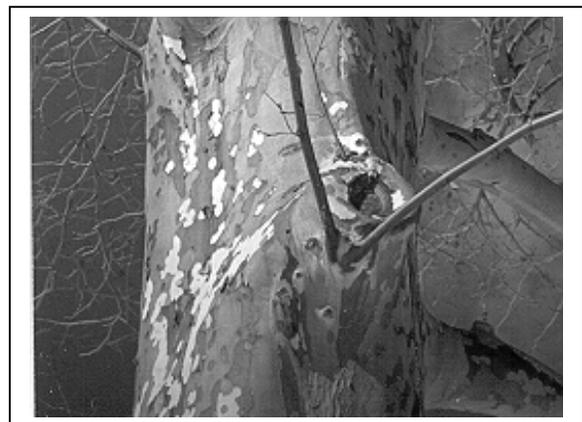


D. Recovery and reforestation

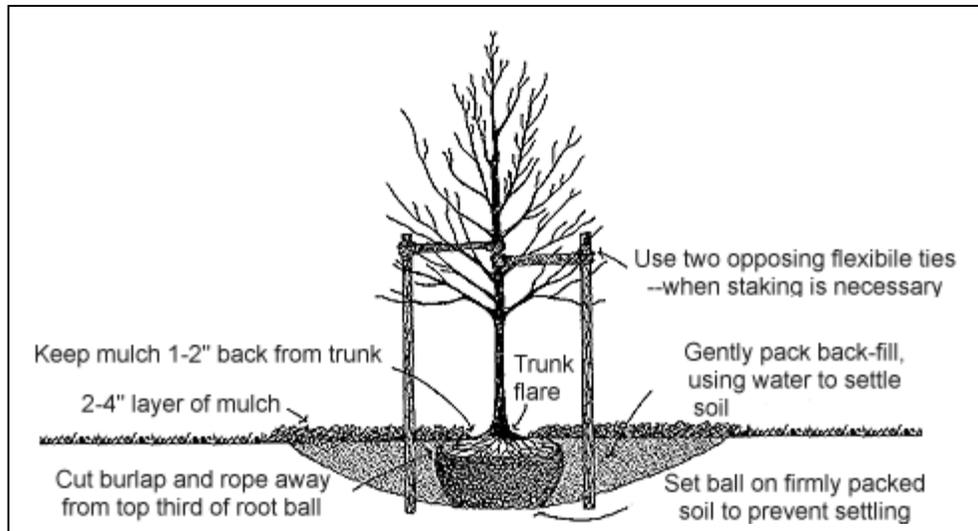
Basic Point: *Tree loss means the community itself has lost value because of factors such as reduced cooling, less air purification, and lower attractiveness. It is in the community's best long-term interests to promote recovery and reforestation.*

- **Trees have means to recover after disasters, because they have been dealing with natural disturbances (storms, fires, floods, insect plagues, etc.) since they first arose.**
 - **All tree species have innate means to control the decay that comes with damage.**
 - Trees produce chemicals through photosynthesis that kill fungi. The healthier the tree is, → **G** the greater its capacity to produce these chemicals.
 - Trees also change the physical structure of cells surrounding the decay, making it harder for the fungus to digest and grow through them.
 - Combining these techniques, trees can build internal barriers to the expansion of decay in a process called "compartmentalization."
 - The larger and deeper the wound, the greater the extent of decay. Also, trees cannot compartmentalize decay associated with the loss of their main stem.
 - **Deciduous trees have another means of recovery: the ability to resprout lost crown.**
 - Buds in older wood that had been suppressed while the crown was healthy are released for growth.
 - Younger, healthier trees on good growing sites will usually respond best.
 - Some species (e.g., green ash) are very good at resprouting lost crowns, others (e.g., sugar maple) are not.
 - The energy to resprout lost crown comes from starch that had been made and stored in previous growing seasons.
 - The length of time required for recovery depends on many factors, but forests often return to normal appearance within 5-10 years.
 - The loss of starch for containing decay and resprouting lost crown leaves the tree vulnerable, however, and long term decline may set in without many external symptoms at first.

On this London plane can be seen signs of a deciduous tree's responses to loss of crown, 8 years after a severe ice storm. The swollen ring of woundwood indicates compartmentalization of decay, and the shoots indicate attempts to sprout new foliage. There are great differences in trees' abilities to compartmentalize decay and to resprout lost crown.



