PART E: HISTORIC LANDSCAPE PRESERVATION GUIDE

INTRODUCTION

The purpose of the landscape preservation maintenance guide is to provide assistance for Ft. Lewis staff to plan, implement, and document immediate and long-term preservation maintenance practices for the Historic District. The preservation guide ensures application of a consistent and comprehensive maintenance strategy to all historic features in the landscape over time and through changes in staff and contractors. The guide may also be used to forecast budget needs based on the type and quantity of work necessary to preserve the Historic District. Because the maintenance of historic structures and small-scale features associated with structures has been addressed in "Maintenance and Repair Manual for Historic Structures: Ft. Lewis", this guide focuses on maintenance of historic vegetation and circulation features in the landscape.

The preservation guide consists of three main sections: Implementation and Record Keeping; Maintenance Zones for Vegetation; and Maintenance Practices. Implementation and Record Keeping provides maintenance work calendars and inventory sheets for recording maintenance activities. Maintenance Zones for Vegetation establishes a three-level hierarchy to maintain vegetation in the Historic District. And, Maintenance Practices provides overviews on how to perform common maintenance tasks related to both vegetation and circulation features.

IMPLEMENTATION AND RECORD KEEPING

IMPLEMENTATION AND RECORD KEEPING

INTRODUCTION:

A primary difference between historic landscape maintenance and standard landscape maintenance requirements is the necessary emphasis on detailed record-keeping on the historic landscape. Inadequate record-keeping of the past has led to poor preservation management decisions and practices. Recording completed maintenance practices, such as recording replacement strategies, will be used in the future by preservation specialists and managers to understand how the landscape evolved with an ongoing maintenance plan and under different maintenance and management staffs. The following work activity calendar and condition assessment sheet provide a consistent level of maintenance and record keeping.

WORK CALENDARS:

Annual work calendars help structure and schedule maintenance efforts by recording the frequency and timing of individual maintenance tasks or activities. Because landscapes, especially vegetation, change through the seasons, calendars are presented on a monthly basis. In this way, the calendar determines what, when, and where to perform maintenance tasks.

Two calendars have been developed to maintain the vegetation and circulation features in the Historic District; a Task Calendar and a Calendar of Monthly Tasks. The first calendar is a list of maintenance tasks and a chart indicating what month to perform the task. The second calendar is a list of maintenance tasks to be performed each month. In addition to these calendars of routine maintenance tasks, this section provides a list of long-term maintenance activities necessary to ensure appropriate management of the historic landscape is provided.

TASK CALENDAR

Note: Some work can be performed during different seasons, for ex. spring & fall. An "X" indicates the preferred time, an asterisk (*) indicates an alternative time.

J	F	M	A	M	J	J	A	S	O	N	D	
		*	*	*					X	X	X	Plant deciduous trees and shrubs.
	X	X										Plant bareroot trees and shrubs.
			*	*					X			Plant evergreen trees and shrubs.
	*	*						X	X	X		Transplant plants.
	X											Check new plantings for frost heave and firm soil.
*	*	*	*	X	X	X	X	X	*	*	*	Prune dead, damaged and decayed branches from trees and shrubs.
X	X										X	Routine pruning for most deciduous and evergreen trees and shrubs every 2-3 years or as needed.
X	X										X	Prune to renovate neglected/oversized shrubs.
	X	X										Prune summer-flowering shrubs annually, every three years or as desired for effect.
		X	X	X	X							Prune spring-flowering shrubs annually, every three years, or as desired for effect.
*	*					X					*	Prune 'bleeder' species-maple, dogwood, pine, birch.
					X							Prune suckers from species prone to suckering.
	X											Prune roses as desired.
X											X	Monitor Spruce Aphid populations in Norway and Blue spruce.
	X	X										Treat Blue and Norway spruce for spruce aphid infestations, as needed.
		X	X	X	X	X	X	X	X			Monitor elms for symptoms of Dutch Elm Disease. Every 2 weeks prior to arrival at Ft. Lewis, 1/week once detected.
X												Rake out moss and any remaining fallen leaves from lawns.
									X	X		Rake fallen leaves from turf areas. Compost if disease and pest free.

J	F	M	A	M	J	J	A	S	O	N	D	
									X	X		Clean up and dispose of fallen foliage, twigs and branches of fruit and ornamental deciduous trees.
									X			Apply lime (dolomitic limestone) to turf areas at 25-30 lb. per 1000 sq. ft. every 3 to 4 years.
	X											Lay sod for new turf areas, or repair old areas.
X												Apply horticultural oil to kill overwintering insects.
	X											Treat moss in lawns.
		X										Test soil fertility and add fertilizer and lime or acidifying chemicals.
			X						X			Dethatch turf areas.
			X									Aerate turf area.
	X	X	X	X	X	X	X	X				Mow lawns once a week or as needed.
			X						X			Seed new turf areas or overseed bare spots in established areas.
			X		X			X				Edge and trim turf areas in High Zones.
			X					X				Edge foundation planting beds in High Zones.
			X									Edge and trim turf areas in Medium Zones.
			X									Edge foundation planting beds in Medium Zones.
				X	X			X			X	Fertilize turf areas in High Zone with 1 lb. of nitrogen per 1000 sq. ft.
				X							X	Fertilize turf areas in Medium Zone with 1 lb. of nitrogen per 1000 sq. ft.
				X				X				Spray lawn weeds with herbicides.
				X								Remove dead heads from flowers that have finished blooming if desired.
				X	X	X	X					Weed plant beds.
			X				X					Mulch foundation planting beds and trees in lawns yearly in High Zones (maintain 4-6" layer), every other year in Medium Zones.
				X	X	X	X	X				Water vegetation to maintain optimal growth as needed.

J	F	M	A	M	J	J	A	S	O	N	D	
		X										Repair winter and storm damage to plants and hard surfaces.
X	X	X	X	X	X	X	X	X	X	X	X	Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
X	X	X	X	X	X	X	X	X	X	X	X	Clean debris from drainage grates.
					X	X	X					Repair roads and sidewalks.
X												Inventory and repair grounds equipment.
	X											Order equipment and materials.
										X		Clean fallen leaves from building gutters and downspouts.
										X		Clean tools for winter storage. Oil moving parts and sharpen pruners.

CALENDAR OF MONTHLY TASKS

JANUARY

◊ Perform routine pruning for most deciduous trees and shrubs every 2-3 years or as needed (if temp. above 20 deg. F.). Prune mature trees conservatively to avoid excessive thinning and wounding.
◊ Prune to renovate neglected/oversized shrubs. Delay pruning spring-blooming ornamentals until after they flower.
◊ Monitor Spruce Aphid populations in Norway and Blue spruce.
◊ Apply horticultural oils to kill overwintering insects.
◊ Rake out moss and any remaining fallen leaves from lawns.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris (snow and ice if necessary) from drainage grates.
◊ Inventory and repair grounds equipment.

Alternative tasks:

* Prune dead, damaged, and decayed branches from trees and shrubs. Pruning dead wood can be performed year round but is easier to detect in summer.
* Prune 'bleeder' species-maple, dogwood, pine, birch.

FEBRUARY

◊ Plant bareroot trees and shrubs as long as soil is not frozen.
◊ Perform routine pruning for most deciduous trees and shrubs every 2-3 years or as needed (as long as temp. is above 20 deg. F.). Caution: do not prune trees during the weeks they are forming leaves. Do not prune American elms (except if eradicative pruning is necessary for Dutch elm disease) between March and October. Prune mature trees conservatively to avoid excessive thinning and wounding. Delay pruning spring blooming ornamentals until after they flower.
◊ Prune to renovate neglected/oversized shrubs.
◊ Prune summer-flowering trees and shrubs. Cycle: annually, every three years, or as desired. Prune when growth begins-late in the month or in March, see lists in Appendix E.
◊ If heavy frost occurs, check new plantings for frost heave and firm soil as necessary.
◊ If spruce aphid populations are large (see Jan.) spray Blue and Norway spruce-see Hazard Tree Survey.
◊ If ground is frost and mud free, lay sod for new turf or repair old as needed.
◊ Give first mowing when grass reaches 3 inches.
◊ Control lawn moss with ferrous or ferric sulfate if uncontrolled by a good thatching, aeration, fertilizing, and watering program.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris (snow and ice if necessary) from drainage grates.
◊ Order equipment and materials.

Alternative tasks:

* Transplant plants if applicable as long as the weather is above freezing.
* Prune dead, damaged, and decayed branches from trees and shrubs.
* Prune 'bleeder' species-maple, dogwood, pine, birch.

MARCH

◊ Prune summer-blooming trees and shrubs before they put on growth (early spring). See list of shrubs-Appendix E. Cycle: annually, every three years, or as desired.

◊ Prune early spring-flowering trees and shrubs just after they finish blooming (see lists in Appendix E. Cycle: annually, every three years, or as desired for effect.

◊ Test soil fertility (especially NPK and Ca) and pH for trees, and shrubs. If necessary, fertilize and apply lime or acidifying chemicals every two to three years or as needed. Test more frequently where trees or shrubs are doing poorly, have been damaged or need special care (see Hazard Tree Survey).

◊ Monitor American Elms for symptoms of Dutch Elm Disease when leaves fully emerge. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.

◊ Spray to control Spruce Aphid infestation for Blue and Norway spruce if needed.

◊ Give first mowing when grass reaches 3 inches.

◊ Clean up litter and debris from driveways, roadways and parking lots, planting beds and lawn edges.

◊ Clean debris and litter from drainage grates as needed.

◊ Repair winter and storm damage to plants and hard surfaces.

Alternative tasks:

* Plant deciduous trees and shrubs. Complete bare-root planting before top growth begins. Delay evergreen plantings for 1-2 months until warmer conditions.
* Transplant plants if applicable.
* Prune dead, damaged, and decayed branches from trees and shrubs.

APRIL

◊ Prune early spring-flowering tree and shrubs just after they finish blooming (see list in Appendix E). Cycle: annually, every three years, or as desired.

◊ Monitor American Elms for symptoms of Dutch Elm Disease when leaves fully emerge. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.

◊ Apply organic mulch (maintain 4-6 inch layer) to planting beds and trees in lawns.

◊ Dethatch turf areas if there is 1/2 inch or more of brown tissue between the green grass blades and the soil.

◊ Aerate turf areas in High Zones annually and Medium Zones every 2-3 years. Caution: Do not aerate lawns around trees due to shallow roots.

◊ Mow High and Medium Zone lawns once a week or as needed to maintain 1 1/4" height (never remove more than 1/3 of blade). Grass clippings may be left on lawns.
◊ Reseed turf areas as needed.
◊ Edge and trim turf areas and foundation planting beds in High and Med. Zones. Instruct equipment operators on how to avoid damage to tree trunks when trimming grass.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and litter from drainage grates as needed.

Alternative tasks:
* Plant evergreen and deciduous trees and shrubs.
* Prune dead, damaged, and decayed branches from trees and shrubs.

MAY
◊ Prune trees and shrubs of dead, decayed, or damaged wood.
◊ Prune spring-flowering tree and shrubs just after they finish blooming (see lists in Appendix E. Cycle: annually, every three years, or as desired.
◊ Monitor American Elms for symptoms of Dutch Elm Disease when leaves fully emerge. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.
◊ Water as needed. Drought stress signs include droopy, off-color foliage and wilting flowers. See Hazard Tree Survey for special needs of specific tree species.
◊ Fertilize turf areas in High and Medium Zones with 1 lb. of nitrogen per sq. ft. at beginning of month.
◊ Mow once per week or as needed.
◊ Spray lawn weeds with herbicides mid-month-only as needed.
◊ Remove dead heads from flowers that have finished blooming.
◊ Weed plant beds.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and litter from drainage grates as needed.

Alternative tasks:
* Plant evergreen and deciduous trees and shrubs.

JUNE
◊ Prune trees and shrubs of dead, decayed, or damaged wood.
◊ Prune spring-flowering trees and shrubs. Cycle: annually, every three years, or as desired (see lists in Appendix E.).
◊ Prune suckers from species prone to suckering (see lists in Appendix E.).
◊ Monitor American Elms for symptoms of Dutch Elm Disease. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.

◊ Water as needed. See Hazard Tree Survey for special needs of specific tree species.
◊ Mow once per week or as needed.
◊ Fertilize turf areas in High Zone with 1 lb. of nitrogen per 1000 sq. ft.
◊ Weed plant beds.
◊ Edge and trim turf areas in High zones.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and litter from drainage grates as needed.
◊ Repair roads and sidewalks as needed.

JULY

◊ Prune trees and shrubs of dead, decayed, or damaged wood.
◊ Prune 'bleeder' species-maple, dogwood, pine, birch as needed. Or prune in winter.
◊ Cut off faded iris blooms and stalks.
◊ Monitor American Elms for symptoms of Dutch Elm Disease. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.
◊ Water as needed. See Hazard Tree Survey for special needs of specific tree species.
◊ Mow once per week or as needed.
◊ Weed plant beds.
◊ Clean debris and litter from drainage grates as needed.
◊ Repair roads and sidewalks as needed.

AUGUST

◊ Prune trees and shrubs of dead, decayed, or damaged wood.
◊ Monitor American Elms for symptoms of Dutch Elm Disease. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.
◊ Water as needed. See Hazard Tree Survey for special needs of specific tree species.
◊ Mow once per week or as needed.
◊ Weed plant beds.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and silt from drainage grates as needed.
◊ Repair roads and sidewalks as needed.

SEPTEMBER

◊ Prune trees and shrubs of dead, decayed, or damaged wood.
◊ Monitor American Elms for symptoms of Dutch Elm Disease. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.
◊ Mow once per week or as needed.
◊ Fertilize turf areas in High Zone with 1 lb. of nitrogen per 1000 sq. ft. in middle of month.
◊ Spray lawn weeds with herbicides-only as needed.
◊ Apply organic mulch (maintain 4 inch layer) to foundation planting beds and trees in lawns.

◊ Water as needed. See Hazard Tree Survey for watering schedule for specific tree species.
◊ Edge and trim turf areas and planting beds in High Zones.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and silt from drainage grates as needed.

OCTOBER

◊ Plant trees and shrubs.
◊ Transplant trees and shrubs if needed.
◊ Rake fallen leaves from turf areas. Compost if disease and pest free.
◊ Monitor American Elms for symptoms of Dutch Elm Disease. Once every two weeks until DED arrives at Ft. Lewis; once detected increase to once per week.
◊ Clean up and dispose of fallen foliage, twigs and branches of edible fruit and ornamental deciduous trees (flowering cherries and crabapples, hawthorns, European mountain ash, dogwoods, apples, sweet cherries, pear, plum and mulberry trees) to control fungal and bacterial infections, and insect pests.
◊ Apply lime (dolomitic limestone) to turf areas at 25-30 lb. per 1000 sq. ft. every 3 to 4 years.
◊ Thatch turf areas as needed.
◊ Seed new turf areas or overseed bare spots in established areas.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and silt from drainage grates as needed.

Alternative tasks:

* Prune trees and shrubs of dead, decayed, or damaged wood.

NOVEMBER

◊ Plant trees and shrubs.
◊ Transplant plants if applicable.
◊ Rake fallen leaves from turf areas. Compost if disease and pest free.
◊ Clean up and dispose of fallen foliage, twigs and branches of edible fruit and ornamental deciduous trees (flowering cherries and crabapples, hawthorns, European mountain ash, dogwoods, apples, sweet cherries, pear, plum and mulberry trees) to control fungal and bacterial infections, and insect pests.
◊ Clean fallen leaves from building gutters and downspouts.
◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.
◊ Clean debris and silt from drainage grates as needed.
◊ Clean tools for winter storage. Oil moving parts and sharpen pruners.

Alternative tasks:

* Prune trees and shrubs of dead, decayed, or damaged wood.

DECEMBER

◊ Plant trees and shrubs as weather permits.

◊ Prune to shape and rejuvenate most deciduous trees and shrubs every 3-4 years or as needed (as long as temp. is above 20 deg. F.). Good time to renovate neglected/oversized shrubs. Prune mature trees conservatively to avoid excessive thinning and wounding.

◊ Monitor Spruce Aphid populations in Norway and Blue spruce.

◊ Fertilize turf areas in High and Medium Zones with 1 lb. of nitrogen per 1000 sq. ft.

◊ Clean up litter and debris from driveways, roadways and parking lots, planted beds and lawn edges.

◊ Clean debris (snow and ice if necessary) from drainage grates.

Alternative tasks:

* Prune trees and shrubs of dead, decayed, or damaged wood.

Prune 'bleeder' species-maple, dogwood, pine, birch.

LONG-TERM MAINTENANCE ACTIVITIES:
1. Establish and implement Dutch Elm Disease Program.
2. Prepare and implement Integrated Pest Management Plan.

CONDITION ASSESSMENT:

In addition to completing monthly work tasks that address general maintenance needs, it is also necessary to conduct condition assessments of landscape features. Monitoring the condition of a feature identifies and records existing problems and schedules and helps implement appropriate repair measures. In addition to the immediate practical application of Condition Assessment Sheets, they can also provide an important record of change in the landscape over time.

Train maintenance staffs and contractors conducting the field condition assessments to observe the following:
-to monitor changes and identify the cause of the change such as:
cultural threats (construction damage, poor maintenance techniques-mower damage, excessive pruning, soil compaction, etc.).
environmental threats (pests, diseases, weather (drought, flooding, temp. extremes, air quality, etc.);
-to ensure work calendar is fully implemented and tasks are not overlooked;
-to monitor conditions during appropriate seasons (detecting pest outbreaks during stages when it is still possible to counter the infestation);
-to diagnose conditions if possible or note further diagnosis is needed;
-to note work needed and treat the condition using the preservation treatment recommendations to guide maintenance decisions.

CONDITION ASSESSMENT FIELD SHEETS

For many historic preservation guides, detailed records are maintained for individual historic features, for example; every tree, shrub, small-scale feature, etc., has its own inventory number and record file. Due to the size of the historic district, the large number of vegetative features, and management constraints (housing residents maintaining their own quarters), maintaining individual records for every feature is impracticable at Ft. Lewis. An alternative is to organize and record feature information according to their association with a particular location. Organize Condition Assessment Sheets according to management zone, character area, and street or individual building location. This ensures a reasonable level of record keeping which should still preserve the overall historic design intent (preserving planting principles, etc.) of the district as a whole and for individual character areas. For example, when removing and replanting historic vegetation in a foundation planting bed at a historic house in Greenwood, reference the information to management Zone I, Greenwood character area, and then the building number. Record work performed on the vegetation by species, general location, and historic function, to provide an overall record of maintenance decisions related to that site

and how the preservation treatment goals are being implemented. One exception to assigning feature numbers is when recording information about historic trees. Use the numbering system established for the 1990 Hazard Tree Survey as part of the maintenance files. This will assist Ft. Lewis staff in cross-referencing maintenance records for the existing Hazard Tree Survey database.

Record major maintenance efforts, such as a street tree replanting effort in Broadmoor, in the Broadmoor character area file. In this way, treatment of the vegetation and circulation features associated with individual structures or particular locations in Broadmoor are consolidated in one maintenance file.

The maintenance of vegetation in family housing areas is complicated by the fact that residents are responsible for maintaining their own yards. If possible, carry out a condition assessment and prepare a work plan in between occupancy to ensure the long-term preservation goals for the Historic District are meet. This allows trained staff to carry out non-routine maintenance activities as well as identify routine tasks that residents need to complete during their stay. Provide general "How To" bulletins on primary maintenance activities when residents move into their homes and, if possible, provide an assistance program through Ft. Lewis staff.

Fort Lewis Historic District

CONDITION ASSESSMENT SHEET

CATEGORY: VEGETATION

Date:_____ Inspected By:_____

LOCATION: Management Zone: _____ Character Area: _____ Street or Bldg. No.: _____ **Feature name (scientific), Type, Historic function, Haz. Tree # & rating if applicable**	Overall form	Leaf, shoots	Branches	Trunk(s)	Roots, soil	FLower, fruit	**Comments on condition, age, size, field diagnosis, and work needed.**	Further diagnosis	Critical work-y/n	Plan to replace-P Replace immed.-R	Reason to replace	**Replacement Species (scientific name)**	Date completed

Historic Function Code:
F=foundation plant
ST=street tree
0=open space vegetation
S=spatial definition

Condition Code:
0=cannot assess
1=satisfactory condition
2=fair, needs some work
3=poor, needs work
*=critical work

Replacement Code:
1=hazard
2=untreatable disease or pest
3=declining, senescent & cannot be restored
4=neglected/overgrown & cannot be renovated

Fort Lewis Historic District

CONDITION ASSESSMENT SHEET-EXAMPLE

CATEGORY: VEGETATION

Date: 12/1/95 Inspected By: T. Taylor

LOCATION: Management Zone: Zone I Character Area: Greenwood Street or Bldg. No.: #0000 **Feature name (scientific), Type, Historic function, Haz. Tree # and rating if applicable**	Overall form	Leaf, shoots	Branches	Trunk(s)	Roots, soil	Flower, fruit	**Comments on condition, age, size, field diagnosis, and work needed.**	Further diagnosis	Critical work-y/n	Plan to replace-P Replace immed.-R	Reason to replace	**Replacement Species (scientific name)**	Date completed
Forsythia x intermedia (forsythia), S., back/south yard.	2	1	2	1	0	2	Needs to be pruned to shape, remove dead & old stems, and to promote flowering.	N	N	-	-	N/A	
Taxus baccata (yew), F., front/north yard.	*	-	-	-	-	-	Plant has overgrown its location-blocking entry-and was poorly pruned in an attempt to reduce size. Proper pruning was attempted to reduce size and restore shape but failed. Needs to be replaced.	N	Y	I	4	Taxus baccata-move location 3 ft. further west of walk than present location.	
Picea pungens (blue spruce), S., #0000,rating 3-10/90	2	2	2	1	2	-	Overall condition fair. Needs some shape pruning-2-3 branches growing beyond natural form, and to remove dead branches. Some needle defoliation from spruce aphid. Control w/ horticultural soaps and oils at appropriate time.	N	Y	-	-	N/A	
Missing historic vegetation:							Few foundation plants exist for this house. Restore plantings using list of common historic plants for Greenwood. Be careful to plant in location that accommodates the plant's size at maturity.	-	-	-	-	Suggested genus: Viburnum, Abelia, Spiraea, Taxus	

Historic Function Code:
F=foundation plant
ST=street tree
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References for maintenance schedules:

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Michigan State Housing Development Authority, Landscape Maintenance Guide, Lansing Michigan, 1986.

MAINTENANCE ZONES FOR VEGETATION

MAINTENANCE ZONES FOR VEGETATION

INTRODUCTION:

In most landscapes, not all areas require the same level of maintenance. By establishing a maintenance hierarchy it is possible to more effectively direct maintenance efforts and budgets. Issues such as the level of visibility an area receives, the type of vegetation, and the areas' function are typically used as a basis to develop maintenance zones. In the Ft. Lewis Historic District, maintenance zones incorporate the above reasons but also correspond to Preservation Management Zones. The maintenance hierarchy for the District consists of High, Medium, and Low Zones. The High and Medium Zones coincide with Management Zone I, and the Low Zone with Management Zone II and the buffer areas outside the Historic District Boundary.

High Zone: This zone includes foundation planting, vegetation used for spatial definition around buildings, street trees, and the Parade Ground in Historic Management Zone I.

Medium Zone: This zone includes designed open spaces in housing areas in Historic Management Zone I.

Low Zone: This zone includes open spaces in Historic Management Zone II and non-historic buffer areas.

TREES AND SHRUBS

FERTILIZING

H Only as required.

M Same as above.

L Same as above.

Comments: Most trees and shrubs do not need fertilizers. Generally, if plant growth is vigorous and leaf color dark, no fertilizer is needed. See Maintenance Practices-Fertilizing for common reasons to fertilize. Always test soils to determine fertilizer needs, and do not over fertilize. Depending on the type of organic mulch used around trees and in planting beds, it may be necessary to add nitrogen to overcome any nitrogen deficit created from the decomposition of the organic matter; if growth is slow and yellowing occurs, test soils for possible nitrogen deficiencies.

INSECT/DISEASE CONTROL

H A certain amount of insect or disease damage is normal and acceptable for most pests and diseases (exceptions at Ft. Lewis include Dutch elm disease and elm leaf beetle). Use physical, mechanical, cultural, biological, and educational practices before resorting to chemical control. A key step to preventing damage is growing and maintaining healthy plants which can survive attacks by many insects and diseases, often without human intervention. If chemical controls are necessary, correctly identify the problem and chemical treatment, apply correctly and at the most effective time.

M Same as above.

L Same as above.

PRUNING

H Prune to shape and rejuvenate (routine pruning) most deciduous and evergreen trees and shrubs every 2-3 years or as needed. Prune yearly to remove dead, diseased, damaged, or hazardous branches.

M Prune yearly to remove dead, diseased, damaged, or hazardous branches.

L Prune as required to remove dead, diseased, damaged, or hazardous branches.

WATERING

H As required to maintain optimal growth.

M Same as above.

L Not required.

Comments: Watering takes longer with mulched areas-be sure water is infiltrating through the mulch and into the soil deep enough to reach the plant roots.

MULCHING

H Uniform thickness of organic mulch (4-6 inches) applied yearly or as needed depending on rate of mulch decomposition.

M Uniform thickness of organic mulch (4-6 inches) applied every other year or as needed depending on rate of mulch decomposition.

L Not required.

EDGING

H Edge plant beds twice a year unless metal edging is in place.

M Edge plant beds once a year.

L Not required.

WEED CONTROL

H Limited amounts of non-invasive weeds are acceptable (less than 5% of bed). Keep beds free of invasive weeds such as horsetail, morning glory, blackberry, wild clematis, running and false bamboo, buttercup, and stinky geranium.

M Same as above.

L Control as necessary to prevent the spread of weeds (especially invasive weeds) into High and Medium Zones.

Comments: One of the most effective ways to control weeds in planting beds is to apply a 4-6 layer of mulch (remove weeds before mulching).

TURF

FERTILIZING

H Minimum of 3-4 fertilizer applications annually (1 lb. per 1000 sq. ft. per application).

M Minimum of 1-2 fertilizer applications annually.

L Not required.

INSECT/DISEASE CONTROL

H Limited insect pest damage (5-10% of lawn area) and limited diseases (less than 5%).

M Same as above.

L As needed to prevent the spread of pest and disease into the High and Medium zones.

Comments: Avoid applying pesticides according to predetermined calendar schedules. Select treatment and application time according to specific pest being targeted. The European crane fly is the only significant insect problem in the Puget Sound area. Monitor populations in late winter and early spring. Good cultural practices (fertilizing, watering, aerating, dethatching) will prevent most disease problems in Western Washington.

WEED CONTROL

H Limited weedy grasses (5-10% of lawn area) and broadleaf weeds (less than 5%).

M Same as above.

L As needed to prevent the spread of weeds into the High and Medium zones.

Comments: Good cultural practices (fertilizing, watering, aerating, dethatching) will help out-compete weeds. Do not routinely apply herbicides in conjunction with fertilizers; trees in lawn areas can be damaged from this practice and the herbicide may not be needed or may be ineffective for the specific weeds needing control. Monitor weed populations in spring and fall to determine the level of control needed.

MOWING

H Mow once or twice weekly as needed to maintain perennial ryegrass and fine-leaf fescue lawns at 1 1/4".

M Maintain perennial ryegrass and fine-leaf fescue turf at 1 1/2-2".

L Mow to contain noxious weed growth and to comply with ordinances.

Comments: Grass clippings may be left on lawns and should help reduce the need for fertilizer applications. They do not contribute significantly to thatch accumulations. Do not cut more than 1/3 of the leaf blade at a time.

WATERING

H Water as required to maintain green turf with vigorous growth with limited dry areas acceptable (95-100% irrigation coverage). Water to a depth of 6-8 inches or more to encourage deep rooting. Lawns should receive 1" of water per week, either from rain or through irrigation.

M No irrigation required except in periods of drought when enough water should be applied to keep grass alive and able to recover during the wet seasons.

L No irrigation required.

AERATION/DETHATCHING

H Once per year or as required by specific on-site conditions.

M Once every 3 years or as required by specific on-site conditions.

L Not required.

Comments: Caution: do not aerate lawns around trees due to shallow roots.

EDGING

H Edge and trim lawn areas (along sidewalks, curbs, etc.) three times per year.

M Edge and trim lawn areas once per year.

L Not required.

HISTORIC DISTRICT VEGETATION MAINTENANCE ZONES

TREES AND SHRUBS

FERTILIZING

H — Only as required.

M — Same as above.

L — Same as above.

Comments: Most trees and shrubs do not need fertilizers. Generally, if plant growth is vigorous and leaf color dark, no fertilizer is needed. See Fertilizer section for reasons to fertilize. Always test soils to determine fertilizer needs, and do not over fertilize. Depending on the type of organic mulch used around trees and in planting beds, it may be necessary to add nitrogen to overcome any nitrogen deficit created from the decomposition of the organic matter; if growth is slow and yellowing occurs, test soils for possible nitrogen deficiencies.

INSECT/DISEASE CONTROL

H — A certain amount of insect or disease damage is normal and acceptable for most pests and diseases (exceptions at Ft. Lewis include Dutch elm disease and elm leaf beetle). Use physical, mechanical, cultural, biological, and educational practices before resorting to chemical control. A key step to preventing damage is growing and maintaining healthy plants which can survive attacks by many insects and diseases, often without human intervention. If chemical controls are necessary, correctly identify the problem and chemical treatment, apply correctly and at the most effective time.

M — Same as above.

L — Same as above.

PRUNING

H — Prune to shape and rejuvenate (routine pruning) most deciduous and evergreen trees and shrubs every 2-3 years or as needed. Prune yearly to remove dead, diseased, damaged, or hazardous branches.

M — Prune yearly to remove dead, diseased, damaged, or hazardous branches.

L — Prune as required to remove dead, diseased, damaged, or hazardous branches.

WATERING

H — As required to maintain optimal growth.

M — Same as above.

L — Not required.

Comments: Watering takes longer with mulched areas-be sure water is infiltrating through the mulch and into the soil deep enough to reach the plant roots.

MULCHING

H — Uniform thickness of organic mulch (4-6 inches) applied yearly or as needed depending on rate of mulch decomposition.

M — Uniform thickness of organic mulch (4-6 inches) applied every other year or as needed depending on rate of mulch decomposition.

L — Not required.

EDGING

H — Edge plant beds twice a year unless metal edging is in place.

M — Edge plant beds once a year.

L — Not required.

WEED CONTROL

H — Limited amounts of non-invasive weeds are acceptable (less than 5% of bed). Keep beds free of invasive weeds such as horsetail, morning glory, blackberry, wild clematis, running and false bamboo, buttercup, and stinky geranium.

M — Same as above.

L — Control as necessary to prevent the spread of weeds (especially invasive weeds) into High and Medium Zones.

Comments: One of the most effective ways to control weeds is to use mulch (remove as many weeds as possible before mulching).

TURF

FERTILIZING

H — Minimum of 3-4 fertilizer applications annually (1 lb. per 1000 sq. ft. per application).

M — Minimum of 1-2 fertilizer applications annually.

L — Not required.

INSECT/DISEASE CONTROL

H — Limited insect pest damage (5-10% of lawn area) and limited diseases (less than 5%).

M — Same as above.

L — As needed to prevent the spread of pest and disease into the High and Medium Zones.

Comments: Avoid applying pesticides according to predetermined calendar schedules. Select treatment and application time according to specific pest being targeted. The European Crane fly is the only significant insect problem in the Puget Sound area. Monitor populations in late winter and early spring. Good cultural practices (fertilizing, watering, aerating, dethatching) will prevent most disease problems in Western Washington.

WEED CONTROL

H — Limited weedy grasses (5-10% of lawn area) and broadleaf weeds (less than 5%).

M — Same as above.

L — As needed to prevent the spread of weeds into the High and Medium zones.

Comments: Good cultural practices (fertilizing, watering, aerating, dethatching) will help out-compete weeds. Do not routinely apply herbicides in conjunction with fertilizers; trees in lawn areas can be damaged from this practice and the herbicide may not be needed or may be ineffective for the specific weeds needing control. Monitor weed populations in spring and fall to determine the level of control needed.

MOWING

H — Mow once or twice weekly as needed to maintain perennial ryegrass and fine-leaf fescue lawns at 1 1/4".

M — Maintain perennial ryegrass and fine-leaf fescue turf at 1 1/2-2".

L — Mow to contain noxious weed growth and to comply with ordinances.

Comments: Grass clippings may be left on lawns and should help reduce the need for fertilizer applications. They do not contribute significantly to thatch accumulations. Do not cut more than 1/3 of the leaf blade at a time.

WATERING

H — Water as required to maintain green turf with vigorous growth with limited dry areas acceptable (95-100% irrigation coverage). Water to a depth of 6-8 inches or more to encourage deep rooting. Lawns should receive 1" of water per week, either from rain or through irrigation.

M — No irrigation required except in periods of drought when enough water should be applied to keep grass alive and able to recover during the wet seasons.

L — No irrigation required.

AERATION/DETHATCHING

H — Once per year or as required by specific on-site conditions.

M — Once every 3 years or as required by specific on-site conditions.

L — Not required.

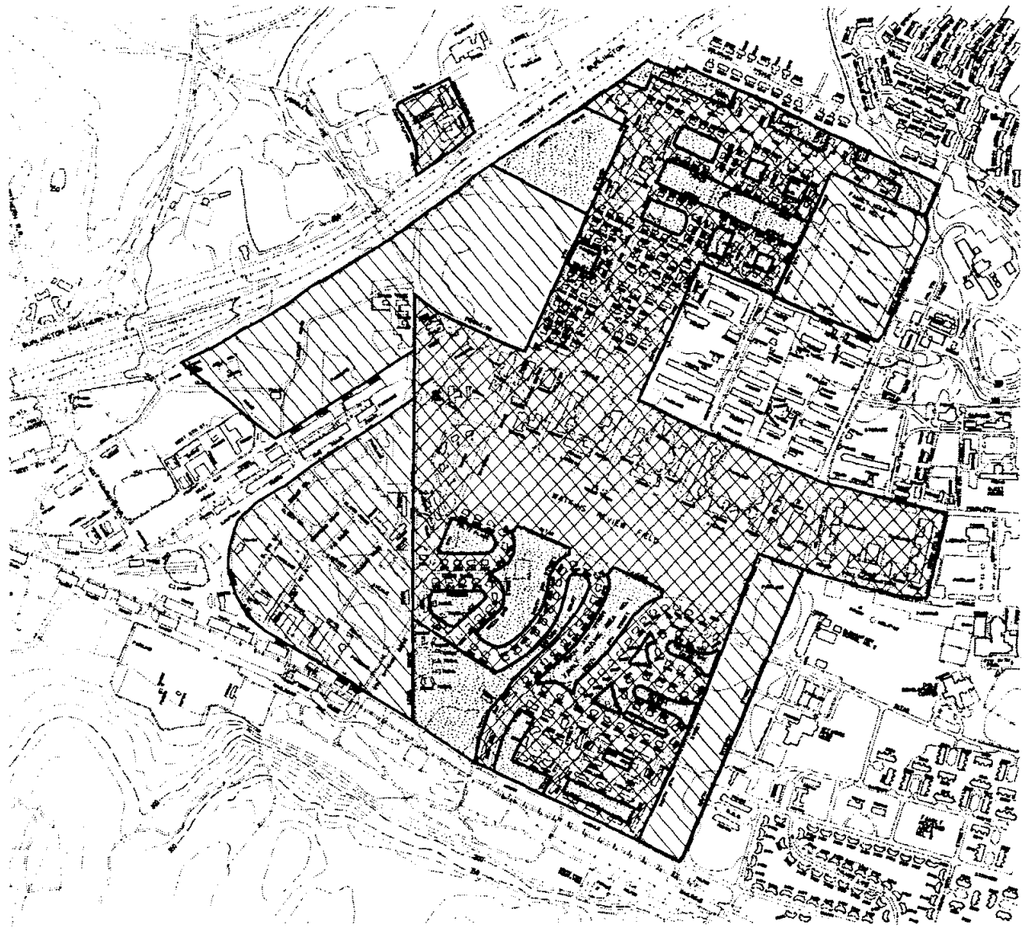
Comments: Cautions do not aerate lawns around trees due to shallow roots.

EDGING

H — Edge and trim lawn areas (along sidewalks, curbs, etc.) three times per year.

M — Edge and trim lawn areas once per year.

L — Not required.



LEGEND

- HIGH MAINTENANCE ZONE
- MEDIUM MAINTENANCE ZONE
- LOW MAINTENANCE ZONE

N

SCALE: 1" = 400' (400' 200' 0 400' 800')

REDUCED TO 50% OF FULL SIZE

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON

LANDSCAPE DEVELOPMENT PLAN
HISTORIC LANDSCAPE PRESERVATION GUIDE

HISTORIC VEGETATION MAINTENANCE ZONES

FORT LEWIS — WASHINGTON

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MAINTENANCE PRACTICES

MAINTENANCE PRACTICES

VEGETATION

INTRODUCTION

Managing urban landscapes is a complex task because of the large number of species and range of environmental conditions encountered. Management strategies must be modified to account for differences in plant character and physical environment, "In short, management programs integrate species and site differences into both general approaches and specific actions".[1]

While this report and the 1990 Ft. Lewis Hazard Tree Survey provide general approaches to increase the overall health of the vegetation of the Historic District, it is beyond the scope of this project to develop a detailed species-by-species management plan. Given the large species diversity, aging tree and shrub population, and range of environmental conditions found at Ft. Lewis, require that a licensed arborist, horticulturist, or urban forester execute this report and the 1990 Hazard Tree Survey, and develop "an enhanced Integrated Plant Management program (IPM +)" for the District. Named "IPM +" by Richard W. Harris, this type of program offers a holistic approach for plant health and performance. "An IPM + approach needs to include site and plant selection; site preparation; planting and early care; managing nutrient, water, and aeration levels; pruning; monitoring plant performance; preventing or moderating plant problems; and knowing when plants should be replaced."[2]

In addition to retaining qualified staff at Ft. Lewis, require all contract work be performed by licensed arborists, urban foresters, or horticulturists.

GENERAL LONG-TERM MAINTENANCE PRACTICES

The following overview developed by James Clark and Nelda Matheny in an article titled "Management of Mature Trees," provides a good summary of what the goals of vegetation management plans at Ft. Lewis should strive to achieve. Although, the article is directed toward managing mature trees, the goals apply to all vegetation.

"The goal of tree management is to avoid or minimize the three causes of death: structural failure, environmental degradation, and parasitic attack.

1) Structural failure: branch, crown and stem failure, uprooting, decay, and girdling.
2) Environmental degradation:
    Acute: flooding, fire, vandalism, construction injury, drought, high or low temperatures

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[1] Clark, James R., and Nelda Matheny, "Management Of Mature Trees," Journal of Arboriculture, Vol. 17, no. 7, July 1991, pp. 183.

[2] Harris, Richard W., Arboriculture: Integrated Management of Landscape Trees, Shrubs, and Vines, Prentice Hall Career & Technology: Englewood Cliffs, New Jersey, 1992, pg. 594.

Chronic: soil toxicity, soil compaction, air pollution, restricted growing space, low fertility, severe pruning.

3) Parasitic invasion: insect, fungus, bacterium, virus, mycoplasma-like organisms, parasitic plant."[3]

"Avoiding or minimizing these causes of death can be accomplished through long-term care, not single treatments applied when something is wrong. Long-term management techniques include:

a) Training trees when they are young to develop a strong branch structure;
b) Pruning mature trees conservatively to avoid excessive thinning and wounding;
c) Observing 'target pruning' to minimize decay development;
d) Planting the right tree in the right place, so the needs of the tree match the environment;
e) Irrigating and fertilizing mature trees judiciously, considering the tree's native environment and past culture;
f) Protecting trees from environmental degradation such as soil compaction, root injury, and mechanical damage, etc.;
g) Developing species-appropriate programs for pest management."[4]

Mulching:

Mulching trees and planting beds is a simple way to accomplish a number of the preceding goals. Mulching with organic materials conserves soil moisture, reduces soil erosion, increases soil fertility, reduces weed competition, improves soil structure, reduces soil compaction, reduces root and trunk damage from lawn mowers and weed eaters, moderates soil temperatures, coarse mulches reduce reflection and re-radiation of heat, and incidence of some diseases is reduced with mulches.

There are two kinds of mulches, organic and inorganic. Organic mulches include bark, wood chips, steer manure compost, leaves, straw, conifer needles, some nut hulls, or other composted tree, shrub, and lawn organic wastes. Inorganic or synthetic mulches include crushed stone and other pavement materials, black plastic (polyethylene), and aluminum foil.

Use organic mulches in the Historic District due to the extra benefits that organic mulches provide over inorganic mulches (increases soil fertility and improves soil structure) and for aesthetic purposes. Apply organic mulches in 4-6 inch layers, taking care to keep the mulches at least 6 inches away from the trunks of trees and shrubs.

Watering Trees and Shrubs:

Many of the non-native landscape and street trees require watering during the summer and in droughts. Some trees in lawns receive adequate water from lawn watering. However, trees with limited rooting space such as some street trees, experience significant stress during droughts and require more water. The 1990 Hazard Tree Survey provides watering recommendations for many of the trees species in the Historic District. It is

[3] Ibid., pg. 177.
[4] Ibid., pg. 183.

especially important to provide watering for elm trees to maximize their health and reduce their susceptibility to Dutch Elm Disease.

Watering should soak the top 12 inches of soil; avoid short frequent watering which encourage shallow root systems to develop. Deep watering can be accomplished by driving a spike-like hose attachment sequentially around the drip line of a tree or with a soaker hose. Or, the deep watering and vertical mulching techniques illustrated in Appendix D: Bulletin No. 5 are also two effective methods of channeling water, oxygen and fertilizers (if necessary) deep into the soil. These methods encourage deeper-rooting trees which can help reduce sidewalk damage.

Watering Lawns:
Keeping lawns properly watered will help create healthy, problem-free lawn. As with trees and shrubs, deep watering is important to encourage deep-growing roots. Enough water should be applied each time to wet the soil to the depth of the root zone. Lawns should receive about 1" of water per week through rain or irrigation. The sandy soils at Ft. Lewis may require more. Check how wet the soil is by probing with a trowel. Allow the soil at the surface to dry some between watering. Water in the mornings, when there is less evaporation, to conserve water. Aerating lawns and removing the plugs helps water penetrate into the root zone.

PLANTING

General Practices:

◊ Be careful to plant foundation plants at adequate distances from buildings; e.g., plan for their size at maturity.

◊ Cultivate soil when it is dry or moist, not saturated. Generally planting should occur in fall or spring. Fall planting may best since the soil is still easily worked and most fall-planted plants will bloom the following season. Spring soils are usually very wet and digging is harder. Furthermore, spring-flowering shrubs may or may not bloom the first season. Summer planting is OK if vegetation is planted with care and plants are watered thoroughly and regularly.

◊ Provide planting holes that are two times the diameter of the rootball. Do not plant too deeply. For trees, use a shovel handle to measure the rootball, then use the stick to gauge the depth of the hole. The bottom of the rootball should rest on undisturbed soil. Plant shrubs 1.5 times the depth of the rootball and rest it on a compacted mound of soil. The root crown or collar for trees and shrubs should be at soil level or a little above to allow for the addition of mulch. Never pull the plant out of the pot or move it by its trunk. Remove at least one-third of the burlap (or more without damaging the rootball). Never allow the rootball to dry out. Backfill with native soil unless an entire bed is being amended (see following). Use a shovel handle or feet to tamp out air pockets. Use water for the final soil settling and soak the plant well. If further soil

settling occurs and additional backfill added, do not tread on the wet soil but instead tamp it with hands or a shovel handle. Build a circular soil dam around the plant to aid in watering.

◊ If needed (test soil fertility), add a low number fertilizer in the planting hole or on top. Newly planted trees make poor use of fertilizer in the first growing season. So, if possible, fertilize after the first season with a long-lasting, slow release fertilizer rather than when planting the tree.