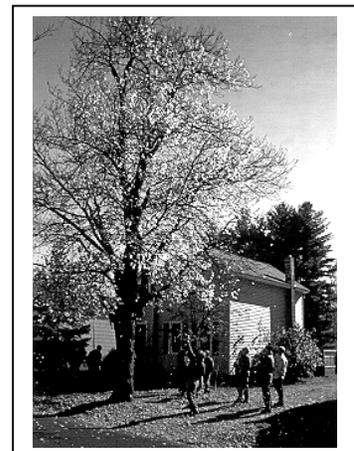
- **Develop a restoration plan** that will become the reference document for the future.
- **Seek out replanting funds** from private and public funds while memories are fresh.
 - Possibilities include local businesses, charity organizations, individuals, nurseries, green professionals, etc.
 - Contact the office of your state (urban and community forestry coordinator for other sources.
Resource : Tree City Bulletin #34, "How to Fund Urban Forestry."
- **Set up and use purchasing and planting specifications** for standard use.



Source: ISA, "New Tree Planting"

- **Have good selection criteria** in place.
 - Check with your state urban and community forestry coordinator or Cooperative Extension office.
Resources: Bassuk 1998, Reynolds and Boivin, 1994.
 - **Establish a Tree Commission**
 - Include concerned citizens as well as tree management personnel.
 - Use them for help in areas such as:
 - basic tree inventory and assessment information
 - tree selection
 - keeping track of species diversity
 - matching tree species to site
 - relations with homeowners.
- Resource: Lipkis and Lipkis, "The Simple Act of Planting a Tree"

Tree Commission members assessing a decayed horsechestnut in the village Right-Of-Way.



III. GETTING READY FOR THE NEXT ONE

A. *Emergency Plan*

Basic Point: You don't want to wait until disaster strikes again to figure out your best way of dealing with tree emergencies.

- **Establish tasks** and assign responsibilities: figure out exactly what will need to be done, and who will do it. Basic task list for a medium-sized community might include (adapted from Andresen and Burban, 1994):
 - Tree pruning and removal
 - Public alley clearance
 - Phone contact for public service calls
 - Communications with other local officials/offices
 - Location of equipment, fuel, generators, etc.
 - Search for additional equipment and assistance
 - Brush removal from private property
 - Debris disposal
 - Record keeping
 - Damage assessment
 - Emergency response evaluation.

- **Determine small management work units with priority routes**, and maintain
 - trees in the Right-Of-Way
 - relevant private trees (for example: any trees that would fall in the road)

- **Identify tree professionals** who are knowledgeable and reliable.
 - Get prices for labor and equipment now, so that later you can figure out how great the markup for emergency work is.
 - The larger the amount of debris, the more equipment you will need to remove it. Businesses like construction or timber companies will be a likely source.

- **Collect emergency documents** and place copies in central locations. Possible inclusions:
 - List of tasks and responsibilities
 - List of priority routes to clear
 - List of emergency officials
 - FEMA rules and regulations
 - Chain of command and organizational chart
 - List of other emergency telephone numbers (utilities, etc.)
 - List of reputable tree professionals
 - Tree care pruning standards (ANSI A300, Part 1)
 - Safety announcements
 - Public releases on safety and other topics.

B. Inventory

Basic Point: The better you manage and maintain trees, the less damage they will suffer.

- Inventories of public trees have multiple benefits:
 - Making and defending budgets is much easier with hard data.
 - Work orders, annual costs, and tree histories can be quickly produced.
 - Homeowners are happier when an inventory is in place. They seem glad that somebody actually knows about "their" tree.
 - By including potential planting sites in your inventory, you can figure out your stocking rate, plan your budget, and find locations for planting. → **G**
 - Funding requests to emergency agencies will usually be processed more quickly, and requests for reimbursement will be easier to justify.

- Computerized inventories are easiest to maintain and use.
 - Buy a professional program, or use an off-the-shelf spreadsheet such as Excel™
 - Resource: recent review of professional programs on the web at <http://willow.ncfes.umn.edu/pubs/urbanforestry/streettree/toc.htm>.
 - Free basic inventory templates based on Excel™ and Access™ are downloadable from the web (<http://www.cce.cornell.edu/monroe/cfep>), or check with your state urban and community forestry coordinator's office.

- If an inventory is not possible, at least make sure that you:
 - have a system of annual inspection for needs and hazards
 - use a reliable method of evaluation
 - keep good records of complaints, decisions, and actions.