◊ Apply a three to four inch layer of organic mulch (compost, bark, wood chips, etc.) over the entire planting bed to conserve moisture, control weeds, improve soil structure, moderate soil temperature extremes, reduce soil compaction and create a neat appearance. Do not spread mulch within 4-6 inches of tree or shrub trunks.

◊ It is critical to water new plants well (deeply) during the first 1-2 years to promote healthier, deeper growing roots. For trees, this averages about 5-15 gallons of water a week depending on the soil conditions and tree size: be sure to let the root zone dry out between watering. To determine when it's time to water, test the soil. If the top 3-4 inches of soil are dry, the plant needs to be watered, especially if it is during the growing season.

Common planting misconceptions:

◊ Amend soils (add peat moss or good soil to improve it). Amending planting holes is not beneficial to plants as roots will not grow beyond the 'good' soil and consequently will not develop well. Therefore always use native soil when backfilling, except if it is possible to amend the soil in the entire bed.

◊ Pruning to balance the loss of roots. Research indicates plants do better if they are not pruned at planting; they use the energy made from their leaves to make new roots. Minor pruning to remove broken branches or the occasional branch that ruins the shape of the plant is OK.

◊ Staking plants. Staking trees, especially when they are staked too securely, is not always necessary and can be detrimental. The slight movement of tree trunks is what makes them grow strong and trees that grow up to rely on stakes develop weak trunks and roots. Therefore, if trees are staked, stake them only for as long as it takes for the roots to become established-about one year. Also, allow some trunk movement while staked by tying the tree about one-third up the tree and being careful not to tie the trunk to the stakes too tightly. It is usually not necessary to stake conifers under 5 ft.

Re-grading operations:

If foundation planting beds are regraded to solve drainage problems and all plants are being removed, any topsoil removed during regrading should be stockpiled and replaced. Four inches of bark should be added to the topsoil layer and rototilled in to a depth of six to twelve inches. Protect soils from compaction during regrading and planting procedures.

Before a compacted soil is brought to final grade, it should be broken up by ripping or deep plowing.

See Planting details on sheet L.10.

PRUNING:

Introduction:
Pruning is done to maintain the long-term health of plants, create a safe working and living environment, and to protect buildings and infrastructure from damage. Proper pruning requires an understanding of a plant's habit, biology, and function in the landscape. Improper pruning is not just an aesthetic problem, it can be detrimental to a plant's health and in severe cases, jeopardize the life of the plant and create hazardous conditions. Pruning requires trained personnel, proper equipment, and proper timing. The following guidelines provide an overview of common pruning practices. They are primarily aimed at pruning shrubs at Ft. Lewis. Pruning trees requires specialized equipment and standards of care, not just to ensure the health of the tree but for safety reasons. Because of the skills and knowledge required to address the diverse population of trees and special conditions (Dutch Elm Disease) found in the historic district, hire licensed arborists for pruning trees.

Reasons to Prune:
Pruning should not be performed indiscriminately but with a specific objective in mind. Good reasons to prune include pruning to: maintain the health of the plant (removing dead, diseased, injured parts); maintain the natural shape of a plant; direct or control growth; encourage or increase fruit or flowering; promote healthy growth by removing old parts and directing energy towards new growth; rejuvenate neglected, overgrown, or badly damaged plants; and prune for special effects such as creating espaliers and topiaries.

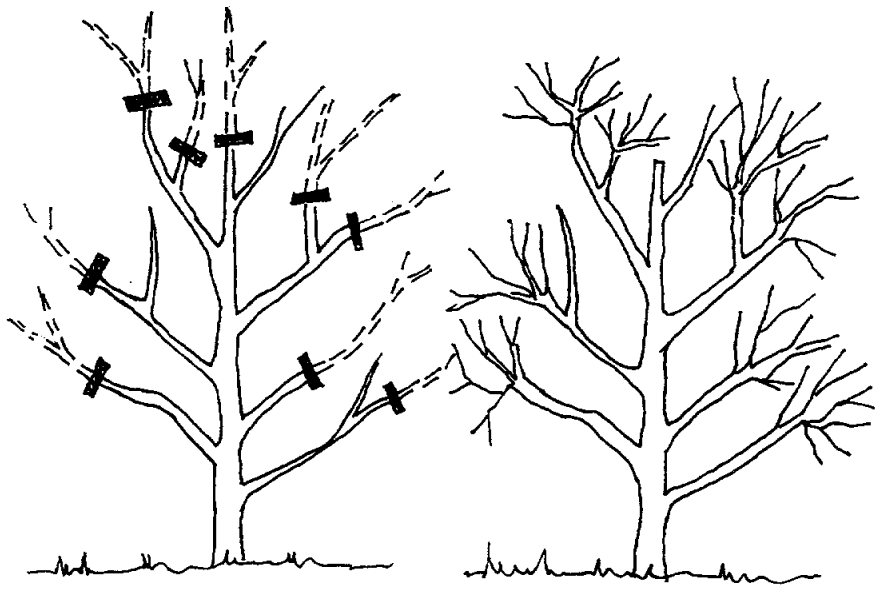
In general, trees and shrubs in the Historic District should be allowed to grow to their natural shape and size. Pruning and training plants for special effect, such as shearing into formal shapes and topiaries, pollarding, or espaliers, is not appropriate. One exception is shearing a few of the existing historic hedges.

Pruning Techniques:

There are two kinds of pruning cuts, heading cuts, and thinning cuts.

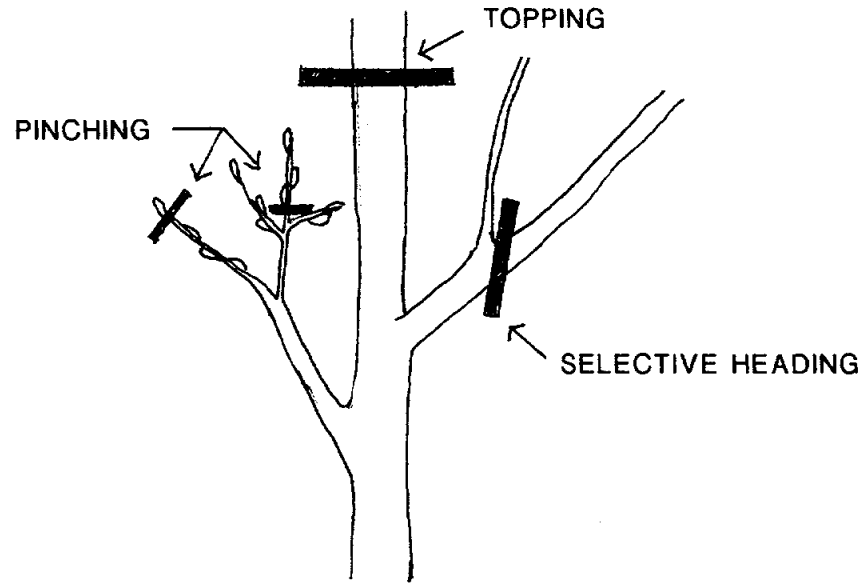
Heading cuts:
Non-selective heading cuts consist of removing part of a stem along its length, but not where it attaches to another branch or to the trunk. Selective heading removes a stem where it joins a smaller side stem or to a bud. Heading usually stimulates rapid regrowth of multiple stems, although non-selective heading can cause the stem that was cut to die. Heading reduces the size of a plant and increases its fullness.

Figure 1: HEADING CUTS



Examples of heading cuts are: topping-severe, non-selective heading of trees; pinching-removing new growth-terminal shoots or buds to stimulate the shoots and buds below; and shearing-indiscriminate removal of all terminal growth, used for hedges and topiary. With the exception of fruit trees, trees generally do not respond well to heading cuts, and should never be topped.

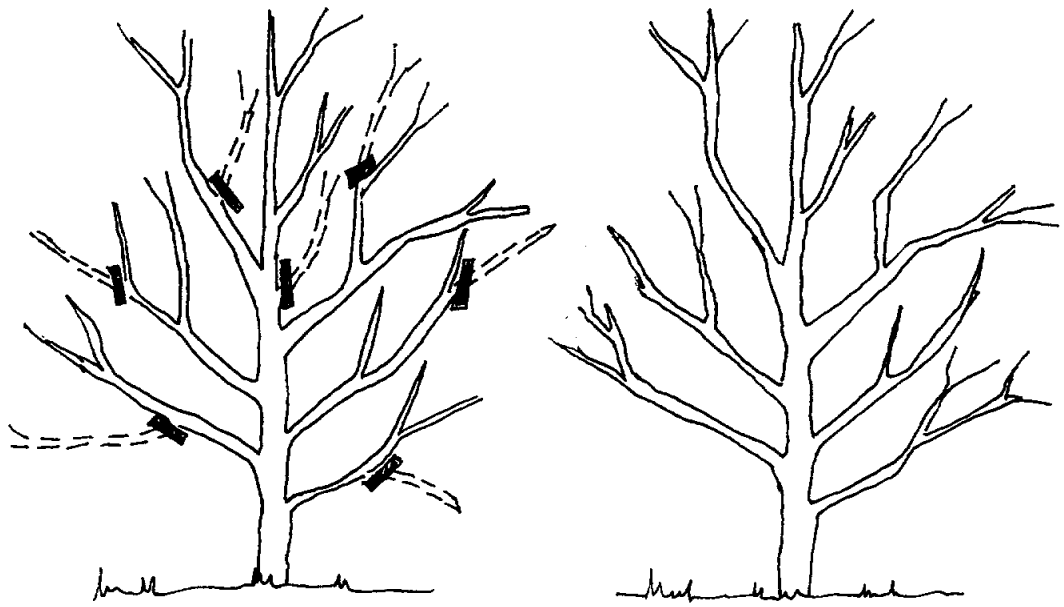
Figure 2: TYPES OF HEADING CUTS



Thinning Cuts:

Thinning removes entire branches, stems, or twigs back to their point of origin (where they began as buds). Thinning is used to direct growth, open up a plant's structure by removing unproductive or competing branches, and reduce the number of new shoots. It is the most common type of selective pruning.

Figure 3: THINNING CUTS



How to Make Correct Pruning Cuts:

To make proper cuts that result in quick healing cut just above the plant part that will continue to grow (an outward facing lateral bud, or branch). Do not leave stubs; they do not heal well and create a point of entry for rot and diseases. Always use sharp tools to make clean cuts. Applying dressing or paints to cut branches and wounds is no longer recommended. Research has shown it does not increase healing or decrease decay. In fact, applying dressings over infected wood can encourage decay. Performing proper pruning cuts is the best way to ensure quick healing.

Figure 4: CORRECT PRUNING CUTS. a) 30-45 deg. cut, 1/8 - 1/4" above bud. b) Cut as close to 1/8 - 1/4" above buds as possible for opposite-leaved plants.

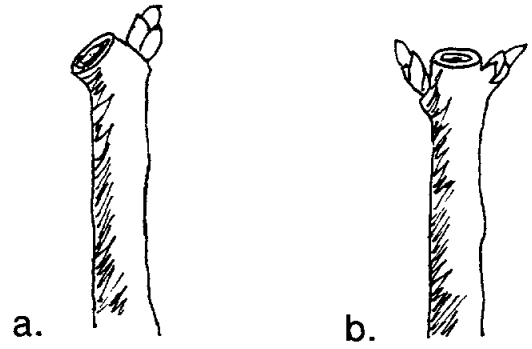


Figure 5: INCORRECT PRUNING CUTS. a) Too slanted and too close to bud. b) Too far from bud, stub will not heal. c) Torn or ragged cuts allow decay to enter.

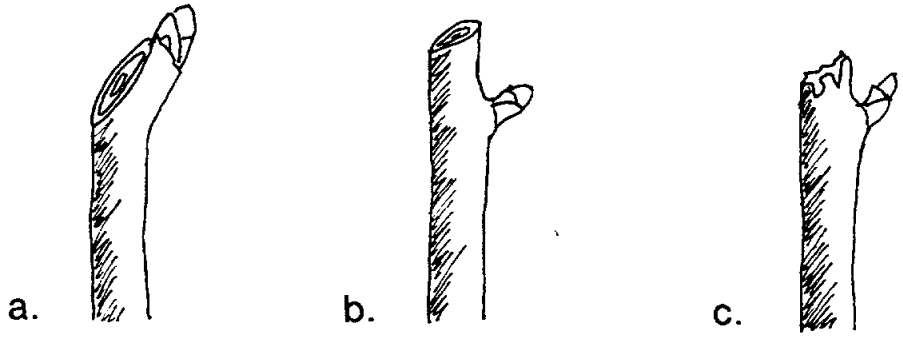
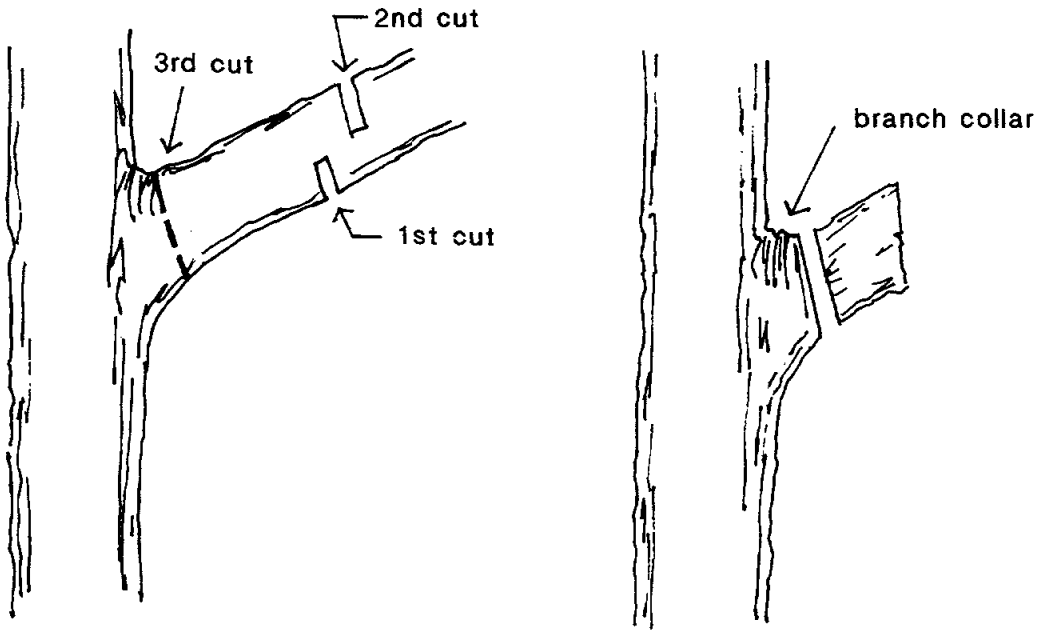


Figure 6: THREE-STEP LARGE LIMB REMOVAL. a) First cut is from below. b) Second cut is from above, a few inches beyond first cut. c) Third cut is from above and removes the stub at the branch collar.



Types of Pruning:

Routine Pruning:

Routine pruning is a straightforward operation that should be carried out at least every 2-3 years. Neglecting to prune routinely allows undetected diseases and other problems to go untreated, and can create the need for remedial pruning which is more costly, timely, and does not always produce the healthiest or most aesthetic results. Routine pruning usually requires only two steps:

1) First remove dead, diseased, broken, injured and weak growth.
2) Second remove branches that rub; grow in the wrong direction or stick out far beyond the natural shape of the plant; cross and crowd the center of the plant; branches lying on the ground; finally remove suckers and watersprouts. For most shrubs, this is all the pruning they require.

General guidelines for pruning:

◊ Use the right tool for the right pruning job and always use sharp tools to make clean cuts.

◊ Practice good pruning techniques (see above). Jagged, bruised or torn branches do not heal well and can allow rot to enter.

◊ **Do not top trees**. Topping a tree allows decay to enter the tree, making it susceptible to damage, which can create a safety hazard and cause a slow death. Crown reduction pruning (drop crotch pruning) may be performed by trained staff, when appropriate, see National Arborist Association "Pruning Standards for Shade Trees."

◊ Pruning dead and damaged wood: Cut back dead or damaged wood to live growth, making the pruning cut just above the highest live bud or another branch. Do not leave stubs.

◊ Pruning diseased wood: Cut back diseased wood to healthy tissue, at least 12 inches below an obviously infected stem. Make the cut just above the top most bud that is pointing in the direction you want the branch or stem to grow (usually outward pointing). Disinfect pruning tools after each cut by dipping blades in rubbing alcohol or household bleach; then wipe dry.

◊ Pruning watersprouts and suckers: Suckers are stems from the base or the rootstock of a plant rather than the portion of the plant that is grafted onto it. Move the soil aside and pull off suckers, including the stem's base with its dormant buds. Do not cut suckers back at the base, multiple suckers will grow back. Watersprouts are a type of sucker that grows straight up from a mature branch or parallel to the main trunk of a tree. Remove them by cutting them off flush whenever they emerge. Summer is a good time to battle suckers.

◊ Drastic pruning will affect a plant's root system, and depending on the species, may jeopardize the health or life of the plant. Generally, except for remedial pruning, only remove between 1/8 and 1/3 of a branch, foliage, or woody growth in one year. Some plants which do not resond well to pruning will produce suckers if they are pruned heavily. These include Cotoneaster, Hamamelis (witch hazel), Malus sp. (crabapple), Viburnum sp. Cornus (dogwood), Prunus sp. (flowering cherry, and plum), Magnolia, and Corylus (filbert). Do not remove more than 1/8 total leaf surface in one year for these plants.

◊ Broad-leaved evergreen shrubs need very little pruning. Cut back dead branches and the occasional branch that spoils the shape plus any rubbing, crossing branches in early spring to hide pruning scars with new growth. Prune off dead flowers.

◊ Generally, pruning should not be used to control the size of a plant, with the exception of shearing hedges. Other than routine pruning to maintain health and enhance their natural habit, most shrubs do not need to be pruned and should be allowed to grow to their mature size and shape. If a plant has to be pruned several times a season to keep it small, it is in the wrong location and should be moved to a more suitable location. See remedial pruning below as a possible solution to restarting some overgrown shrubs.

♦ As with shrubs, most ornamental trees need little or no regular pruning. However, they will likely benefit from formative pruning when they are young to establish a framework and remove extra, weak or poorly located branches. Most of this formative pruning occurs at the nursery although occasional pruning may be needed. Prune mature trees conservatively to avoid excessive thinning and wounding. As noted previously, maintaining the large diverse population of trees in the Historic District requires experienced, well trained professionals. Hire licensed arborists for all tree work. See bulletins provided in Appendix F for more detailed information on pruning trees.

Other Types of Pruning:
Other types of pruning that will be required at Ft. Lewis include remedial pruning to rejuvenate old, neglected plants, conifers, pruning to increase flowering, and hedges.

Remedial Pruning:
Shrubs that have been neglected, are overgrown, badly damaged or improperly pruned can sometimes be rejuvenated or started over by remedial pruning. Remedial pruning consists of severely cutting back a plant. Depending on the health of the plant, it can be done in one step or in stages.

◊ The shrubs that respond best to remedial pruning are those which have a cane-like growth habit. These plants have multiple, often arching stems or canes originating from the base of the plant. They send up new canes when pruned and include many of

the deciduous flowering shrubs such as *Forsythia, Weigela, Philadelphus, Kolkwitzia, Hydrangea,* and *Deutzia.* These shrubs are very tough. If they are in good health, all the canes on the shrub can be cut back to within four to six inches of the ground. Or to reduce pruning shock or help maintain the fountain-like arching shape of the shrub created by the older stems, one-third of the canes can be removed every year for three years.

◊ Although they are not a tough as the cane-growing shrubs, many other shrubs (*abelia, aucuba, berberis, choisya, escallonia,* evergreen azaleas, *spireas*), can also be successfully renovated by either cutting back to the ground or removing one-third of the growth every year.

◊ It is possible but more difficult to renovate large growing broad-leaf evergreens (*rhododendrons, camellias, pieris,* laurels). And, they require diligent thinning and retraining for several years after this treatment. Do not try remedial pruning on broadleaf evergreens that are prone to suckering. Another pruning option for this group of shrubs is to remove their lower limbs, turning them from a shrub into a small tree. This technique is useful if a shrub is blocking foot traffic, or completely covering a window. It works best on large older shrubs. Work with the natural shape of the shrub, lightly thinning the top too so that you are not left with a dense round ball of foliage at the top of a trunk. Do not over-thin and be sure to provide adequate water and fertilizer (for non-suckering plants).

◊ All plants should be healthy before attempting remedial pruning and well watered after they are pruned. Remedial pruning should only be attempted as a last resort as the stress can kill them. After remedial pruning, it will take 2-3 season or more for renovated shrubs to look presentable and follow-up pruning to retrain new growth.

◊ Remedial pruning cannot be performed on conifers because, with few exceptions (yews), trunks and older branches cannot not sprout new growth.

◊ Remedial pruning cannot change the natural habit of a plant such as making a shrub with a large open habit into a small, compact shrub. It will also not keep plants small; it will only start them over. A plant should have room to grow to its 'mature size'. The size listed on most plant tags refers to its mature size, not its potential or ultimate size. When a plant reaches its mature size its growth slows down but it does not stop growing for many more years and can reach a size that is twice its mature size. Remedial pruning can help restore a plant to its mature size, reducing it from its ultimate size.

◊ For more information on remedial pruning see "The Complete Guide to Landscape Design, Renovation, and Maintenance" 1991, by Cass Turnball.

Pruning Conifers:[5]

Conifers normally do not require much pruning, although they are sometimes pruned to control the density of branching, the shape of young trees, and the size of older ones. Pruning in the Historic District should be focused on pruning out dead and diseased wood and enhancing the natural shape of the plant (no shearing). In most cases, intensive pruning year after year to keep a conifer small is too labor intensive and is not appropriate.

How much a conifer can be pruned depends on the location of latent buds or growing points. Most conifers do not have latent buds below the area with foliage on older wood so the branch stub usually dies when the branches are cut beyond the foliage. It is best to limit pruning to cutting within the foliage. However, if more severe pruning is necessary, cut back to active laterals while trying to maintain the natural shape of the tree or shrub.

The branching characteristics of conifers also determine pruning techniques. The two broad classes of conifers are whorled branching species and random-branching species. Whorled-branching conifers include pine, spruce, fir and Douglas-fir. To direct growth or reduce size for pines, cut to lateral shoots only and do not cut below terminal buds; no growth will occur below them. For spruce, fir and Douglas-fir, cut to lateral shoots or visible dormant buds. Density in whorled-branching conifers can be increased by pinching the lateral shoots (or candles for pines) when they expand in the spring.

Random-branching conifers include cedar, larch, arborvitae, false cypress, incense cedar, cypress, juniper and yew. To direct growth or reduce size for cedar and larch prune to a lateral on long shoots. For arborvitae, false cypress, incense cedar and cypress, thin to lateral or within visible foliage. For juniper and yew, thin to laterals and tip prune. To increase density for cedar and larch, pinch the expanding shoots. For arborvitae, false cypress, incense cedar, cypress, juniper, and yew, tip prune to increase density.

There are a number of columnar-shaped or upright conifers in the Historic District including arborvitae, false cypress, and yew. These conifers have branches that rise from the bottom to the top. Although these trees can be formally sheared or clipped, in the Historic District they should always be pruned to have a natural, textured appearance. Pruning usually consists of removing branches that grow or bend away from the natural columnar shape. It also includes cutting back branches that start near the ground that grow so long that they cover branches above and can cause the inside foliage to die. Both problems can be remedied by cutting upright branches back to short, spreading laterals; carefully spacing them to create small openings showing the trunk. Wash weak or dead foliage out with a hose. Yew may be too sparsely branched for this treatment therefore branches should be headed back at varying lengths above their laterals; leaving branches that are one or more ft. long.

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[5] Primary source for pruning conifers section: Harris, Richard W., Arboriculture: Care of Trees, Shrubs, and Vines in the Landscape, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1983, p. 429-437.

Pruning to increase flowering:

Most shrubs only need occasional pruning to remove defective, overcrowded, or badly-placed shoots. Some groups of shrubs, however, give better displays when regularly pruned such as: 1) Shrubs that flower in summer or fall on the current year's growth; they are pruned hard in early spring. 2) Shrubs that flower in spring or early summer on shoots produced during the previous growing season.. See plant lists in Appendix E.

Shrubs that flower in summer or fall on the current year's growth:

◊ Pruning consists of removing as much as possible of the old growth (the previous season's flowering shoots) so new shoots are produced. In early spring, as soon as growth begins, the previous season's flowering stems are cut back to one or two pairs of buds from their point of origin. New shoots will then form and flower by summer. As basal stems become congested over the years, cut some stems out at ground level.

Shrubs that flower in spring or early summer on shoots produced during the previous growing season:

◊ Prune these shrubs as soon as flowering is complete; removing the one year old growth. This allows the plant to channel its energy into the young growth at the base of the older wood and develop into strong replacement shoots for flowering in the next growing season. When several new shoots grow at the base of a stem, it is usually best to cut back to the lowest, which is usually also the strongest, as long as the plant is well balanced. If main stems forming the framework at the base of the shrub become overcrowded after a few years, cut some stems out completely.

Pruning Hedges:

The small number of existing hedges located in the Historic District should be formally sheared. Trim hedges with sloping sides so they are slightly narrower at the top than at the bottom. This allows light to reach both the top and the bottom and creates full compact growth throughout the hedge.

When to Prune:

In most cases, the best time to prune is when the plant is dormant which, in this climate, is in the winter. Many plants will tolerate light pruning out of season, but always consider the type and health of the plant first. Generally, dead, diseased (see exception below), or damaged parts can be pruned anytime of year.

♦ According to the National Arborist Association Pruning Standards for Shade Trees (revised 1988): "Trees susceptible to serious infectious diseases should not be pruned at the time of year during which the pathogens causing the diseases or the insect vectors are most active. Similarly, if pruning wounds may attract harmful insects, pruning should be timed so as to avoid insect infestations." Due to Dutch Elm Disease, do not prune elms at Ft. Lewis between March and October. Open cuts attract the elm bark beetle which allows the pathogen to infect the tree.

◊ Winter pruning (dormant period) is less stressful to plants and is usually the best time to prune, especially heavy pruning such as remedial pruning. Winter pruning stimulates growth although not as much as spring pruning . Do not prune when temperatures are below 20 degrees F.

◊ Spring pruning stimulates rapid regrowth. Prune shrubs that flower in summer or fall (see above) on in early spring as soon as soon as growth begins. Be careful of pruning plants that "bleed" when pruned such as maple, dogwood, birch. Late spring pruning is not recommended because energy is being channeled into forming new shoots, buds, blossoms, and fruit

◊ Summer pruning is less stimulating but more stressful to plants; keep summer pruned plants well watered. Less stimulation however, makes summer a good time to fight suckers and watersprouts. Be careful of sunburning newly exposed areas on pruned plants.

◊ Late summer through early autumn pruning is also not recommended since pruning may stimulate tender growth which will be more sensitive to damage from freezes.

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FERTILIZING:

Introduction:
In addition to light, carbon dioxide and water, plants require both macro-nutrients and micro-nutrients from the soil to carry out their biological processes. Usually most micro-nutrients or trace elements are needed in such small amounts that they are available in most soils. Macro-nutrients include nitrogen, phosphorus, and potassium (primary), and calcium, magnesium and sulfur (secondary). The primary nutrients (N-P-K) are the most necessary nutrients for plant growth and if they are not present in the soil in large enough quantities they must be supplied.

Nitrogen (N) is know for promoting top growth. It is most active in new, tender growth such as tips of shoots, buds, and opening leaves. When there is inadequate nitrogen, stunted growth occurs and older leaves can turn yellow, die, and drop off (chlorosis). Too much nitrogen can affect growth quality and may pollute ground water.

Phosphorus (P) is vital to growth and metabolism and plays a role in photosynthesis, energy transfer, and membrane function. It assists in root growth, developing larger flowers, winter-hardiness, and disease resistance. If a P is too low, plant growth is retarded.

Potassium or "soluble potash" (K), is important in photosynthesis, and carbohydrate and N metabolism. Plants with inadequate K are often deficient in carbohydrates which can cause problems such as reduced yield, reduced cold-hardiness, and poor quality growth.

Types of Fertilizers:
There are several different types of fertilizers: complete, special purpose, slow release, organic and chemical. Complete fertilizers are any that contain all three of the primary macro-nutrients N-P-K. Typically, the percentages of N-P-K are listed in a product's the label such as 5-10-5 which indicates 5% N and K and 10% P.

Special purpose fertilizers are packaged for certain uses or types of shrubs. For example, fertilizers with compounds which have an acid reaction are commonly packaged for acid-loving plants such as rhododendrons and azaleas. Camellia and rose foods are also common special purpose fertilizers.

Slow release fertilizers are manufactured to release their elements at a steady rate and over a longer time period than typical complete fertilizers. They are less likely to burn roots. Some are coated to release elements when they become moist, or are coated to allow the fertilizer to be released when the weather is warm enough and the plant needs it more. Organic fertilizers are those derived from once-living organisms such as cottonseed meal, bone meal, blood meal, wood ashes, rock phosphate, compost, and manure (make sure it's well rotted). In general, organic fertilizers are released slowly because they have to be processed by microorganisms from complex organic molecules or mineral structures into simpler compounds. And, since it must be warm and moist for these microorganisms to be

active, organic fertilizers are not always available. Although some say the drawback to organic fertilizers is they are not effective year round, proponents say this is actually an advantage since it keeps plants growing during the right time of year. In general, organic fertilizers are safer to use (slower release and less concentrated), they help increase organic material, and constitute a type of recycling of organic wastes.

Chemical fertilizers are processed from the atmosphere, minerals, and salts. This processing breaks the elements down into simple molecules so they are readily available. Disadvantages to this fast release are the potential to "burn" plants, and the possibility of providing elements before plants should have them or when growth should be slowing for fall. These potential problems can be mitigated with proper timing and application. One major disadvantage to chemical fertilizers is that soil organic matter is decreased over time because no organic matter is being added when chemical fertilizers are used. This reduces the soil's native fertility and may affect its workability and water holding capacity.

Compare cost, long-term effects and convenience when deciding on what type of fertilizer to use; chemical and organic fertilizers can be used together. Both organic and chemical fertilizers can pollute if too much is used. In general, it is best to use organic fertilizers in the Historic District due to the long-term benefit of increasing organic matter and improving the soil.

Some fertilizers are prepared with insecticides and herbicides. In general, these kinds of fertilizers are not recommended in the Historic District; especially when applied to lawns with trees.

Fertilizing Trees and Shrubs:
Fertilizing trees and shrubs is not usually necessary if soils are adequate, especially if mulches are used. Although the predominantly sandy soils in the Historic District are likely nutrient deficient, they should be tested and the specific needs of the trees or shrubs determined before fertilizers are applied. According to Washington State Cooperative Service Bulletin No. 0648: Organic Gardening, the "long range objective of fertilizing should be to build your garden area to a high fertility level and then to maintain fertility through composting and mulches, reducing reliance on commercial and organic fertilizers."

Fertilizers may be necessary if the following symptoms are observed:
1. A tree or shrub does not leaf out although it has been planted for several months.
2. A tree or shrub shows obvious signs of lacking some chemical such as less vigorous growth, tip dieback, poor foliage color (yellowing) or mottling of leaves.
3. A shrub has not flowered for several years. Help it bloom by adding rock phosphate (contains phosphorous) in spring and fall.
4. Sometimes, if you want certain plants (small or rare) to grow a bit better, a slow-release complete fertilizer such as a 10-6-4 can be used in early spring.
5. Sometimes adding organic matter as a mulch or soil amendment can deplete the soil of nitrogen. When organic matter is incorporated into the soil as a soil amendment then soil

microbes, which need N to decompose the organic matter, can deplete the nitrogen in the soil they are in contact with to meet their needs. However, if organic matter is added to the soil surface as a mulch, then immobilization is not as likely to be a problem. Watch for signs of N deficiency such as slow growth and yellowing. If incorporating organic matter *into* the soil as an amendment, use a maximum of 2 inches per year to reduce nitrogen depletion. And, add N fertilizer when incorporating organic matter that is low in nitrogen such as sawdust and straw, or mulches and manure with lots of bedding. Apply 2 lb. per 100 sq. ft. of ammonium sulfate to offset N loss. If sawdust is incorporated use up to 3.5 lb. of N per cubic yard to offset N loss.

Fertilizing Turf:
Maintaining a proper fertility level in lawns, especially nitrogen, lessen the chance of invasion by weeds, moss, and pests. Use a 3-1-2 or 6-1-6 ratio fertilizer and apply 1 pound of actual nitrogen per 1000 sq. ft. 3-4 times per year (for a total of 3-4 lb.. per year). Apply in May, late June (optional), mid-September and December. Be careful not to over fertilize and water well after applying the fertilizer to avoid burning.

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WEED CONTROL:

Weeds compete with desirable plants and turf for water, nutrients, and space. Weeds thrive in harsh conditions and will quickly out-compete landscape plants in poor soils and extreme heat and droughts. The best defense against weeds is to grow healthy plants that can out-compete weeds.

Weed Control Methods:
Weeds can be controlled by cultural, mechanical, and chemical means. Cultural methods include mulching and good maintenance practices such as proper watering and fertilizing. Mechanical methods include hoeing, pulling, or cultivating. A variety of tools exist to aid in mechanical removal. Removing weeds when they are young is easier than removing deeper-rooted large weeds. Cultural and mechanical methods should be always be attempted before resorting to chemicals.

Chemical weed killers (herbicides) are classified several ways. *Contact* herbicides kill only the plant parts they contact. They are usually *non-selective* since they kill whatever they touch. They are primarily used to control annual weeds; the tops are killed and few re-sprout. Although if annual weeds have already gone to seed, the weeds will return. *Translocated* herbicides kill the entire plant. These herbicides are carried from the part that was sprayed throughout the plant and into the roots. For this reason, translocated herbicides are especially effective in controlling perennial broad-leaved weeds. *Selective* herbicides eradicate target weeds, for example, those that selectively kill broad-leaved weeds without killing turf grasses. Or conversely, herbicides that kill grass but do not kill shrubs or trees. *Preemergent* herbicides are applied before weed seedlings emerge; they have limited effect if weed growth has started. *Postemergent* herbicides are applied after weeds are growing.

Herbicides are poisons and must be used with caution. Overuse or improper use can kill or injure landscape plants, and can be harmful to animals (including humans). Always follow label directions precisely and use the proper equipment. Never combine chemicals. Be careful of drift when spraying and never spray when the wind is over 2-3 mph; use lower pressure and larger droplet size to reduce drift. Use the right type of herbicide for the right problem. Most products list the weeds that are controlled by the product. Contact the Cooperative Extension Service for weed identification if needed.

Planting beds:
The best way to control weeds in plant beds is to mulch the beds regularly. A thick layer (4-6") of mulch reduces weed seed germination and keeps weeds that germinate from growing toward light. And, those weeds that do grow through the mulch are easier to remove. Scuffle hoes (flat-bladed, disk type, or U-shaped) are especially useful for removing weeds in mulch, particularly when weeds are young. Be sure to weed beds before applying mulch. In general, use mulches and mechanical removal to control weeds in planting beds. However, if weeds are out of control in a particular area and mechanical

removal is impractical, it may be more effective to use herbicides to "knock-back" the weed population and then revert to mechanical and cultural means.

Turf:
Creating and maintaining healthy, vigorous turf through proper fertilizing, watering, aeration, and thatching, is the best protection against weeds and moss growing in lawns. Dig out perennial weeds when possible and reseed spot. Do not routinely apply herbicides in combination with fertilizers (weed and feed products) to lawns. If herbicides must be used on lawns try spot treating individual weeds. The best time to apply them is mid-spring (early May) or during September. Do not apply herbicides within the drip line of trees in lawns; they are very susceptible to chemical damage.

To control moss in lawns apply lime to help reduce soil acidity and encourage microorganism activity. Apply 25-30 pounds per 1000 sq. ft. Lime does not kill moss; it increases turf performance so grasses can out-compete moss.

Types of Weeds:
Two main types of weeds are annual and broadleaf perennials.

Annual Weeds:
Annual weeds include chickweed, pigweed, lamb's quarters, crabgrass, and prickly lettuce. Annual weeds complete their life cycle in one growing season and tend to reproduce in large numbers. They are usually easy to mechanically remove because of their shallow roots. Mulching is effective since mulches will usually smother both seeds and remnant weeds that were turned under during weeding. Whenever possible, remove annuals before they flower and go to seed-this lessens the battle.

Broad-leaf Perennial Weeds:
Broad-leaf perennial weeds include dandelion, plantain, buttercup, stinky geranium, some types of oxalis and clover, morning glory (bindweed), and horsetail. Perennial weeds live for more than two years and reproduce by seed and vegetatively. Their two-fold ability to reproduce makes them much more persistent than annual weeds. All of the roots must be removed to eradicate perennials; if just the tops are removed, they will re-grow. For perennials with roots that are runners (stolons), such as morning glory and horsetail, root removal can be difficult. Persistent and repeated removal of the tops and at least some of the roots, can sometimes effectively starve the weed to death. Make sure to control or eliminate if possible, aggressive weeds such as morning glory, false bamboo, and horsetail. These weeds spread very rapidly and are difficult to eradicate once started; chemicals may be necessary to control them.

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INSECTS AND INSECT-RELATED PESTS:

Integrated Pest Management[6]:

The best approach to controlling pest in the Historic District is to develop an Integrated Pest Management plan. The Integrated Pest Management (IPM) approach grew out of the need to counter the health, environmental, and pest resistance problems that developed from the heavy use of chemicals that began in the 1940s with the introduction of synthetic pesticides. It is beyond the scope of this project to develop an IPM program for the Historic District. However, this section provides and overview of the principles and strategies used in IPM programs which can be incorporated into managing the Historic District even without a formal IPM plan.

IPM concepts include the following:

> "A plant or landscape planting is a component of a functioning ecosystem, even though the planting is man-made. Hence, actions should be designed to develop, restore, preserve, or augment natural checks and balances, not necessarily to eliminate pest species.
>
> The mere presence of a pest organism does not necessarily constitute a pest problem. Acceptable population and damage levels must be determined.
>
> All possible pest control options should be considered before action is taken. Techniques employed should be as compatible as possible."

IPM programs should be based on the following guidelines.

> "Understand the biology of the plants involved, especially the manner in which they are influenced by the surrounding ecosystem.
>
> Identify the key pests, know their biology, recognize the kind of damage they inflict, and study the economic and aesthetic consequences of control measures.
>
> Identify the key environmental factors that impinge (favorably or unfavorably) upon pest species and potential pest species in the ecosystem.
>
> Consider concepts, methods, and materials that, individually and in concert, will facilitate permanent suppression or restraint of pest and potential pest species.
>
> Structure the program so that it can be adjusted to meet change or varying situations.

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[6] Primary reference: Harris, Richard W. Arboriculture: Care of Trees, Shrubs, and Vines in the Landscape, Prentice-Hall, Inc.: Englewood Cliffs, New Jersey, pg. 613-624, 1983.

Seek the weak links in the life cycle and population structure of important pest species, and direct control practices as narrowly as possible at those weak links. Avoid broad impact on the plant ecosystem.

Whenever possible, employ methods that preserve, complement, and augment the biological dynamics that characterize the ecosystem.

Monitor pests, natural enemies, and tree health regularly.

Anticipate unforeseen developments, move with caution, and be aware of the complexity of the landscape ecosystem and the changes that can occur within it."[7]

One important principle of IPM is determining injury levels; how much damage can the user tolerate and how much damage can the plant take. For urban landscapes, establishing the *aesthetic* injury level is important step in deciding on a control plan. An aesthetic injury level is the highest level of pest damage or presence that is acceptable by residents or those who use the area. Although some pests can cause death or serious injury, most only change the appearance of a plant or create products that are a nuisance such as honeydew excreted from aphids, and scales. Acceptable aesthetic injury levels are usually increased with education about how pests affect plant and human health, and how they can be managed with integrated control methods.

IPM Control Methods:

There are four types of control measures that are commonly used in integrated pest management programs: genetic, biological, cultural, and chemical. Many of these practices are effective in controlling plant diseases as well as pests.

Genetic Control:

Genetic control consists of controlling pests in two ways: developing host resistance and autocidal control. Developing host resistance consists of using plant species and cultivars that are naturally resistant or have been breed to be resistant to pests. It is a very successful and ecologically sound method of controlling pests. It is also a favorable method to use when replacing historic plant material in the Historic District where maintaining the characteristics of historic plants is an important preservation goal. Autocidal control is modifying the genetic make up of a pest population to lead to its demise, for example, propagating sterile males to stop reproduction in a population.

Biological Control:

Biological control consists of conserving or increasing a pest's natural enemies organisms such as predators, parasites, pathogens, and competitors. Examples of biological controls include controlling aphid populations by introducing predators such as lacewings and ladybird beetles (ladybugs). Or, using diluted soap sprays on aphid infested plants so that parasitic insects are not killed when they are feeding on those plants. This illustrates one

[7] Harris, Richard W. Arboriculture: Care of Trees, Shrubs, and Vines in the Landscape, Prentice-Hall, Inc.: Englewood Cliffs, New Jersey, pg. 611-612, 1983.

of the major disadvantage to using chemicals; the fact that they often destroy a pest's natural enemies, which can keep a pest within acceptable injury levels, along with the pest. Biological controls can be effective, cost efficient, and usually complement or enhance the ecosystems natural checks and balances.

Cultural Controls:
Cultural Controls are practices that create unfavorable conditions in order to limit a pest's ability to reproduce, move, or survive. Cultural practices that can be used at Ft. Lewis include: *maintaining plant health* or vigor through proper nutrition, and watering; *select pest-free plants* when planting new plants; *pruning* to remove dead and weak wood-potential breeding grounds for pests, thinning dense growth to reduce some leaf diseases anthracnose, powdery mildew, scab), and pruning infected or infested branches to remove pests; using *proper pruning techniques* to ensure quick healing and create less potential for decay; practicing good *sanitation*, clean up plant litter to remove breeding, overwintering, and refuge sites of pests; *mulching*; *proper planting timing;* and *physical controls*-washing pests away or the "2-brick" method.

Chemical Controls:
Chemical Controls (insecticides) may be the only means of controlling some pests, but generally they should be used as a last resort; after cultural, biological, and genetic controls have been attempted. As with herbicides, pesticides are toxic to animals and a number of steps must be used to ensure safe and effective control. These include proper pest identification and pesticide selection, and proper application and timing.

Whenever possible, use least-toxic pesticides such as insecticidal soaps, horticultural oils, and botanical insecticides. Insecticidal soaps are commercial products formulated to kill certain insects while not harming beneficial insects. They are biodegradable, breaking down in 7 to 14 days so they do not harm plants or the environment. Horticultural oils work by smothering insects and their eggs. They do not remain on plants long and are very low in toxicity to wildlife, pets, and people. Generally, they also pose little threat to the natural enemies of target pests.

Botanical insecticides are poisons derived from certain plants. Common examples include nicotine, pyrethrum, rotenone, and neem. They advantage to using botanical insecticides is that they break down into non-toxic compounds within hours or days when exposed to sunlight. Although natural substances, they are still poisons, and as with synthetic chemicals, must be used carefully; always follow directions on the label. They also kill beneficial insects as well as insect pests so use them only when other non-chemical controls do not work.

Types of Insects and Insect-related Pests:
Insects and mites are arthropods; characterized by having a segmented body-with three body regions, external skeletons, and may have the ability to fly-one or two pairs of wings. Mites are spiders (Arachnida) and have four pairs of legs, no wings, and bodies with an abdomen, fused head, and thorax.

Most insects hatch from eggs and have one of two life cycles; complete metamorphosis or incomplete metamorphosis. Insects with complete metamorphosis cycles have four stages, egg, larvae, pupa, and adult. The young in this group do not resemble the adult, for example, flies/ pupa), and moths/caterpillars. Plant injury can occur during the larvae (caterpillars, grubs, borer) or adult stage. Incomplete metamorphosis cycles consist of egg, nymph, and adult stages. These insects resemble each other in their nymph and adult stages for example, mites, crickets, grasshoppers. Plant injury can occur in the nymph and adult stages. Understanding life cycles and applying appropriate control measures must go hand in hand to be effective.