Example: Simple Inventory (using Excel™)

DBH = diameter at breast height; Cond = condition (5=excellent, 1=dead);
 HazEv = hazard evaluation rating (3=no hazard, 12 = highest hazard);
 Remv = remove; Remv/Trim codes: 0=None, 1=Required, 2=Optional

Trees Sorted by Address

Address	Species	DBH	Cond	HazEv	Remv	Trim	Comments
Bell St.							
21 Bigelow Side N	Sugar Maple	28	3	6	1		Clean
21 Bigelow Side S	Sugar Maple	28	4	3	2		Raise
3 Bell	Norway Maple	14	4	3	0		
5 Bell S	Green Ash	23	3	5	0		
5 Bell N	Sugar Maple	21	3	9	1		Decay btw leaders

Trees Sorted by Hazard Potential

Address	Species	DBH	Cond	HazEv	Remv	Trim	Comments
5 Bell N	Sugar Maple	21	3	9	2		Decay btw leaders
21 Bigelow Side N	Sugar Maple	28	3	6	0		Clean
5 Bell S	Green Ash	23	3	5	2		
21 Bigelow Side S	Sugar Maple	28	4	3	0		Raise
3 Bell	Norway Maple	14	4	3	0		

- A useful option is to determine **hazard potential** for your trees, using a consistent rating system. → **G**
Here is one well-tested simple formula for hazard potential developed by tree professionals in conjunction with the International Society of Arboriculture:

HAZARD POTENTIAL = failure possibility + part size + target rating

- Each category on the right side is assigned by field examiners a number between 1 and 4, the higher numbers being more serious. The tree's hazard potential is the sum of those numbers.



Resource: Matheny/Clark 1994.

- This hazard potential has little meaning all by itself, but gains value in comparison with other trees in the same area. It is a method to direct your resources toward the most dangerous trees.
- Action on trees with a hazard rating higher than 8 or 9 is often considered obligatory, and the trees are usually put on more frequent inspection as well.
- Good hazard evaluation depends on trained and experienced observers, and on consistency. For these reasons, it is best done by professionals.
- If you conduct the hazard survey yourself and are not a tree professional, be as consistent as you can in applying the rating system.
- Here is **an example** of a sugar maple on a country road with the top half dead:



Hazard Rating:

Failure possibility	4	(dead wood is non-negotiable)
Part size	3	(dead wood is about 24" in diameter)
Target rating	1	(occasional use road)
TOTAL	8	

C. Mitigation: How to Limit the Damage Potential

Basic Point: what you do now--and the way you do it--will strongly impact how much damage you will have and how well your forest will survive in the next disaster.

■ Tree Selection

- **Require site analysis** before selection, so limitations are known before a tree goes into the ground. Try to plant the "right tree for the right place."
Resource: site analysis form in Bassuk, 1998
- **Adjust the size of tree to the width of the tree lawn.** In the long run, the health of an urban tree will depend its having an appropriate rooting volume for its size.
- **Avoid planting large-growing trees under power lines.** You can train young trees around wires, but they will always have to be pruned, setting them up for weakness and failure.
- **Establish a list of acceptable species,** using materials from your state state urban and community forestry coordinator or Cooperative Extension . Do not plant species known to fail.

→ G



In the Northeast, boxelder often fails during storms without any apparent damage or decay. This one went down in a 1998 ice storm.

- **Aim for species diversity** to limit damage from any one kind of disaster. One common guideline states that any one species (e.g., sugar maple) should be limited to 10% of the forest, and any one genus (e.g., all maples) to 20%.
- **Limit use of nuisance species (e.g., cottonwood) and species known to be invasive in your area (e.g., Norway maple).**
- **Buy high quality stock:**
 - no defects or pests,
 - good crown and root structureResource: "Buying High-Quality Trees", on the web at <http://www2.champaign.isa-arbor.com/consumer/buying.html>

→ G



■ Planting

- Dig shallow and wide holes. Make sure root ball sits on undisturbed soil, and that root flare is at soil grade, so roots don't suffocate or drown.
- Check for girdling roots, and prune them to promote outward growth.
- Don't stake unless necessary, and then only with wide, soft ties.
- Place organic mulch 2-6" deep out to the dripline (but not against trunk), and renew it when it decomposes.

→ G

→ G

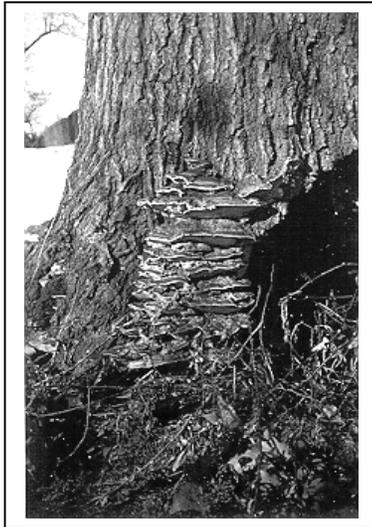
→ G

- Guard the young trunk with a recommended method (such as mulch and hardware cloth) to prevent damage to young tree from string trimmers, lawn mowers, etc.