Insects are typically divided into two groups based on the type of mouthpart they have; chewing mouthparts and sucking mouthparts.

Chewing insects:
Chewing insects chew or grind various plant parts and can leave holes (caterpillars, cutworms, slugs), tunnel through and skeletonize leaves (leaf miners), eat above ground parts (beetles and grasshoppers), feed on roots (larval stages of some), and bore inside roots, trunks, branches, and plant shoots. Although slugs and snails are not insects, they are included in the chewing insect group because they have rasping eating habits that can cause tissue loss.

Sucking insects and mites:
Sucking insects have mouthparts that are specialized to suck juice out of plant tissue. They can attack all plant parts but leaves and developing shoots are a preferred target; in large numbers, they can seriously weaken plants. Sucking insects include aphids, scale insects, galls (created by wasps and flies), and although not insects, mites (spiders) and plant-parasitic nematodes (microscopic worms). Symptoms include stunted or deformed new growth, and distorted, curled or yellow leaves and the formation of galls.

Descriptions and treatment overviews for problem insects previously recorded at Ft. Lewis or common to the Pacific Northwest:

Aphids:

Aphid damage in the District has been noted in both birch and spruce trees. According the 1990 Hazard Tree Survey, damage is common to Colorado blue spruce and Norway spruce from the spruce aphid *Elatobium abietinum*. And, birch aphids, *Fenusa pusilla*, are common on European white birch.

Symptoms and Identification:
Aphids have pear-shaped, soft bodies and are about the size of a pin head. Depending on the species, they may be green, brown, bluish, or pink. They have sucking mouthparts which pierce plant parts to remove plant fluid. Many aphids have complex life cycles which include generations of different life forms and plant hosts. Males are produced in

fall and mating results in egg production. These eggs overwinter until spring when they emerge as female aphids. These females give birth to females and the cycle is repeated several times during the season. The first few generations are wingless, but as the population increases or as fall approaches, aphids with wings are produced. A sure indication that aphids are present is finding honeydew, a sugary substance excreted by aphids. Honeydew commonly attracts ant and often controlling ants, which can prey on natural enemies of aphids, can aid in managing aphids.

Spruce aphids are green and only 1/16-inch long. They attack the undersides of older needles, turning them a mottled yellow, then they go brown and drop. Spruce aphids are a cool weather aphid, they feed throughout the year except in summer. Their populations increase in February and March and decline in late spring. During the height of the infestation, damage is not readily apparent and close observation is needed to detect them. It is usually April, May, and June before damage is detected but by this time, aphid numbers are lower than during the early season and control methods are too late to be very effective. In mild winters, damage may be worse. Since most of the damage occurs before new growth begins, the current year's needles are not affected; trees frequently damaged by aphids only have needles on the tips of branches. Heavy infestations may decrease the aesthetic value of the trees, and heavy damage year after year weakens trees and may increase the chance of death if the trees are also stressed by other conditions such as adverse weather.

Control Methods:
Apply control measures as soon as aphids appear; usually late fall to March. Waiting until damage is evident is too late. Sample for aphids every week or two. Use a one-foot square white placard and "thump" the tips of branches against them at several locations around the tree. If aphids are seen, begin control measures.

Cultural controls:
Improving the vigor of plants (proper pruning, mulching, watering, and fertilizer if necessary) is essential in keeping aphids at bay. When plants are stressed aphids can take a heavy toll. Reduce aphid outbreaks by spraying with horticultural oils in winter to smother overwintering eggs. Spruce trees should be sprayed with horticultural oils in fall to control spruce aphids.

Control heavy infestations by spraying trees vigorously with water to wash them off, or spray with insecticidal soaps every two to three days until aphids are gone. Insecticidal soap is specially formulated to kill certain insects and not harm beneficial insects. It is biodegradable and breaks down in 7-14 days so it does not harm plants or the environment. It is a direct contact insecticide so insects must be directly sprayed to be effective.[8]

[8] Ball, Jeff and Liz, Rodale's Landscape Problem Solver: A Plant-by-Plant Guide, Rodale Press, Emmaus, Pennsylvania, 1989, pg. 246.

Biological Controls:
Lady beetles (ladybugs) and lacewings (larval stage) are natural predators of aphids. And, parasitic wasps (*Trichogramma* & others), which are non-stinging, parasitize aphids.

The spruce aphid is a cool weather aphid and there are not as many cool weather predators around to keep them in check in this area.

Genetic Controls:
Use Picea pungens 'Moerheimii' which is more resistant to the aphids as a replacement for Colorado blue spruce when they must be removed.[9]

Chemical controls:
If above methods do not bring infestations under control (complete elimination is not realistic or desirable in most cases), use botanical insecticides (poisons derived from plants) such as nicotine, pyrethrum or neem. While botanical insecticides break down quickly so are less of a threat to the environment, they kill beneficial insects along with pests so use them with care. Avoid non-botanical, broad spectrum insecticides which are more complex, and persistent, and consequently have a more devastating effect on beneficial insects and the environment.

<u>European elm bark beetle:</u>

The presence of the European bark beetle, *Scolytus multistriatus*, at Ft. Lewis is uncertain. It was not observed during the 1990 Hazard Tree Survey, however, according to the authors, it could have been overlooked, and since that time it could have populated the area. It is very important to monitor and control the beetle because it is the primary vector of DED in the Pacific Northwest.

Symptoms and Identification:
The adult beetle is reddish black and only 1/10-inch long. The female adults bore through the bark and excavate galleries in the sapwood where they lay their eggs. Small white larvae hatch from the eggs and leave tiny holes in the bark when they emerge as adults. The adults feed on the 2-4 year old twig crotches of living elms during the summer. Mass attacks by beetles may occur. When a female beetle finds a weakened tree, she may release a pheromone to attract others to the site. This often results in numerous "gum drops" or pitch masses. The larval tunneling from a mass attack can girdle and kill the tree.

[9] Walt Bubelis, director of the Horticulture program at Edmond's' Community College, supported continuing to plant spruce in urban landscapes. Insect infestations usually run in cycles and in time, the heavy spruce aphid infestation will likely end. He emphasized that just reducing plant stress, especially from summer drought, will go a long way in reducing damage from infestations. He recommended 'Moerheimii' as a resistant variety.

Control Methods:

Cultural Controls:
Prevention is the most effective method of managing the elm bark beetle. Trees in weakened condition are most subject to infestation by the European elm bark beetles. Increase the vigor of elm trees by providing adequate water, proper pruning, fertilizer if needed, and protecting roots and trunk from soil compaction and mechanical injury. Remove and destroy infested branches, and eliminate bark beetle breeding grounds-see sanitation controls in DED segment.

Biological Controls:
A strain of *Bacillus thuringiensis* is available to control the larvae of the native elm leaf beetle *Pyrrhalta luteola*. It was not mentioned as a control for the European elm bark beetle but other references should be checked.

Chemical Controls:
Unless monitored regularly to detect the insect early, spraying will likely be too late and ineffective. Valuable trees may be protected from further attacks by spraying with a persistent insecticide in spring. However, proper cultural care is the first line of defense. Bark beetles cannot be controlled or prevented by systemic insecticides injected through the bark.

Rodale's Landscape Problem Solver (1989), recommends controlling the beetle by spraying plants with a mixture of the botanical insecticide pyrethrum and isopropyl alcohol, every three to five days for two weeks. Use two parts alcohol, one part water and pyrethrum in the concentration recommended on the bottle.

European Crane Fly:[10]

Symptoms and Identification:
The European crane fly, *Tipula paludosa*, primarily feeds on turf and in pastures although it may also feed on annual and perennial flowers, and several types of vegetables and small fruits. The adult crane fly resembles a large mosquito, with long legs and a one-inch long body. They do not bite or sting, or do damage to houses (they often gather in large numbers on the sides of buildings).

"Adult crane flies emerge from soil of lawns, pastures, and other grass areas from late August to mid-September. The females mate and lay eggs in grass within 24 hours after emerging. These eggs hatch into small, gray-brown, worm-like larvae, which develop a tough skin; they are commonly called "leatherjackets." The leatherjackets feed on the root crowns of clover and grass during the fall. They winter in the leatherjacket stage. As the weather warms in spring, they continue to feed. Damage by their feeding may become especially noticeable in March and April. During the day, leatherjackets mostly stay

[10] Cooperative Extension, Washington State University, " Extension Bulletin 0856: The European Crane Fly: A Lawn and Pasture Pest," Pullman, WA., 1994.

underground, but on damp, warm nights they come to the surface to feed on the aboveground parts of many plants. Leatherjacket feeding stops about mid-May. They go into a non-feeding stage just below the soil surface during July and August. From late August through September pupae wriggle to the surface and the adult crane flies emerge" (EB0856, pg.1).

Control Methods:

Chemical controls:
Control crane flies in turf with registered insecticides. Consult the Pacific Northwest Handbook for a list of products and application rates etc. Several products come as granules. Be careful in spreading them so children and pets do not come in contact with them. Avoid spilling onto walks and patios. Check cautionary statements on insecticide labels for their toxicity to waterfowl and birds. Since natural controls often eliminate high fall populations, wait until early spring to treat residential areas. Survey lawns in early-spring (March) or when the temperatures are consistently warmer, to see if crane flies are abundant. Test by selecting 4-5 one-foot square, random spots in the lawn and digging up the top layer (1-2 inches) and counting larvae. If the average number of larvae exceeds 25-30 per square foot, consider chemical treatments. Or, if the lawn is generally unthrifty, treatment at lower levels (10-15/sq. ft.) may be necessary.

Slugs:

Symptoms and Identification:
Slugs and snails feed on many different types of plants. However, they prefer succulent foliage near the ground so seedlings, bulbs, herbaceous plants, and low-growing vegetation are more commonly attacked. Evidence of slugs and snails includes dried silvery trails on and around plants, and chewed plants. Slugs and snails are most active during the mild, damp periods of night and early morning. They hibernate in topsoil during cold weather.

Control Methods:

Cultural Controls:
Prevent slugs and snails by reducing daytime hiding places such as debris, loose boards, stones, weedy areas around plants, and leafy branches growing near the ground. Because they are attracted to moist, humid conditions, water and irrigate early in the day so surfaces can dry by nightfall.. Controls include hand-picking (drop in soapy water; hunt at night for best results), destroying pearl-like egg clusters, or creating slug traps from cans or containers filled with fresh beer or yeast and water Slug barriers include salt, wood ashes, egg shells, or diatomaceous earth. Recent research suggest that the most effective barrier is sheet cooper barriers (several inches high) used as a fence around beds or vulnerable plants.

Biological Controls:
Natural enemies include ground beetles (found in compost), pathogens, snakes and birds. Help improve their contribution to controlling slugs and snails by avoiding the use of broad-spectrum pesticides.

Chemical controls:
If commercial pesticide baits must be used, be careful to use covered containers or make covered containers out of plastic yogurt or margarine tubs; most are toxic to pets. Baits provide only temporary control, integrated biological and cultural controls work best for long-term control.

Root weevils on Rhododendrons:

Symptoms and Identification:
Root weevils are the most important pests of rhododendrons and azaleas in the Pacific Northwest. Of the dozen kinds of weevils attacking these plants, three kinds are the most important; the obscure root weevil *Sciopithes obscures,* the black vine weevil *Otiorhynchus sulcatus*, and the woods weevil *Nemocestes incomptus.* The obscure root weevil is about 1/4 inch long, brown with a wavy brown line across the back near the rear. The black root weevil is about 2/5 inch long, black or brownish black, often with small flecks of yellow or white. The woods root weevil 1/4 inch long and is light to dark brown with gray spots on its back.

The larvae of all species of root weevils look alike; they are legless, white grubs with brown heads. The pupa is about the same size and appearance as the adult but is soft and white/translucent.

Weevils feed on leaves, initially creating notches in leaf margins, but eventually they may eat all but the petiole. Heavily infested plants are may be badly defoliated by the fall. New leaves and shoots are a favorite target. The larvae also consume the roots of plants and may girdle plants at the soil line which may cause the plant to die. However, this is usually only a serious problem in potted nursery stock or very sandy soil.

Control Methods:

Cultural Controls:
Mechanical controls include using bands of sticky material such as Tanglefoot, Stik-Em, or Tack Trap, at the base of the trunks of shrubs. Weevils feed at night, generally moving up the trunk to get access to the foliage. They will not cross the sticky materials or will get trapped in them. There are some indication that prolonged use of this material may damage bark. Use a strip of polyethylene (Visqueen) snugly fit around the trunk to use under the sticky material to help avoid damage.

Genetic Controls:
Some species and hybrids are less susceptible to adult root weevil feeding. The resistant species are generally more less susceptible than the hybrids. Dark red flowering hybrid and species rhododendrons are the least resistant.

Biological Controls:
Predators include birds and beneficial nematodes. The beneficial nematode *Neoplectana carpocapsae* is available to control immature root weevils. Other beneficial nematodes such as BioSafe, can be purchased and released around the soil around planting time.

Chemical Controls:
Least-toxic insecticides such as the botanical insecticides neem and pyrethrum may be used to kill weevils. Remember, they are also toxic to beneficial insects, birds and mammals; use with care.

Tent caterpillars:

There are two types of tent caterpillars in the Northwest, the Forest Tent Caterpillar *Melacoscoma disstria*, and the Western Tent Caterpillar *Malacosoma californica*. The Forest Tent Caterpillar is blue with black spatters and white, footprint-shaped markings. It spins a silken mat on tree branches or trunks rather than forming a true tent. The Western Tent Caterpillar is more frequently seen in Western Washington.

Symptoms and Identification:
Western Tent Caterpillars are orange-brown with blue dots on their backs and sides. As they grow, they spin webby tents on branches. They leave the tents to feed on leaves. They grow to a length of about 2 inches. In June, the caterpillars leave the branches to find protected places where they pupate. About ten days after pupation, moths emerge from the cocoons. The adult moth has beige to brown wings spanning about 1-1/4 inches. The females fly to tree branches where they lay bands of eggs around branches and twigs. For protection they cover them with a shiny, hard substance in which they overwinter. In early spring, the eggs hatch into tiny caterpillars and the cycle continues.

Damage is most often aesthetic in nature, due to the defoliated leaves and unsightly tents. Even if completely defoliated, a tree rarely dies. It is a judgment call when determining the nuisance level of the caterpillars. Since they are a native insect, they will be controlled by natural forces in the long-run. It is not necessary to remove all tents. However, it the trees is valuable and damage is severe and there are numerous tents, remove as many as possible.

Control Methods:

Cultural Controls:
Crush or prune egg masses from branches during fall and winter. Remove tents by hand or remove them by pruning.

Biological Controls:
Since it is native, the Western Tent Caterpillars has many natural enemies. The trachinid fly is a parasitizes the caterpillars, laying eggs on its body. Tent caterpillars are also subject to a virus disease called wilt, as well as many other lesser parasites and diseases. These natural controls eventually reduce populations, however, it may take several years and some plants may suffer severe damage is populations remain high. Outbreaks usually persist for 1 to 4 years until they are brought under control by disease, parasites, scarcity of food, weather or combinations of these conditions.

If pruning out the tents does not reduce populations below an acceptable level, use the parasitic bacterium *Bacillus thuringinesis* (Bt) to control caterpillars. Be sure to apply when the caterpillars are present (spring); it does not work at any other time. Bt acts as a stomach poison after it is eaten by the caterpillar (cover foliage completely to assure it is eaten). It has no effect on organisms other than caterpillars. However, it is toxic to all caterpillars, even non-pest caterpillars that are attractive butterflies in their adult stage. Therefore, be careful to spray Bt only on affected plants to reduce its impact on other types of caterpillars.

Chemical Controls:
Although there are several types of chemicals used to control tent caterpillars, other control measures are so effective that chemicals should not be used.

Chemicals used to control tent caterpillars all are also highly toxic to tent caterpillars' natural enemies and their use can actually increase pest populations in future years. Two common insecticides, carbaryl and diazinon, are highly toxic to bees and birds. Residual sprays carried back to bee hives can kill all occupants. Diazinon is extremely toxic to birds and has been implicated in several large kills of migrating birds on golf courses.

Beneficial insects:
There are numerous beneficial insects that can help control pests. Common ones include syrphids, flies, lady beetles, parasitic wasps, lacewings, spiders, and predacious ground beetles. Use of beneficial insects as part of integrated pest management strategies is growing and these insects are now available from commercial mail order suppliers and many local garden centers. When and how these insects are released determines their potential success; be sure to follow recommendations.

Syrphid flies or hover flies resemble small wasps. The larvae is the predator, feeding on aphids, leafhoppers, thrips, and several other soft-bodied pests.

The larval stage of flies, such as the tachinid fly, parasitize and kill caterpillars by laying their eggs in them.

The larvae and adult stages of lady beetles or ladybugs, feed on aphids, mealybugs, small worms, spider mites, and similar soft-bodied insects. Releasing them has mixed results because they commonly fly away, but their are methods to encourage them to stay (release at night, place them gently at the base of plants or on leaves, spray with sugar water, etc.).

Parasitic wasps are non-stinging wasps that lay their eggs in the egg, larval, or adult forms of many pests. The tiny trichogramma wasp parasitize aphids, armyworms, loopers, fall webworms, leaf rollers, mealybugs, scale insects, whiteflies, and various beetle larvae.

Lacewing larvae feed on small caterpillars, aphids, scale, moth eggs, and mealybugs. They use a sickle-like mandible to capture their prey. One lacewing larvae can consume up to 750 aphids during its development.

Predacious ground beetles feed in their larval and adult stages on cutworms, maggots, and sometimes snails and slugs. They feed at night.

References for Insect and Insect-related Pest Section:
See Plant Disease References

PLANT DISEASES:

Introduction:
Plant diseases include fungi, bacteria, viruses, mycoplasmas and nematodes. Nematodes (microscopic worms) are sometimes included in plant disease discussions because some are disease-causing agents that invade plants. Plant diseases can be transported a variety of ways including wind, rain, animals (humans too), and insects. All plants are susceptible to plant diseases which can cause a variety of problems including poor and distorted growth, disrupted plant processes, and even death. Most disease damage is caused by pathogens that are endemic or have been present in the area for an extended period. For example, leaf spots and blights, mildews, rusts, and vascular wilt.

As with pests, the health and vigor of plants affects their susceptibility and how seriously they are affected. "Healthy plants are likely to become diseased if: the disease organisms are aggressive; the plants constitute susceptible hosts; and climate and soil conditions are favorable for disease development. Although a few of the pathogens that cause stem cankers, dieback, decline, and some root rots aggressively attack healthy plants, many attack only plants that are weakened or low in vigor. Reductions in plant vigor usually arise from exposure to stress: drought, poor soil aeration, freezing or extreme temperature fluctuation, defoliation, nutrient deficiency, chemical injury, mechanical damage, or transplant shock."[11]

Types of Diseases:

Fungi:
Fungi are filamentous plants that lack chlorophyll and are widely found on plants, in soil and in the air. While most are beneficial and essential in breaking down dead organic matter; some are the most common cause of infectious plant disease. The microscopic filaments (hypae) may be difficult to detect with the naked eye, but some of their fruiting bodies such as conks, mold, mushrooms, and mildews, are highly visible. The fungi usually live within the tissue of leaves, stems, and roots of the host plant; entering by natural openings or wounds. The fruiting bodies produce millions of spores which germinate in warm and moist conditions, thereby continuing the life cycle. Common fungi include Armillaria root rot, Dutch elm disease, and leaf diseases such as spot, blotch, anthracnose, powdery mildew, blister, and rust.

Bacteria:
Bacteria are single-celled (usually), microscopic organisms that lack chlorophyll and therefore live as parasites on living plants or as saprophytes on dead organic matter. Most bacteria are beneficial, but some cause diseases and can be harder to control than fungal diseases. Bacteria enter plants through natural openings (stomata, lenticels, flower glands, terminal openings of leaf veins) or wounds. They kill or cause cells to grow abnormally,

[11] Harris, Richard W. Arboriculture: Care of Trees, Shrubs, and Vines in the Landscape, Prentice-Hall, Inc.: Englewood Cliffs, New Jersey, 1983, pg. 566.

and break down tissue. Some plant bacteria are spread by pruning and grafting tools, transporting diseased planting stock, insects, rain and dust.

Viruses:
Viruses are submicroscopic complex molecules that interfere with some normal plant functions. They are transmitted to other plants by sucking insects, typically aphids and leaf hoppers; grafting or budding infected scions onto healthy rootstock; and possibly pruning tools. Viruses can only reproduce within living tissue. Viruses can weaken plants but rarely kill them, although infected plants are more susceptible to fungal and bacterial diseases and to physiological stress. The best protection against viral diseases is to select virus-free plants. Some government and nursery procedures have been established to propagate plants free of the more serious viruses.

Mycoplasmas:
Mycoplasmas are similar to bacteria but have a plasma membrane instead of a cell wall. They are also similar to bacteria in that they multiply in living cells by division. They move within the phloem of the plant so can move throughout the plant. Leafhoppers are a common mycoplasma vector. The mycoplasma incubates in the insect for ten days and can then be spread by the insect to other plants. Once infected, the insect can carry and transmit the disease for the rest of its life.

Descriptions and treatment overviews for diseases previously recorded at Ft. Lewis or common to the Pacific Northwest:

Dutch Elm Disease[12]:

The fungus *Ophiostoma ulmi* (formally *Ceratocystis ulmi*), commonly known as Dutch Elm Disease (DED), was first discovered in Europe in 1918 and appeared in the United States in the 1930s. It arrived in the Pacific Northwest in 1968 and was reported in Tacoma and Bellvue, WA. in 1994. The fungus grows throughout the vascular system of the tree. It spreads upward and downward by means of passive transport of spores in liquid within xylem vessels and grows as hypae between vessels after spores germinate at points of initial contact.

The disease is spread by elm bark beetles and root grafts. In the Pacific Northwest, the fungus is carried by the European elm bark beetle *Scolytus multistriatus*, a small (3 mm), shiny, reddish brown or black beetle. Bark beetles breed in diseased trees and feed on healthy trees. They feed primarily on two to four year old twig crotches of living elms. The fungus produces spores in the galleries that beetles bore under the bark. The beetles carry these spores to healthy trees when they are feeding. After feeding, adult beetles find

[12] Koepsell, Paul A., and Jay W. Pscheidt (editors), 1995 Plant Disease Control Handbook, Agricultural Communications, Oregon State University, Corvallis, OR. 1995, pg. 102-103.
Van Pelt, Cathy, City of Tacoma Urban Forester, personal communication 24 January 1996.
Waggoner, Laura, Portland Parks and Recreation, Urban Forestry Division, Dutch Elm Disease Program-slide show script, 1996 and personal communication, January 1996.

breeding sites under the bark of dead or weakened trees or logs, boring through the bark into the cambium where they lay eggs. Depending on the season, the larvae overwinter under the bark, completing their growth cycle in spring when the larvae pupate and change into adults; then seeking out healthy trees for feeding. Beetles are active from March to October. In the mild climate of the Pacific Northwest, three to four generations can be produced per year. The use of dead wood for bark beetle breeding sites makes sanitation (elimination of breeding grounds) a critical link in preventing the spread of the disease.

The disease also spreads through roots when roots of nearby trees (within 40 feet) cross and naturally form root grafts. The fungus, carried in the vascular system of a diseased tree, can spread to adjacent trees through these root grafts.

Symptoms and Identification:
Symptoms can be detected as soon as a few days after infection, beginning with wilting leaves and sparse foliage, followed by yellowing or browning, and premature defoliation. It first appears on single limbs but later can affect the entire tree. Another symptom of infection is brown streaking under the bark, especially in the current season's growth; this shows as a continuous brown ring in cross section. Those monitoring for the disease may observe a progression from a yellowing or browning of leaves at the base of the canopy, to full yellowing of a side of a tree, to complete browning of the tree, to death. The disease spreads at different rates depending on the season and where the infection originates in the tree. Infected trees can die within a few weeks or live for several years.

Positive identification only occurs through isolating and culturing the fungus. Suspicious samples should be collected and sent to a diagnostic laboratory such as the Oregon Department of Agriculture Plant Division or The Plant Clinic (Cordley Hall 1089, Oregon State Univ., Corvallis, OR 97331-2903). The sample (twigs, branches, or wood) should be 6 inches long and be alive. Decayed or badly rotted bark or wood, and dead twigs cannot be used for identification.

DED Control:
Cultural and chemical methods are used to control both the fungus and the elm bark beetle. Developing a comprehensive program can control Dutch Elm Disease. These programs have proved to be less costly than removal and replanting costs.[13]

Cultural Control:
1. The most effective control programs depend on prompt detection. This requires that all elm trees be mapped and monitored routinely during the active period of the bark beetle, which depending on the weather, begins in March, April or May and lasts through October.

[13] An innovative DED/forestry program in suburban Chicago cost an average of $20 per tree versus an average of $800 per tree for removal and replanting. See "Urban Forests," Feb./March 1994, p. 7. In 1995-6, removing a large tree and grinding the stump in the City of Tacoma cost an average of $1400 per tree-Personal communication, January 29, 1996. And, Harris (1983) pg. 625.

To date, only elms inside the Historic District have been mapped; all elms in Ft. Lewis must be included in the DED program to be effective. Until the disease arrives at Ft. Lewis, monitor once every two weeks. If it is detected, increase the monitoring to once a week.[14]

Most diseased trees are removed once the infection is detected. However, "eradicative pruning" techniques and fungicides can sometimes be used to control the infection depending on timing of the pruning, and the severity, location, and stage of infection. A licensed arborist should determine the best approach to be used for trees at Ft. Lewis based on their individual health and the overall health of the population.

2. Removing the breeding ground of the bark beetle-logs with bark intact- is also critical in controlling the disease. Remove all dead wood and branches and chip, burn (if allowed), or bury it. Do not save the wood for firewood unless the bark is removed. Some studies show pruning tools can carry the disease; always sterilize equipment when pruning elm trees.

3. Protect adjacent trees by severing root grafts with mechanical trenches. This is particularly important for trees planted within 40 feet of each other. Chance of spreading the disease through root grafts at Ft. Lewis may be reduced since most of the elms are 50-75 feet apart.

4. Maintaining healthy trees helps reduce an elms susceptibility to bark beetles. Reduce stress by deep-watering during droughts; regular pruning schedules to remove dead wood, and limit breaking and tearing branches; and protecting from soil compaction and lawn mower damage (mulching). Do not prune elms between March and October, with the possible exception of eradicative pruning; beetles can enter through pruning cuts.

Chemical Control:
Consult current guides such as the PNW Plant Disease Control Handbook for up-to-date chemicals and application procedures.

1. Fungicides injected in the tree can be used to increase resistance to DED. They are also used to treat infected trees (in combination with eradicative pruning) when less than 10% of the tree canopy has been infected. Preventive treatments are more effective than therapeutic treatments. To date, Arbortect 20-S and Alamo are two commonly used fungicides.

2. Fumigants administered into drill holes in the ground can be used to severe root grafts.

3. Chemicals (insecticides) are also sometimes used to control the elm bark beetle; spraying the canopy for adults and the base for over-wintering beetles.

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[14] According to Laura Waggoner of the Portland DED Program, trained staff can monitor about one hundred trees per hour. For large trees, use binoculars to look for flagging (wilting) and yellowing high in the crown. Personal communication, January 1996.

Prior to inoculating elm trees at Ft. Lewis, or spraying for the bark beetle, have a licensed arborist assess the health of the trees. These treatments can be stressful to trees; possibly compromising their health rather than aiding in their protection.

Hawthorn leaf spot (blight):

Hawthorn leaf spot-*Diplocarpon mespili (*or *Entomosporium mespili)*-a fungus, has primarily affected the pink (English) hawthorns (*Crateagus oxacantha or laevigata)* at Ft. Lewis. The common hawthorn (*Crateagus monogyna)* appeared to be little affected.

Symptoms and Identification:
The fungus appears as small, reddish-brown spots on the upper surface of leaves. The spots darken and enlarge as leaves mature. Spore-forming bodies eventually appear in the center of the spots. The fungus overwinters mainly as spores on fallen leaves or as mycelia within tissue. The disease favors cool, wet weather and spots can be numerous after a wet spring. When spots are severe, defoliation often occurs.

Control Methods:

Cultural Controls:
Rake up, remove and destroy leaves in the fall. Thin crowns to increase air flow and drying and do not allow sprinklers to water over crowns. Mulch beneath trees. Increase the vigor of trees (especially watering during summer droughts) to lessen damage.

Genetic Controls:
Use blight resistant varieties such as *Crateagus laevigata 'Crimson Cloud'*.

Chemical Controls:
Use fungicides as a last resort after other methods have been attempted. Begin application at bud break and repeat at 10-14 day intervals until dry weather occurs. The 1995 PNW Plant Disease Control Handbook lists Fore, Daconil and Cleary's as controls. See current edition for application rates.

Dogwood anthracnose:

According to the 1990 Hazard Tree Survey, although there is only a small population of dogwoods in the Historic District, all had some level of dogwood anthracnose caused by the fungus *Discula destructiva (Gloeosporium spp.*). During the past 15 years, the Pacific Northwest native dogwood, *Cornus nuttalli* (Pacific dogwood), has been hit hard by the disease.

Symptoms and Identification:

The most common symptoms of the fungus are brown blotches on the leaves, or occasionally instead of blotches, brown spots with dark brown to purple leaf margins. Twigs are also affected. They have sunken tan to brown spots with purple borders which eventually enlarge and cause twig dieback and defoliation. In severe cases, trees can die.

Controls:
Cultural controls
Cultural controls consists of pruning and destroying infected twigs when possible; raking and destroying fallen leaves during the growing season and in fall. Do not let irrigation wet the tree canopy. Attempt cultural controls before resorting to chemicals.

Genetic Controls:
Cornus kousa, the kousa dogwood is less susceptible to the disease than flowering dogwood (*Cornus florida)*, and the Pacific dogwood. In addition, growers have recently developed a number of hybrids between flowering dogwood and kousa which are supposed to combine the best traits of each species. Consider using disease resistant species when replacing historic flowering dogwoods.

Chemical Controls:
Rodale's Landscape Problem Solver (1989. pg. 18) recommends the above cultural controls and spraying the diseased tree once with a copper fungicide, such as Bordeaux mixture.

As a last resort, other chemicals controls consists of spraying beginning at bud break and continuing at 10 to 14-day intervals until dry weather. Applications during the remainder of the growing season may be needed if periods of wet weather occur and there are infected leaves or twigs on the tree. Chemicals listed in the 1995 PNW Plant Disease Control Handbook include: Fore, Microcop, Zyban, Daconil, Banner and Cleary's. Consult current edition for application rates.

Fireblight:

Symptoms and Identification:
Fireblight, *Erwinia amylovora,* is a bacterial disease that affects the pome members of the rose family (*Prunus sp.*) such as apple, evergreen pear, hawthorn, pear, and pyracantha. Symptoms include sudden wilting, shriveling and blackening or browning of shoots, blossoms, and fruit. With rapid infections, dead leaves remain attached to twigs and create a scorched appearance, which is where the disease gets its name. Diagnose fireblight by peeling back bark from cankers (which form on twigs and branches), and newly infected twigs and branches. The wood turns reddish-brown when newly infected and once it dies, turns black.

Fireblight infects new growth in the spring through the flowers. The bacteria oozes brownish droplets from around cankers during warm, wet, or humid weather and is spread to flowers by insects. Bees and splashing water may then carry the bacteria from infected

flowers to uninfected flowers. The infection spreads from the flower through twigs and terminal branches. It overwinters in plant tissue around cracked, sunken cankers that form in the bark.

Control Methods:

Cultural Controls:
Prune diseased branches at least 6 inches into healthy appearing tissue. Remove and destroy all infected tissue. Sterilize pruning equipment to avoid spreading bacteria.

Genetic Controls:
Disease resistant varieties are available. Or the Washington thorn, *Crateagus phaenopyrum*, is one of the least susceptible hawthorns species to fireblight and is a preferred street and lawn tree.

Chemical Controls:
Apply a weak mixture (about 1/2 percent) Bordeaux mixture during the dormant season for holdover cankers. Apply copper fungicide several times as blossoms open to reduce infections.

Powdery mildew:[15]

Powdery mildew refers to several different kinds of fungus diseases which infect an assortment of plant. For example, roses, grapes, lawn grasses, lilacs, azaleas, fruit trees, annual and perennial flowers, and rhododendrons. "Mildew infected plants typically have a grayish-white powdery coating over affected leaves and shoots. Leaves infected with mildew are usually distorted, curled or twisted and may be stunted or smaller than normal. Severely infected foliage may become chlorotic or yellowish, turn brown and prematurely fall from the plant. Badly infected new shoots may also die (KC 161, pg. 1)."

The powder coating is the body of the fungus, the mycelial strands, as well as the organism's spores. The fungus overwinters in a variety of ways, depending on which powdery mildew organism is involved. Powdery mildews that attack evergreen shrubs and roses often spend the winter in buds or green leaves that remain on the shrub. Some produce black fruiting bodies that survive the winter on dead leaves or twigs that fall or hang on the plant.

High relative humidity and light coatings of dew formed when cool nights follow warm days encourage the fungus. These conditions are common in late summer and early fall and powdery mildew is prevalent during this time. Contrary to popular belief, steady rain does not increase the fungus, rather it tends to wash mildew spores off the plant before they can penetrate the tissue.

[15] Cooperative Extension, Washington State University, "KC 161: Powdery Mildew on Rhododendrons," Pullman, WA., by George Pinyuh, 1993.

Control Methods:

Cultural Controls:
Space plants well for good circulation. Clean up and destroy all fallen leaves and prune out dead branches and twigs. Remove infected leaves if practical. Water in the morning so foliage has a chance to dry out before nighttime.

Chemical Controls:
Use wettable sulfur as directed. Apply as new growth expands in the spring; several applications may be necessary up until the new growth hardens off.

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Cooperative Extension, Washington State University, "The Gardener", Winter 1995-96, pg. 1-2.

CIRCULATION FEATURES

Pavement Maintenance:

Cleaning Concrete Roads, parking lots, and driveways:
All roads and parking lots in the Historic District should be cleaned regularly to remove soil and debris from curb areas to prevent silting of storm drains. Cleaning soil and debris will also reduce the incidence of weeds growing between expansion joints. In general, use street sweepers (cleaners) to remove soil, debris, and weeds. Or use water blasting equipment in moderation; do not spray too long or at too high a pressure to avoid washing away fines. Or refer to Appendix G: Army Corps of Engineers Guide Specification for Military Construction: Section 03307-Restoration of Concrete in Historic Structures.

Cleaning concrete sidewalks and steps:
Use water blasting equipment to clean sidewalks and steps. Use equipment in moderation. Spray the amount of time and at a high enough pressure to remove dirt and moss but avoid washing away fines. Or refer to Appendix G: Section 03307-Restoration of Concrete in Historic Structures.

Do not use cleaning solutions that will harm tree roots when sidewalks are adjacent to street trees or lawn trees and shrubs.

Pavement Repairs and Replacement:

Sidewalks and Steps:
According to the Army Family Housing Planning Guide: Whole-Neighborhood Revitalization Program (1993), sidewalks and steps should be inspected for pitting, spalling, or scaling of the surface concrete; and for cracks and differential settling and vertical displacement across cracks. Minor repairs include caulking and patching joints and cracks. They may be used when the concrete surface shows no sign of deterioration, and two or three concrete squares are cracked but cracks are less than 1/4-inch-wide or are accompanied by a vertical displacement of less that 3/16-inch. Major repairs, which constitute removal and replacement of the damaged sidewalk, are necessary when the concrete surface is deteriorated and crumbling or one-third or more of the concrete squares have significant cracks (1/4-inch wide or accompanied by a vertical displacement of more that 3/16-inch). Due to the potential damage to tree roots caused during sidewalk replacement, change minor repair criteria to vertical displacements that are less than 1/2-inch when sidewalks are repaired within the critical root zone of street trees. This addresses safety concerns as well as lessens the potential for damage to trees.

Roads, driveways, and parking lots:
According to the Army Family Housing Planning Guide: Whole-Neighborhood Revitalization Program (1993), inspect roads, driveways and parking for pitting, spalling, scaling, cracks, differential settling, and buckling. Hairline cracks are normal and

acceptable. Cracks exceeding 1/4 inch in width and 1\4 inch in vertical displacement, loose aggregates, or pieces of concrete are not acceptable and should be repaired.

Repair and replacement guidelines:
No completion reports recording the original design of pavement materials has been located to date. However, the existing aggregate-textured pattern of sidewalks, and steps appears to be due an original exposed-aggregate design, not just exposure of aggregates by the erosion of fines. In either case, compatible matching of patch material and pavement replacements to existing concrete is critical for both appearance and durability. For example, matching as closely as possible, coefficient of thermal expansion, strength, color, and texture (aggregate size and texture (fractured or natural). See Appendix G: Section 03307-Restoration of Concrete in Historic Structures, for detailed information.

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United States Army, Engineering and Housing Support Center, Army Family Housing Planning Guide: Whole-Neighborhood Revitalization Program, TN 210-50-01, Fort Belvoir, VA., May 1993., pg. 77-80.

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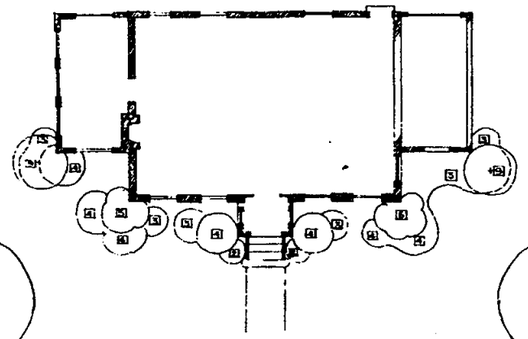
APPENDICES

APPENDIX A: U.S. ARMY STANDARD PLANS

ILLUSTRATION OF TYPE	SCIENTIFIC NAME	COMMON NAME	TYPE NO.
	JUNIPERUS HORIZONTALIS GLAUCA	BLUE RUG JUNIPER	
	" SABINA TAMARISCIFOLIA	TAMARIX SAVIN "	
	" SQUAMATA		
	TAXUS CUSPIDATA NANA	DWARF JAPANESE YEW	
	" REPANDENS	SPREADING ENGLISH YEW	
	COTONEASTER HORIZONTALIS	ROCK COTONEASTER	1
	" MICANA	DWARF LANTANA	
	PINUS MONTANA MUGHO	MUGHO PINE	
	COTONEASTER HORIZONTALIS	ROCK COTONEASTER	
	BERBERIS VERRUCULOSA	WARTY BARBERRY	
	VACCINIUM OXYCOCCUS MACROCARPUM	DWARF CRANBERRYBUSH	
	LONICERA PILEATA	PRIVET HONEYSUCKLE	
	YUCCA FILAMENTOSA	COMMON YUCCA	2
	BUXUS SUFFRUTICOSA	ENGLISH OR TRUE DWARF BOXWOOD	
	AZALEA AMOENA VAR VARIETY	JAPANESE AZALEAS	
	JUNIPERUS PFITZERIANA	PFITZER'S JUNIPER	
	JASMINUM NUDIFLORUM	WINTER JASMINE	3
	BUXUS SUFFRUTICOSA	ENGLISH OR TRUE DWARF BOXWOOD	
	TAXUS CUSPIDATA	JAPANESE YEW	
	BERBERIS THUNBERGII	" BARBERRY	
	" JULIANAE	WINTERGREEN "	
	PHILADELPHUS CORONARIUS	MOCKORANGE SWEET SYRINGA	
	ILEX GLABRA (INKBERRY)	INKBERRY	
	LONICERA NITIDA	SHINING HONEYSUCKLE	
	PITTOSPORUM TOBIRA	TOBIRA	4
	FORSYTHIA COR. LALANDI	LALAND FIRETHORN	
	ILEX CRENATA & MICROPHYLLA	JAPANESE HOLLY & SMALL LEAF VARIETY	
	TAXUS CUSPIDATA CAPITATA	UPRIGHT JAPANESE YEW	
	CAMELLIA JAPONICA	COMMON CAMELLIA	
	THUJA OCC. WARREANA	SUNSHINE ARBORVITAE	5
	LAGERSTROEMIA INDICA-IN VAR.	CRAPE MYRTLE	
	CHIONANTHUS VIRGINICUS	COMMON AMERICAN BOXWOOD	
	RHODODENDRONS-IN VARIETY	RHODODENDRON-(USE IN PARTIAL SHADE)	
	LIGUSTRUM LUCIDUM & JAPONICA	GLOSSY & JAPANESE PRIVET	
	SYRINGA-IN VARIETY	LILACS	
	VIBURNUM-IN VARIETY	VIBURNUMS	
	LAURUCERASUS-IN VARIETY	ENGLISH, CHERRY & CAROLINA CHERRYLAUREL	
	VACCINIUM CORYMBOSUM	HIGHBUSH BLUEBERRY	
	EVONYMUS JAPONICUS	EVERGREEN BURNINGBUSH	
	PHOTINIA SERRULATA	EVERGREEN LOW PHOTINIA	
	PITTOSPORUM EUGENIOIDES	TARATA	6
	PHORMIUM TENAX	NEW ZEALAND FLAX	
	CORTADERIA ARGENTEA	PAMPAS GRASS	7
	SORBUS AUCUPARIA	EUROPEAN MOUNTAIN ASH	
	CRATAEGUS CORDATA	WASHINGTON HAWTHORNE	
	EUONYMUS EUROPAEUS	EUROPEAN BURNINGBUSH	
	" BIGNONIOIDES	WINTERBERRY EUONYMUS	8
	CORNUS FLORIDA	FLOWERING DOGWOOD	
	CERCIS CANADENSIS	AMERICAN REDBUD	
	CRATAEGUS CORDATA	WASHINGTON HAWTHORNE	
	" CRUS-GALLI	ENGLISH "	
	CHIONANTHUS VIRGINICA	WHITE FRINGE	
	MALUS CORONARIA ETC.	WILD SWEET CRAB ETC.	9
	TAXUS BACCATA HIBERNICA	IRISH YEW	
	JUNIPERUS "	" JUNIPER	
	" SUECICA	SWEDISH "	
	" EXCELSA	GREEK "	10
	JUNIPERUS VIRGINIANA	REDCEDAR	
	" " CANNARTI	CANNART REDCEDAR	
	" " GLAUCA	SILVER "	
	THUJA OCC. PYRAMIDALIS	APEX PYRAMIDAL ARBORVITAE	
	CHAMAECYPARIS LAWSONIANA	LAWSON CYPRESS	
	CUPRESS MACROCARPA	MONTEREY " (WEST)	
	" SEMPERVIRENS	ITALIAN "	
	EUGENIA MYRTIFOLIA	AUSTRALIAN BRUSH-CHERRY	
	POPULUS ITALICA	LOMBARDY POPLAR	
	" ROLLANDI & NIGRA	ROLLANDI & NIGRA "	11
	ILEX OPACA	AMERICAN HOLLY	
	" AQUIFOLIUM	ENGLISH "	
	OSMANTHUS AQUIFOLIUM	HOLLY OSMANTHUS	12
	TSUGA CANADENSIS	CANADIAN HEMLOCK	
	ABIES-IN VARIETY	WHITE, FRAZER, NORDMANN & DOUGLAS FIR	
	PICEA- " "	WHITE, NORWAY, ORIENTAL, COLORADO SPRUCE	
	PINUS STROBUS	WHITE PINE	
	" NIGRA	AUSTRIAN "	
	" RESINOSA	RED "	
	" SYLVESTRIS	SCOTCH "	
	CEDRUS ATLANTICA	ATLAS CEDAR	
	" DEODARA	DEODAR "	
	TAXODIUM DISTICHUM	COMMON BALDCYPRESS	
	LARIX LARICINA	AMERICAN LARCH	13
	COCOS PLUMOSA	QUEEN PALM	
	WASHINGTONIA FILIFERA	CALIFORNIA FAN PALM	
	" GRACILIS	MEXICAN "	14
	ULMUS AMERICANA	AMERICAN ELM	
	PLATANUS OCCIDENTALIS	PLANE OR SYCAMORE	
	LIRIODENDRON TULIPIFERA	TULIP TREE	
	GYMNOCLADUS DIOICA	KENTUCKY COFFEE TREE	
	QUERCUS ALBA	WHITE OAK	
	" RUBRA	RED "	
	" MACROCARPA	MOSSYCUP OAK	
	ACER RUBRUM	RED SWAMP MAPLE	
	GLEDITSIA TRIACANTHOS	COMMON HONEYLOCUST	
	ROBINIA PSEUDOACACIA	LOCUST	
	MAGNOLIA GRANDIFLORA	SOUTHERN MAGNOLIA	15

PLANT TYPES & EXAMPLES

NOTE: THE PLANTS LISTED ABOVE REPRESENT THE RESPECTIVE ILLUSTRATIONS IN GENERAL. MANY ADDITIONAL VARIETIES ARE AVAILABLE AND THE MOST APPROPRIATE SHOULD BE SELECTED IN EACH LOCALITY.



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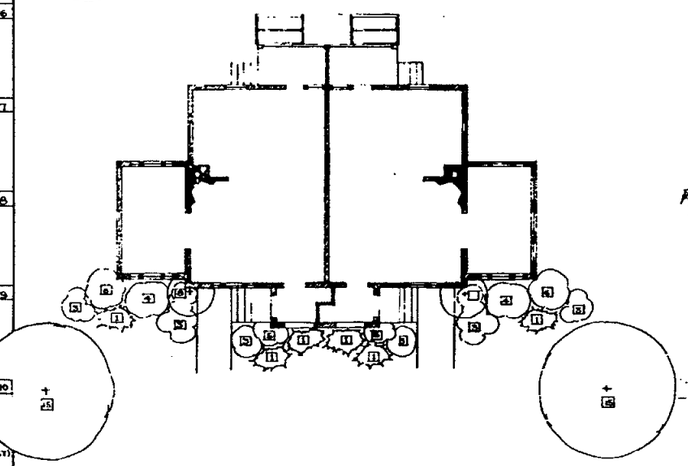

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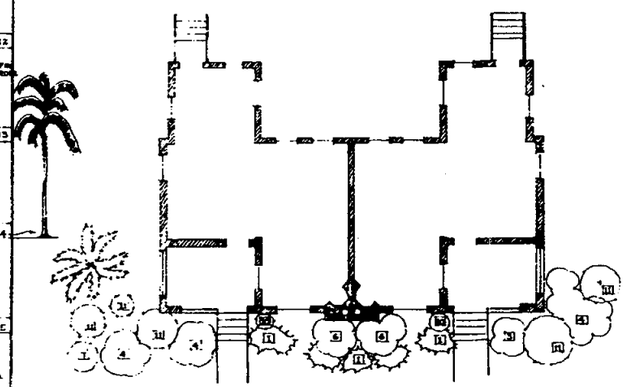
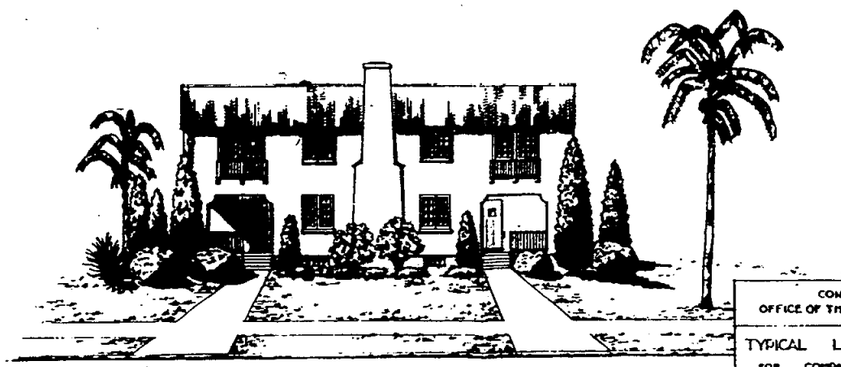




DOUBLE N.C.O. QUARTERS

SCALE 1/8" = 1'-0"

CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL

TYPICAL LANDSCAPE PLANTING

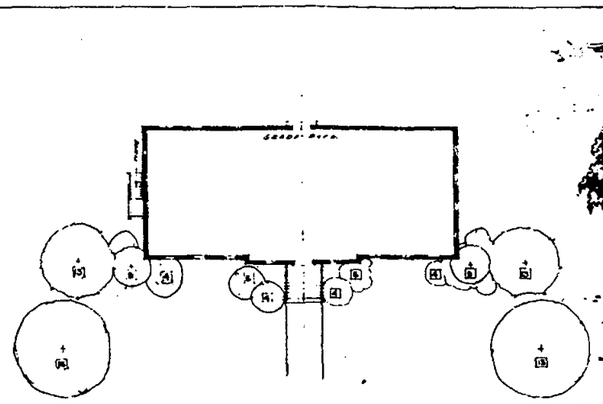
FOR COMPANY OFFICERS' QUARTERS AND DOUBLE N.C.O. QUARTERS

DRAWN BY	CHECKED BY	APPROVED AND RECOMMENDED FOR APPROVAL	DATE
E.C. LANDING		CHIEF, ENGINEERING BRANCH	DRAWING NO. 630-100

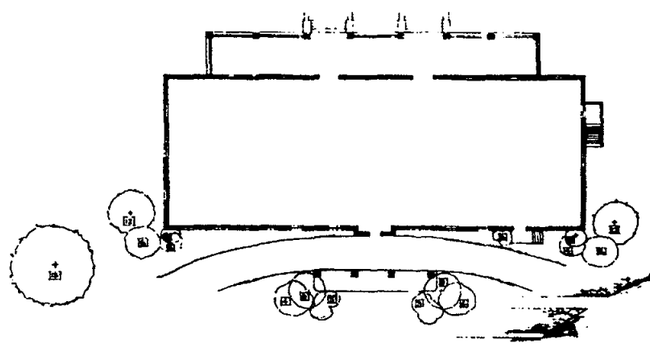
Illustration of Type	Scientific Name	Common Name	Type No.
	JUNIPERUS HORIZONTALIS DOUGLASI " SABINA TAMARISCIFOLIA EUONYMUS TAXUS CUSPIDATA NANA " " LEWISONII COTONEASTER HORIZONTALIS VARIEGATA	CANADIAN JUNIPER TAMARIX SAVIN " DWARF JAPANESE YEW SPREADING ENGLISH YEW ROCK COTONEASTER DWARF VARIEGATA	1
	PINUS MONTANA MUGHO COTONEASTER HORIZONTALIS BERBERIS VERUCULOSA VIBURNUM OPULUS NANUM LONICERA PILEATA YUCCA FILAMENTOSA	MUGHO PINE ROCK COTONEASTER WARTY BARBERRY DWARF CRANBERRYBUSH PRIVET HONEYSUCKLE COMMON YUCCA	2
	BUXUS SUFFRUTICOSA AZALEA JAPONICA VAR VARIETY JUNIPERUS PFITZERIANA TAXODIUM MUCRONATUM	ENGLISH OR TRUEDWARF BOXWOOD JAPANESE AZALEA PFITZER'S JUNIPER MONTEZUMA BALDCYPRESS	3
	BUXUS SUFFRUTICOSA TAXUS CUSPIDATA BERBERIS THUNBERGI " JULIANAE MYRICA CAROLINENSIS ILEX GLABRA (IN PART) LONICERA NITIDA PITTOSPORUM TOBIRA	ENGLISH OR TRUEDWARF BOXWOOD JAPANESE YEW BARBERRY WINTERGREEN " NORTHERN BAYBERRY INKBERRY CHINESE HONEYSUCKLE TOBIRA	4
	PYRACANTHA COCC. LELAND: ILEX CRENATA & HYPERPHYLLA TAXUS CUSPIDATA CAPITATA CAMELLIA JAPONICA THUJA OCC. WARREANA	LELAND FIRETHORN JAPANESE HOLLY & SMALL LEAF VARIETY "BROWN" JAPANESE YEW COMMON CAMELLIA SIBERIAN ARBORVITAE	5
	LAGERSTROEMIA INDICA IN VAR. BUXUS SEMPERVIRENS RHODODENDRON IN VARIETY LIGUSTRUM JUCIDUM & JAPONICA SYRINGA IN VARIETY VIBURNUM IN VARIETY WEIGELA IN VARIETY JUNIPERUS CHINENSIS EUONYMUS JAPONICUS PHOTINIA SERRULATA PITTOSPORUM EUGENIOIDES	CRAPE MYRTLE COMMON AMERICAN BOXWOOD RHODODENDRON (USE IN PARTIAL SHADE) GLOSSY & JAPANESE PRIVET LILAC VIBURNUMS ENGLISH, SPIREA & CAROLINA ALLSPICE "BROWN" JAPANESE YEW "BROWN" BLUEBERRY EVERGREEN BURNINGBUSH EVERGREEN LOW PHOTINIA TOBIRA	6
	PHORMIUM TENAX CORTADERIA ARGENTEA	NEW ZEALAND FLAX PAMPAS GRASS	7
	SORBUS AUCUPARIA STYRACIFOLIUM AB BOREUM EUONYMUS EUROPAEUS " " BUNGEANUS	EUROPEAN MOUNTAIN-ASH STORAX EUROPEAN BURNINGBUSH WINTERBERRY EUONYMUS	8
	CORNUS FLORIDA CERCIS CANADENSIS CRATAEGUS CORDATA " OXYACANTHA CHIONANTHUS VIRGINICA MALUS CORONARIA - ETC.	FLOWERING DOGWOOD AMERICAN REDBUD WASHINGTON HAWTHORNE ENGLISH " WHITE FRINGE ANY SWEET CRAB - ETC.	9
	TAXUS BACCATA HIBERNICA JUNIPERUS " SUECICA " " EXCELSA	IRISH YEW " JUNIPER SWEDISH " GREEN "	10
	JUNIPERUS VIRGINIANA " " CANAERTI " " GLAUCA THUJA OCC PYRAMIDALIS CHAMAECYPARIS LAWSONIANA CUPRESS MACROCARPA " SEMPERVIRENS EUGENIA MYRTIFOLIA POPULUS ITALICA " BOLLEANA & P. FIONI	RED CEDAR CANARY " " SILVER " " ARBOR PYRAMIDAL ARBORVITAE LAWSON CYPRESS MONTEREY " ITALIAN " AUSTRALIAN BRUSH CHERRY LOMBARDY POPLAR BOLLEANA & PYRAMIDAL "	11
	ILEX OPACA " AQUIFOLIUM CEPHALOTAXUS AQUIFOLIUM	AMERICAN HOLLY ENGLISH " HOLLY CEPHALOTUS	12
	TSUGA CANADENSIS ABIES - IN VARIETY PICEA - " " PINUS STROBUS " NIGRA " RESINOSA " SYLVESTRIS CEDRUS ATLANTICA " DEODARA TAXODIUM DISTICHUM ABIES LARICINA	CANADIAN HEMLOCK WHITE, FRASER, NORDMANN & COLORADO SPRUCE WHITE, NORWAY, ORIENTAL, COLORADO SPRUCE WHITE PINE AUSTRIAN " RED " SCOTCH " ATLAS CEDAR DEODAR " COMMON BALDCYPRESS AMERICAN LARCH	13
	COCOS BUCIFERA WASHINGTONIA FILIFERA " ROBUSTA ULMUS AMERICANA PLATANUS OCCIDENTALIS LIRIODENDRON TULIPIFERA EUPHORBIA CYCAS QUERCUS ALBA " RUBRA " PALUSTRIS ACER SPICATUM GLEDITSIA TRIACANTHOS ROBINIA PSEUDOACACIA MAGNOLIA GRANDIFLORA	QUEEN PALM CALIFORNIA FAN PALM MEXICAN " AMERICAN ELM PLANE OR SYCAMORE TULIPTREE KENTUCKY COFFEE TREE WHITE OAK RED " PIN OAK MOUNTAIN MAPLE COMMON HONEYLOCUST LOCUST SOUTHERN MAGNOLIA	14 15

PLANT TYPES & EXAMPLES

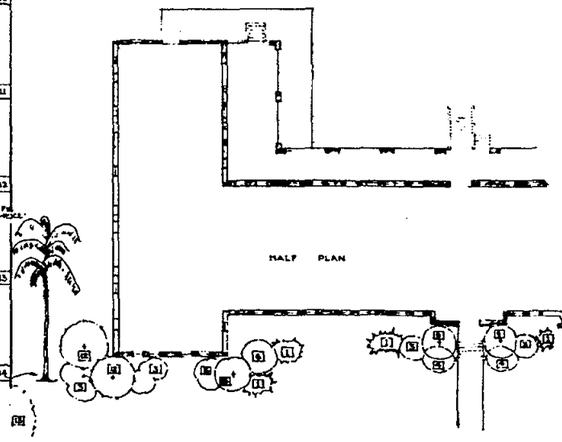
NOTE: THE PLANTS LISTED ABOVE REPRESENT THE RESPECTIVE ILLUSTRATIONS IN GENERAL. MANY ADDITIONAL VARIETIES ARE AVAILABLE, AND THE MOST APPROPRIATE SHOULD BE SELECTED IN EACH LOCALITY.



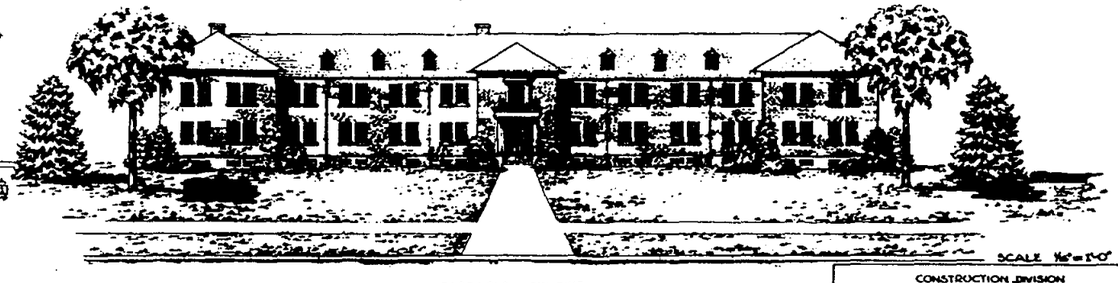
HEADQUARTERS ADMINISTRATION BUILDING



BACHELOR OFFICERS' QUARTERS



HALF PLAN



BARRACKS BUILDING

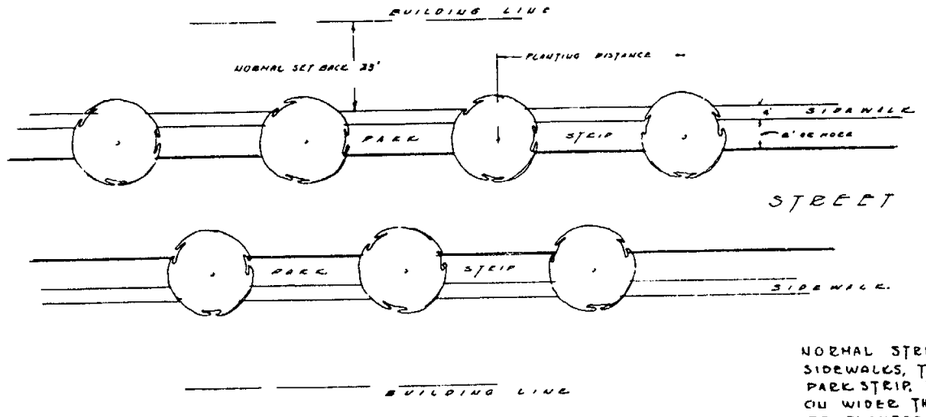
SCALE 1/16" = 1'-0"

CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL

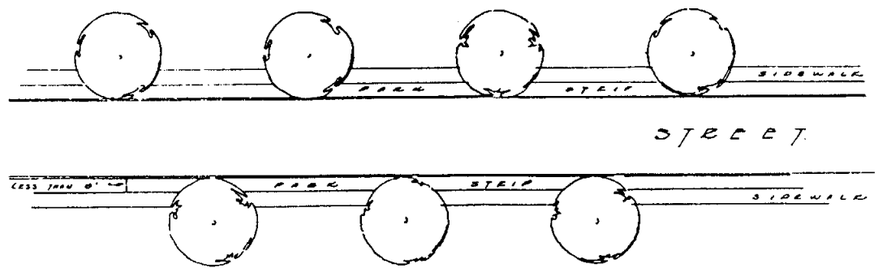
TYPICAL LANDSCAPE PLANTING

HEADQUARTERS ADMINISTRATION BUILDING
BACHELOR OFFICERS' QUARTERS
AND BARRACKS BUILDING

DRAWN BY	CHECKED BY	APPROVED BY DIRECTION	DATE
L.G. LEONARD		BRIGADIER GENERAL, QMC	



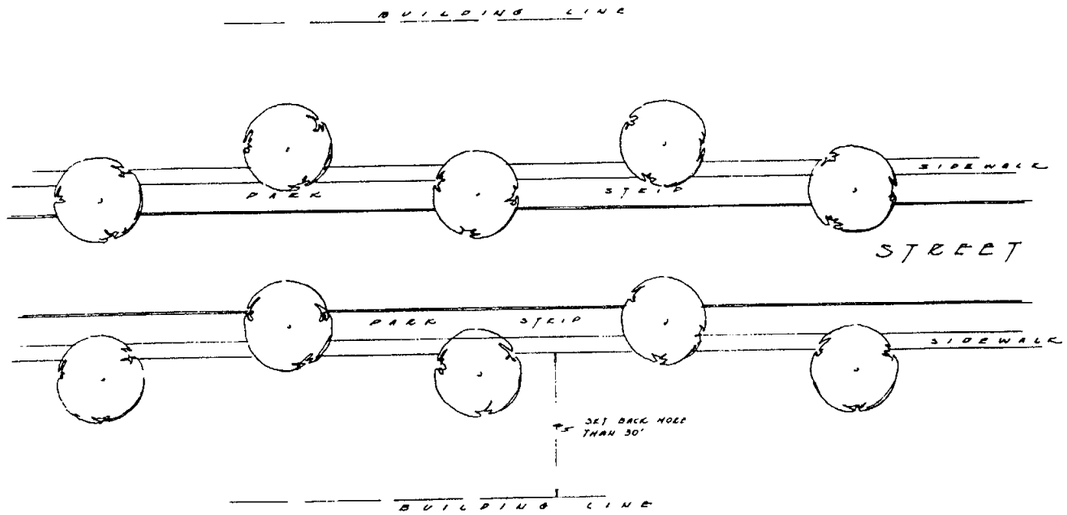
NORMAL STREET, WITH NORMAL PARKING & SIDEWALKS, TREES PLANTED IN CENTER OF PARK STRIP. TREES STAGGERED ON STREET. ON WIDER THAN NORMAL STREET, TREES MAY BE PLANTED OPPOSITE.



NARROWER THAN NORMAL STREET, OR WITH LESS THAN USUAL PARKING STRIP. TREES PLANTED ON INSIDE OF WALK.

NOTE:

PLANTING DISTANCES WILL VARY WITHIN REASONABLE LIMITS, ACCORDING TO INTERFERENCES SUCH AS DRIVES, SIDEWALKS, ETC., AND AS TO LENGTH OF BLOCK BEING PLANTED. IN GENERAL, THE PLANTING DISTANCES AS GIVEN ON LIST OF STREET TREES, SHOULD NOT BE EXCEEDED.



STREET NORMAL, WITH GREATER THAN NORMAL BUILDING LINE SET BACK. TREES ALTERNATED ON EITHER SIDE OF WALK.

CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL

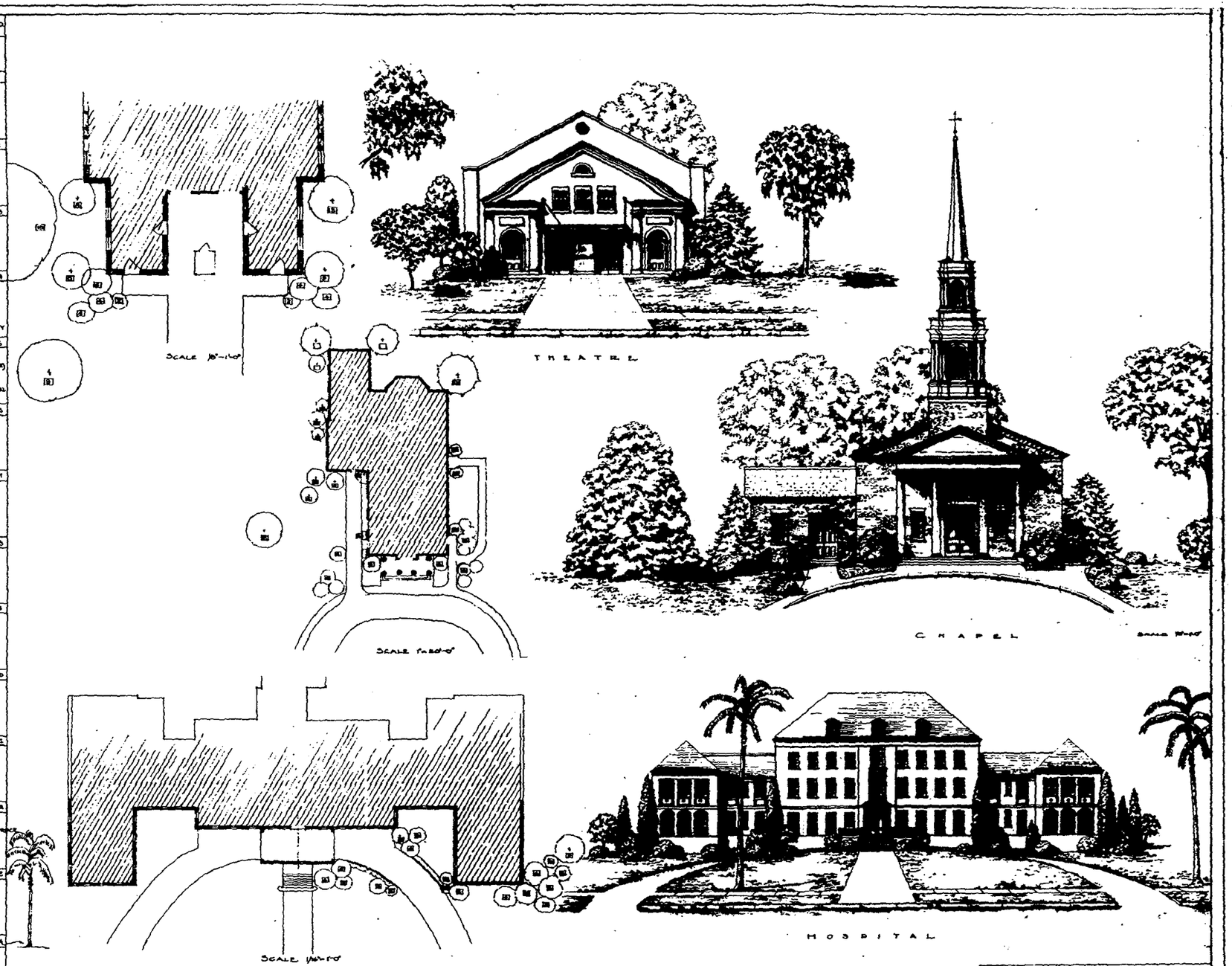
TYPICAL STREET TREE PLANTINGS

DRAWN BY	CHECKED BY	APPROVED BY DIRECTION	DATE
ECI		BRIG GEN Q.M.C.	DEC. 14, 1933
TRACED BY			NUMBER 630-102

ILLUSTRATION OF TYPE	SCIENTIFIC NAME	COMMON NAME	TYPE NO.
	JUNIPERUS HORIZONTALIS DOUGLASI	MAIDENHAIR JUNIPER	
	" SABINA TAMARISCIFOLIA	TAMARIX SAVIN "	
	" SQUAMATA		
	TAXUS CUSPIDATA NANA	DWARF JAPANESE YEW	
	" " REPANDENS	SPREADING ENGLISH YEW	
	COTONEASTER HORIZONTALIS	ROCK COTONEASTER	1
	LANTANA	SHRUB LANTANA	
	ABIES FRONTANA, MUNRO	TENDRO PINE	
	COTONEASTER HORIZONTALIS	ROCK COTONEASTER	
	PERIBERIS VERSICOLORA	VARITY BARBERRY	
	VIBURNUM OPULUS NANUM	DWARF CRANBERRYBUSH	
	LONICERA FIELATA	WINTER HONEYSUCKLE	
	YUCCA FILAMENTOSA	COMMON YUCCA	2
	BUXUS SUFFRUTICOSA	ENGLISH OR TRUE DWARF BOXWOOD	
	AZALEA, RUBRINE - IN VARIETY	RUBRINE AZALEAS	
	JUNIPERUS PFITZERIANA	PFITZERS JUNIPER	
	" HORIZONTALIS	WINTER JUNIPER	3
	BUXUS SUFFRUTICOSA	ENGLISH OR TRUE DWARF BOXWOOD	
	TAXUS CUSPIDATA "	JAPANESE YEW "	
	BERBERIS THUNBERGII "	BARBERRY "	
	" JULIANAE	VARITY BARBERRY	
	HYRICA CAROLINENSIS	NORTHERN BAYBERRY	
	ILEX ALBRA ON MASS	BAYBERRY	
	LONICERA NITIDA	DWARF HONEYSUCKLE	
	SPIRAEA BUMALDA	TOURIA	4
	PYRACANTHA, COCC. LALANDI	LALAND FIRETHORN	
	ILEX CRENATA & RHODRYTULA	JAPANESE HOLLY & SMALL LEAF VARIETY	
	TAXUS COERDIDA CAPITATA	UPRIGHT JAPANESE YEW	
	CAMELLIA JAPONICA	COMMON CAMELLIA	
	THUYA OCC. WARREANA	SIBERIAN ARBORVITAE	5
	LAGERSTROEMIA INDICA - IN VAR.	CRAPE MYRTLE	
	CORNUS NUTTALLII	COMMON AMERICAN BOXWOOD	
	RHODODENDRONS - IN VARIETY	RHODODENDRON (LIKE IN SPECIAL GRADE)	
	LIGUSTRUM LUCIDUM & JAPONICA	GLOSSY & JAPANESE PRIVET	
	SYRINGA - IN VARIETY	LILACS	
	VIBURNUM - IN VARIETY	VIBURNUMS	
	RHODODENDRUS - IN VARIETY	ENGLISH, CATPBA & CAROLINA, CHEROKEE	
	VACCINIUM CORYMBOSUM	HIGHBUSH BLUEBERRY	
	EUONYMUS JAPONICUS	EVERGREEN BURNING BUSH	
	PHOTINIA SERRULATA	EVERGREEN LOW PHOTINIA	
	PITTOSPORUM EUGENIOIDES	TARATA	6
	PHORMIUM TENAX	NEW ZEALAND FLAX	
	CORTADERIA ARGENTEA	PAMPAS GRASS	7
	SORBUS AUCUPARIA	EUROPEAN MOUNTAIN-ASH	
	OXYDENDRUM ARBOREUM	SOURWOOD	
	EUONYMUS EUROPAEUS	EUROPEAN BURNINGBUSH	
	" " BONGEANUS	WINTER BERRY EUONYMUS	8
	CORNUS FLORIDA	FLOWERING DOGWOOD	
	CERCIS CANADENSIS	AMERICAN REDBUD	
	CRATAEGUS CORDATA	WASHINGTON HAWTHORNE	
	" OXYACANTHA	ENGLISH "	
	CHIONANTHUS VIRGINICA	WHITE FRINGE	
	PYRUS CORONARIA - ETC.	WILD SWEET CRAB - ETC.	9
	TAXUS BACCATA HIBERNICA	IRISH YEW	
	JUNIPERUS "	" JUNIPER	
	" SUECICA	SWEDISH "	
	" ERECTA	BREEN "	10
	JUNIPERUS VIRGINIANA	RED CEDAR	
	" " CANAERTI	CANAERT RED CEDAR	
	" " GLAUCA	SILVER "	
	THUJA OCC. PYRAMIDALIS	ARBS. PYRAMIDAL ARBORVITAE	
	CHAMAECYPARIS LAWSONIANA	LAWSON CYPRESS	
	CUPRESS MACROCARPA	MONTEREY "	
	" SEMPERVIRENS	ITALIAN "	
	EUGENIA MYRTIFOLIA	AUSTRALIAN BRUSH CHERRY	
	POPULUS ITALICA	LOMBARDY POPLAR	
	" BOLLEANA & SIMONI	BOLLEANA & SIMONI "	11
	ILEX OPACA	AMERICAN HOLLY	
	" AQUIFOLIUM	ENGLISH "	
	OSMANTHUS AQUIFOLIUM	HOLLY OSMANTHUS	12
	TSUGA CANADENSIS	CANADIAN HEMLOCK	
	MAGNOLIA GRANDIFLORA	SOUTHERN MAGNOLIA	
	ABIES " IN VARIETY	WHITE NORWAY ORIENTAL, COLORADO SPRUCE	
	PINUS STROBUS	WHITE PINE	
	" NIGRA	AUSTRIAN "	
	" RESINOSA	RED "	
	" SYLVESTRIS	SCOTCH "	
	CEDRUS ATLANTICA	ATLAS CEDAR	
	" DEODARA	DEODAR "	
	TAXODIUM DISTICHUM	COMMON BALD CYPRESS	
	ABIES - IN VARIETY	WHITE FIR(SP. HERSHMAN & DOUGLAS FIR)	13
	COCOS ELLIOTICA	QUEEN PALM	
	WASHINGTONIA FILIFERA	CALIFORNIA FAN PALM	
	" GRACILIS	MEXICAN "	14
	ULMUS AMERICANA	AMERICAN ELM	
	PLATANUS OCCIDENTALIS	PLANE OR SYCAMORE	
	LIRIODENDRON TULIPIFERA	TULIPTREE	
	GYMNOCLADUS DOICA	KENTUCKY COFFEE TREE	
	QUERCUS ALBA	WHITE OAK	
	" RUBRA	RED "	
	" PALUSTRIS	PIN SYLVA OAK	
	ACER RUBRUM	RED SWAMP MAPLE	
	GLEDITSIA TRIACANTHOS	COMMON HONEYLOCUST	
	" INERMIS	LOCUST "	
	MAGNOLIA GRANDIFLORA	SOUTHERN MAGNOLIA	15

PLANT TYPES & EXAMPLES

NOTE: THE PLANTS LISTED ABOVE REPRESENT THE RESPECTIVE ILLUSTRATIONS IN GENERAL. MANY ADDITIONAL VARIETIES ARE AVAILABLE AND THE MOST APPROPRIATE SHOULD BE SELECTED IN EACH LOCALITY.



CONSTRUCTION DIVISION
OFFICE OF THE QUARTERMASTER GENERAL

TYPICAL LANDSCAPE PLANTING FOR THEATRE — CHAPEL AND HOSPITAL

6-30-103

APPENDIX B: COMMON PLANTS USED HISTORICALLY

These lists represent the most common plants used historically in the district. As with any plant design, the size, location, and disease and pest problems of plants should be considered before they are selected. Species marked with an asterisk (*) indicate plants that in the past grew too large for their location, or had serious insect, disease, or maintenance problems. Species marked with a plus sign (+) may be difficult to find in local nurseries. It may be necessary to use a different species when replacing these plants if these problems cannot be resolved (see summary that follows lists of common plants). The lists of common plants are arranged by character area and function.

GENERALS' QUARTERS

COMMON FOUNDATION TREES:

*+ CHAMAECYPARIS LAWSONIANA-LAWSON CYPRESS
*+ CHAMAECYPARIS PISIFERA-SAWARA CYPRESS
THUJA OCCIDENTALIS 'PYRAMIDALIS'-ARBORVITAE

COMMON FOUNDATION SHRUBS:

AUCUBA JAPONICA-AUCUBA
AZALEA SP.
BERBERIS THUNBERGII ATROPURPUREA-JAPANESE BARBERRY
BUXUS SEMPERVIRENS-BOXWOOD
BERBERIS THUNBERGII-JAPANESE BARBERRY
CAMELLIA SP.
*CHAENOMELES JAPONICA-JAPANESE QUINCE
COTONEASTER SP.
DEUTZIA SP.
FERNS
*FORSYTHIA SP.
HYDRANGEA MACROPHYLLUM-BIGLEAF HYDRANGEA
JUNIPER SP.
LONICERA SP.-HONEYSUCKLE
LIGUSTRUM SP.-PRIVET
MAHONIA AQUIFOLIUM-OREGON GRAPE
PIERIS JAPONICA-PIERIS
*PRUNUS LAUROCERASUS-ENGLISH LAUREL
*PRUNUS LUSITANICA-PORTUGAL LAUREL
RHODODENDRON SP.
ROSE SP.
SPIRAEA SP.
SYRINGA VULGARIS-COMMON LILAC
VIBURNUM SP. including:
V. PLICATUM TOMENTOSUM-DOUBLEFILE VIBURNUM
+V. RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM
V. OPULUS-EUROPEAN CRANBERRY BUSH
V. TINUS-LAURUSTINUS VIBURNUM
WEIGELA SP.
OTHER-Iris and Daylillies

COMMON TREES USED IN OPEN SPACE PLANTING MASS:

ACER RUBRA-RED MAPLE
ACER PALMATUM-JAPANESE MAPLE
BETULA PENDULA-EUROPEAN WHITE BIRCH
*CRATAEGUS OXYACANTHA-PINK HAWTHORN
+CHAMAECYPARIS PISIFERA-SAWARA CYPRESS
ILEX AQUIFOLIUM-ENGLISH HOLLY
PICEA ABIES-NORWAY SPRUCE
*PRUNUS SP.-CHERRY
PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
PINUS MUGO-MUGO PINE
*PICEA PUNGENS-BLUE SPRUCE
ROBINIA PSEUDOACACIA-BLACK LOCUST
SORBUS AUCUPARIA-EUROPEAN MOUNTAIN ASH
TAXUS BACCATA-ENGLISH YEW
THUJA OCCIDENTALIS 'PYRAMIDALIS'-ARBORVITAE

COMMON SHRUBS USED IN OPEN SPACE PLANTING MASS:

AZALEA SP.
BERBERIS THUNBERGII 'ATROPURPUREA'-JAPANESE BARBERRY
CAMELLIA SP.
CHAENOMELES SP.-QUINCE
DEUTZIA SP.
FERNS
FORSYTHIA SP.
LINDERA BENZOIN-SPICE BUSH
LONICERA SP.-HONEYSUCKLE
MAHONIA AQUIFOLIUM-OREGON GRAPE
PRUNUS LAUROCERASUS-ENGLISH LAUREL
PRUNUS LUSITANICA-PORTUGAL LAUREL
SPIRAEA SP.
*SYRINGA VULGARIS-COMMON LILAC
VIBURNUM SP. including:
V. OPULUS-EUROPEAN CRANBERRY BUSH
+V. RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM
V. TINUS-LAURUSTINUS VIBURNUM
WEIGELA SP.

BROADMOOR-OFFICERS' HOUSING AREA

COMMON FOUNDATION TREES:

*CHAMAECYPARIS LAWSONIANA. CV. 'ELLWOODII'-ELLWOOD LAWSON CYPRESS
TAXUS BACCATA-ENGLISH YEW
THUJA OCCIDENTALIS 'FASTIGIATA'- FASTIGIATE ARBORVITAE
THUJA OCCIDENTALIS 'PYRAMIDALIS'-ARBORVITAE

COMMON FOUNDATION SHRUBS:

ABELIA GRANDIFLORA
AUCUBA JAPONICA
AZALEA SP.
BERBERIS SP.-BARBERRY
BUXUS SEMPERVIRENS-BOXWOOD
CHAMAECYPARIS SP.
*CHAENOMELES SP.-QUINCE
CHOISYA TERNATA-MEXICAN ORANGE
COTONEASTER SP.
DEUTZIA SP.
FERNS
*FORSYTHIA SP.
JUNIPERUS SP.-JUNIPER
LIGUSTRUM SP.-PRIVET
MAHONIA AQUIFOLIUM-OREGON GRAPE
PIERIS JAPONICA
SPIRAEA SP.
RHODODENDRON SP.
VIBURNUM SP. including:
V. OPULUS-EUROPEAN CRANBERRY BUSH
V. PLICATUM TOMENTOSUM-DOUBLEFILE VIBURNUM
*+V. RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM
V. TINUS-LAURUSTINUS VIBURNUM
WEIGELA SP.
OTHER-Iris and Daylillies

COMMON TREES USED FOR SPATIAL DEFINITION:
*CRATAEGUS OXYACANTHA-PINK HAWTHORN
CEDRUS DEODORA-DEODAR CEDAR
+CHAMAECYPARIS LAWSONIANA VAR.- Several var. of Lawson cypress including:
CHAMAECYPARIS L. 'ALLUMII'-BLUE LAWSON CYPRESS
+CHAMAECYPARIS L. 'LUTEA'-GOLDEN LAWSON CYPRESS
CHAMAECYPARIS L. 'ELLWOODII'-ELLWOOD LAWSON CYPRESS
+CHAMAECYPARIS PISIFERA-SAWARA CYPRESS Several var. of Sawara cypress including:
+CHAMAECYPARIS P. 'SQUARROSA'-MOSS SAWARA CYPRESS
CHAMAECYPARIS P. 'FILIFERA'-THREAD-BRANCH SAWARA CYPRESS
ILEX AQUIFOLIUM-ENGLISH HOLLY
PICEA ABIES-NORWAY SPRUCE
*PRUNUS SP. -FRUIT TREES
*POPULUS CANESCENS-GRAY POPLAR
PRUNUS LAUROCERASUS-ENGLISH LAUREL-prune as small tree
PRUNUS LUSITANICA-PORTUGAL LAUREL
*PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
SORBUS AUCUPARIA-EUROPEAN MOUNTAIN ASH
TAXUS BACCATA-ENGLISH YEW
THUJA OCCIDENTALIS 'FASTIGIATA'- FASTIGIATE ARBORVITAE
THUJA OCCIDENTALIS-ARBORVITAE
THUJA PLICATA-WESTERN RED CEDAR
THUJA PLICATA ZEBRINA-VARIGATED WESTERN RED CEDAR
*ULMUS AMERICANA-AMERICAN ELM

COMMON SHRUBS USED FOR SPATIAL DEFINITION

ABELIA GRANDIFLORA
AUCUBA JAPONICA
AZALEA SP.
BERBERIS SP.
BUXUS SEMPERVIRENS-BOXWOOD
CAMELLIA SP.
CHAENOMELES SP.-QUINCE
COTONEASTER SP.
DEUTZIA SP.
FERNS
FORSYTHIA SP.
JUNIPERUS SP.-JUNIPER
LABURNUM X WATERERI-HYBRID GOLDENCHAIN
LIGUSTRUM SP.-PRIVET
MAHONIA AQUIFOLIUM-OREGON GRAPE
PHILADELPHUS SP.-MOCK-ORANGE
PIERIS JAPONICA
*PRUNUS LAUROCERASUS-ENGLISH LAUREL
*PRUNUS LUSITANICA-PORTUGAL LAUREL
RHODODENDRON SP.
ROSE (shrub varieties)
SPIRAEA SP.
SYRINGA VULGARIS-COMMON LILAC
VIBURNUM SP. including:
V. OPULUS-EUROPEAN CRANBERRY BUSH
V. PLICATUM TOMENTOSUM-DOUBLEFILE VIBURNUM
+V. RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM
V. TINUS-LAURUSTINUS VIBURNUM
WEIGELA SP.

STREET TREES:

*CRATAEGUS OXYACANTHA-PINK HAWTHORN
*POPULUS CANESCENS-GRAY POPLAR
*ULMUS AMERICANA-AMERICAN ELM

HISTORIC BARRACKS AREA

COMMON FOUNDATION TREES:

As indicated below, many of the trees originally planted as foundation trees may be too large at maturity to be successfully replanted without high maintenance costs. See summary that follows for list of replacement suggestions, or Appendix C: Restoration of 2012.

*CHAMAECYPARIS LAWSONIANA-cultivars including:
*CHAMAECYPARIS LAWSONIANA 'ALLUMII'-BLUE LAWSON CYPRESS
*+C. LAWSONIANA 'ERECTA VIRDIS'-GREEN COLUMN CYPRESS
*C. LAWSONIANA 'FLETCHERI'
*+C. LAWSONIANA 'FRASERI'
*+C. LAWSONIANA 'STEWARTII'-STEWART'S GOLDEN LAWSON CYPRESS
*CHAMAECYPARIS PISIFERA-SAWARA CYPRESS-several cultivars including:
*+C. PISIFERA 'PLUMOSA'-PLUME SAWARA CYPRESS
*+C. PISIFERA 'SQUARROSA'-MOSS SAWARA CYPRESS
*C. PISIFERA 'FILIFERA'-THREAD-BRANCH SAWARA CYPRESS
*CEDRUS DEODORA-DEODAR CEDAR
*PICEA PUNGENS-BLUE SPRUCE
TAXUS BACCATA
THUJA OCCIDENTALIS 'FASTIGIATA'- FASTIGIATE ARBORVITAE
THUJA OCCIDENTALIS 'PYRAMIDALIS'-ARBORVITAE
*THUJA PLICATA-WESTERN RED CEDAR
*THUJA PLICATA 'ZEBRINA'-VARIGATED WESTERN RED CEDAR

COMMON FOUNDATION SHRUBS:

BERBERIS SP. including:
B. JULIANAE-WINTERGREEN BARBERRY
B. STENOPHYLLA-ROSEMARY BARBERRY
B. THUNBERGII-JAPANESE BARBERRY
B. THUNBERGII 'ATROPURPUREA'-RED-LEAF JAPANESE BARBERRY
B. VERRUCULOSA-WARTY BARBERRY
BUXUS SEMPERVIRENS-BOXWOOD
CHAENOMELES SP.-QUINCE
COTONEASTER SP.
CHOISYA TERNATA-MEXICAN ORANGE
FERNS
FORSYTHIA SP.
JUNIPERUS SP.
LIGUSTRUM SP. PRIVET
LIGUSTRUM OVALIFOLIUM-'AUREUM'- GOLDEN PRIVET
LINDERA BENZOIN-SPICE BUSH
*PRUNUS LAUROCERASUS-ENGLISH LAUREL
*PYRACANTHA SP.-FIRETHORN
SYRINGA VULGARIS-COMMON LILAC
THUJA SP.
+VIBURNUM RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM
OTHER-Iris and Daylillies

COMMON TREES USED FOR SPATIAL DEFINITION:

*ACER MACROPHYLLUM-BIGLEAF MAPLE
ABIES FIRMA-MOMI FIR
CEDRUS DEODORA-DEODAR CEDAR
+CHAMAECYPARIS LAWSONIANA-LAWSON CYPRESS
C. LAWSONIANA'ALLUMII'-BLUE LAWSON CYPRESS
+CHAMAECYPARIS PISIFERA-SAWARA CYPRESS
+C. PISIFERA 'SQUARROSA'-MOSS SAWARA CYPRESS
ILEX AQUIFOLIUM-ENGLISH HOLLY
PICEA ABIES-NORWAY SPRUCE
*PRUNUS SP.-CHERRY
PRUNUS LAUROCERASUS-ENGLISH LAUREL
PRUNUS LUSITANICA-PORTUGAL LAUREL
PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
*PICEA PUNGENS-BLUE SPRUCE
THUJA PLICATA-WESTERN RED CEDAR
THUJA PLICATA 'ZEBRINA'-VARIGATED WESTERN RED CEDAR

COMMON SHRUBS USED FOR SPATIAL DEFINITION:

BUXUS SEMPERVIRENS-BOXWOOD
JUNIPERUS SP.
LIGUSTRUM OVALIFOLIUM-'AUREUM'- GOLDEN PRIVET
LIGUSTRUM SP.-PRIVET
PRUNUS LAUROCERASUS-ENGLISH LAUREL
SYRINGA VULGARIS-COMMON LILAC
THUJA SP.
+VIBURNUM RHYTIDOPHYLLUM-LEATHERLEAF VIBURNUM

STREET TREES:

*ULMUS AMERICANA-AMERICAN ELM

GREENWOOD-NCO HOUSING AREA

COMMON FOUNDATION TREES:

TAXUS BACCATA-ENGLISH YEW
THUJA OCCIDENTALIS 'FASTIGIATA'- FASTIGIATE ARBORVITAE
THUJA OCCIDENTALIS 'PYRAMIDALIS'-PYRAMIDAL ARBORVITAE

COMMON FOUNDATION SHRUBS:

ABELIA GRANDIFLORA-ABELIA
AUCUBA JAPONICA-AUCUBA
BERBERIS SP.
BUXUS SEMPERVIRENS-BOXWOOD
CHAMAECYPARIS SP.
*CHAENOMELES SP.-QUINCE

DEUTZIA SP.
FERNS
JUNIPERUS SP.
LIGUSTRUM SP.-PRIVET
MAHONIA AQUIFOLIUM-OREGON GRAPE
*PHILADELPHUS SP.-MOCK-ORANGE
*PRUNUS LAUROCERASUS-ENGLISH LAUREL
*PYRACANTHA SP.-FIRETHORN
RHODODENDRON SP.
SPIRAEA SP.
*SYRINGA VULGARIS-COMMON LILAC
THUJA SP.
VACCINIUM OVATUM-EVERGREEN HUCKLEBERRY
VIBURNUM SP.
OTHER-Iris and Daylillies

COMMON SHRUBS USED FOR SPATIAL DEFINITION:
CHAENOMELES SP.-QUINCE
DEUTZIA SP.
FORSYTHIA SP.
PHILADELPHUS SP.-MOCK-ORANGE
SPIRAEA SP.
SYRINGA VULGARIS-COMMON LILAC
VIBURNUM SP.