Resource: Reynolds and Ossenbruggen 1993.

■ Pruning and Removals

- **Prune young trees for strength and form** (= "training"), starting a few years after planting. → **G**
 - Training is particularly important for species that tend to produce codominant stems.
- Resource "Pruning Young Trees" on the web at <http://www2.champaign.isaarbor.com/consumer/young.html>
- Carry out the pruning and removals indicated by hazard potential on your inventory.
 - Make annual inspections, and remove the riskiest trees as your budget permits.
 - Larger trees with indications of butt rot (hollow buttress roots, mushrooms on the base, etc.) must be evaluated carefully. → **G**

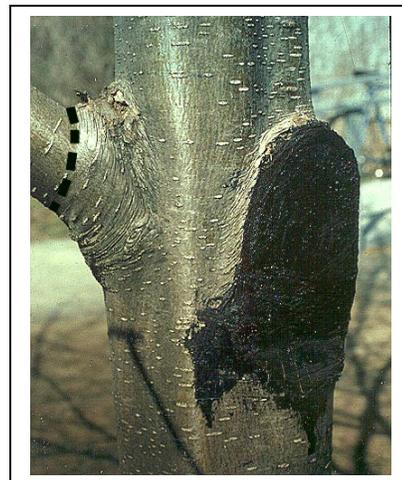


This red oak in a park was diagnosed to have extensive butt decay but, because it had no reasonable target, was left standing. Six months later, it toppled over in a severe windstorm, revealing the extent of dead and rotted roots.

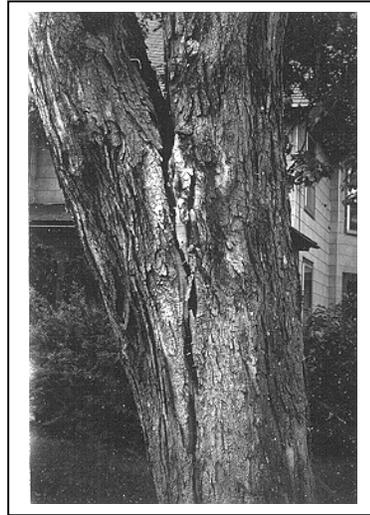
- Make sure proper pruning cuts are made at proper times. Remember that decay routinely follows cutting, and that it will be less serious with:
 - *better cuts, smaller exposed surfaces*
 - *faster wound sealing, younger trees*
- Resource "How to Prune Trees" (USDA, 1995).

On the right side of this tree is a flush cut painted with a creosote-based material. This technique is now known to be harmful to the tree. A proper cut is indicated on the left side with a dotted line; nothing should be applied to the cut surface afterwards in most cases.

Source: adapted from a slide by Alex Shigo in the set "TLC for City Trees"



- **Pay attention to codominant stems** on larger trees: they commonly fail in windstorms.
 - The time to remove codominant stems is when the trees are young, because they can recover very well at that time.
 - Removing a codominant stem on a large tree can cause as many problems as it solves, and should only be done when no other solution is possible and the target is serious.

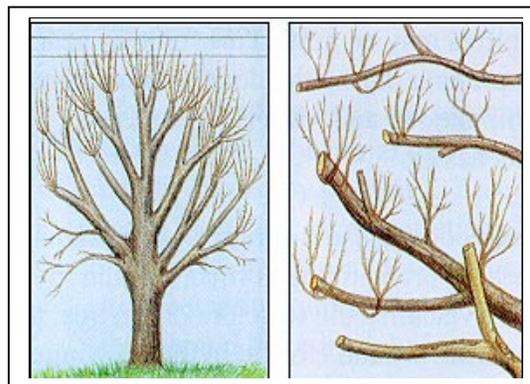


The codominant stems on this red maple failed in a windstorm, leaving this crack on both sides of the trunk. **Such a tree is already in failure, and requires immediate action.** The best mitigation strategy would have been to remove one of the stems as early in the life of the tree as possible, cutting at an angle and avoiding wounding the branch ridge through the middle of the union.

- **Avoid (if you can) cutting live wood in the spring** between bud break and full leaf expansion, **and in the early fall** when decay fungi are dispersing their spores. → **G**
- **Establish maintenance pruning** on a rotational basis. Maintained forests suffer less damage and cause less harm in disasters than those that are not maintained. → **G**
 Resource: "Community Maintenance Pruning" on the web at www.cce.cornell.edu/monroe/cfep. 
- **Do not top or tip trees.** This only causes more problems, and creates weaker trees. → **G**
 Resource: "Why Topping Hurts Trees" on the web at <http://www2.champaign.isa-arbor.com/consumer/topping.html>

Topping (left) and tipping

Source: USDA, 1995, *How to prune trees*



■ Roots

- **Promote the health of the root zone as much as possible.** This may include keeping a 2-6" layer of organic mulch underneath the crown, installing fencing, or planting other woody and herbaceous plants with the tree.
- Protecting the roots and their soil environment is the best long-term investment in the health of the tree.