COMMON TREES USED FOR SPATIAL DEFINITION:

*ACER MACROPHYLLUM-BIGLEAF MAPLE
*CRATAEGUS MONOGYNA-COMMON HAWTHORN
CEDRUS DEODORA-DEODAR CEDAR
+CHAMAECYPARIS LAWSONIANA-LAWSON CYPRESS
+CHAMAECYPARIS PISIFERA-SAWARA CYPRESS
ILEX AQUIFOLIUM-ENGLISH HOLLY
MALUS DOMESTICUS
*PRUNUS SP.-CHERRY
*POPULUS CANESCENS-GRAY POPLAR
*PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
*PICEA PUNGENS-BLUE SPRUCE
QUERCUS GARRYANA-OREGON OAK
SORBUS AUCUPARIA-EUROPEAN MOUNTAIN ASH
SALIX X CHRYSOCOMA-GOLDEN WEEPING WILLOW
TAXUS BACCATA-ENGLISH YEW
THUJA PLICATA-WESTERN RED CEDAR
THUJA PLICATA ZEBRINA-VARIGATED WESTERN RED CEDAR

GREENWOOD STREET TREES:
*CRATAEGUS MONOGYNA-COMMON HAWTHORN
*POPULUS CANESCENS-GRAY POPLAR
SORBUS AUCUPARIA-EUROPEAN MOUNTAIN ASH
*ULMUS AMERICANA-AMERICAN ELM

DIVISION HEADQUARTERS (#1010)

COMMON TREES

CEDRUS DEODORA-DEODAR CEDAR
+CHAMAECYPARIS LAWSONIANA-LAWSON CYPRESS
*CRATAEGUS OXYACANTHA-PINK HAWTHORN
ILEX AQUIFOLIUM-ENGLISH HOLLY
PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
*ULMUS AMERICANA-AMERICAN ELM

THE CHAPEL (#2001)

COMMON TREES

BETULA PUBESCENS-DOWNY BIRCH
BETULA PENDULA-EUROPEAN WHITE BIRCH
CEDRUS ATLANTICA-ATLAS CEDAR
+CHAMAECYPARIS LAWSONIANA-LAWSON CYPRESS
CATALPA SPECIOSA-NORTHERN CATALPA
ILEX AQUIFOLIUM-ENGLISH HOLLY
PSEUDOTSUGA MENZIESII-DOUGLAS-FIR
*PICEA PUNGENS-BLUE SPRUCE
SORBUS AUCUPARIA-EUROPEAN MOUNTAIN ASH
SALIX X CHRYSOCOMA-GOLDEN WEEPING WILLOW
THUJA OCCIDENTALIS-ARBORVITAE
THUJA PLICATA ZEBRINA-VARIGATED WESTERN RED CEDAR

COMMON SHRUBS
ABELIA GRANDIFLORA
AUCUBA JAPONICA
AZALEA SP.
BERBERIS THUNBERGII ATROPURPUREA-JAPANESE BARBERRY
CAMELLIA SP.
COTONEASTER HORIZONTALIS-ROCKSPRAY COTONEASTER
FERNS
JUNIPERUS SP.
*PYRACANTHA SP.-FIRETHORN
SPIRAEA JAPONICA-JAPANESE SPIRAEA
WEIGELIA FLORIDA-RUBY WEIGELIA

Summary of Potential Replacement Species

As noted above, some of the trees and shrubs commonly used during the historic period grew too large for their original location, have had serious pest or disease problems or may be difficult to find in local nurseries. In some instances these problems can be solved and the species can continue to be planted. For example, using resistant species or varieties to replace disease or insect prone species. In other instances, trees or shrubs that are too large at maturity will cost too much to maintain and more suitable species may be used to replace them. The following list represents a few plants that have caused concern or problems in the past. Always consider a plants size, location, potential serious disease and pest problems as well as other major maintenance concerns prior to their use. Use the replacement philosophy and sequence on Sheet L.4. to guide replacement decisions.

Note: Species that are too large as foundation plants may usually be used successfully as screens or in open spaces etc. so do not stop using them in all situations if they are inappropriate in only certain cases. Some acceptable replacement species are suggested below. These are suggestions only. Explore other options prior to replacement, especially disease resistant varieties which continue to be improved and developed by nurseries, etc.

Trees Too Large For Foundation Plantings:

Cedrus deodora-deodar cedar
Chamaecyparis lawsoniana-Lawson cypress
Chamaecyparis pisifera-sawara cypress
Picea pungens-blue spruce
Pseudotsuga menziesii-Douglas-fir
Thuja plicata-western red cedar
Thuja plicata 'Zebrina'- variegated western red cedar

Acceptable replacements for foundation trees; there are many more possibilities:
Thuja occidentalis 'Pyramidalis'-pyramidal arborvitae
Taxus baccata 'Fastigiata'-Irish yew
Chamaecyparis obtusa 'Gracilis'-slender Hinoki cypress
Juniperus chinensis 'Robusta Green'-'Robusta Green' juniper
Juniperus scopulorum 'Witchita Blue'-Witchita Blue' juniper

Shrubs Often Too Large For Foundation Plantings:
Use of these shrubs depends on the size of the building and window clearance.

Chaenomeles japonica-Japanese quince
Forsythia sp.
Prunus laurocerasus-English laurel
Prunus lusitanica-Portugal laurel
Pyracantha sp.-firethorn
Syringa vulgaris-common lilac
Viburnum rhytiophyllum-leatherleaf viburnum
*All of the above shrubs are good plants for screens and creating spatial definition.

Trees Potentially Too Large or With Potential Maintenance Concerns When Planted Near Buildings or Used As Street Trees:

Acer macrophyllum-bigleaf maple: Needs plenty of room.
Crataegus oxyacantha-pink (English) hawthorn: Problems with leaf blight, consider replacing with disease resistant variety *Crataegus laevigata 'Crimson Cloud'*, or disease

resistant varieties of flowering crabapple-*Malus sp.* '*Adams*', '*Centurion*', '*Prairifire*', '*Robinson*', and '*Strawberry Parfait*'.

Picea pungens-blue spruce: Problems with spruce aphid. A concerted effort needs to be made to control aphid infestations before replacements are used. See Insect Pest section for control methods. *Picea pungens 'Moerheimii'* is more resistant to spruce aphids.

Populus canescens-gray poplar: Not recommended as street tree due to brittle wood and invasive roots. Use with caution in other areas-provide plenty of room. Try *Acer pseudoplatanus*-sycamore maple as replacement species.

Prunus laurocerasus-English laurel: Needs plenty of room but can be very successfully pruned as small tree ('arborized') and used for creating spatial definition-for example, existing laurels located between barracks buildings.

Prunus lusitanica-Portugal laurel: same as above.

Pseudotsuga menziesii-Douglas-fir: According to the Hazard Tree Survey: "In general, the population of Douglas-fir in the historic district is fairly young...and is in good shape. Douglas-fir is well-suited to the landscape at Ft. Lewis. With careful attention to butt rott development, and scheduled removal or large forked individuals near houses, Douglas-fir can be managed in a safe manner within the historic district. ...if there is concern about large healthy Douglas-fir breaking, consider crown thinning to reduce wind resistance or "sail area"." Consider potential targets when replanting.

Prunus sp. cherry: Can be a high maintenance tree. Consider replacement with disease resistant varieties of flowering crabapple-*Malus sp.* '*Adams*', '*Centurion*', '*Prairifire*', '*Robinson*', and '*Strawberry Parfait*', etc.

Ulmus americana-American elm: Potential for Dutch Elm Disease. Very important tree in the historic district. Implement DED program and when they must be replaced use disease resistant varieties such as '*Homestead*' or '*Pioneer*'. Consult with horticultural and nursery industry for ongoing development of disease resistant varieties.

Species Difficult to Find in Local Nurseries:

Chamaecyparis lawsoniana-Lawson cypress:
Chamaecyparis pisifera-sawara cypress:
A large number and variety of Lawson cypress and sawara cypress were planted during the 1930-40s in the historic district and as well as urban areas of the Pacific Northwest. Some such as *C. lawsoniana 'Allumii'*-blue Lawson cypress, and *C. pisifera 'Filifera'*-thread-branch sawara cypress, are still planted and are available in some nurseries. Many of the other varieties are no longer readily available in local nurseries. However, before replacing these species, make a complete search of smaller, more specialized nurseries. Also, the nursery industry is constantly changing and plants go in and out of style so species unavailable now may become available in the future. Note: Many nurseries offer plant searches free of charge.

Viburnum rhytiophyllum-leatherleaf viburnum. This viburnum species was also once more common in nurseries but is more difficult to find today. It is available, but it may take some persistence to locate it. This shrub grows too large for most foundation plantings but is very successful in other locations and is worth replanting; it is very low maintenance and has very distinctive characteristics.

APPENDIX C: RESTORATION PLAN FOR BLDG. 2012

2012 A

2012 B

Bed

JS

TO

2-SA

fern-PM

1-CL

3-VD

3-VD

2 FT. BUFFER TYP.

fern-PM

1-CL

fern-PM

3-VD

3-VD

1-CL

fern-PM

TB

2-SA

JC

WINDOWS

NOTE 1:

MULCHED BED
HAND-TOOLED EDGES

IC

269'

270'

RETAIN

RETAIN

REMOVE

REMOVE

REMOVE

REMOVE

0 10' 20'

NORTH

LIGGETT AVE.

PLANT LEGEND

TO	*Thuja occidentalis 'Pyramidalis'*
TB	*Taxus baccata 'Fastigiata' ('Stricta')*
CO	*Chamaecyparis obtusa 'Gracilis'*
JC	*Juniperus chinensis 'Robusta Green'*
JS	*Juniperus scopulorum 'Wichita Blue'*
IC	*Ilex crenata 'Convexa'*
VD	*Viburnum davidii*
CO	*Cotoneaster lacteus*
SA	*Symphoricarpos albus*
Bed	*Polystichum munitum, Iris,* and *Hemerocallis fulva..*

Note 1: Do not disturb soil (regrade or amend soil) in area within 10 ft. of dripline of tree # 970.

CONIFEROUS TREE

SHRUB

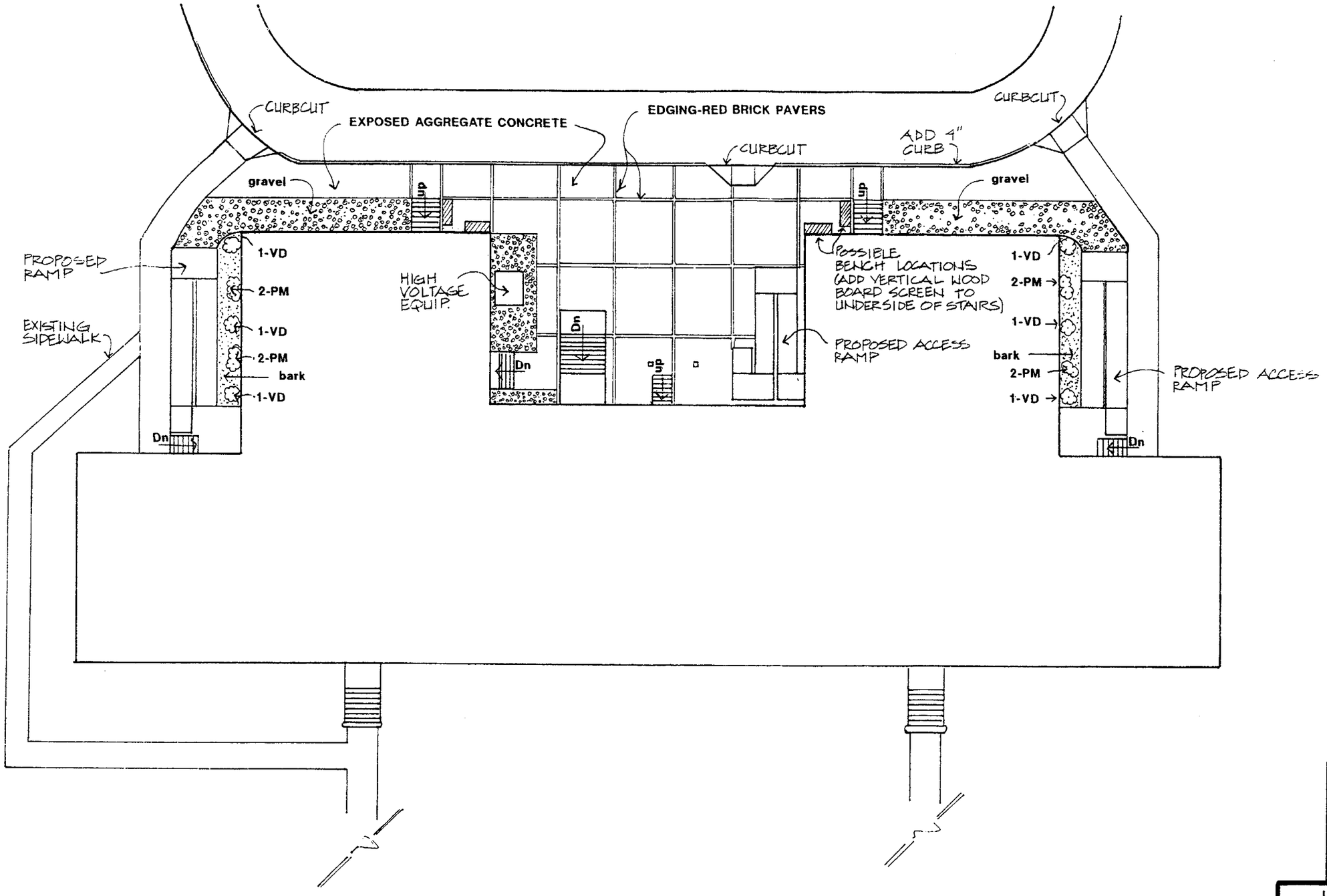
EXISTING TREE (RETAIN)

EXISTING SHRUB (RETAIN)

U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS

BARRACKS BUILDING 2012
PROPOSED PLANTING PLAN

FORT LEWIS, WASHINGTON



0' 10' 20'

NORTH

VD-VIBURNUM DAVIDII

PM-POLYSTICHUM MUNITUM

U.S.ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS

BARRACKS BUILDING 2012 CONCEPTUAL REAR ENTRY SITE UPGRADE

FORT LEWIS, WASHINGTON

APPENDIX D: TREES, SIDEWALKS, AND CONSTRUCTION

TREE CITY USA
BULLETIN
for the
Friends of Tree City USA

Bulletin No. 3
James R. Fazio, Editor

Resolving Tree-Sidewalk Conflicts

In resolving conflicts between trees and sidewalks, as in so much of life, an ounce of prevention is worth a pound of cure.

With careful planning there are many ways to avoid such conflicts. Bulletin editor Jim Fazio describes them well: wide treelawns, proper species selection, tree wells, root barriers and better built sidewalks are examples.

I hope you will follow his good advice to head off problems between your own trees and sidewalks, and that you will work to bring about this kind of foresight throughout your community.

With good planning, the cost of tree-sidewalk conflicts can be substantially reduced.

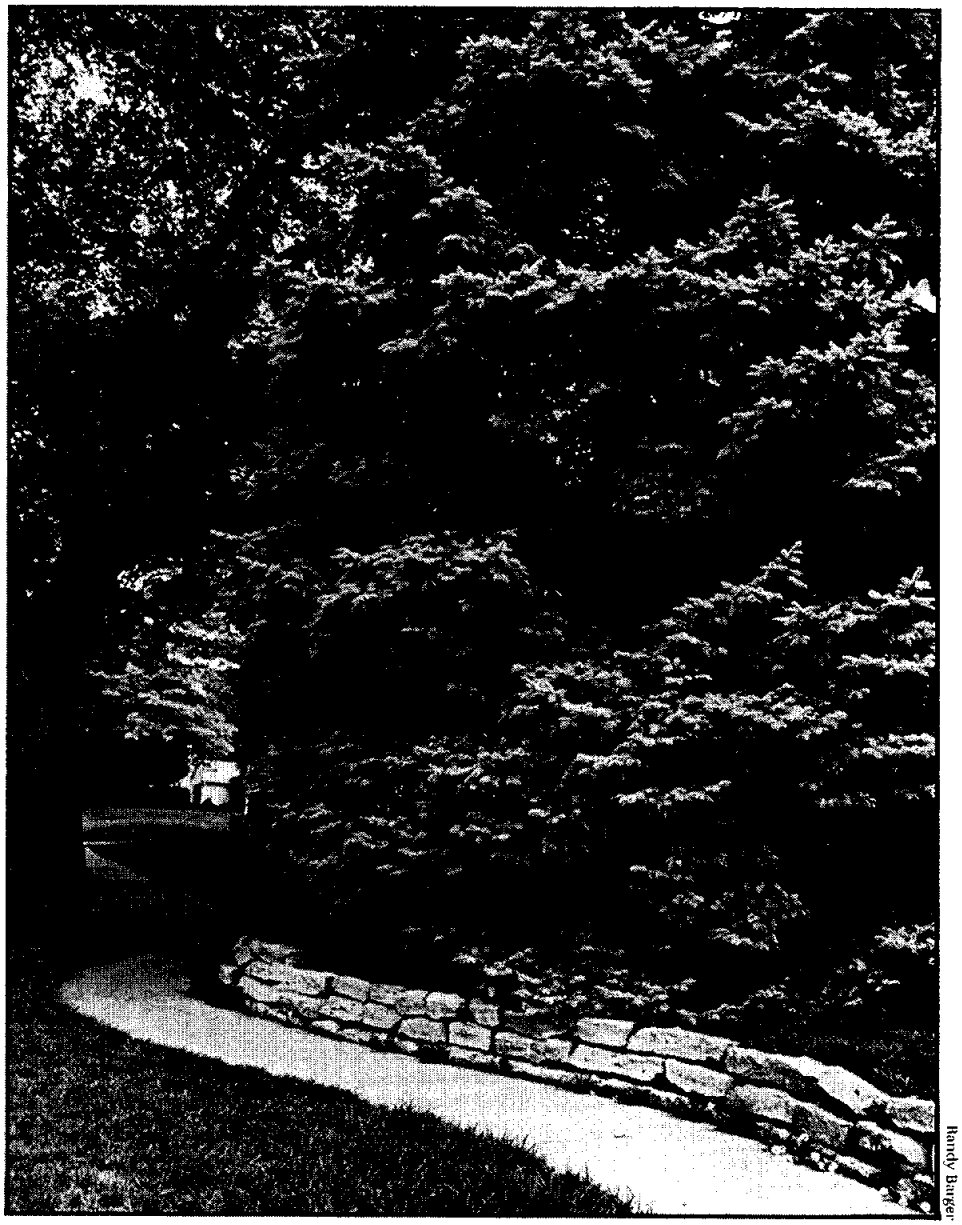
Dealing with tree roots and sidewalks that are already tangled can be a more difficult matter. The solutions may require compromises, such as narrowing the sidewalk beside the tree, adjusting the new sidewalk's location, or wisely accepting imperfect concrete if that saves beautiful trees.

Solutions to tree-sidewalk problems can enhance your city's landscape. Brick pavers, tree grates, and retaining walls can be interesting visual elements in the urban fabric. These features, together with the specimen trees which they preserve, can give your town a feeling of quality and distinction. They'll advertise to your residents and visitors that you care about the things that matter.

When conflicts between trees and sidewalks arise, I hope you will do everything possible to resolve them in favor of the trees.

John Rosenow

John Rosenow, Executive Director
National Arbor Day Foundation



Randy Burger

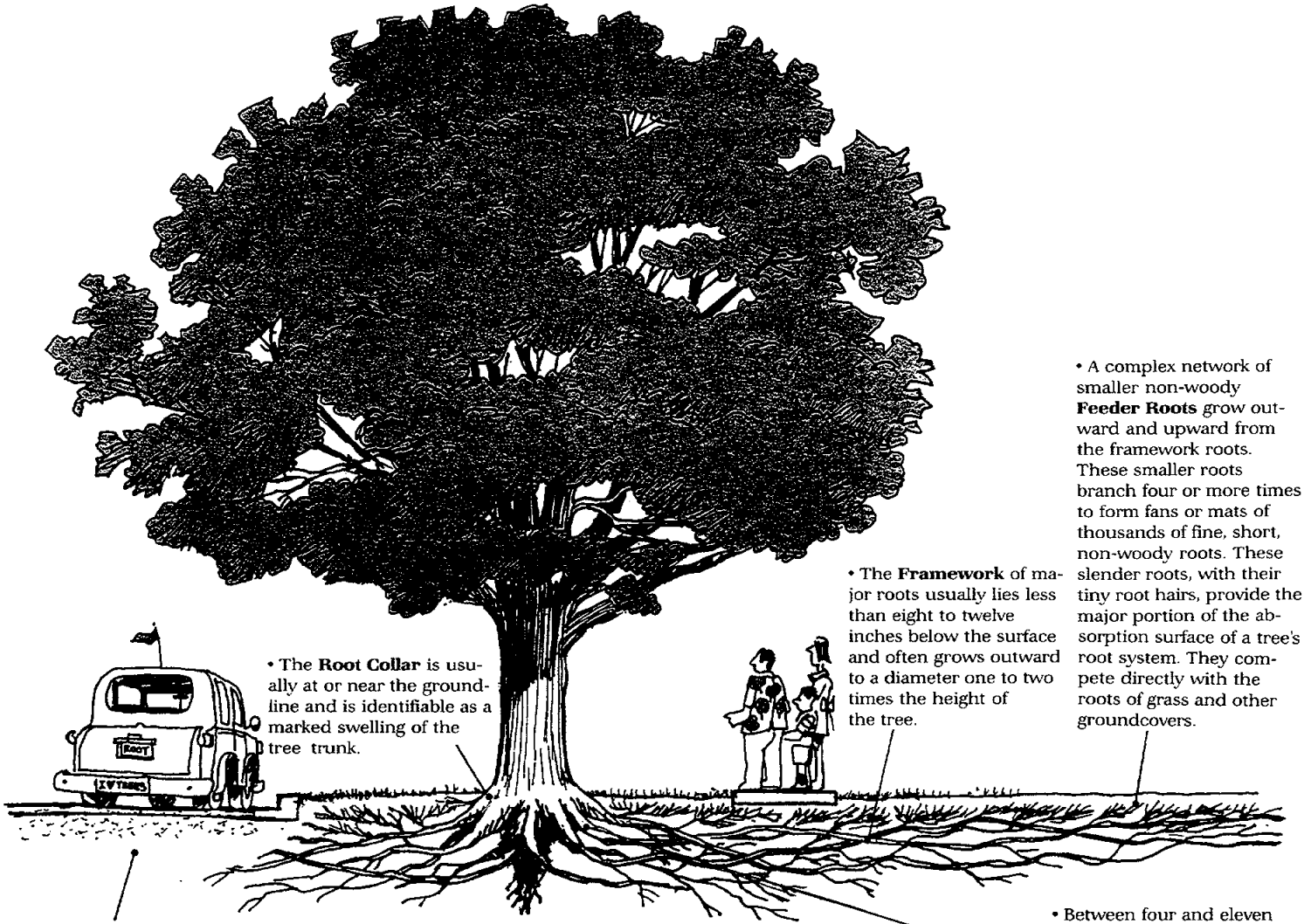
How Roots Really Work

Tree roots are active, opportunistic extensions of the tree that provide support and supply water, oxygen, and nutrients needed to feed the tree and sustain its life. The anatomy of a tree consists of approximately 5 percent leaves, 15 percent branches, 60 percent trunk, 15 percent large transport roots, and 5 percent fine feeder roots. Roots can range in size from over a foot in diameter to less than .008 inch.

The woody transport roots increase regularly in diameter, and even display annual rings. It is this increase in size that swells the base of trees, raises the earth around them, and lifts sidewalks.

Roots can be damaged in a number of ways. Extremes of heat and cold, drying, and frost heaving in the upper layers of soil can kill many of the delicate, non-woody feeder roots. Foraging by nematodes and other soil creatures, as well as digging by humans, take their toll on roots. New roots form rapidly after injuries, but there is a limit to how much root mortality a tree can withstand. The severing of even a few major transport roots quickly reduces the total system.

Roots will also die when oxygen supplies are cut off by soil compaction, flooding, or construction of large, impervious pavement areas on the ground surface.



• The **Root Collar** is usually at or near the groundline and is identifiable as a marked swelling of the tree trunk.

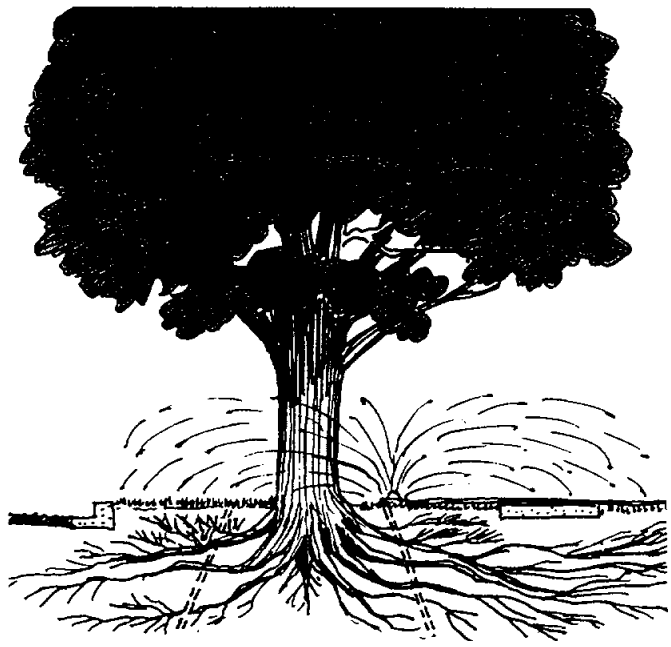
• The **Framework** of major roots usually lies less than eight to twelve inches below the surface and often grows outward to a diameter one to two times the height of the tree.

• A complex network of smaller non-woody **Feeder Roots** grow outward and upward from the framework roots. These smaller roots branch four or more times to form fans or mats of thousands of fine, short, non-woody roots. These slender roots, with their tiny root hairs, provide the major portion of the absorption surface of a tree's root system. They compete directly with the roots of grass and other groundcovers.

• Because **Roots Need Oxygen** in order to grow, they don't normally grow in the compacted, oxygen-poor soils under paved streets.

Note: A few species have a **Taproot** that grows straight down three to seven feet or more until they encounter impenetrable soil or rock layers, or reach layers with insufficient supplies of oxygen.

• Between four and eleven **Major Woody Roots** originate from the root collar and grow horizontally through the soil. These major roots branch and taper over a distance of three to fifteen feet from the trunk to form an extensive framework of long, rope-like roots which are 1/4 to one inch in diameter. These are important structural roots, supporting the tree against wind, etc.



Encourage Deep Root Growth

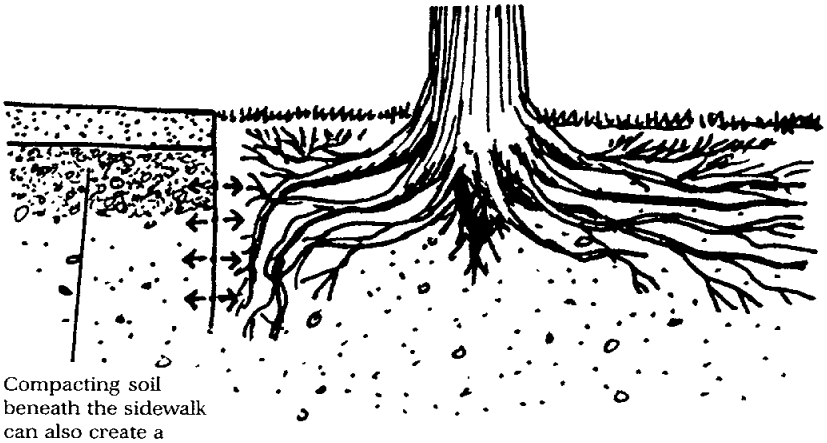
You can encourage the roots of your trees to grow deep and safely out of harm's way.

- **Watering**
  Short, frequent waterings wet only the top few inches of soil and encourage roots to grow near the surface. Water longer and less frequently, letting the soil become moist to a depth of several feet. Drilling can aid deep watering.
  One inch of water per week is recommended, applied slowly within the entire dripline (area under the spread of the tree's crown) and just beyond. You may want to water from a gently running garden hose for 4 to 6 hours on a weekly basis.

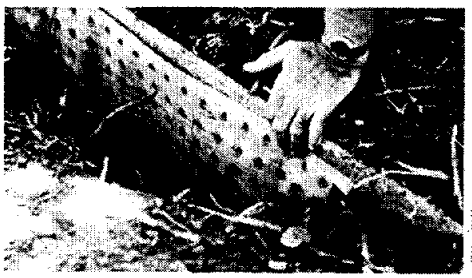
- **Holes**
  Every 2-3 years, 3 or 4 holes approximately 1-2 inches in diameter may be drilled or water-jetted at an angle down and outward from near the base of the tree. The holes allow penetration of water and oxygen.

Root Barriers

Barriers force root growth downward. Research is beginning to show that in well-drained, loamy soils, the trick works. Where soil aeration is poor from either compaction or excessive water; roots sometimes quickly turn back up toward the surface after passing the barrier. However, the roots seem to be less massive when this occurs. Gravel surrounding planter-type barriers like the one shown in the photo below, right, may also help supply enough water and oxygen to greater depths to meet the needs of the roots and keep them deep.



Compacting soil beneath the sidewalk can also create a barrier.



Bergmann Dept.

A variation of the solid barrier now being tested is a new herbicide-impregnated fabric that upon contact retards root growth by preventing cell division. The chemical is not taken up in the plant system like most herbicides, so there is no danger of killing the tree or spreading it to other trees through root grafts. The chemicals involved are said to be long-lasting, environmentally safe and non-toxic to animals. The fabric is flexible and can be wrapped around drain pipes to prevent clogging, or spread like a curtain to deflect growth from beneath sidewalk slabs.

Deep Root Corporation

Impenetrable barriers placed to a depth of 12 inches around the rootball of a new tree, or between a tree and a sidewalk, are showing promise of reducing damage to walkways. These may be commercial products, or such things as exterior grade plywood, inverted plastic garbage cans, metal, particleboard, etc.

Community Forestry and the Sidewalk Conflict

An active urban forestry program can be the best means of preventing conflicts between roots and sidewalks. By focusing attention on a few preventive methods, any community can cut the costs of sidewalk replacement, reduce the mess from torn-up streets, safeguard its trees, and protect people and parked cars from blown-over trees. But it takes planning, leadership and a willingness to compromise.

TREE CITY USA

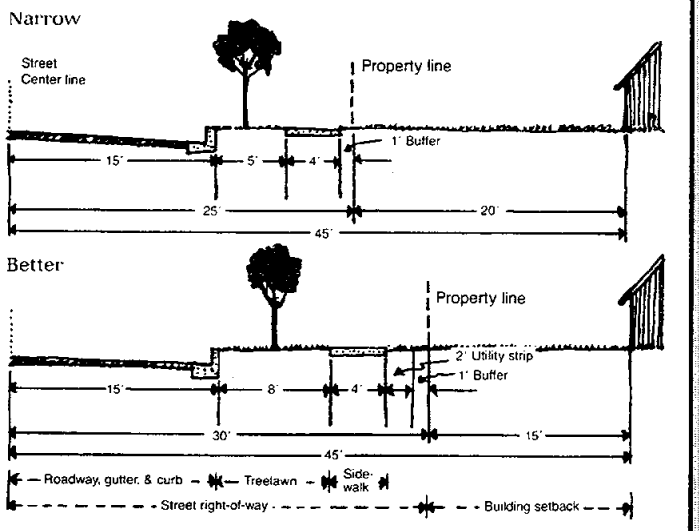
When You Start with a Clean Slate

The most efficient way of preventing conflicts is to plan for growing space before streets and houses are even built. Urban foresters and interested citizens need to work with developers and review all subdivision plans prior to their official approval. Space for tree planting *must* be addressed in the plans just like streets and sewers, and criteria need to reflect what is best for the community, not what is most expedient for the developer.

Curbside Treelawns

Curbside treelawns are disappearing as new neighborhoods expand the boundaries of our cities and towns. They are ignored by planners, written out by specifications calling for contiguous curbs and sidewalks, or they are built so narrowly they become a nuisance and soon get filled in with concrete. A revival of curbside treelawns would lend grace and beauty to our new developments, provide a place for piling snow off the street and sidewalks, and give an added measure of protection to pedestrians or children playing on the walks.

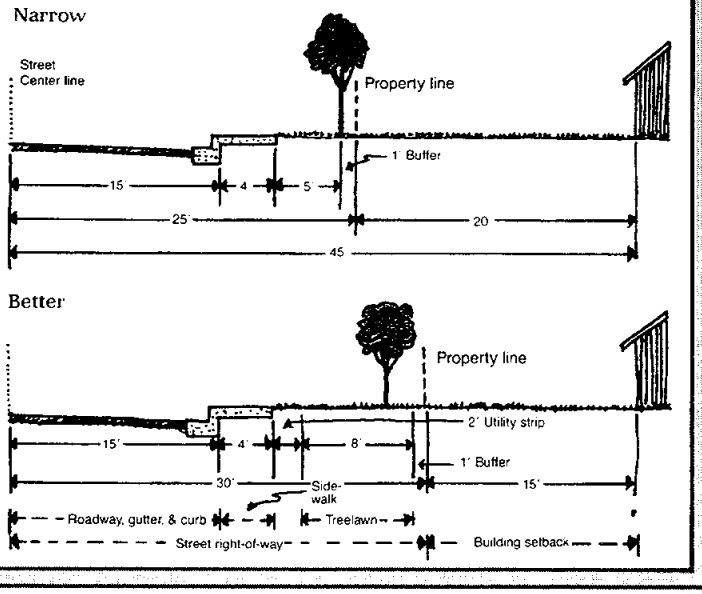
Although there is little agreement about the minimum width of a curbside treelawn, consider that even in an 8-foot strip, a mature tree planted in the center will still only have approximately 3 feet separating it from the sidewalk. This space needs to absorb the raised soil that accompanies the swelling of most older trees at ground level. The treelawn must also provide room for a large portion of the spreading lateral root system.



Boundary Treelawns

By planting trees at least 3 feet from the edge of the walk, there should be no problem with uplifting as the lower trunk expands.

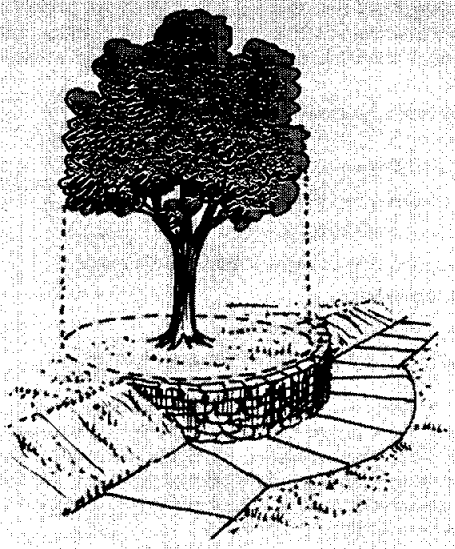
It is possible to provide either curbside or boundary treelawns of adequate width *without* reducing the number of lots per subdivision (a major objection from developers and tax-conscious officials). As illustrated by the USDA Forest Service's Landscape and Urban Forestry Research Unit at Berkeley, California, the difference between adequate and inadequate space for urban trees can be made up by reducing the required distance between the street right-of-way and the closest edge of a house or other building. *The space between the house and the actual street remain the same.* This is illustrated in the schematic to the right. Notice, too, that under improved conditions, a utility strip is provided and located far enough away from the trees that root damage is minimized when digging becomes necessary.



When You Replace a Sidewalk

In established neighborhoods, there is much that a good forestry program can do to prevent trees (and people) from being the losers when roots must be cut during sidewalk replacement. Here are some suggestions offered by experienced urban foresters:

- ☑ Prune a year in advance to reduce mechanical stress on the roots and to allow recovery before the tree receives additional trauma from root cutting.
- ☑ Do sidewalk work early in the spring and end all root cutting by mid-summer. This will allow maximum root recovery before dormancy.
- ☑ Provide a coordinated service in which the municipality does the pruning, then fertilizes immediately following construction. A needle-injected, soluable compound that is low in nitrogen and high in phosphorus and potassium is recommended for aiding root recovery.
- ☑ Provide residents who are affected by sidewalk replacement with literature about adequate watering (slow application of at least 1 inch of water per week. Better yet, give them a copy of this Bulletin.
- ☑ Write into any contract that excavated roots will be back-filled the same day to prevent drying. When this method is not possible, roots should be covered with wet burlap and watered. Cleanly prune off the jagged ends of cut roots.
- ☑ Require that digging near tree roots be done by hand rather than with a backhoe.
- ☑ Assign an arborist to monitor construction and assure that damage to trees is kept to a minimum.
- ☑ When grade changes are necessary, use retaining walls on cuts, or wells (covered by a grate) in fills, to minimize root cutting and to keep the base of the trunk at the original ground level.
- ☑ Make ordinances and street plans flexible enough to allow variations in sidewalk widths to accommodate existing mature trees.
- ☑ Match sidewalk construction standards to soil properties.



- ☑ Consult an arborist to evaluate the effects of root cutting. Species, prevailing wind patterns, lean, and condition of the tree help to predict the risks involved when roots are cut for sidewalk replacement. For safety, tree removal and replacement is sometimes necessary.

Cindy Richter

Randy Barger

When Minor Repairs Will Do

The root in the photo at the left has raised the sidewalk a bit. One option is to move the sidewalk a foot or two to the right — with the homeowner's permission. A less expensive solution is the addition of a sloped ramp, as shown below, to reduce tripping.

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Other Sources of Information

Tree City USA Bulletin will inform readers about helpful, up-to-date publications which provide more depth, or are readily available for community distribution. The editor welcomes sample copies to consider for inclusion in future revisions.

ROOT ECOLOGY

See "The Ecology of Tree Roots and the Practical Significance Thereof" by Thomas O. Perry. Journal of Arboriculture (P.O. Box 71, Urbana, IL 61801), August 1982.

USDA Forest Service Urban Forestry Research Unit

The USDA Forest Service conducts research on tree-sidewalk conflicts at its Pacific Southwest Forest and Range Experiment Station (P.O. Box 245, Berkeley, CA 94701). According to research horticulturist Philip A. Barker, numerous reports are available on research being done to identify possible solutions to this widespread problem. Copies are available for the asking and include:

Some Urban Trees of California: Maintenance Problems and Genetic Improvement Possibilities

Urban Foresters and Tree Improvement

Studies on Controlling Root Damage of Sidewalks

Tree-Root Damage to Sidewalks and Curbs

Planting Strips in Street Rights-of-Way: A Key Public Land Resource

Space for Trees in Street Rights-of-Way

Reducing Conflicts Between Sidewalks and Trees

Reducing Surface Rooting of Trees With Control Planters and Wells

American Forestry Association

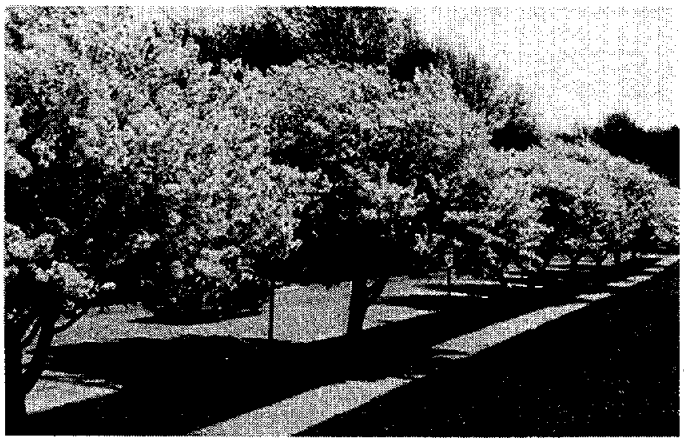
In California, Redwood City serves as a model program for restoring sidewalks while at the same time saving trees. The program is described in AFA's *Forum — Technical Update* titled "Solving Conflicts Between Trees and Sidewalks." Also available is "Solving Sidewalk Problems," part of the Home Workbook Series. These are available at no charge from: American Forestry Association, P.O. Box 2000, Washington, DC 20013.

To order additional Bulletin copies... Friends of Tree City USA members may obtain a single copy of any Tree City USA Bulletin free of cost. Quantities of any issue are available at 25 for $6.25 or 500 for $100. To order, specify the issue number and quantity, and make your check payable to: The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410

The Bulletins available are:

- No. 1 *How to Prune Young Shade Trees*
- No. 2 *When a Storm Strikes*
- No. 3 *Resolving Tree-Sidewalk Conflicts*

To join the Friends of Tree City USA... to receive a subscription to the Tree City USA Bulletin...and to become more involved in the urban forestry movement in your town and throughout America, send a $10 dues-donation to Friends of Tree City USA, National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. Make your check payable to National Arbor Day Foundation.



Cheryl Richter

TREE CITY USA

The Tree City USA program is sponsored by The National Arbor Day Foundation in cooperation with the USDA Forest Service and National Association of State Foresters. To be named as a Tree City USA, a town or city must meet four standards:

Standard 1: A Tree Board or Department
Standard 2: A City Tree Ordinance
Standard 3: An Annual Community Forestry Program
Standard 4: An Arbor Day Observance and Proclamation

Each winning community receives a Tree City USA flag, plaque, and community entrance signs. Towns and cities of every size can qualify. Tree City USA application forms are available from your state forester or The National Arbor Day Foundation.

88710021

Published for the
Friends of Tree City USA
by
The National Arbor Day Foundation
100 Arbor Avenue · Nebraska City, NE 68410

Plan to Avoid Future Conflicts

The best way to prevent tree-sidewalk conflicts is to keep the combatants separated from each other. This, of course, is not easy under crowded conditions, especially given a tree's natural tendency to spread its roots laterally in the upper soil layers where nutrients, water and oxygen are most plentiful. There is no single solution to the problem, but here are some techniques that may help.

Careful Selection

One simple solution to the tree-sidewalk problem that is available to anyone is to select the right tree for the right place.

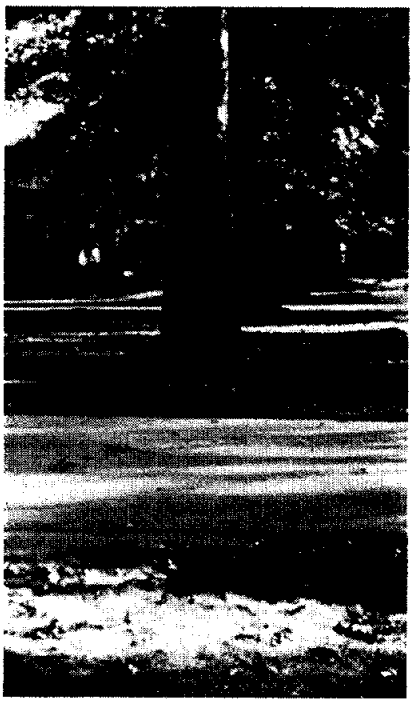
☑ Match tree size to the width of the tree-lawn

Treelawn	Tree size
4-6′	Small
6-8′	Medium
8′ or more	Large

Less than 4 feet is generally insufficient space for growing trees. (Select trees with a single trunk in narrow treelawns)

☑ Where construction, sidewalk replacement or other work is predictable and root-cutting is inevitable, use species that arborists have found to be more tolerant to root damage. Opinions and local conditions vary, but examples include: Norway maple, ginkgo, hackberry, hawthornes, ironwoods, cherries and river birch. (Note: Oaks, beeches and redbuds are among the species that often can *not* withstand root damage.)

☑ Always plant any tree at the correct depth. According to tree expert Dr. Alex Shigo, much unnecessary swelling at the base of tree trunks is caused by planting too deeply.



Cheryl Richter

☑ Deep-rooted trees like oaks are best near sidewalks.

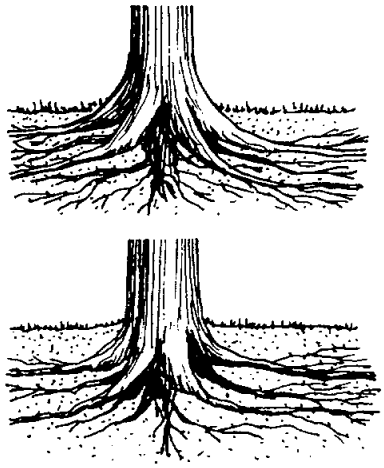
Better Sidewalks

Sometimes trees take a bum rap! As proof of this, notice that there are sometimes uneven sidewalks on streets where trees have never been planted. The reason is that soil type was not considered in construction of the sidewalk.

Where the soil type is one that shrinks and swells as moisture content changes, a higher standard of sidewalk construction is necessary to prevent lifting and sinking. This might include mechanically compacting the soil before paving (as is done on streets) and using thicker concrete with wire mesh reinforcement. This adds to the expense, but it will prolong the life of the sidewalk whether tree roots are present or not.

For help with identifying the soil properties under a sidewalk, obtain a soil survey map of the area from your local office of the USDA Soil Conservation Service. These maps usually rate soils for construction stability. If the soil is fill or mixed with other materials, a Soil Conservation Service specialist can tell you how to have the soil analyzed.

The Promise of Genetic Engineering



"...Tree species of a global origin in urban areas are diamonds in the rough...Their potential for genetic improvement compares to that of the wild ancestors of such commercial crops as corn, wheat, broccoli, apples and oranges."

–Philip A. Barker
USDA Forest Service

When researchers looked at 35 years of maintenance records for 100 sweetgum trees growing along a street in Oakland, California, they found that sidewalks or curbs never had been repaired or replaced beside three of the trees. Elsewhere in California, the scientists noticed that sometimes the buttressed trunk of the popular camphortree was missing, bearing instead a straight trunk right into the ground. Using tissue-cultured progeny of the individual trees with the more desirable traits, scientists hope to develop cultivars that send their roots deeper than their kin's

Another promising method is to graft (or bud) one species onto a rootstock of the same or different species that is inherently deeper-rooted. For example, ash cultivars which are commonly budded onto the shallow-rooted green ash may be improved for use along streets by budding them onto a deeper-rooted species such as Arizona ash.

Avoiding Conflicts (Continued)

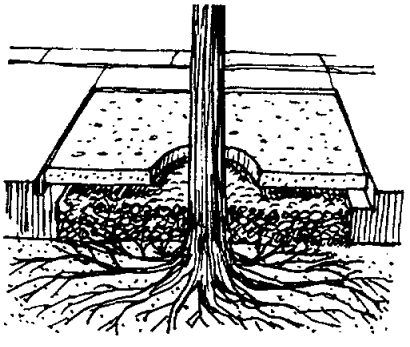
Vancouver Parks and Recreation

An attractive alternative to bare earth or loose mulch is to cover the soil with a layer of sand, then bricks or paving blocks. As the tree grows, the bricks or blocks must be removed to enlarge the growing space.

Use Pavers and Grates

There are many ways to provide expansion space for sidewalk trees while at the same time providing adequate water and aeration.

Whatever is used to cover planting wells, have a plan for enlarging the cover as the tree ages and the trunk widens. Otherwise, the cover will damage and eventually kill the tree. Inspection and adjustment must be planned into the community forestry program just like pruning or watering.

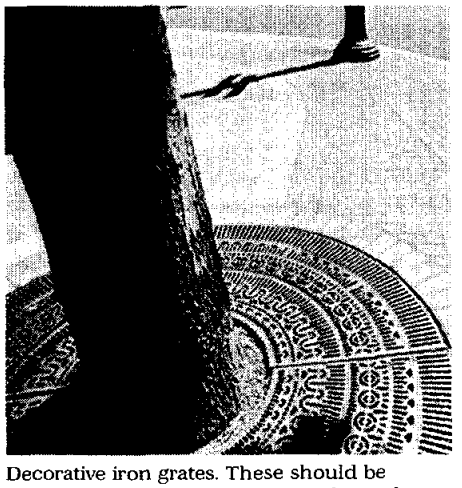


The use of planting wells with covers such as 2-inch-thick wood planks provides a smooth walking surface. This method also allows deeper planting, helping to keep roots away from the surface as they begin to spread from beneath the tree's root collar. By filling the space under the cover with coarse gravel, problems with rodents and trash buildup can be reduced.

The tree wells should be large — 4 to 6 feet square — for best effectiveness.

One method is simply to leave a patch of earth, sand or decorative gravel, delineated and held in place by landscaping timbers or concrete. However, if the border is raised, as in this one, it can be a potential tripping hazard and would be illegal in some cities.

Concrete slabs. Note placement of pavement joints that will minimize pavement replacement when roots eventually follow their predictable path to the lawn area.



Decorative iron grates. These should be removed when the tree grows to their edge.

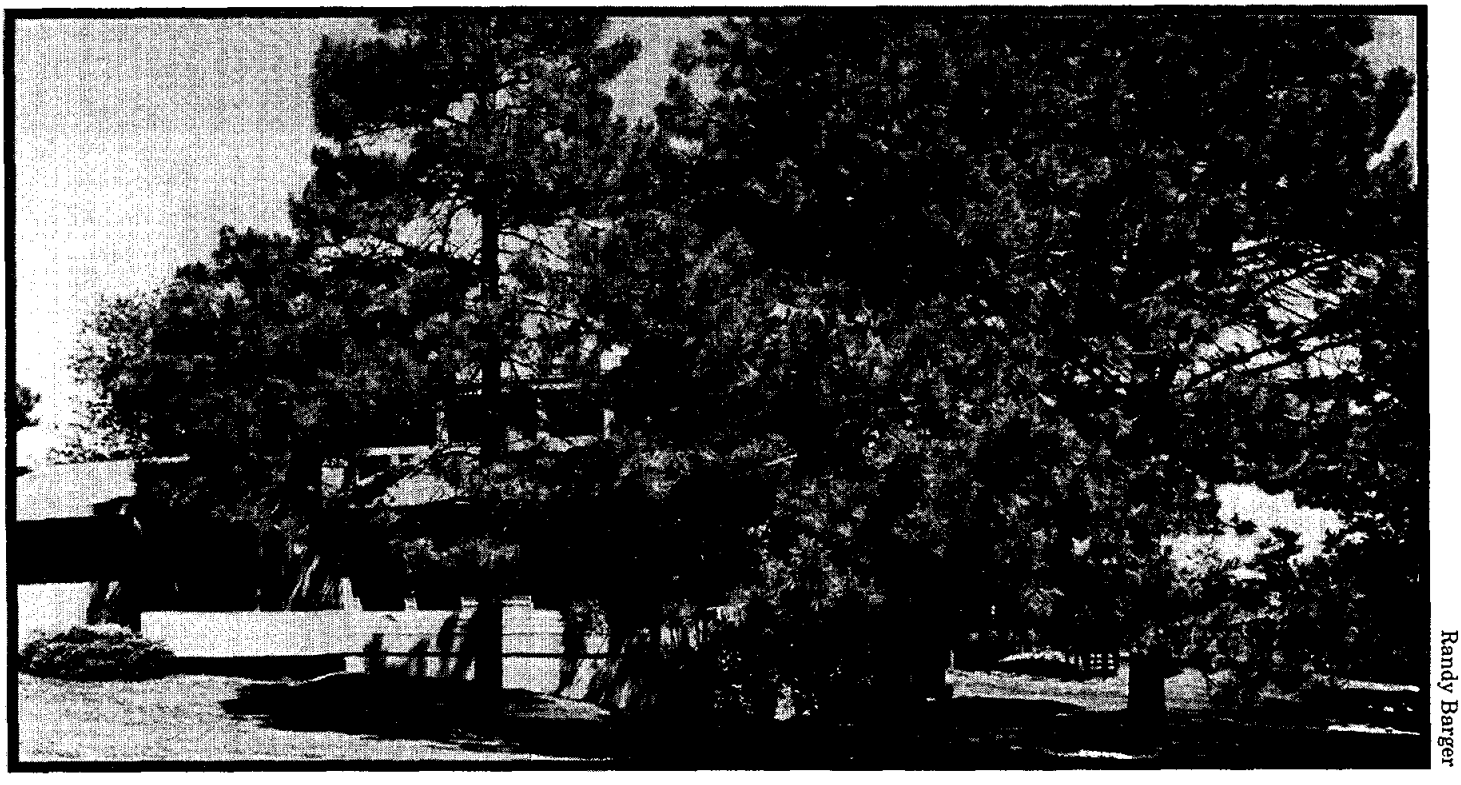
SPC Structural Plastics

Tough, but lightweight structural plastic/-fiberglass.

TREE CITY USA
BULLETIN
for the
Friends of Tree City USA

Bulletin No. 7
James R. Fazio, Editor

How to Save Trees During Construction



Randy Barger

Life is just better when you are surrounded by trees. Bird songs fill the air adding delight to daily routine. Trees cast their sheltering shade as they moderate the temperature, quiet the noise, and clean the air.

In summer, shade trees can save up to 50% of air-conditioning costs. In winter, windbreaks can reduce heating bills as much as 30%.

As an organization, The National Arbor Day Foundation works hard to encourage people to plant trees. However, it is equally important to save the trees that Mother Nature has invested years in growing.

Saving trees during construction often requires courage by an individual — especially in communities where the common practice is simply to bulldoze everything in sight before construction begins. Of all the letters I receive here at the Foundation, few inspire me more than the stories of people who battled to save trees that were to have been needlessly destroyed for a construction project. And few sadden me more than the stories of people who willfully destroy trees that could and should be saved.

But saving trees during construction requires more than the right attitude. It requires the right actions. Bulletin editor Jim Fazio has prepared a concise description of the actions you need to take to ensure the health of existing trees long after the sounds of construction fade away. I hope you will put this good information to good use. Your efforts will pay off for years as you enjoy the trees you've saved.

John Rosenow

John Rosenow
Executive Director
The National Arbor Day Foundation

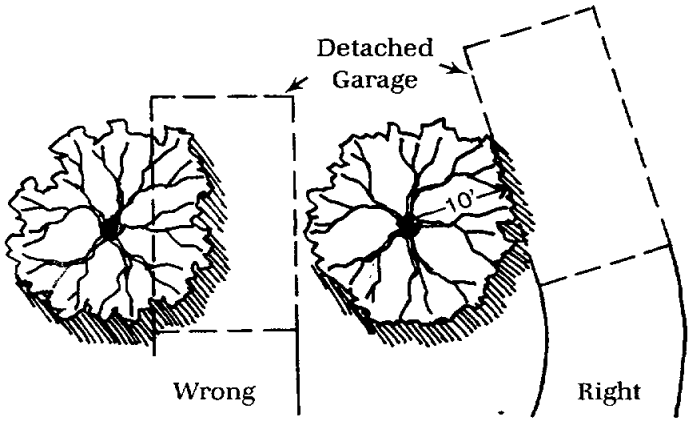
Plan to Avoid Trouble

Randy Barger

One of the toughest parts of building on a wooded lot is also the first step — deciding which trees to save and which to cut. A good rule to remember is that it is easier, cheaper and safer to remove future problems *before* construction begins.

Here's how:

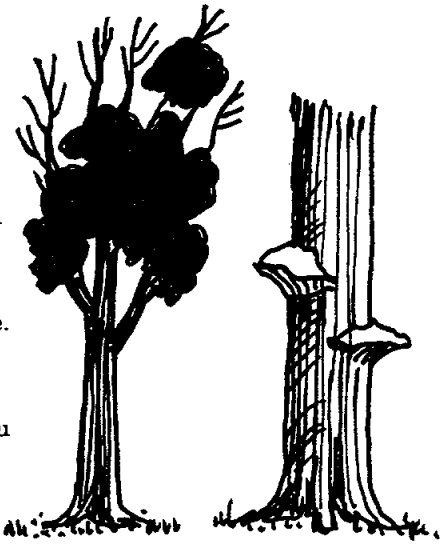
Right Site, Right Trees



1 On a plat of your property, show the location of trees that are important to you. Consider these in deciding the location of the house, garage, driveway, walks, and patio. Stake out the location of improvements for better visualization. Sometimes by changing the angle of a building or curving a walk you can preserve the essential root space of a prized tree.

2 Know your trees, or find someone who does. This is necessary to help make the right decisions. For example, some species growing in shade may do poorly if changes result in more sunlight. Each species also differs in how it can withstand root cutting or how susceptible it is to local insects and disease. A knowledge of trees will help guide your decisions about which to remove and which to save.

3 Consider the vigor and health of existing trees. If the tips of the branches are dying on a large tree or fruiting bodies of fungus are growing on its trunk, it is probably over-mature. In general, it is best to keep only those trees that are in good health. An arborist can help you evaluate tree health.



4 If the existing trees make it possible, try for a good mix of ages and sizes in the stand that remains after construction. This is more visually pleasing, and reduces the impact when a tree does die.

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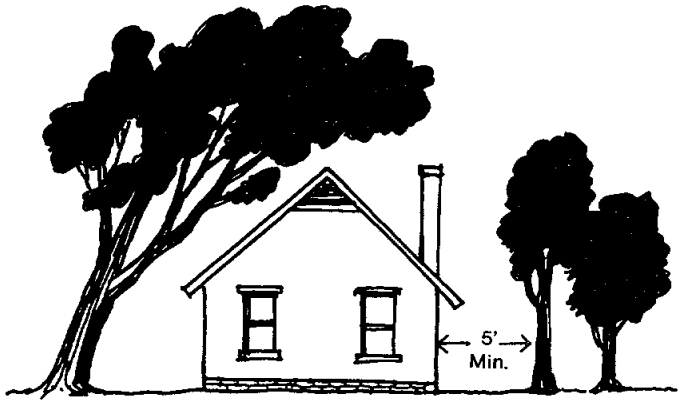
Removals and Pruning



- ☑ Remove trees that are leaning over the site of future structures.
- ☑ It is usually best to remove trees that will be closer than five feet from a new house.
- ☑ Rather than destroying all trees where structures will be located, consider transplanting trees that are under two inches in diameter and ten feet tall. Tree spades can move larger trees.
- ☑ After all trees to be saved are selected and marked with bright-color flagging, prune each one as needed. Follow the guidelines of good pruning that are available from local experts or are shown in *Tree City USA Bulletins 1 and 2.* Pruning will help trees survive the stresses of construction activities. Also, for safety, remove large limbs that will overhang structures.

Design with Nature

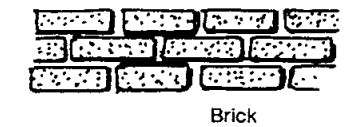
To minimize root damage, do not alter the terrain except where absolutely necessary. Levelling, cutting and filling:

- severs roots
- removes nutrient-rich topsoil
- dries roots when soil depth is reduced
- smothers roots when soil depth is increased
- changes the natural flow of water

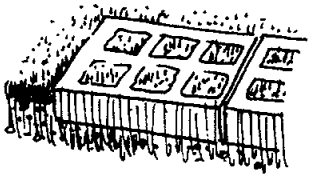
An architect can help by:

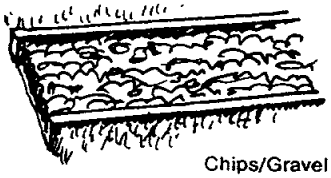
- ☑ locating buildings to harmonize with the natural terrain
- ☑ using posts, bridges and decks to suspend parts of buildings over uneven terrain
- ☑ raising paved driveways and using similar techniques that minimize excavation

To allow maximum aeration and water penetration to tree roots, select walk materials other than concrete or asphalt:

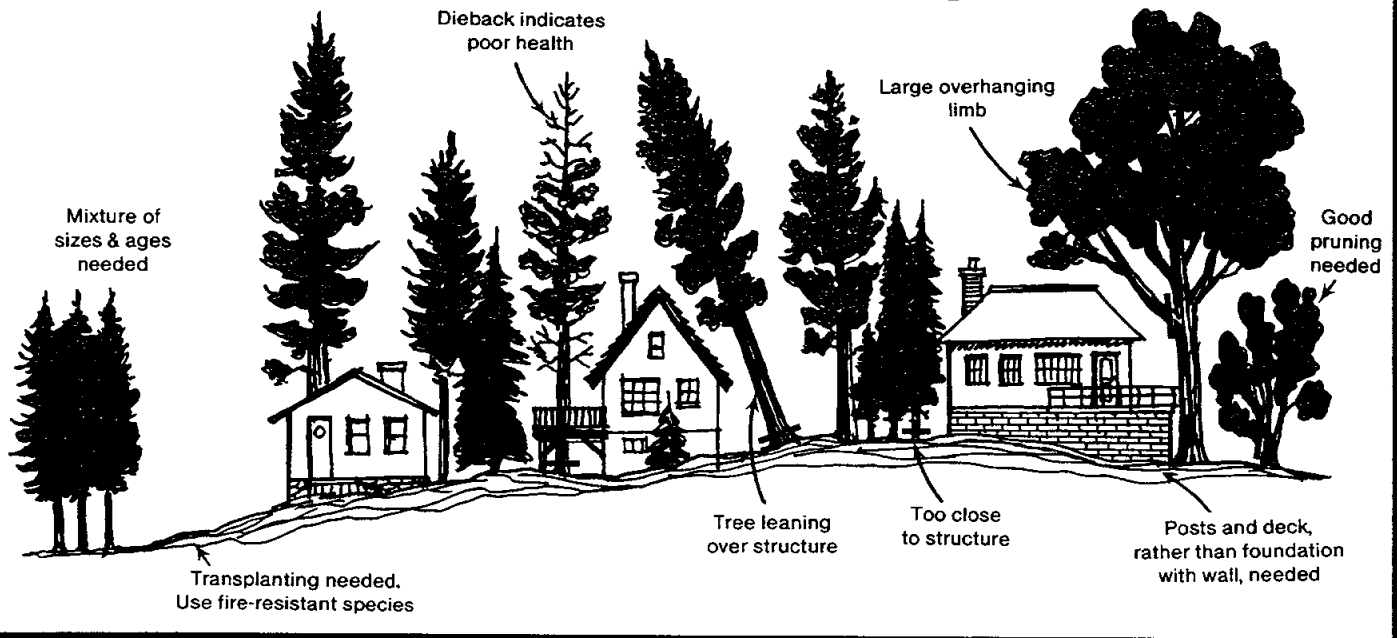

Brick


Flagstone


Honeycomb Block


Chips/Gravel

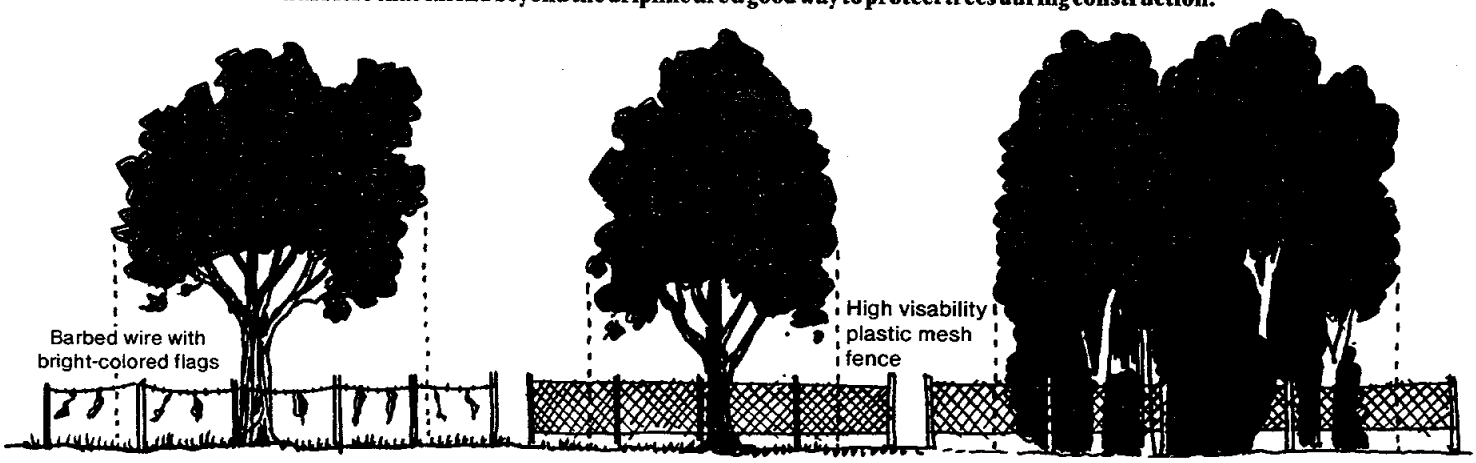
Some Problems that Planning can Prevent



Avoiding Damage During Construction

As the organized chaos of building takes place, the surest way to protect trees that are to be saved is to: (1) work with the builder to locate and mark with flagging and/or signs all construction roads, parking places for workers, and areas for storage of building materials, gravel and soil, (2) work with utility contractors to stake out the exact locations of trenches, and (3) erect physical barriers around all "save" trees or, better yet, around *groups* of trees, near the construction activity.

Barriers that extend beyond the dripline are a good way to protect trees during construction.



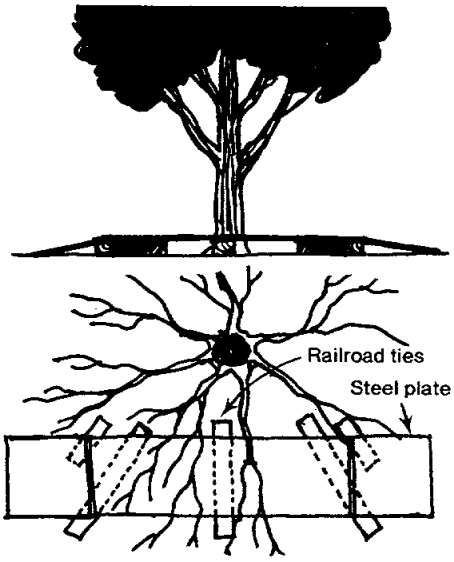
Below the Ground

A Cardinal Principle:

What happens below the ground is more important than what meets the eye above ground!

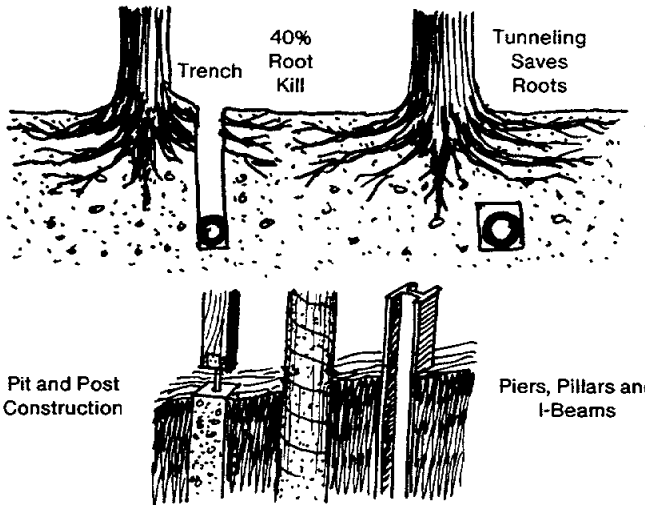
Soil Compaction

The key to tree survival in the years following construction is protection of the roots *during* construction. This is probably the most insidious problem because the results of compaction cutting off air and water passages in the soil show up slowly. When barriers are not possible to keep away vehicles and foot traffic, other protective methods that can be used include: spreading several inches of wood chips; pumping concrete from the truck through conveyor pipes instead of driving over root systems; and bridging root areas with plates of steel.



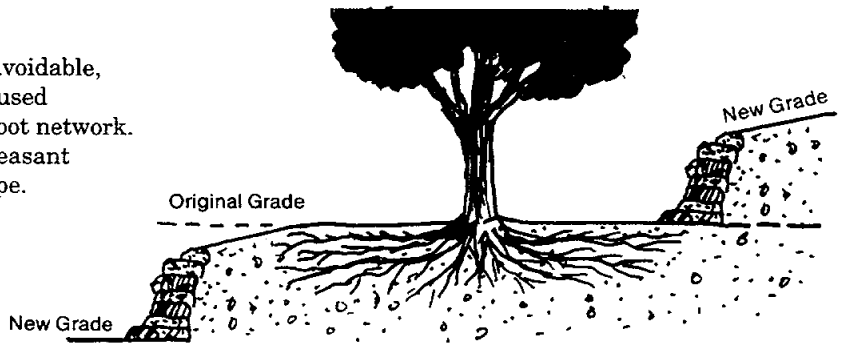
Severing Roots

Some cutting of roots near construction is inevitable, but much *is* avoidable. For example, the routing of underground utilities does *not* have to follow a straight line from street to house. Careful route selection can often avoid important trees. When that is not possible, tunneling is a good way to reduce damage. To reduce trenching for foundations, posts and pillars can be substituted for footers and walls.

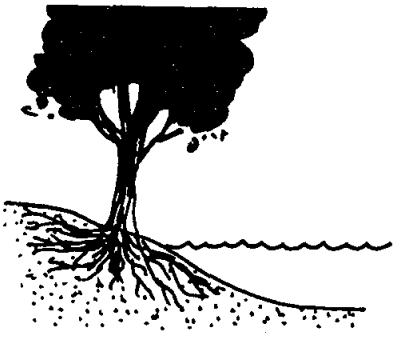


Changing Grade

If a grade change is unavoidable, a retaining wall can be used to protect much of the root network. It can also lend some pleasant diversity to the landscape.



Drainage Changes



If terrain is altered, there will be a change in how water drains from the land. If flows are created that add too much moisture to a wooded site, a drainage system may be needed to maintain the previous amount of moisture (which provided the natural growing conditions for the existing trees). Similarly, existing trees along the edge of a new pond may eventually die from their roots suffocating. On sites *deprived* of water, irrigation may be needed to maintain existing trees.

Above the Ground

Breaks and Scrapes

Even with barriers around trees, equipment sometimes breaks limbs or gouges tree trunks. Watch for damage and repair it promptly. See *Tree City USA Bulletin No. 2.*

Soil Chemistry

Poisoning or otherwise altering the soil can result in weakened trees, making them more susceptible to insects and disease. In some cases, trees can be killed outright within a few years after construction. To prevent adverse effects on soil chemistry:

- ☑ Spread heavy plastic tarp where concrete is to be mixed or sheet rock will be cut. The alkalinity of these materials can change the soil pH.
- ☑ Read labels. Do not use wood products containing pentachlorophenol. These are deadly to roots. CCA-treated timber (greenish color) is a safer alternative.
- ☑ Paint brushes and tools should not be cleaned over tree roots.
- ☑ Chemical wastes (paint thinner, etc.) should be disposed of properly and not drained on site. Local sanitary authorities can advise on recommended disposal methods.

Nails

Keep trees free of nails, screw eyes and other fastening devices. Use posts, not trees, for signs, electrical wires, pulleys, etc.

Communication is Essential

Duane Belanger© 1988 The Detroit News

There are many techniques that will help save trees during construction, but this in only one part of the challenge. The key to success is communication. It begins with the property owner making it very clear to the architect that mature trees on the lot are just as important as the size of the kitchen. In fact, you may want to seek out an architect who has interest and experience designing with trees in mind. Communication continues as plans are discussed with landscape architects, arborists, foresters, extension agents or other experts.

Most importantly, communication with the actual builder is essential. Many builders sympathize with the need to save trees, but often they view it as too time-consuming or otherwise costly. Still others may not know as much about tree-saving techniques as you do, so there is an education challenge.

Finally, there are the dozer operators, truck drivers, painters, masons, and a small army of others who are on the site daily. While it is usually not possible to work with each one or even visit the site daily, it *is* possible to convince contractors and foremen that you are serious in your desire to save trees and that they need to relay this concern to their workers.

To Save A Tree...

When this house was recently constructed, the 30-year-old pin oak directly adjacent to it was kept vigorously healthy, a result of good planning and communications. These are the steps that were taken:

- The house was designed so that a terrace on piers was located near the tree, not a wall requiring a foundation and footings.
- As much of the tree's root zone as possible was fenced off to minimize the compaction of the roots by construction equipment and workers.
- The pier at the corner of the terrace nearest the tree was carefully located between major roots so the roots were not severed.
- Following construction the soil in the root zone was aerated by an arborist injecting pressurized water.
- A fertilizer high in phosphorus was applied to stimulate root growth.

A beautiful, healthy, mature tree shading a new house is the result.

A Word about Water, Bugs and Disease

Despite your best efforts, trees in construction areas will suffer some degree of stress. Unfortunately, trees under stress fall victim more easily to insect and disease attacks.

A good way to help your trees stay healthy is to provide adequate water during dry spells both during construction and afterwards. Soil should be moistened to a depth of approximately 12-18 inches. A good rule of thumb is to slowly apply at least one inch of water per week over the entire area beneath the tree's branches.

Inspect your trees regularly and consult an expert if insect or disease damage begins to appear.

Keep Your Property Fire Safe

In all regions of the country, homes in wooded areas are destroyed each year by wildfires. Keep your home and neighborhood safe by:

- breaking up solid areas of evergreens.
- asking nursery professionals about fire-resistant shrubs to use in landscaping.
- keeping trees well-watered, regularly pruned and in healthy condition.
- preventing build-up of leaves and old branches.
- making sure your roads and bridges allow access for heavy fire equipment.
- and, of course ... think! Prevent forest fires.

For more information about fire-safe construction in wooded areas, write for a copy of *Wildfire Strikes Home* (National Fire Protection Assoc., Fire Prevention Division, Batterymarch Park, Quincy, MA 02269.)

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Construction and the Urban Forestry Program

In communities where the urban or suburban forest is endangered by building projects, protection of existing trees deserves high priority in the urban forestry program. There are three primary paths to action:

1 Ordinances

Many communities have found it necessary to regulate the development of private property in order to protect the public-asset value of trees. This will be covered in more detail in a future issue of *Tree City USA Bulletin*. However, there are alternatives to legal restrictions, and in most cases the benefits from enlightened private enterprise pay higher dividends to the community.

2 Education

Professionals in urban forestry are usually in a good position to provide the education necessary to save trees during construction, or at least to begin the chain reaction. In this process, there are several distinct audiences to reach, each needing a different approach. For example:

Homeowners
Whether for do-it-yourself projects or planning a new home, homeowners need to be made aware of the benefits provided by mature trees and how to protect these assets. The owner is in the catbird seat when it comes to working with builders, but he or she needs to know the available options.

Architects
Some architects specialize in designing with nature, but to others the potentials need to be pointed out. Architects not only have the opportunity to prevent many kinds of tree problems for their clients, they can also enhance their firm's reputation by demonstrating a sensitivity toward trees on wooded lots.

Developers / Builders
Once a developer or builder understands the concept of saving trees, it has been estimated that he or she can add 3-7 percent to sale prices — and sometimes even save on labor costs by clearing less land. However, more is required than simply not cutting down trees. Knowledge of the long-term effects of each activity is needed, and how to avoid negative impacts.

City Employees
Sewer and utility workers, sidewalk crews and engineers need to understand the damage that trenching can do. Without their respect for roots, all other efforts can come to naught.

Others
Real estate agents, planning and zoning boards and others need to be made aware that wooded property is more appealing, offers a higher standard of living, and commands higher re-sale prices than similar property that has been denuded during construction.

In all cases, copies of this bulletin may serve as a good starting point. Encouraging all parties to seek the assistance of urban foresters and arborists *before* construction begins would also be a valuable service.

3 Public Action

Actions do speak louder than words and they are a good way to get public attention. Saving trees during construction must include the projects of government. Whether it is widening a street or building a new office complex, an urban forestry program can guide the way to saving trees and set a good example for others to follow.

Some model projects include:

In Keene, New Hampshire, trees were saved during downtown renovation by moving 7- to 8-inch maples to another part of town, then re-planting some on site when construction was ended. In addition to saving trees, a benefit was that the older trees lent variety to the sizes in the revitalized downtown area.

In nearby Durham, New Hampshire, the local tree warden seized upon an opportunity to save trees during the development of a shopping mall. The warden convinced the developer to give the town funds equivalent to the costs of tree removal. Using this money, the town was able to have the trees moved to public property rather than destroyed.

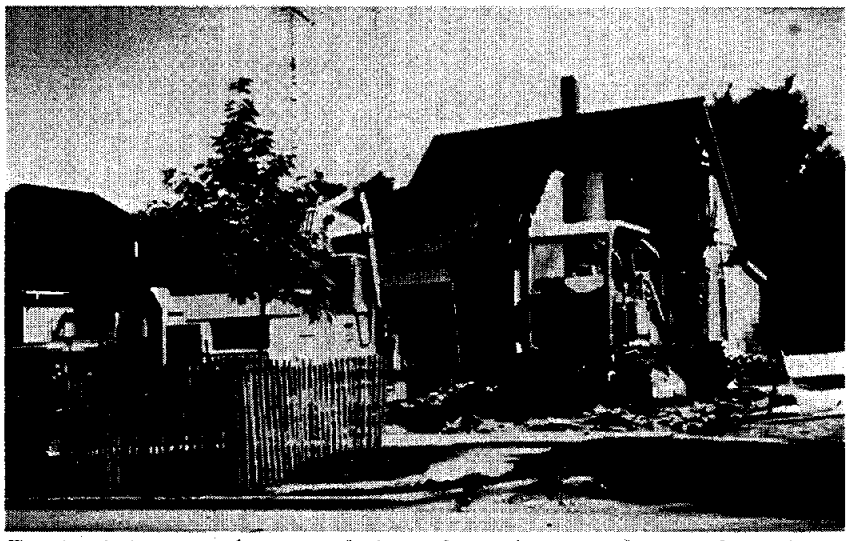
In Fort Collins, Colorado, old-aged cottonwoods were spared during improvement of an arterial highway by redesigning the bicycle lane. Rather than adhering to the straight-line design, some curves in the bicycle lane were added and it now swings away from the road and behind the trees. Widening the lane at its curves added some cost to the project, but large trees still grace that section of the city. Elsewhere in Fort Collins, the planning and zoning board blocked development of a 15-acre shopping mall because no way could be found to preserve a small creek and the trees on its banks. The stalemate was broken when a city councilman suggested saving as many of the trees as possible and paying the city a sum of money to be used toward preserving open space elsewhere.

In saving trees during construction, the right action begins with awareness of the values of large trees and a "can do" attitude. The result is a better community for everyone!

TREE CITY USA

Training Opportunity

Learn a system and specific techniques for saving trees during construction by attending a Building *With* Trees Workshop. For a list of workshop dates and locations, contact The Arbor Day Institute, P.O. Box 81415, Lincoln, NE 68501 or phone 402-474-5655.



Fencing is just one of many techniques for saving trees that are shown in the videos described below.

Other Sources of Information

VIDEOS

Two useful videotapes are available for self-study, or to show at meetings of builders, developers, architects, planning and zoning boards, tree commissions, neighborhood associations, civic groups and others that can make a difference. Both tapes are VHS ½" and can be purchased for $25 each. Contact:

International Society of Arboriculture
PO Box 908
Urbana, IL 61801

"Effects of Construction Damage to Trees on Wooded Lots" (Tape I)
The purpose of this video is to create an awareness that trees are easily damaged during construction, and why. Examples are shown, including some techniques for prevention. (15 min.)

"Avoidance of Construction Damage to Trees on Wooded Lots"
This is an interesting and comprehensive overview of how developers, builders, landscape architects, arborists and homeowners need to work together to avoid damage to existing trees on a building lot. Testimonials and examples make this a very effective tape. (22 1/2 min.)

REPRINTS

The following reprints from the *American Forests* Home Workbook Series were written by urban forester Gary Moll and are available free from:

American Forests
PO Box 2000
Washington, DC 20013

"Creative Construction (Or, How the do-it-yourselfer can avoid killing trees)"
"How to Select a Wooded Homesite" Parts I & II

BOOKLET

"Protecting Trees When Building on Forested Land"
This excellent, 12-page, full color booklet is especially applicable in California and the west coast. It includes discussions of insect and disease threats that should be considered when building on a wooded lot. Copies are for sale at $1.25 each; 20% discount for 10-49; 25% discount for 50 or more. Add 15% of total for shipping/handling. Order from:

ARA Publications
University of California
6701 San Pablo Ave..
Oakland, CA 94608-1239

To order additional *Bulletin* copies... Friends of Tree City USA members may obtain a single copy of this or any of the preceding *Tree City USA Bulletins* free of cost. Quantities of any issue are available at 25 for $6.25 or 500 for $100. To order: specify the issue number and quantity, and make your check payable to The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410.

The Bulletins available are:

- No. 1 *How to Prune Young Shade Trees*
- No. 2 *When a Storm Strikes*
- No. 3 *Resolving Tree-Sidewalk Conflicts*
- No. 4 *The Right Tree for the Right Place*
- No. 5 *Living With Urban Soils*
- No. 6 *How to Hire an Arborist*
- No. 7 *How to Save Trees During Construction*

To join the Friends of Tree City USA... to receive a subscription to *Tree City USA Bulletin*, and to become more involved in the urban forestry movement in your town and throughout America, send a $10 dues-donation to Friends of Tree City USA, The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. Make your check payable to The National Arbor Day Foundation.

TREE CITY USA

The Tree City USA program is sponsored by The National Arbor Day Foundation in cooperation with the USDA Forest Service and National Association of State Foresters. To achieve the national recognition of being named as a Tree City USA, a town or city must meet four standards:

Standard 1: A Tree Board or Department
Standard 2: A City Tree Ordinance
Standard 3: An Annual Community Forestry Program
Standard 4: An Arbor Day Observance and Proclamation

Each winning community receives a Tree City USA flag, plaque, and community entrance signs. Towns and cities of every size can qualify. Tree City USA application forms are available from your state forester or The National Arbor Day Foundation.

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The National Arbor Day Foundation™
100 Arbor Avenue Nebraska City, NE 68410

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TREE CITY USA
BULLETIN
for the
Friends of Tree City USA

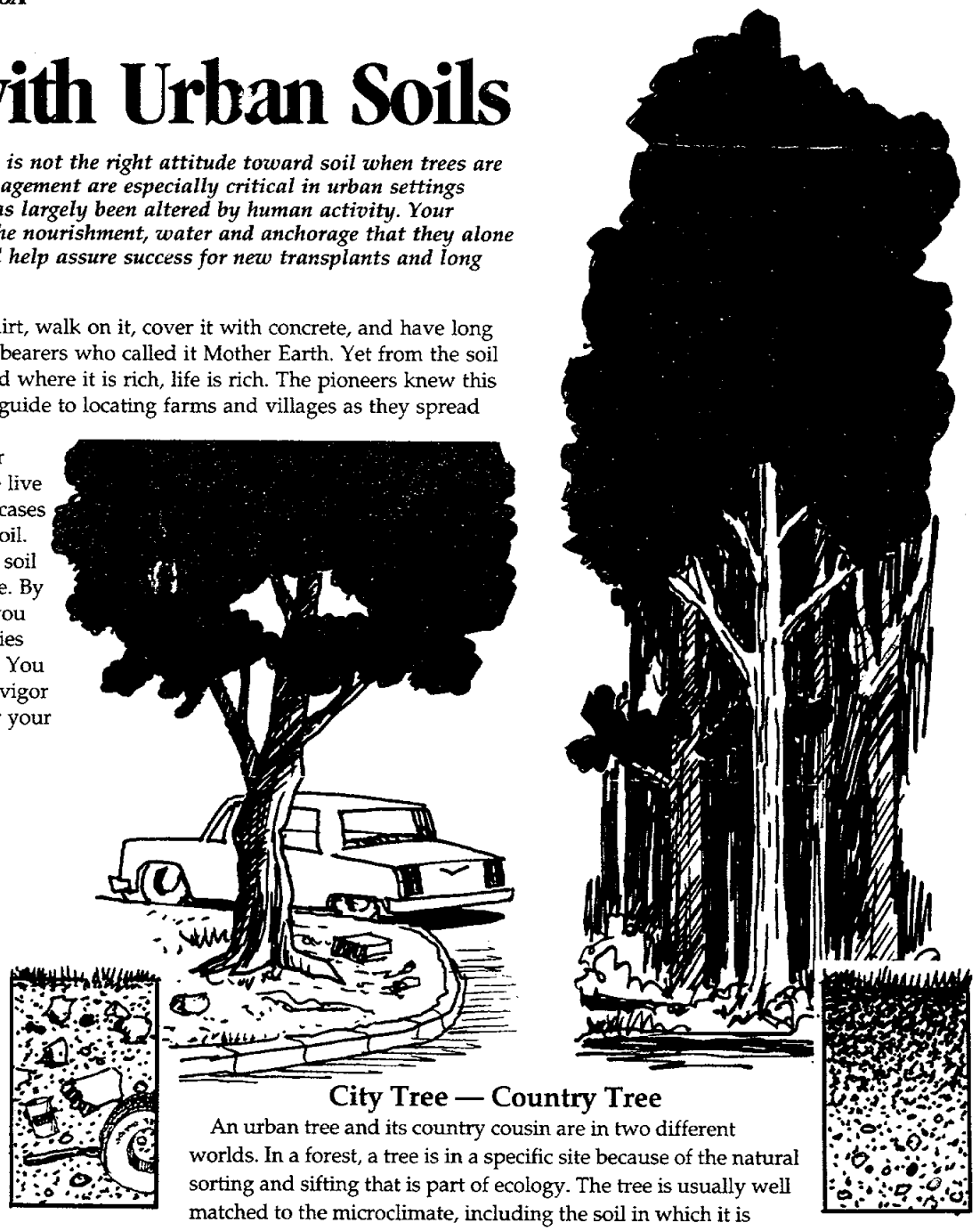
Bulletin No. 5
James R. Fazio, Editor

Living with Urban Soils

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

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

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



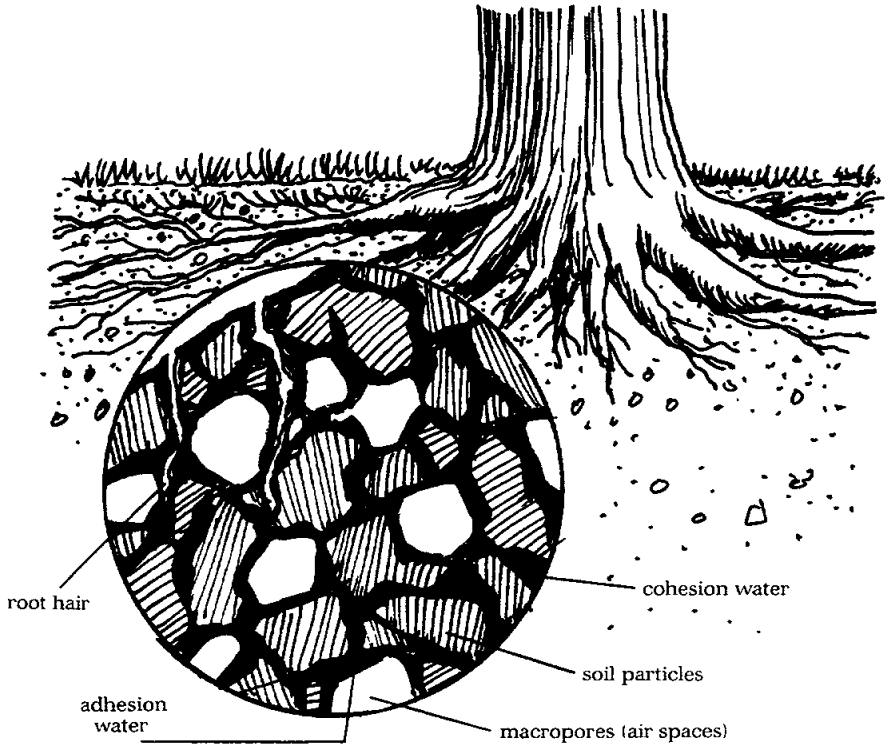
City Tree — Country Tree

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

Understanding the Nature of Soils

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

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



In most healthy soils, the combination of these soil features is approximately 50 percent inorganic minerals, 1-6 percent organic matter, and 44-49 percent pore space for use by water and oxygen.