Resource: Shigo, "Troubles."

A large mulched zone around a tree set into turf. Such a separation of grass and trees leads in the long run to healthier, safer, and less costly trees.

Source: the slide set "Tree Anatomy Below Ground" by Alex Shigo

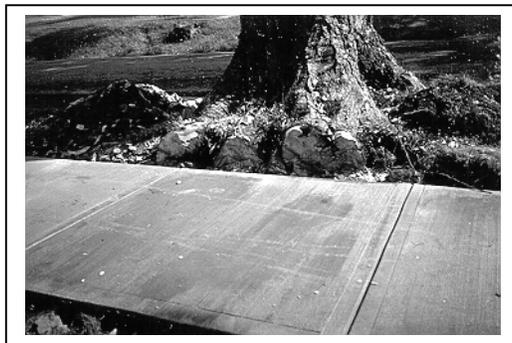


- **Keep grass away from the root system, especially around young trees.** Grass competes well against trees, and limits growth above and below ground.
- Provide slow-release fertilizer to young trees in the early fall or early spring. Young trees have been shown to benefit especially from a small amount of additional nitrogen—check for details on amounts and methods with your local Cooperative Extension office. → G

Resource: ANSI A300 fertilization standards.

- Consider tunneling instead of trenching when installing underground utilities.
- **Avoid grade changes over mature tree roots**, since the additional soil will suffocate them.
- **Avoid cutting the large buttress roots** that flare out from tree bases. One common example occurs during sidewalk repair, and alternatives should be considered where possible.

Resource: "Trees and Sidewalks" on the web at www.cce.cornell.edu/monroe/cfep



Large sugar maple with buttress roots cut for new sidewalk. When buttress roots are cut on a tree of this age and species on such a site, it will often die in 3-5 years or suffer from windthrow.

IV. RESOURCES

A. Printed resources

General

- Albers, Mike, et al. 1993. *How to detect, assess and correct hazard trees in recreational areas*. St. Paul MN: Minnesota DNR.
- Andresen, John, and Lisa Burban. 1994. *Storms over the urban forest. Planning, responding, and greening -- a community guide to natural disaster relief*. 2nd ed. Illinois: Division of Forest Resources. On the web at <http://willow.ncfes.umn.edu/sotuf/sotuf.htm>.
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- ANSI. 1998. *A300 (Part 2) American National Standard for Tree Care Operations. Tree, shrub, and other woody plant maintenance --standard practices fertilization*. New York: ANSI.
- ANSI. 1994. *Z133.1 American National Standard for Tree Care Operations. Pruning, trimming, repairing, maintaining, and removing trees and cutting brush safely*. New York: ANSI.
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- Capon, Brian. 1990. *Botany for gardeners*. Portland OR: Timber Press.
- Chaney, William. 1996. "How trees grow." *Tree Care Industry*. April, pp. 28-36.
- Elmendorff, William F., and Henry D. Gerhold. 1996. *A Guide for municipal tree commissions*. Mechanicsburg PA: Pennsylvania Forestry Association.
- Hanson, Trish, and E. Bradford Walker. 1996. *Field guide to common insect pests of urban trees in the northeast*. Waterbury VT: Department of Forests, Parks and Recreation. Order off the web at <http://www.state.vt.us/anr/fpr/forestry/pubs/pest.html>
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C. Emergency and Urban/Community Forestry Web Sites

- <http://www.isa-arbor.com/> The International Society of Arboriculture
- <http://www.asca-consultants.org/> The American Society of Consulting Arborists
- <http://www.treelink.org/> The National Urban and Community Forestry Advisory Committee
- <http://www.willow.ncfes.umn.edu/> The USDA Forest Service in Minnesota, includes a "Hazard Tree Page"
- <http://www.natlarb.com/> The National Arborist Association
- <http://www.arborday.org/> The National Arborday Foundation's home page
- <http://www.amfor.org/> The American Forests home page
- <http://www.aces.uiuc.edu/~eden/resources.html> The Extension Disaster Education Network
- <http://www.fema.gov> The home page for the Federal Emergency Management Agency. Regional offices (Boston, New York, etc.) are linked to the site.
- <http://www.umass.edu/urbantree/> Northeast Center for Urban and Community Forestry Amherst MA.
- See "Emergency Contacts" (cover insert) for your state urban and community forestry web site.