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

Soils are highly variable. Their diversity is the product of dozens of physical and climatic factors, all interacting over time to yield the substance that lies under your lawn. Scientists have identified thousands of soils with specific characteristics, mapped their locations, given them names after the localities where they're found (Yakima loam, Gooding silt loam), and described their properties that are either a help or hindrance to farming, tree growth and building activities.

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

Know Your Soil

For a description of the soils in your area, there is nothing like a soil map produced by the USDA Soil Conservation Service. Contact your local SCS office through the phone directory and obtain the soil survey map for your county. Find your home on the map, then read the description of the native soil on your property. You will also be warned of any limitations such as shallowness, lack of fertility, potential for erosion, and a score of other details. There is a soil survey map for every county in the United States.

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

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

Key Soil Features that Affect Tree Growth

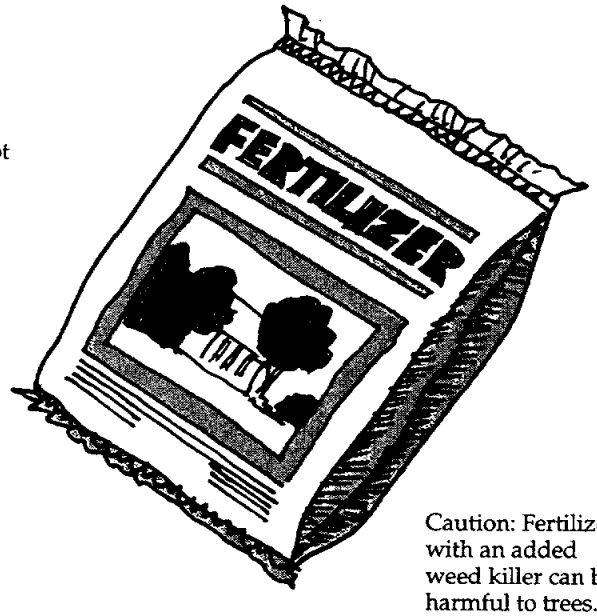
- ☑ **Texture** — The size distribution of particles (See chart below).
- ☑ **Structure** — Groupings of soil particles, held together chemically and electrically and aided by decomposing organic matter. Soil with "good" structure (aggregates of particles) provides a better environment for roots.
- ☑ **Depth** — The depth of the topsoil layer, which contains organic matter and the total distance from surface to bedrock.
- ☑ **Hardpan** — A sub-surface layer impervious to water drainage and root penetration.
- ☑ **pH** — Acidity or alkalinity ranging from 3 (strongly acid) to 11 (strongly alkaline), with 7 being neutral.
- ☑ **Nutrients** — Essential for plant growth, including trees.

Macronutrients:
nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg)

Micro (trace) Nutrients:
manganese (Mn), zinc (Zn), boron (B), copper (Cu), iron (Fe), molybdenum (Mo), chlorine (Cl)

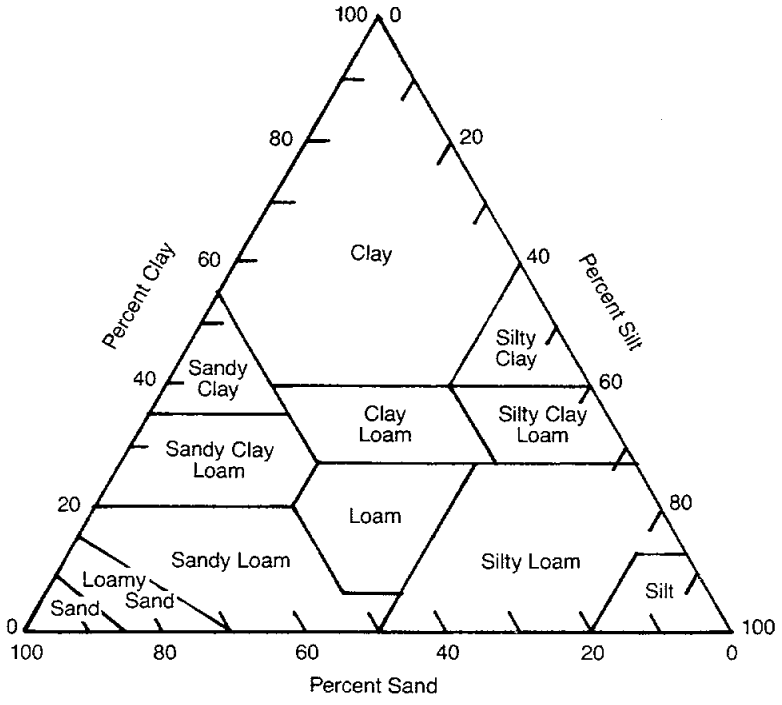
From Air and Water:
hydrogen (H), oxygen (O), carbon (C)

Note:
On most fertilizer packages used by homeowners there is a 3-part figure such as 10-8-6 or 20-20-20. These numbers refer to the main ingredients, nitrogen (N), phosphorus (P), and potassium (K) — always in that order. The numbers are the percentage, by weight, of the three nutrients. Other nutrients are sometimes added, and will be labeled accordingly. Most of the package consists of neutral bulk materials.



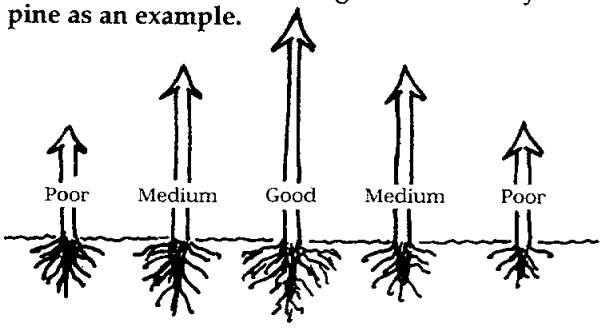
Caution: Fertilizers with an added weed killer can be harmful to trees.

Soil Texture



- **Clay** — Smaller soil particles with wafer-like shapes that provide greater surface area, contributing to a higher ability to hold water and nutrients.
- **Silt** — Between clay and sand in particle size; spherical and cubical in shape.
- **Sand** — Largest particle size; has spherical and cubical shapes that provide smaller surface-to-volume ratio and therefore a soil that is better aerated and easier to work, but which has the lowest water-and nutrient-holding abilities.
- **Loam** — A combination of all particle sizes, with the desirable attributes of each.

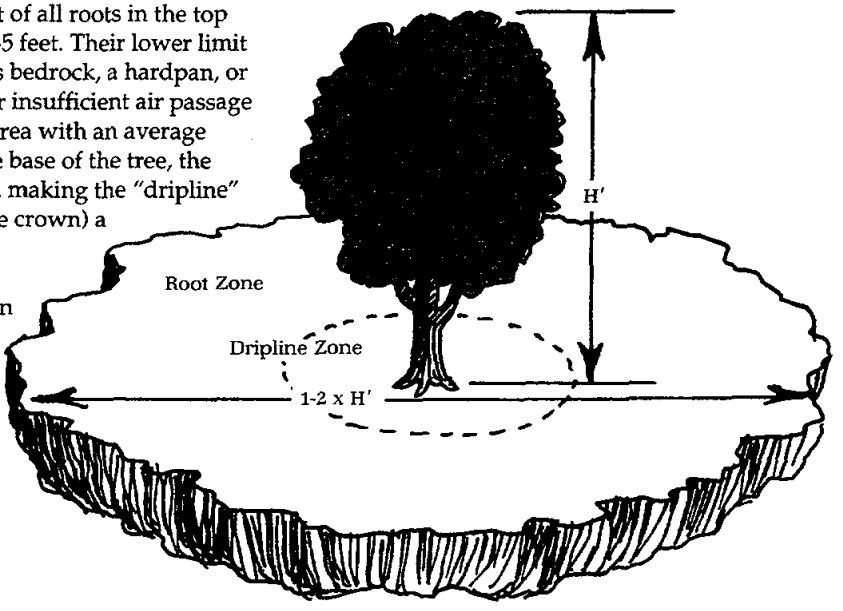
How texture can affect tree growth. Loblolly pine as an example.



Solving Problems Created by Soil

The life of your tree depends on the soil in its root zone. The zone occupies a surprisingly large and shallow area, with about 90 percent of all roots in the top 24 inches of soil, and usually not extending deeper than 3-5 feet. Their lower limit depends on where they reach one or more barriers such as bedrock, a hardpan, or a lack of oxygen caused either by water (the watertable) or insufficient air passage through the soil. The outward spread forms an irregular area with an average diameter roughly 1-2 times the height of the tree. Near the base of the tree, the vast network of roots narrows into fewer, shallower roots, making the "dripline" zone (the area beneath and within the circumference of the crown) a particularly critical area for the tree.

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



Note:
Before drilling or digging, always contact your local telephone and utility companies. They will be glad to mark the location of buried cables and pipes to prevent costly breakage.

Nutrient Deficiencies

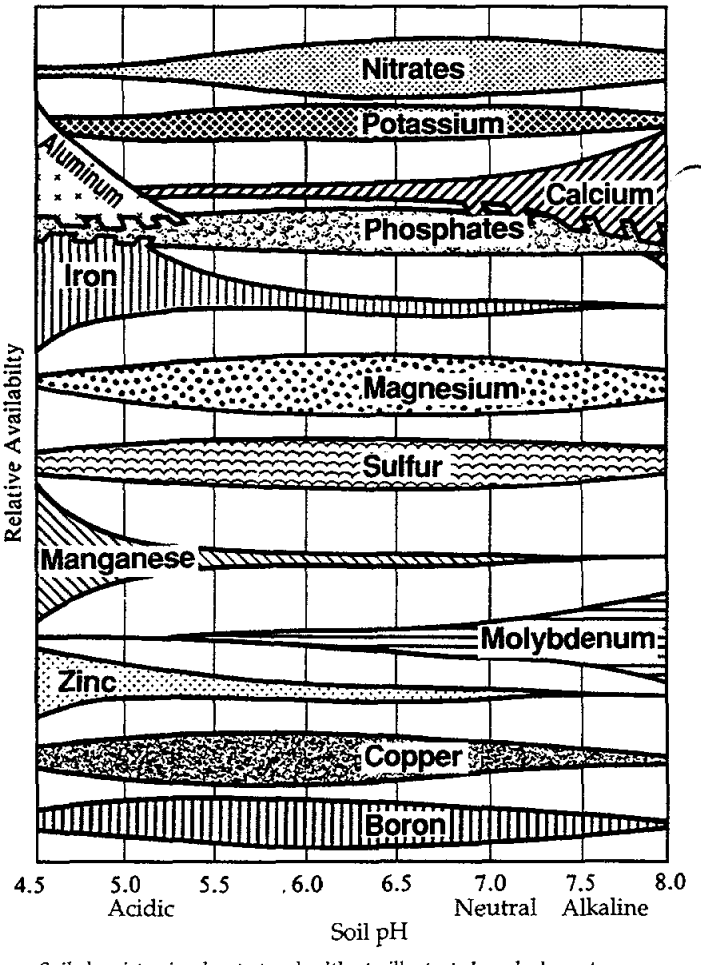
Like the weak link in a chain, if any one of the 16 essential elements is deficient in the soil, it will control the growth of your tree. Deficiencies show themselves in a number of ways, usually in leaf or needle discoloration and various abnormal growth patterns. An experienced arborist or urban forester can recognize the signs, and excellent guides are available in *Arboriculture* and *Soils and Tree Growth*, referenced on page 8.

Fertilizing is the answer to nutrient deficiencies. Fertilizing urban trees correctly is difficult and, when necessary, best done by an arborist. Fortunately, fertilizing is usually *not* necessary, especially for tree roots growing under lawns that are treated regularly by the broadcast method of application. This is because most of the tree's fine, feeder roots are near enough to the surface to utilize the grass fertilizer as it seeps into the soil. While this is good for shade trees as well as your grass, it also points out two dangers to avoid: (1) fertilizer mixes that contain herbicides should be used sparingly, if at all, within the root zones of trees, and (2) fertilizers that are high in nitrogen should be avoided around very young trees and mature trees. Too much nitrogen can cause the tree to accelerate the growth of its top, creating an unhealthy imbalance between its crown and the root system that supports it.

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

Wrong pH

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



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

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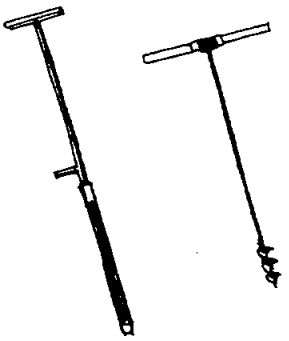
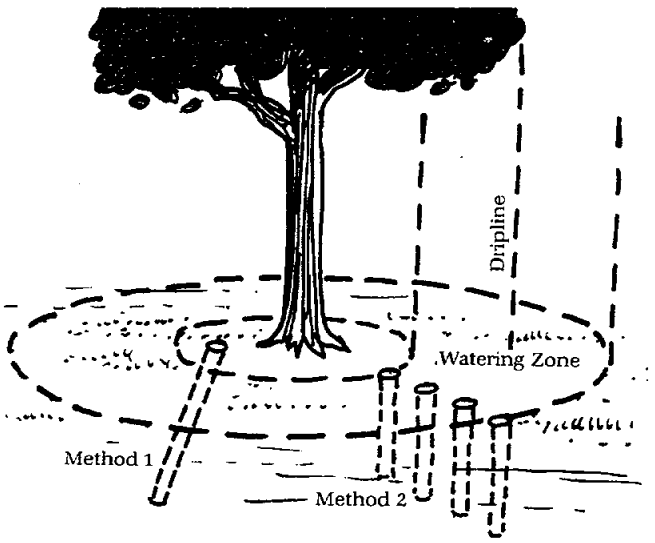
Dryness

During their first 3-4 years of life, urban trees are especially vulnerable to drought. Older trees usually have a large enough root network to enable them to draw out the water molecules held tightly around soil particles. Even so, deep watering after a prolonged dry spell is beneficial to all but those dryland species that have adapted to such conditions (California live oaks, for example). It is important that conifers have adequate water just before the winter freeze sets in, because these species hold their "leaves" all winter and continue to lose water through transpiration.

Watering should soak the top 12 inches of soil. A simple soil sampler can be used to determine how much watering is required to soak your soil to that depth. It can also be used to check on how soon the sub-soil dries out. Generally, sandy soils need rain or watering every 4-7 days, whereas clay soils hold their water in the root zone for up to 10 days. *Avoid short, frequent watering, as this usually does not penetrate deep enough and encourages roots to grow toward the surface.*



Watering may be effective simply by using the garden hose or sprinkler, especially if the planting site is level or saucer-shaped. However, to aid deep watering, as well as to provide aeration for roots and greater penetration of fertilizer, consider one of the two methods illustrated at right. Or use an "injector wand" which can be purchased at a nursery or garden center.



Deep Watering Methods

Method 1

Drill 3 or 4 holes approx. 18" deep and 1"-2" in diameter at an angle and outward from near the base of the tree. Inserting perforated plastic pipe and/or gravel will prolong the use of the holes before new ones need to be drilled.

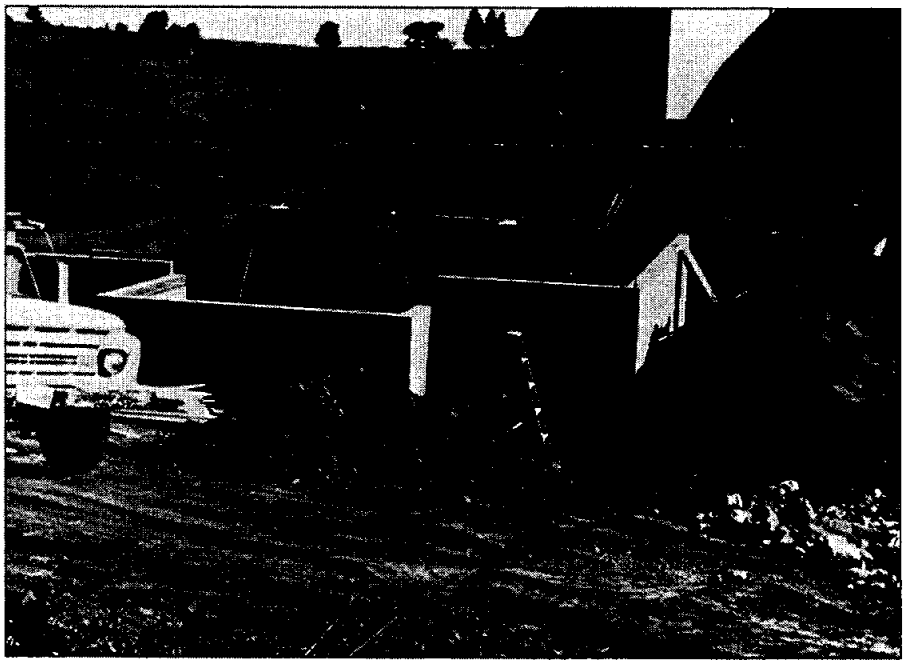
Method 2

Drill 18"-deep holes, $^3/_4$"-$1^1/_2$" in diameter, at 12" intervals around the dripline. Repeat at 12"-24" intervals within the watering zone. Fill holes with coarse sand and peat, fine gravel, or insert perforated pipes. Gravel surrounding a pipe, with less frequent holes, may also be used. Drill new holes when the old ones no longer accept water easily.

Hardpans

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

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

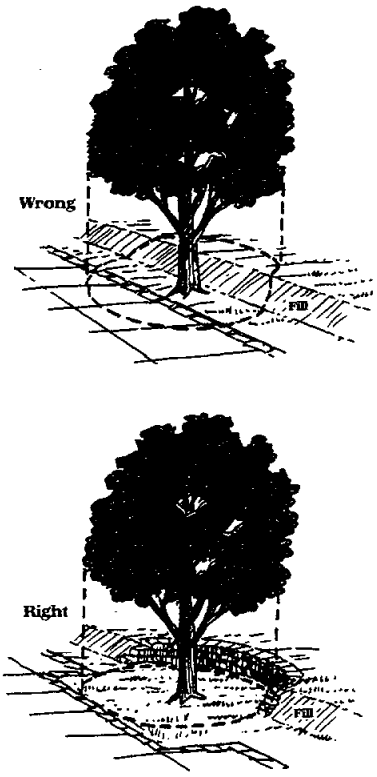


Soils around construction sites can become compacted. If covered by topsoil without first being broken up, the compacted soil presents a danger to tree growth.

Suffocation

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

- **Overwatering**
  Keeping soil excessively wet prevents the macropores from draining and letting in air. Deep watering the equivalent of 1" of rain once a week is healthier for your trees than daily watering. Watering too frequently will actually "drown" trees planted in heavy soil (i.e., high clay content).
- **Compaction**
  Cars, heavy equipment and feet break down the soil structure and close pores. The most vulnerable time in the root zone is while drying occurs, usually within a day or so after a heavy rain or irrigation. Preventing excessive foot or vehicular traffic over the root zone is the best way to prevent compaction.
- **Filling or Paving**
  Paving near trees or covering the root zone with even a few inches of fill can reduce the roots' oxygen supply significantly. Retaining walls and careful planning of paved areas can add many years to the life of a tree.



One method of preventing root suffocation when changing grade.

MULCH: A Tree's Best Friend

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

Mulch covering all or a portion of a tree's dripline zone can significantly enhance growing conditions. There are some dangers, including fire hazard, insect or disease enhancement, fluids toxic to young trees, and nitrogen depletion in the soil as some materials (such as straw or sawdust) decompose. Most of these problems are preventable and are easily balanced by the many benefits. A few are listed below.

Benefits of Mulch

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

Soils and the Urban Forestry Program

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

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

Here are some comments from experts on the management of soil as part of urban forestry.

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

One Community's Experience With 'Vertical Mulching'

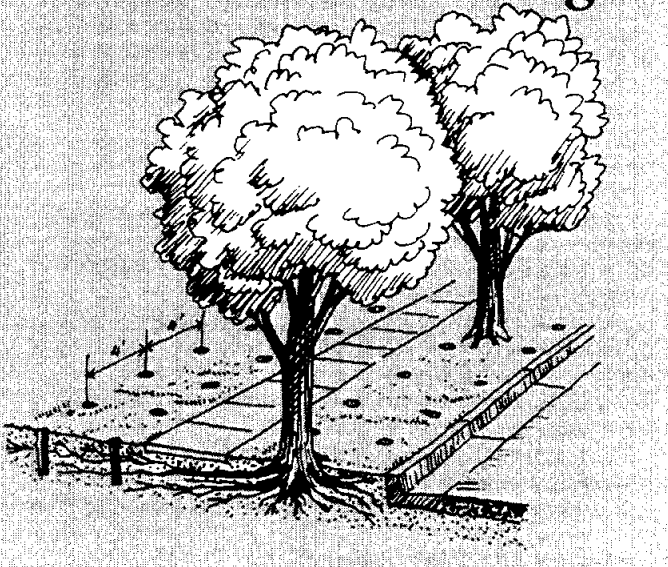
Trees are a source of joy for the citizens of Mariemont, Ohio, a small residential community in the rolling hills not far from Cincinnati. The village's magnificent trees were planted in the early 1930s, including a number of white oaks which, with excellent growing conditions, now measure 36 inches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

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

"Vertical mulching has been talked about for years and seems to go in and out of favor," says Sandfort. "Basically, it is a method for channelling water, oxygen and fertilizer through the sod and compacted soil to the roots of a stressed tree."

Treatment consisted of drilling 3- to 4-inch holes 18-24 inches deep in a 4-foot grid pattern around each tree. In each hole was placed a carefully determined amount of 10-6-4 fertilizer covered by coarse sand and organic matter. Because roots know no boundary lines, permission was obtained from all abutting property owners to work in their front yards also.

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



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

TREE CITY USA

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Other Sources of Information

Tree City USA Bulletin will inform readers about helpful, up-to-date publications that provide more depth, serve as good models, or are readily available for community distribution. The editor welcomes sample copies to consider for inclusion in revised editions of this and other *Bulletins*.

Books

Arboriculture — Integrated Management of Landscape Trees, Shrubs, and Vines
by Richard W. Harris. Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. 674 pp.

Tree Maintenance
by P.P. Pirone, J.R. Hartman, M.A. Sall and T.P. Pirone. Oxford University Press, New York. 514 pp.
These two arborist bibles are probably the best sources of condensed information about urban soils and their relationship to trees. For greater depth, a number of soils texts are available through the bookstores of forestry and agricultural colleges.

The Woodland Steward — A Practical Guide to the Management of Small Private Forests
by James R. Fazio. The Woodland Press, 9201 S. 66th St., Lincoln, NE 68516. 211 pp.
The nature of soil and its effects on growing trees for a purpose such as Christmas trees is included as well as a guide to mail-order suppliers of tools such as soil samplers, earth augers, moisture meters, pH testing kits and other equipment for the professional or do-it-yourselfer.

Leaflets and Booklets

Soils and Tree Growth
by Richard C. Schultz. Dept of Forestry, Iowa State University, Ames, Iowa 50011.
A large amount of information has been condensed into this publication. It is well illustrated and contains useful lists such as symptoms of nutrient deficiencies and the soil requirements of specific species. Copies are available at cost. Contact Dr. Schultz for current price.

Vertical Mulching Fact Sheet
Division of Forestry, City Hall, City of Cincinnati, Cincinnati, OH 45202
A free leaflet describing the technique shown on page 7.

Watering Trees: When, How and How Much
by Jerry Koch. American Forestry Association, P.O. Box 2000, Washington, DC 20013
An excellent article that is part of AFA's *Urban Forestry Home Workbook* series. Available free.

Watering Trees and Shrubs
by Jim Cook. Cooperative Extension Service, University of Wyoming, Laramie, WY 82071.
This 2-page flier is 3-hole punched and would make a nice companion piece in your *Tree City USA Bulletin* binder. Good details on deep watering. Single copies available free.

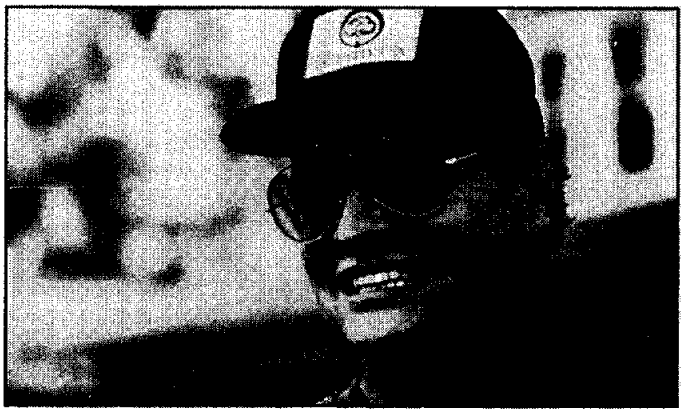
Continuing Education Opportunity

Soil and urban soil management are just two of the many topics covered in The National Urban Forestry School, a program of The Arbor Day Institute. Session I of the School is a week-long introduction to the basics of arboriculture and urban forestry. Session II, a week-long follow-up session, focuses on fewer topics but those considered by experts to be most deficient among urban and community foresters. Session III is a capstone summit seminar with some of the nation's top urban foresters.

Sessions are held several times a year and may be held in any area of the country with a minimum of 15 participants. For information, phone 402-474-5655.

To order additional Bulletin copies... Friends of Tree City USA members may obtain a single copy of any *Tree City USA Bulletin* free of cost. Quantities of any issue are available at 25 for $6.25 or 500 for $100. To order, specify the issue number and quantity, and make your check payable to: The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. The Bulletins available are:

- No. 1 *How to Prune Young Shade Trees*
- No. 2 *When a Storm Strikes*
- No. 3 *Resolving Tree-Sidewalk Conflicts*
- No. 4 *The Right Tree for the Right Place*
- No. 5 *Living with Urban Soils*



To Join the Friends of Tree City USA... to receive a subscription to the *Tree City USA Bulletin*...and to become more involved in the urban forestry movement in your town and throughout America, send a $10 dues-donation to Friends of Tree City USA, National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. Make your check payable to National Arbor Day Foundation.

TREE CITY USA

The Tree City USA program is sponsored by The National Arbor Day Foundation in cooperation with the USDA Forest Service and National Association of State Foresters. To achieve the national recognition of being named as a Tree City USA, a town or city must meet four standards:

Standard 1: A Tree Board of Department
Standard 2: A City Tree Ordinance
Standard 3: An Annual Community Forestry Program
Standard 4: An Arbor Day Observance and Proclamation

Each winning community receives a Tree City USA flag, plaque, and community entrance signs. Towns and cities of every size can qualify. Tree City USA application forms are available from your state forester or The National Arbor Day Foundation.

Published for the

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APPENDIX E: SHRUBS PRUNED FOR SPECIAL EFFECTS

PRUNING FOR FLOWERING:

A. Plants which flower on current year's growth (in summer) and which should be pruned hard in early spring, as soon as growth starts.

Abelia grandiflora
Berberis
Buddleja davidii
Callicarpa
Ceanothus (deciduous)
Clethra
Escallonia
Fuchsia (hardy)
Hibiscus syriacus
Hydrangea paniculata
Kerria
Ligustrum
Lonicera
Philadelphus-some
Rhus
Rosa
Spiraea
Spiraea douglasii
Spiraea japonica
Spiraea x bumalda
Staphylea

B. Deciduous shrubs that benefit from heavy pruning right after flowering:

Cut back about one-half of the branches to two or three buds from the ground, cutting just above a bud:

Buddleja alternifolia
Buddleja alternifolia
Cytisus scoparius
Deutzia
Forsythia
Hydrangea macrophylla
Kerria
Kolkwitzia
Philadelphus-some
Ribes sanguineum
Spiraea x arguta
Spiraea bumalda 'Anthony Waterer'
S. bumalda 'Froebelii'
S. thunbergii
Weigela

Shrubs that require little or no pruning except removing dead wood:

Amelanchier
Azalea
Calycanthus
Cercis
Chionanthus
Cotoneaster
Cytisus
Halesia
Kalmia
Laburnum
Magnolia
Mahonia
Pieris
Prunus glandulosa
Rhododendron
Ribes
spring-flowering Viburnums

Plants that can be arborized:
Arbutus unedo
Camellia
Cedrus atlantica
Cedrus deodora
Chamaecyparis pisifera 'Filifera'
Pieris
Photinia
Pinus
Prunus laurocerasus
Prunus lusitanica
Rhododendron

Species prone to suckering: Always prune these plants lightly to avoid suckering (one-eighth of the total green area in any one year). Prune suckers out in summer to reduce sucker re-growth.

Cornus florida-Eastern dogwood
Cornus kousa-Korean dogwood
Cornus mas-Cornelian cherry
Cornus nuttalli-Western dogwood
Corylopsis-winter hazel
Corylus-filbert
Cotoneaster
Crataegus-hawthorn
Ficus-fig
Hamamelis-witch hazel
Magnolia
Malus sp.-crabapple
Prunus sp.-flowering cherry
Prunus sp.-flowering plum
Viburnum plicatum tomentosum-
doublefile viburnum
Viburnum sp.

APPENDIX F: PRUNING TREES

TREE CITY USA
BULLETIN
for the
Friends of Tree City USA

Bulletin No. 1
James R. Fazio, Editor

How to Prune Young Shade Trees

"As the twig is bent, so grows the tree." This insightful old bromide about children might just as well serve as the cardinal principle for pruning young shade trees. What you do to your tree in its first few years of life will affect its shape, strength, and even its life span. In importance, early pruning must rank just after selecting the right tree for the site, and careful planting.

The sketch of the tree on the right represents what we like shade trees to look like 15 years or so after planting: a tall, straight trunk; and a full, healthy crown with strong, well-spaced branches... a tree that casts a broad expanse of sheltering shade, that resists damage by wind and ice, that is easy to maintain.

The sketch at the left also represents a 15-year-old tree. But it looks more like a big, rambling bush than a well-groomed shade tree. Its low-growing branches obscure streets, driveways, and walks, posing traffic hazards. Many branches have been damaged during storms, and weak, unsightly shoots sprout in abundance. Maintenance is badly needed and will now be expensive.

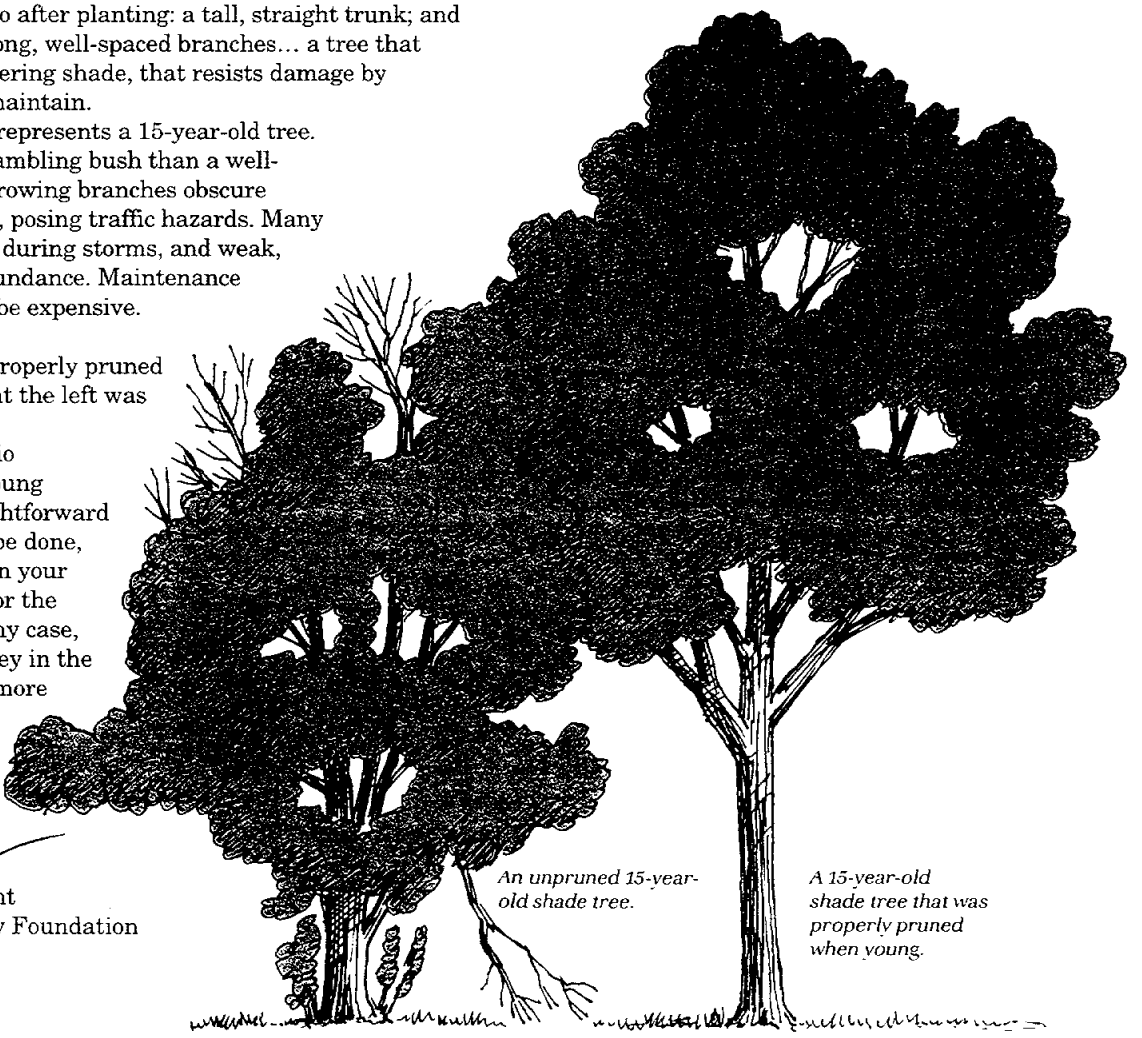
What made the difference?

The tree at the right was properly pruned when it was young. The tree at the left was neglected.

As *Bulletin* editor Jim Fazio skillfully explains, pruning young shade trees is a simple, straightforward task. It is a job that needs to be done, whether by you for the trees in your yard, or by your community for the trees on public property. In any case, proper pruning will save money in the long run, and give you safer, more beautiful, healthy, easy-to-maintain trees.

John Rosenow

John Rosenow, President
The National Arbor Day Foundation



An unpruned 15-year-old shade tree.

A 15-year-old shade tree that was properly pruned when young.

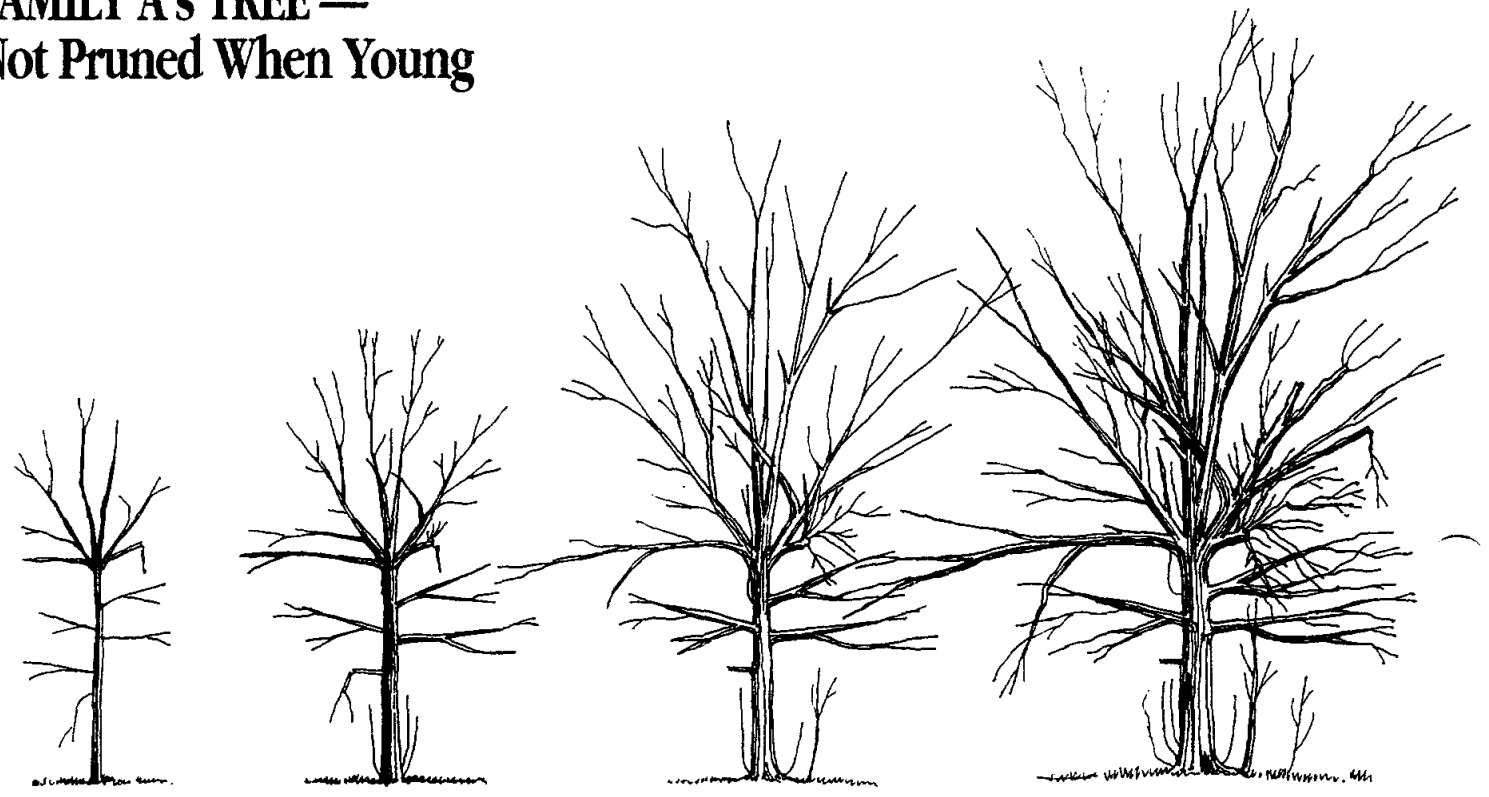
A Tale of Two Trees

One happy day in May the all-American dream came true for two families. Brand new houses of their own in the suburbs. The good life for their kids. New friends and neighbors. More space and comfort. And good investments, too.

Now, it happened that both families loved trees, so they each promptly planted one to commemorate their new start in life. Unknown to each other, both families planted trees that were the same species and the same age.

Looking ahead, we would expect the twin trees to eventually make a nice contribution to the neighborhood, each spreading its shade to grateful residents for generations to come. But, it was not to be. Unfortunately, Family A had the misguided belief that a tree should be left alone, just as it is in

FAMILY A's TREE — Not Pruned When Young



At Planting

Family A didn't ask for planting instructions. They knew how to plant a tree. When that was done, they believed their work was done.

Actually, they were partly correct. You may receive instructions to the contrary, but little should be done to the tree at this stage. In most cases, it is best to leave all the leaf surface possible to manufacture food that will build a larger root system. It has been found that both roots and top will be larger after one year if left unpruned.

After 3-4 Years

By the time many transplants are in their new home for 2 to 4 growing seasons, sprouts and suckers may appear. The root suckers protruding near the base sap strength from the tree. The sprouts are disproportionally vigorous and weakly attached to the tree. And look at the broken limb. By now, it has sprouted numerous branches just below the break — too many, in fact.

After 5-7 Years

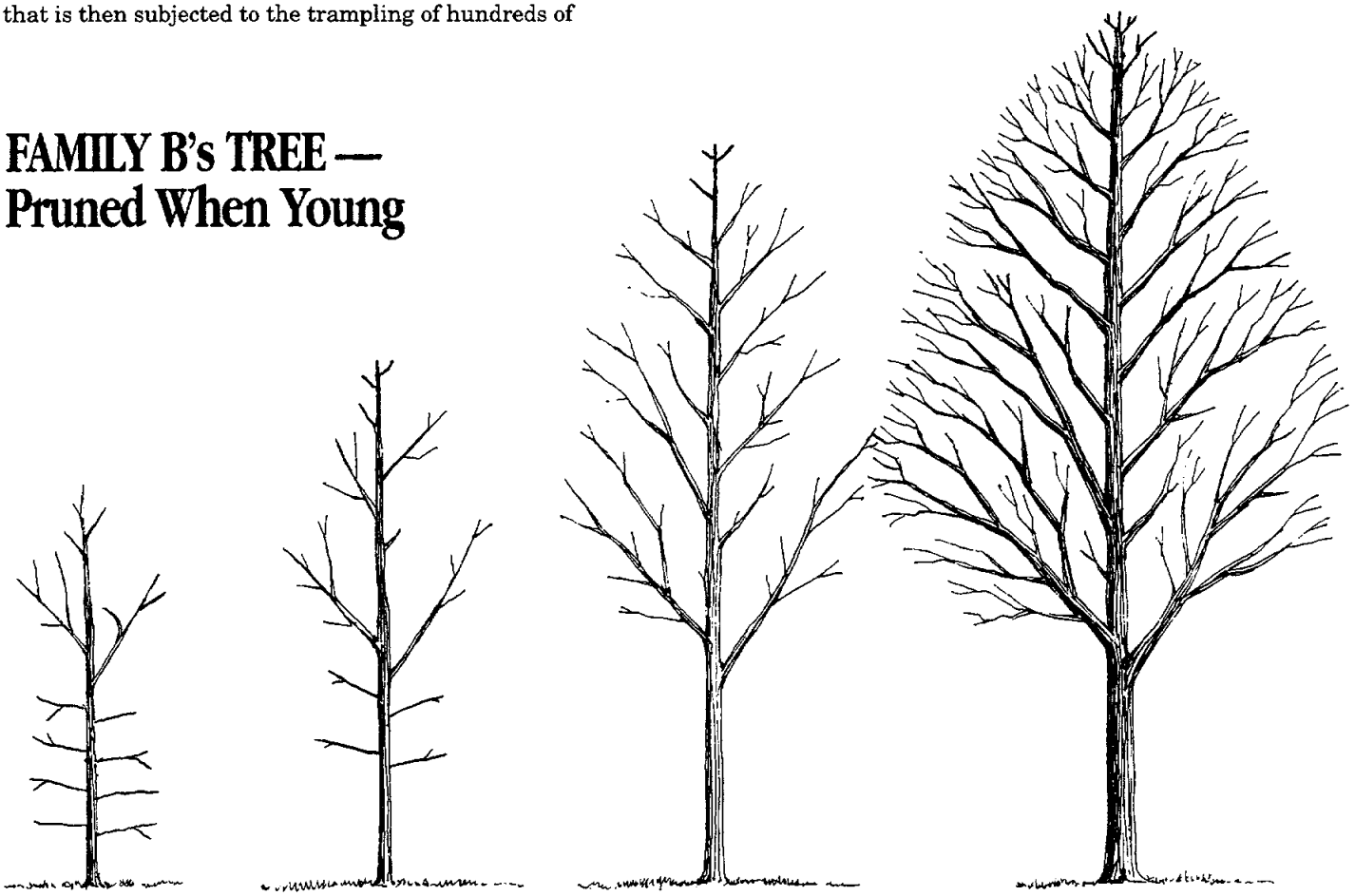
The baby is quickly becoming an adult. The results of not making corrections early in life are now quite visible, although some are still not obvious to the untrained eye. To the more careful observer, the form of the future crown is apparent.