D. Useful Addresses for Additional Resources

In addition to local FEMA, state urban and community forestry coordinator, and Cooperative Extension offices listed on the cover insert, here are some further places where you can obtain useful resources:

American National Standards Institute (ANSI)
11 West 42nd Street
New York, NY 10036

International Society of Arboriculture
PO Box 3129
Champaign IL 61826-3129

Northeast Center for Urban and Community Forestry
Department of Forestry & Wildlife
Holdsworth Center
University of Massachusetts
Amherst, MA 01003-4210

E. The Tree Emergency Compendium

*The **Tree Emergency Compendium** can be obtained from your state urban and community forestry coordinator (see front cover insert). It is also available on the web at the web site of the USDA Forest Service, Northeast Center for Urban & Community Forestry (<http://www.umass.edu/urbantree/>). It contains the following resource documents for tree emergency use:*

I. Emergency Response

- "A300 Tree Care Standards"
- "How to Determine Percent Live Crown loss in Hardwoods Before Leaf-Out"
- "How to Prune Trees"
- "In the Storm's Wake"
- "Safety Tips for Preventing Injury"
- "Watch Out for Scam Artists Posing as Arborists"

II. After the Dust Settles

- "A First Look at Tree Decay"
- "Buying High-Quality Trees"
- "Can these trees be saved?"
- "Flooding and its Effects on Trees"
- "Helping Trees Recover From Ice Storms"
- "Mulching Trees"
- "Native Tree Species"
- "Planting Trees for Communities"
- "Rating System for Tree Hazard Potential"
- "Risk Assessment Guidelines for Hazard Trees"
- "Setback Planting"
- "Site Assessment Checklist"
- "Staking Trees"
- "Underwire Trees"

III. Getting Ready for the Next One

- "Agency Planning Worksheet"
- "Community Maintenance Pruning"
- "Evaluation of Trunk Cavities"
- "Helping Trees Recover From Ice Storms"
- "How to Recognize Hazardous Defects in Trees"
- "Predicting Limb Breakage"
- "Pruning Young Trees"
- "Sample Brief Tree Ordinance"
- "Trees and Sidewalks"
- "Why Topping Hurts Trees"

IV. Other resources and useful information

V. GLOSSARY

Borer

A borer is any sort of insect that bores into wood, including moths, beetles, sawflies, horntails, and flies. Most of the damage is done when they are in the larval ("grub") stage. A common example is the bronze birch borer that can kill a susceptible tree within a few years.

Branch collar

At a branch's point of attachment, there is usually a swollen area where branch tissue and main stem tissue overlap. This collar contains the tree's primary defense mechanism against decay when the branch loses vigor or dies. In pruning, it is important that this collar be left intact.

Bud break

Bud break is the moment in the spring that the scales of a bud first open and shoot elongation begins. The exact time of bud break varies by species, plant health, and weather.

Butt rot

When decay fungi (see below) attack the part of a tree where the trunk meets the roots, it is commonly termed butt rot. It is a very dangerous form of tree decay, since it leads to failure of the whole tree but is often difficult to detect without special means.

Buttress root

This term applies to the large thickened roots that flare out from the trunk to the ground and form the upper part of the root crown. They provide much of the stability of a tree, and are the major path for water nutrients to the upper tree.

Certified arborist

The term "certified arborist" usually refers to someone who has fulfilled the requirements of the International Society of Arboriculture, which include a rigorous and long examination. Continuing education on an annual basis is required to retain certification. Some states have their own certification program as well.

Consulting arborist, registered

A registered consulting arborist has satisfied the requirements for technical education and experience set by the American Society of Consulting Arborists. They can bring a comprehensive and objective viewpoint to the diagnosis, appraisal, and evaluation of tree issues.

Codominant stems

Double or twin leaders of similar diameter that meet in a "V" union at their base. Such narrow unions commonly develop on opposite budded trees (such as maples) and some other species or cultivars (such as Bradford pear). They tend to fail during storms, especially when associated with decay, and dealing with them before serious storm events is good practice.

Crown

The crown is used here as a synonym of "canopy," and includes all the smaller branches, leaves, and fruiting structures that form the upper and outer part of the tree. It is one of the main parts of the tree, along with the roots, trunk, and scaffold branches. The crown's condition—leaf color or size, twig vigor, etc.—is a good indication of the overall health of the tree, although it says little about its stability (its ability to remain standing).

Crown cleaning

This term refers to the removal of dead wood above a certain minimum diameter (often 2"). One of the standard pruning types.

Crown raising

You raise the crown when you remove limbs that reach down below a certain minimum such as 8' (over sidewalks) or 14' (over roads). One of the standard pruning types.

Crown restoration

After crown loss in a disaster or in radical pruning, trees often release many new shoots from one location. With crown restoration, these new shoots are reduced to a few in order to produce a stronger crown and more natural shape. One of the standard pruning types.

Decay fungi

Most fungi are able to break down dead wood, but a few are actually parasitic and can attack living wood. They digest the wood of the tree, leading to strength loss and eventual failure of the tree part. They attack branches, roots, and any wounded part, and range from visible decay of the growth layer ("canker") to hidden decay of the roots. When decay has advanced, mushrooms appear as the fruiting body of the fungus. Decayed wood typically appears brown and crumbly or white and stringy.

Defect

Any tree factor that affects its health or stability negatively is a defect. Examples include chlorotic leaves, cut roots, wounded trunk, decayed branch wounds, codominant stems (see above), etc. Tree evaluation depends upon the careful detection and analysis of defects.

Dripline

A tree's dripline is the imaginary line around the edge of the crown projected on the ground. The outline of the canopy shadow when the sun is exactly overhead is a good approximation. It is used as an estimate of the extent of a tree's root system for things like tree protection or root fertilization, although in many situations the actual roots extend much further away from the trunk.

Flush cut

A way of pruning off branches that takes off the branch and its branch collar (see above) so that the cut is flush to the trunk. It used to be done for looks and health, and was once much recommended and practiced. It is now known to be detrimental to the tree's ability to limit the resulting decay.

Girdling root

When a root curls around the trunk base instead of growing outward away from the tree, it is called a girdling root. As it becomes larger over the years, it can cut off the flow of sugars down from the leaves to the roots. The roots will die, and the tree then lacks both water and support from that direction.

Hanger

Any dead piece of wood that is broken and hanging up in the crown, whether still attached or not. This obvious yet common defect poses a hazard to traffic or objects below.

Hazard potential/hazard rating

The hazard potential of a tree is a measure of its threat to an urban population. Methods to evaluate it usually examine the tree's potential to failure, the size of the part that might fail, and the relative significance of potential targets below.

Hazard tree

A hazard tree is one that in the judgment of an evaluator poses a significant threat to a significant target. Examples include a tree with a large dead branch over a street

Leader

A leader is a large, dominant, and more or less upright limb attached to the trunk. In some species, there is only a single or central leader, in others, there may be several.

Low-vigor trees

Vigor refers here to the average rate of growth of a tree, which can vary by species, age, site, and weather. When a tree has reduced growth, it often has a reduced ability to make sugar and to resist pests. Vigor can be measured directly with an increment borer, which takes a small core of wood directly out of the tree. A good non-invasive field estimate can often be made by looking at the annual growth increments of terminal twigs; anything consistently under 2" usually indicates low vigor.

Maintenance pruning

Maintenance pruning refers to the practice of maintaining tree structure, form, and appearance by periodic pruning visits. It is safer and more cost-effective to conduct maintenance pruning for an urban forest than to manage it by simply responding to reported problems.

Pest

A pest is any insect or disease that adversely affects the health or appearance of a plant. It is important to separate serious pests, such as borers, from cosmetic pests, such as galls.

Photosynthesis

Any plant that has chlorophyll can produce sugar and other chemicals from water and carbon dioxide in the presence of light. The reverse of photosynthesis is respiration (see below). The plant's photosynthetic rate is closely connected to its growth and health.

Pruning types

Six categories of pruning are defined in the ANSI A300 standards for hazard or maintenance pruning. These "pruning types" include crown raising, crown cleaning, crown thinning, crown reduction, vista pruning, and crown restoration. Using such standard terms brings clarity and responsibility to tree care.

Respiration

Sugars are consumed by plants as by animals: oxygen is taken in, and carbon dioxide is released. Trees need a certain level of respiration to maintain their health, and even more to be able to grow. If oxygen is cut off from respiring plant parts, such as when soil is heaped over small roots, they suffocate and die.

Root flare

When tree roots experience stress, they are strengthened. Trees undergo great stress from wind and gravity where the trunk meets the roots, and the result is a root thickening that produces a flare. The lack of a flare on an open-grown tree often indicates serious root problems, and should be evaluated carefully.

Rotational pruning

It is a common practice to conduct maintenance pruning (see above) in larger urban forests by dividing the forest into management units, and rotating the pruning to a different unit or group of units each year. This has been shown to be a very cost-effective way to manage public trees.

Scaffold branch

Scaffold branches are the large limbs that define the overall structure of the crown. They include leaders and large lateral limbs on many hardwoods, the central leader alone on many softwoods.

Site analysis

Many factors influence whether a tree will be able to grow successfully on a given site, and it is important to analyze them if the future forest is to be healthy and strong. These factors include: soil pH and soil texture (ratio of sand, silt, and clay), rooting volume, presence of utilities, heat load, soil moisture, etc.

Slow-release fertilizer

A slow-release fertilizer uses a method to make a small amount of its nutrients available to the plant over a long period of time. It has been shown that young trees particularly benefit from such a technique, because extra nitrogen is available whenever they need it.

Species diversity

The best defense against pests and disasters lies in having species diversity, or a mix of species, in the urban forest. Forests that contain predominantly one species (such as American elm), or one genus (such as maples) are much more susceptible to harm than those have a variety.

Stocking rate

This number is found by dividing the number of existing trees by the number of possible trees (= # of planting sites, whether filled or not). Expressed as a percentage, it can be used to estimate the degree of historic commitment to public trees, as well as to indicate the potential for growth.

Target pruning/Lateral pruning/Directional pruning

A tree's growth can be directed away from a target such as a building or wire by pruning to a sufficiently large lateral branch pointing away from the target. Fewer cuts have to be made, and pruning visits are reduced. If the trunk or limb is simply headed back without attention to where the cuts are made, resprouting will be encouraged on hardwoods and even more work will be produced.

Topping

When many branches are simply pruned back indiscriminately to reduce the height of a tree, it is called topping. Topping produces many new sprouts and introduces multiples wounds for decay fungi, and is therefore harmful to the tree. It also produces disfigured trees.

Training

Training is the pruning of young hardwood trees for strength and beauty. Well-spaced limbs with strong unions result from proper training. It is also the best method of taking care of codominant stems (see above), since one of the stems can be removed while the tree is young and can recover quickly.

Appendix F
i-Tree Storm Information

Information to be included for final plan when i-Tree 3.0 is released

Appendix G
Contracting Tree Work

Contracting Tree Work

Tree care companies can be utilized to perform work beyond the capabilities of municipal manpower and equipment. Some of the advantages of using contracted crews to do tree work are:

- Does not require an increase in municipality personnel or re-training of existing personnel.
- Does not require large capital expenditures on equipment.
- Allows for greater flexibility in scheduling tree care operations.
- Allows the amount of work performed on an annual basis to be adjusted based on available municipality budget, without laying off municipality personnel.

A municipality can most cost-effectively contract tree work by:

- Scheduling work in the winter months, since this is traditionally the slow season for tree care companies. Companies may offer reduced rates (10% to 20%) for off-season work to keep their employees on the payroll.
- Performing work on a project basis. In this way, the tree care company is guaranteed a certain dollar volume of work, and the municipality is guaranteed specific work rates. Tree companies may offer a reduced rate (5% to 15%) for fixed-volume business.

Contracting of Tree Care on a Project Basis

To secure the best possible prices, Davey Resource Group recommends contracting on a project-by-project basis. Projects can include work on an individual tree or work on a group of trees, based on either the type of maintenance to be performed or by location of work. In the first example, all of the removals can be identified as a project, and bids can be solicited for the performance of the removals alone within a specific time frame. Ideally, bids for work should be on a per tree basis by diameter class. In the second example, the maintenance for all trees on several streets can be identified as a single project and bids solicited for the entire project. There are many variations of this concept for contracting tree care, and the Municipality can select the method that best suits its requirements. Project planning should focus on the efficient use of workers and equipment by the selected contractor. This will aid the Municipality in obtaining the best pricing for tree care projects.

It is important to consider more than just pricing when selecting a tree care contractor. Contractors should be required to post performance bonds on projects over a certain dollar amount; should show proof of adequate general liability and workers' compensation insurance; should be able to demonstrate sufficient ability to perform the work as specified; should hold all necessary licenses, such as pesticide application certification; and should be able to provide references to past work that is similar to the work specified for the project. In addition, the Municipality should maintain awareness of any public relations problems involving the contractor's work procedures, equipment, and personnel appearance. Such problems or potential problems should be remedied as soon as possible.

Recommendations for Contractor Crew Inspection

When inspecting contractor tree crew operations, the Municipality should make sure the crews follow the guidelines set forth in contract specifications for the work being performed. These specifications should be developed and approved by the Municipality to ensure quality performance by contractors. Following these guidelines should result in improved pruning procedures and safe work practices. The inspection process should ensure that the contractual procedures are followed. Examples include:

- Climbing crews do not use climbing spikes except for tree removals.
- All pruning cuts are made according to specifications. Pollarding, framing, or rounding over is not acceptable practice.
- Work operations are properly protected with traffic cones, pedestrian barriers, and flaggers to prevent injury to crew personnel and the general public, and to prevent damage to adjacent property.