15 Years After Planting

Family A's tree is now not only unattractive, but dangerous, especially when the wind is blowing. Lopsided and dense, the tree in full leaf catches the wind like a sail. Also, the narrow branch angles and multiple leaders have resulted in a weak top. The broken branch not only attracted insects, but may soon break off under the weight of too many sprouts. Decay has entered the trunk where the little bent branch tore off many years ago and a jagged stub protrudes just above it. The tree is an accident waiting to happen. It is becoming more of a liability than an asset for the property.

the forest. Family B knew better. They realized that a tree in the yard or along a street is not growing there because ecological sorting matched its needs to the site. It is there because it was planted there; Nature's method was circumvented. The new transplant is probably on poor soil that is then subjected to the trampling of hundreds of footsteps. It most likely is not enjoying the optimum conditions of sunlight or shade, and it certainly does not have the advantage of forest neighbors to shield it from wind, prune its lower branches, and form the outline of its crown. In short, it needs help.

FAMILY B's TREE — Pruned When Young



At Planting

Family B also planted their tree correctly, but they also noticed a broken branch and a branch that was competing with the leader. Both were pruned close to the trunk. Another, swollen from the sting of an insect laying eggs (a gall), was snipped off. Otherwise, all branches were left intact to provide maximum leaf surface to manufacture food during the first year of life in its new home.

After 3-4 Years

By now root growth should be well on its way to anchoring the transplant and expanding to the size necessary to nourish the growing branches. Family B decides to cut off the root suckers and sprouts in the crown. Other excessive branches are thinned to reduce competition for light, water and nutrients, and a co-dominant leader is removed. A few of the lowest limbs are also removed, but others are temporarily left to help the trunk develop more taper and strength.

Growth is far enough along to reveal problems developing such as branches that rub or are growing in an undesirable direction. Narrow angles are also eliminated for reasons explained on page 4.

After 5-7 Years

Now is the time to make a good tree even better. Lower limbs are pruned off to "raise" the bottom of the crown well out of the way of human heads. The lowest limbs are now the permanent lowest limbs. *An important fact is recognized here. Branches do not move upward as a tree grows taller. The center of a branch at 5 feet will always be at 5 feet.*

Higher up, a few overzealous branches are cut back so they do not protrude beyond the graceful outline of the crown. A branch here and there is removed for more even spacing — but basically the job of sculpturing the tree is now complete.

15 Years After Planting

Family B was amazed to see their tree survive a major wind storm one summer day. While many other trees in the neighborhood suffered split tops and broken limbs, theirs stood strong and firm. Proper pruning gave strength to the branches and allowed the wind to pass harmlessly through the thinned crown. Early each spring, the tree gets scrutinized and dead or damaged limbs are cut off using proper pruning methods. Otherwise, Family B has only to enjoy the beauty and shade of their tree. And what do you know? Just before they moved recently, the real estate agent told them it was the trees in their yard that helped sell the property so quickly.

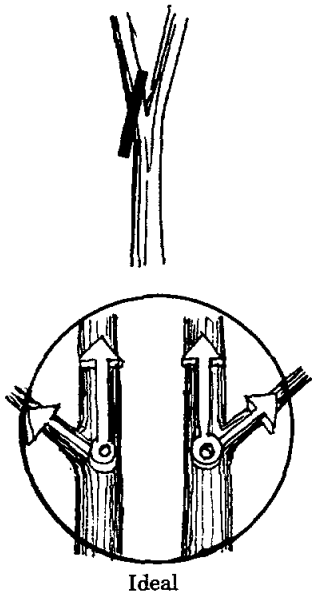
Pruning for Strength

The first guide to pruning a young shade tree is to have a clear understanding about what pruning can do for the tree — and you.

For example, we know to prune modestly — if at all — when transplanting a new tree. An immediate objective must be to strengthen and expand the root system which is usually reduced by 80-90 percent during transplanting. To meet this objective, as much as possible of the leaf surface (the tree's food factories) is left intact. Only damaged or dead limbs should be removed.

After the first year, pruning should begin in earnest. Pruning with strength as the objective is the best way to avoid weak branches later on, and to prevent expensive corrections that will otherwise become necessary.

What to look for:

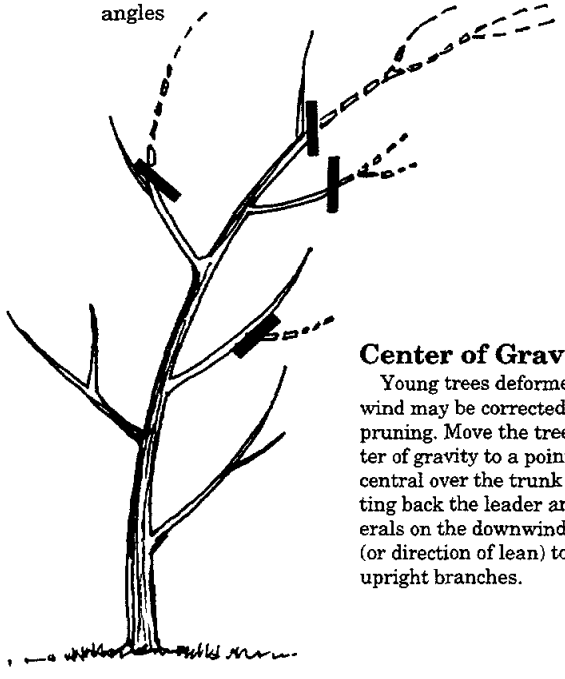


Ideal angles

Branch Angles and Size

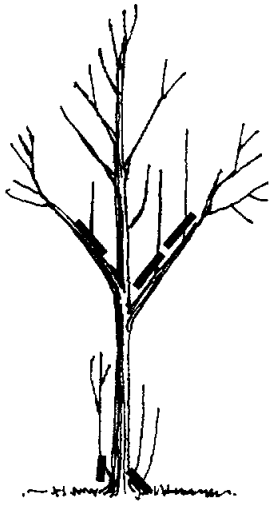
Narrow angles signal a point of future weakness, whether in the trunk or crown. The reason is that as the two branches grow, neither has sufficient space to add the wood needed for strength. Instead, they grow against each other. The effect is similar to hammering in a wedge. To prevent this and the expensive problems that are sure to follow, simply remove one of the two branches. For strength, the ideal branching angle approximates 10 or 2 o'clock.

Lateral branches should be no more than ½ to ¾ the diameter of the trunk. As the trunk grows it will strengthen the joint by adding wood around the branch — like a dowel in a chair leg.



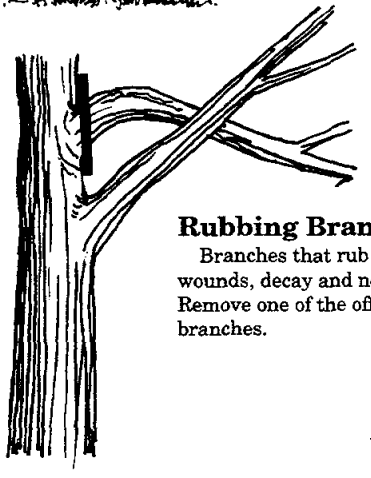
Center of Gravity

Young trees deformed by wind may be corrected by pruning. Move the tree's center of gravity to a point more central over the trunk by cutting back the leader and laterals on the downwind side (or direction of lean) to more upright branches.



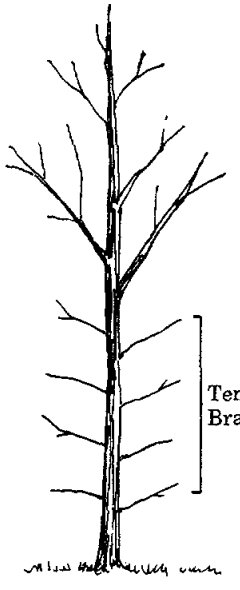
Watersprouts and Suckers

These "parasite" sprouts can occur at the base or inside the crown. They are rapidly growing, weakly attached, and upright. Usually they use more energy than they return to the tree. It is best to remove them as soon as possible when it is obvious they are vigorous sprouts.



Rubbing Branches

Branches that rub result in wounds, decay and notches. Remove one of the offending branches.



Temporary Branches

Branches below the lowest permanent branch can protect young bark from injury from the sun and add taper and strength to the trunk. Particularly in lawn plantings where lower limbs do not block passage or tempt vandals, the limbs may be left for 3-4 years after planting. Then remove over the next 2-3 years, beginning with the larger temporaries. Don't let the temporary branches become large and vigorous. Shorten the larger temporary branches, or remove vigorous temporaries if less vigorous ones can be selected.

Caution: *When pruning diseased trees, dip your shears in household bleach before storing or moving to the next tree. Be sure to rinse and wipe dry before storage.*

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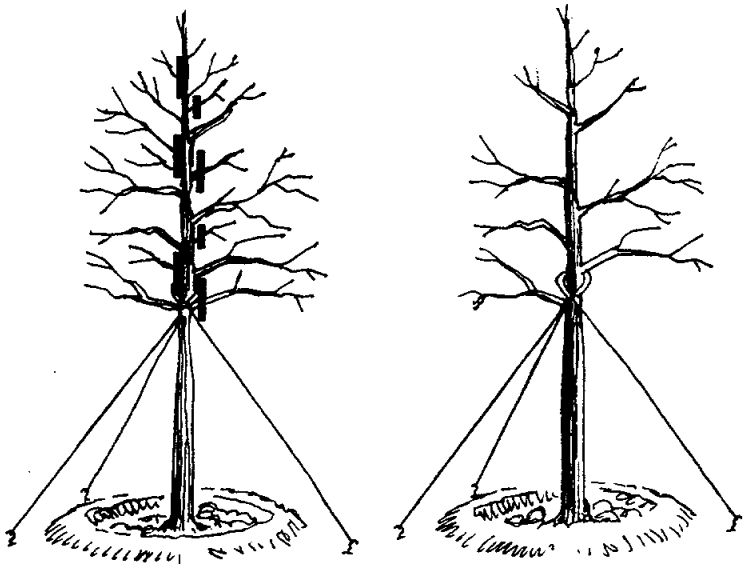
Pruning for Form

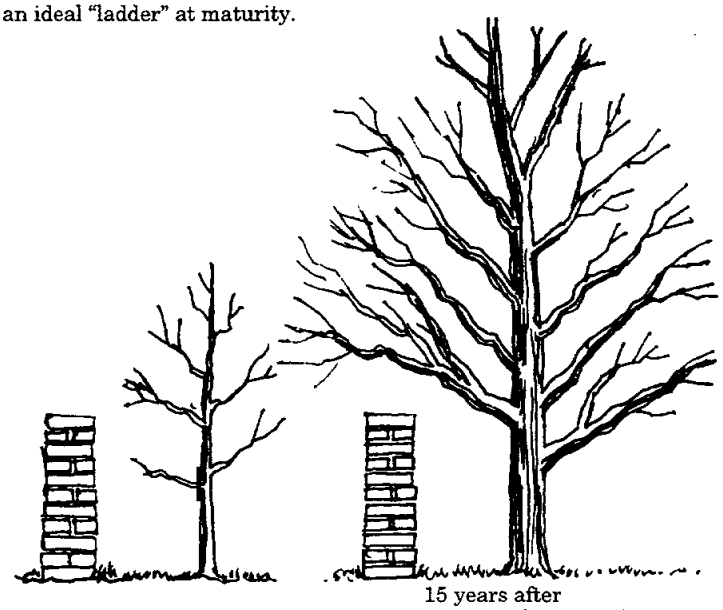
The objective in pruning for form is to help shape a tree that is aesthetically pleasing and serves well in the space it is to occupy. After pruning with strength in mind, look for ways to help shape the most desirable tree.



Before pruning After

Thinning and Spacing

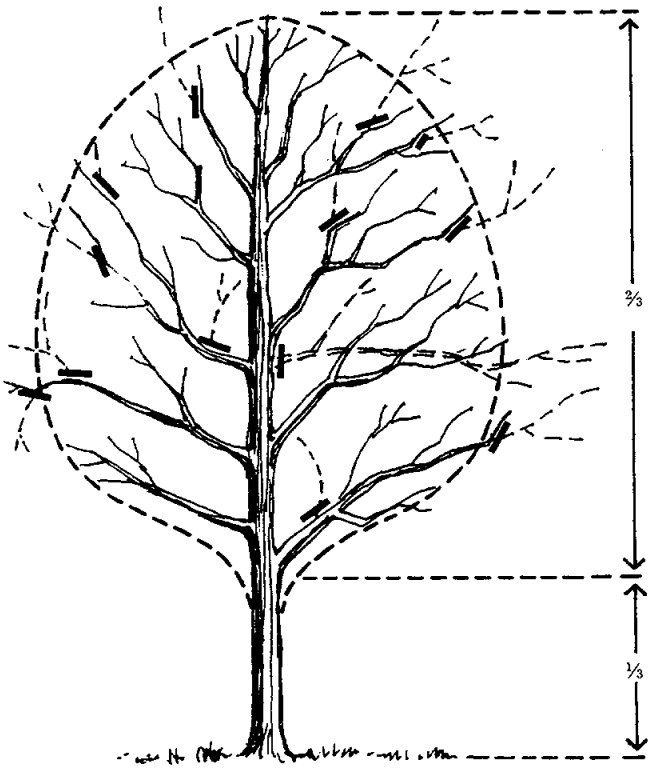
Most trees benefit from thinning — removing a portion of the limbs that compete for space and light. Evenly spaced laterals, 8-12 inches apart in the young tree, is a good rule of thumb to help assure an ideal "ladder" at maturity.



15 years after removing low branch

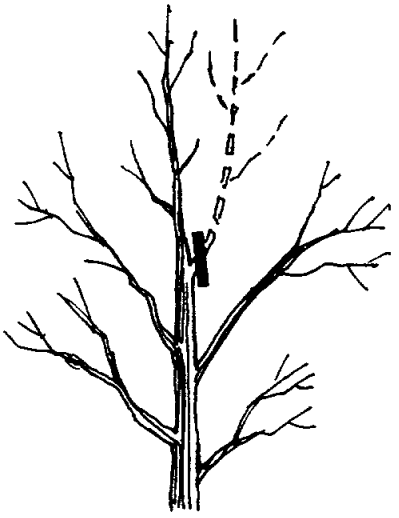
Function

Try to imagine what the tree will look like when it is larger. If a limb is headed toward trouble (the house, walkway, sign, etc.), remove as early as possible in the life of the tree. Closure of the wound will be more complete when the limb is small, and it is less trouble and expense. Remember, limbs do not move upward as a tree grows in height.



Ingrowers
Protruders and Crown Ratio

When a crown is dense, look for limbs that turn inward, and those that extend beyond the "natural" outline of the crown. Prune at the trunk or down to an appropriate lateral branch. Over-pruning can damage or even kill your tree. Always maintain at least ⅔ of the tree as the live crown.



Double Leaders

Protect the leader from competition. In trees with co-dominant leaders, remove the one with a crook or other defects, or that creates a lop-sided appearance.

Caution: *Do not prune too high too quickly. To "lift" (raise) the crown, remove lower limbs over several years. No more than 1/3 of the live crown should ever be removed in a single cutting.*

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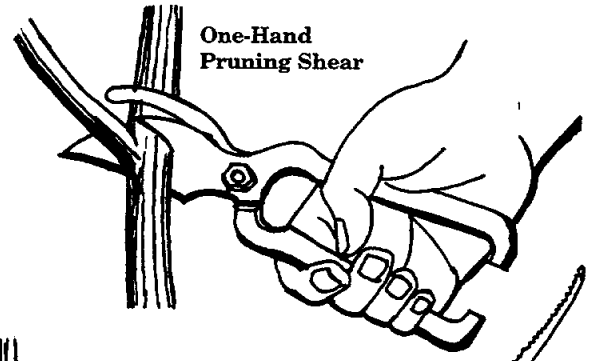
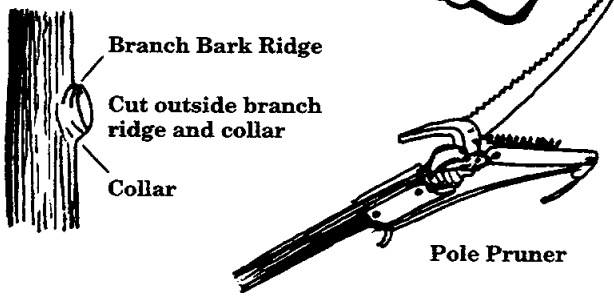
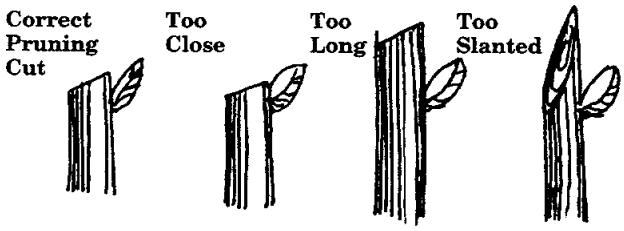
Keys To Good Pruning

1. Prune early in the life of the tree so pruning wounds are small and so growth goes where you want it.
2. Begin your visual inspection at the top of the tree and work downward.
3. Identify the best leader and lateral branches (scaffold limbs) before you begin pruning and remove defective parts before pruning for form.
4. Don't worry about protecting pruning cuts. For aesthetics, you may feel better painting larger wounds with a neutral-color tree paint, but the evidence is that it does not prevent or reduce decay.
5. Keep your tools sharp. One-hand pruning shears with curved blades (secateurs) work best on young trees.
6. Make safety a number one priority. For high branches use a pole pruner. Some, like the one pictured, have both a saw and shears on the same tool. A major job on a big tree should be done by a professional arborist.
7. When you prune back to the trunk or a larger limb, branches too small to have formed a collar (swollen area at base) should be cut close. (Notice in the drawing of the pruning shears that the cutting blade is cutting upward for less effort and a close cut.) Otherwise, follow the rules of good pruning of larger limbs by cutting just outside the branch ridge and collar and at a slight down-and-outward angle (so as not to injure the collar). Do not leave a protruding stub.
8. When simply shortening a small branch, make the cut at a lateral bud or another lateral branch (referred to as "head" or "headback pruning"). Favor a bud that will produce a branch that will grow in a desired direction (usually outward). The cut should be sharp and clean, and made at a slight angle about ¼ inch beyond the bud.

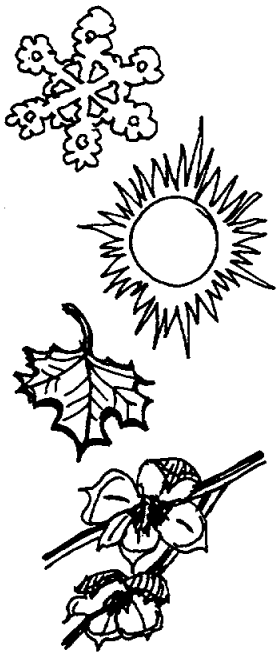






When To Prune

depends to a large extent on *why* you prune. Light pruning and the removal of dead wood can be done anytime. Otherwise, here are some guidelines, but recognizing that individual species may differ.



Winter Pruning during dormancy is the most common practice. It results in a vigorous burst of new growth in the spring and should be used if that is the desired effect. It is usually best to wait until the coldest part of winter has passed. Some species, such as maple, walnuts and birches, may "bleed" when the sap begins to flow. This is not harmful and will cease when the tree leafs out.

Summer To direct the growth by slowing the branches you don't want; or to slow or "dwarf" the development of a tree or branch, pruning should be done soon after seasonal growth is complete. The reason for the slowing effect is that you reduce the total leaf surface, thereby reducing the amount of food manufactured and sent to the roots for their development and next year's growth of the crown.

Another reason to prune in the summer is for corrective purposes. Defective limbs can be seen more easily, or limbs that hang down too far under the weight of leaves.

Fall Because decay fungi spread their spores profusely in the fall and healing of wounds seems to be slower on fall cuts, this is a good time to leave your pruning tools in storage.

Flowering Trees If your purpose for pruning is to enhance flowering: 1. For trees or shrubs that bloom in summer or fall on *current* year's growth (e.g., crape myrtle), prune in winter. 2. For trees that bloom in spring from buds on one-year-old wood (e.g., dogwood and flowering fruit trees), prune when their flowers fade.

Caution: *In some areas of the country, diseases or insect occurrence may be affected by the time of pruning. Check with your county extension agent or city forester, or an arborist or nursery operator to see if there are any local problems.*

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TREE CITY USA

Pruning Is A Vital Part Of Any Urban Forestry Program

A survey conducted by American Forests (AF) showed that many of the nation's urban forests are in serious trouble. To stem the decline of shade trees, more and more communities are engaging in vigorous planting programs. The magnitude of this effort may vary from a few dozen park trees in small towns to the annual planting of thousands of trees in large cities. In all cases, the investment is significant. AF's Gary Moll suggests that 20 percent of an urban forestry budget should be directed at planting and early care.

It follows that the early care of new trees is one of a community's best ways to maximize its investment in planting. Systematic pruning of trees during the first several years of growth should be an integral part of the program.

A basic mission of the Tree City USA program is to encourage ongoing shade tree care. Early pruning is part of the care necessary for strong, healthy, beautiful trees. Of the four standards shown on the back page of this bulletin, time spent pruning young trees would contribute to Standard 3 as a portion of the comprehensive community forestry program. In every way, your community will gain from making early pruning a part of urban forestry.

Within a tree maintenance program, urban foresters and arborists have suggested that the following steps be included:

1. Minimum pruning immediately after transplanting; within 3 years, pruning for strength and form; and every 3 years thereafter pruning to "lift" the canopy of street trees (usually to 8 feet above sidewalks and 14 feet above residential streets).
2. Providing initial training and annual refresher training for crews doing the pruning. *Caution: Crews that regularly prune older trees tend to overprune young trees.*
3. Stressing tool sharpness and, if necessary, disinfective methods.
4. Developing an inventory which is kept up to date with all maintenance operations, including pruning, and future needs being noted.
5. Monitoring on an annual basis.

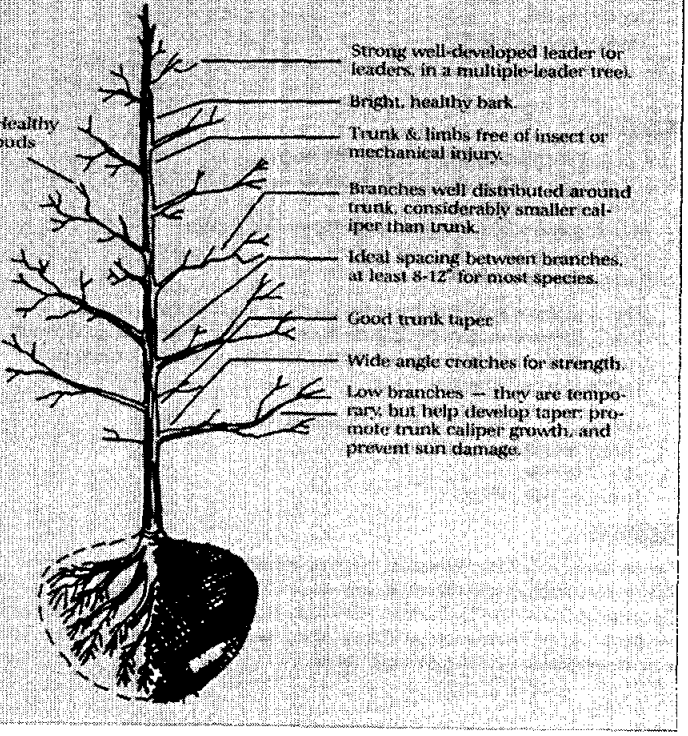
For The Best Start, Start in the Nursery

A good tree management program begins with selecting good trees. When choosing trees for city plantings along streets and in parks and other public places, you will want trees with a fairly substantial caliper even if they are initially more expensive. Some things to look for:

Bare root tree:
Abundant root growth, fiberous and numerous small roots, good color; moist.

Balled & Burlapped tree:
Firm soil ball with trunk securely tied. Do not accept a plant with a broken "ball." Do not accept a tree with a circling root at the base of the trunk. Always carry B&B plants by the soil ball, not by the trunk, stems or branches.

Container-grown tree:
Avoid trees that are "root-bound" in the can. Roots that circle around the edge of the container may become circling roots. Because of this, B&B trees are generally preferred. Always remove can, basket or pot when planting. (Cut any circling roots when planting.)



For some street planting, such as next to narrow sidewalks, it may be necessary to plant trees that immediately have high crowns. In this case, the height of the lowest limbs should be specified when ordering from the nursery. However, whether raising the crown during the years after planting, or as the trees are grown in the nursery, it is generally important to maintain a ratio of ⅔ green top to ⅓ pruned trunk.

Tree boards should be wary buyers. Carefully write specifications and be sure an expert inspects the trees before accepting delivery on behalf of the city. After a good start with good nursery stock, remember — *a program of pruning young trees is a wise, long-term investment.*

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Other Sources of Information or Help

Tree City USA Bulletin will inform readers of helpful, up-to-date publications which provide more depth or that are readily available for community distribution. The editor welcomes sample copies to consider for inclusion in future revisions.

On the subject of pruning young shade trees, material is scattered throughout texts and literature of a more encompassing nature. In most states, the Cooperative Extension Service and state forestry offices have leaflets on pruning, although most focus on the care of mature trees. Greater detail is available in the scores of excellent books available on general tree care. As a starting point, we recommend three of the standards that should be on the shelf of all urban foresters and other individuals interested in urban forests:

GENERAL TEXTS

- *Arboriculture — Integrated Management of Landscape Trees, Shrubs, and Vines in the Landscape*
  Richard W. Harris, 1992.
  Regents/Prentice Hall, Inc.,
  Englewood Cliffs, NJ (674 pp.)
- *Urban Forestry — Planning and Managing Urban Greenspaces*
  Robert W. Miller, 1988.
  Regents/Prentice Hall, Inc.
  Englewood Cliffs, NJ (404 pp.)
- *Urban Forestry*
  Gene W. Grey and Frederick J. Deneke, 1986.
  John Wiley & Sons, NY (299 pp.)

PRUNING BOOKS

- *All about Pruning (96 pp.)*
  Ortho Information Services
  P.O. Box 5006
  San Ramon, CA 94583-0906
- *Tree Pruning — A Worldwide Photo Guide (192 pp.)*
  Alex L. Shigo
  Shigo and Tree Associates
  P.O. Box 769, Durham, NH 03824
- *Pruning Handbook (96 pp.)*
  Sunset Publishing
  80 Willow Rd.
  Menlo Park, CA 94025
- *The Complete Guide to Landscape Design, Renovation, and Maintenance* (192 pp.)
  Cass Turnbull
  Betterway Publications, Inc.
  P.O. Box 219, Crozet, VA 22932

LEAFLETS

- For public distribution, consider this leaflet:
  Homeowner's Guide for Beautiful, Safe and Healthy Trees
  USDA Forest Service
  Northeastern Forest Experiment Station Publications
  359 Main Road
  Delaware, Ohio 43015
- For assistance in writing pruning contract specifications, request the *Pruning Standards for Shade Trees* flyer from the National Arborist Association, P.O. Box 1094, Amherst, NH 03031. Include a stamped self-addressed envelope.
- *Caring For Young Trees From Nurseries to Landscapes*
  Shigo and Trees Associates
  P.O. Box 769
  Durham, NH 03824

TRAINING

The National Arbor Day Foundation offers continuing education throughout the year on pruning and other tree care topics. Write to: Conferences and Training, P.O. Box 81415, Lincoln, NE 68501-1415 or phone 402/474-5655 and ask about current workshops and home study courses. Arrangements may also be made for local, co-sponsored workshops.

Homeowners can obtain advice on pruning young shade trees from their county extension agent, local arborist, or city forester. Communities can obtain assistance in designing pruning and other community forestry programs from their state forester's office.

To order additional *Bulletin* copies... Friends of Tree City USA members may obtain a single copy of any *Tree City USA Bulletins* free of cost. Quantities are available at 25 for $6.25 or 500 for $100. To order: specify the issue number and quantity, and make your check payable to The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410.

To join the Friends of Tree City USA... to receive a subscription to *Tree City USA Bulletin*, and to become more involved in the urban forestry movement in your town and throughout America, send a $10 dues-donation to Friends of Tree City USA, The National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410. Make your check payable to The National Arbor Day Foundation.

TREE CITY USA

The Tree City USA program is sponsored by The National Arbor Day Foundation in cooperation with the USDA Forest Service and National Association of State Foresters. To achieve the national recognition of being named as a Tree City USA, a town or city must meet four standards:

Standard 1: A Tree Board or Department
Standard 2: A City Tree Ordinance
Standard 3: An Annual Community Forestry Program
Standard 4: An Arbor Day Observance and Proclamation

Each winning community receives a Tree City USA flag, plaque, and community entrance signs. Towns and cities of every size can qualify. Tree City USA application forms are available from your state forester or The National Arbor Day Foundation.

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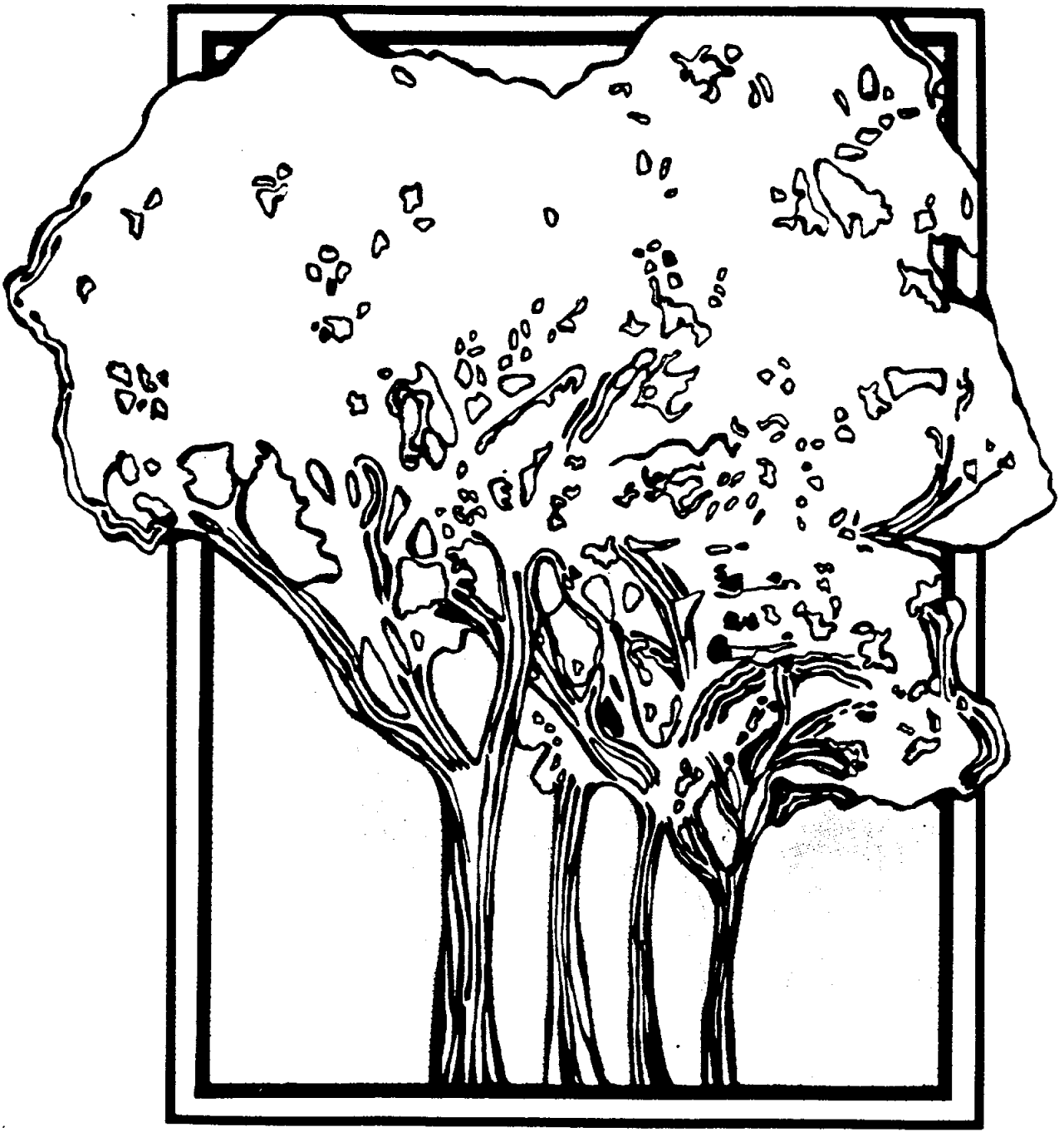
by

The National Arbor Day Foundation
100 Arbor Avenue · Nebraska City, NE 68410

RECYCLED PAPER RECYCLABLE PRINTED WITH SOY INK

Bulletin No. 621

How To Prune Deciduous Trees



Don Hanley • W. Michael Colt • Arthur D. Partridge

Cooperative Extension Service
UNIVERSITY OF IDAHO
College of Agriculture

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How To Prune Deciduous Trees

Don Hanley, W. Michael Colt and Arthur D. Partridge

Shade trees in Idaho make important contributions toward pleasant environments around our homes, in our parks and along our highways However, these trees are often taken for granted and receive inadequate care. A regular maintenance program should be carried out over the lifetime of the tree to minimize problems and to exploit shade tree benefits. Proper pruning techniques are one phase of a complete maintenance program.

Why Prune?

Pruning is done to maintain natural tree form, to correct undesirable branch growth or to eliminate disease. Nature's way of pruning is through crowding and shading which results in dying branches and twigs. While this process is normal, such branches should be pruned out of ornamental trees before they die.

If pruning is carried out on a regular basis and undesirable growth is removed, this will prevent the need for an extensive and expensive pruning job later. This does not mean that pruning is required each year on every tree. The key idea is that "undesirable growth" is removed on a regular basis.

Should I Prune Myself Or Hire a Professional?

This decision depends, of course, on your physical ability, your time availability, your pruning knowledge and the tree's size and location. If you decide to hire a tree service professional, follow these points:

1. The pruning contractor must be bonded and insured. Crews should have a copy of liability insurance in their possession.
2. Can the service company give references of past work in the community?
3. Require that the job is done on a "job basis" not an hourly basis. Use a written contract.
4. Does the crew have safe climbing equipment? Is the tree near a powerline? If so, you should hire a professional.
5. Don't be forced into quick action by high pressure "salesmen." Get a second or third estimate of costs.

If you decide to prune the tree yourself, read this publication Study the illustrations carefully. Work safely. If you have questions, contact your Extension agricultural agent for advice.

When To Prune

One of the first occasions when a tree may require pruning is when it is planted. At this time, roots have been disturbed and partly destroyed. The branch structure should be brought into balance with the remaining root system. Pruning at this time consists of thinning out some of the branches by concentrating on the prevention of weak crotches and the elimination of branches which cross over each other.

In established trees, pruning should be carried out regularly. Inspections should be made each year and corrective action taken, if needed.

Deciduous trees may be pruned at any time of the year. Basically the choice of summer or winter is left up to the individual. There are, however, some reasons to prune during each season of the year.

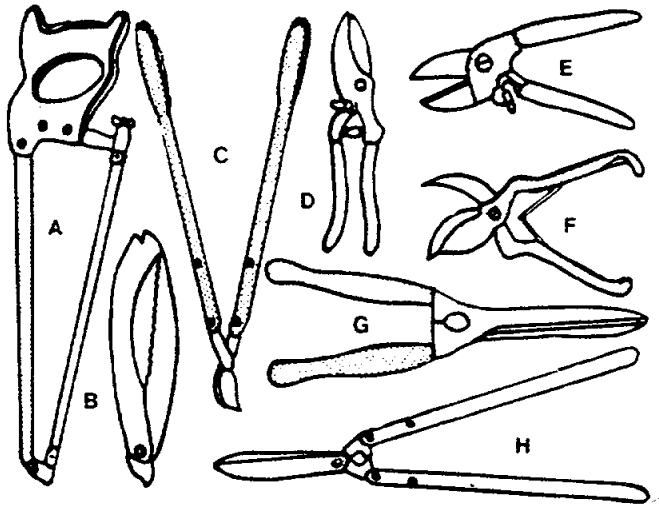
Most deciduous trees are pruned during the dormant season because you can easily see dead and diseased wood at this time. Pruning during the dormant season also minimizes the clean up effort and reduces the probability of spreading disease organisms. If pruning is done in the early spring, before the leaves develop, the wounds will begin to heal during this period of most rapid growth. Callus tissue development will be rapid. Pruning the tree while it is in leaf allows the pruner to see the effect that cuts have on the tree's form.

Additionally, some trees — such as birch, maple, walnut and sycamore — "bleed" clear sap from pruning. This sap flow is not harmful to the tree but is often unsightly. **These trees should be pruned after they leaf out in summer to minimize the sap flow.**

Flowering trees — such as dogwoods and crabapples — should be pruned after they flower. Otherwise, you will lose a year's flower production.

What Tools To Use

Hand saws that cut on the pull stroke are recommended because they are easiest to use and provide excellent control. Pole saws are desirable where branches are less than 20 feet in height. Looping shears and hand shears are also recommended for light, small branch removal.



GOOD PRUNING TOOLS — pruning saws (A and B), looping shears (C) ar hand shears (D. E and F). Do not use hedge shears (G and H), as they do nc make a clean cut on tree branches. Similarly, do not use chain saws for final cuts on large branches.

Hedge shears are not recommended because most of them are not large enough to remove tree branches cleanly. Chain saws are only recommended for preliminary or rough cuts.

Using axes and hatchets has needlessly injured many valuable shade trees. Removing limbs with these tools without leaving a stub or projection of some kind is virtually impossible. Stubs prevent rapid healing. A poor aim with an axe can also cause unnecessary trunk injury.

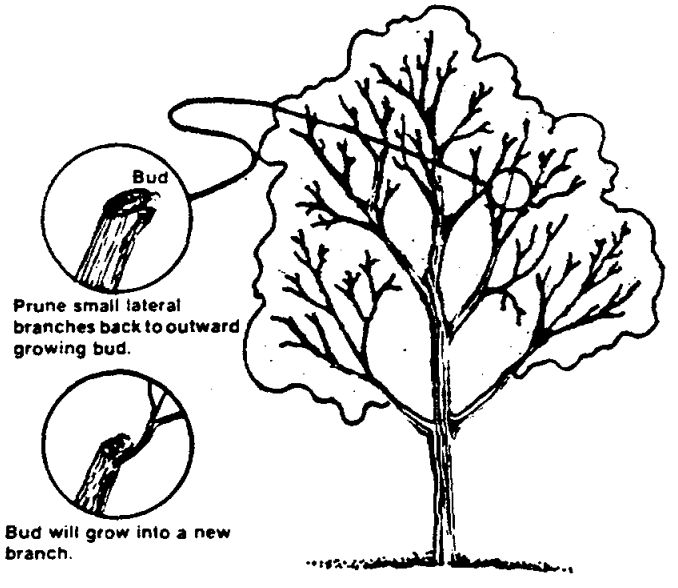
How To Prune

Pruning Small Trees

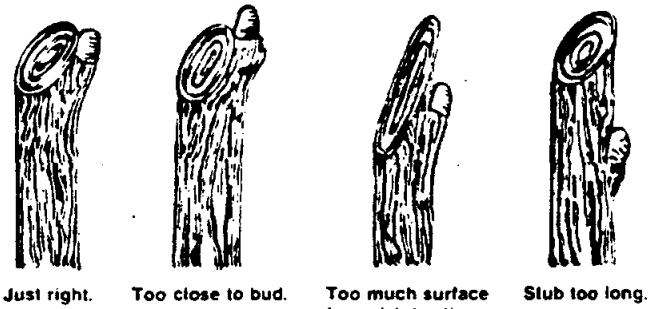
Removal of young, small limbs is quick and simple. If pruning is delayed until limbs become large, they are more difficult to remove and may affect the natural shape of the tree. A young tree, well pruned and trained in its formative stage, will need minimal pruning later on.

Small Twig Removal

The principle behind pruning twigs is always to cut back to a bud that is directed outward and which will produce new growth.



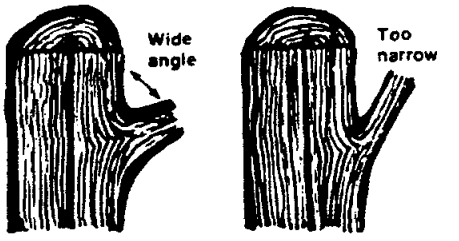
Make slanted cuts back to healthy wood. The proper pruning cut should be about one-quarter inch above the bud, slanted away from it.



Just right. | Too close to bud. | Too much surface for quick healing. | Stub too long.

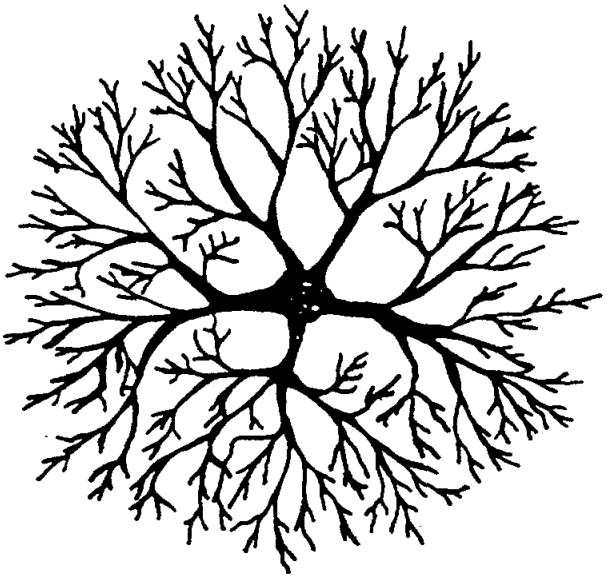
This type of cut is common when "heading back" newly planted, nursery stock. Do not leave stubs because they are a detriment to proper healing and invite diseases.

Selecting Scaffold Branches



You should select the main scaffold or lateral branches that grow at wide angles to the trunk for strong support.

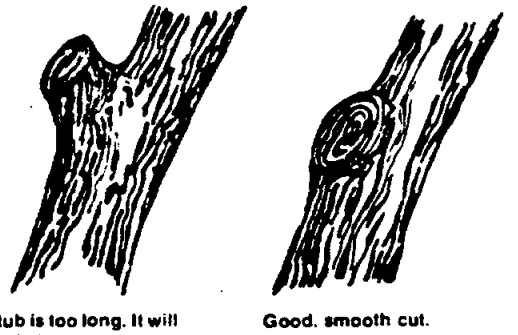
Narrow, angled crotches increase the chance of splitting during the times of stress like ice or snow storms. The major scaffold branches should be spaced at least 8 to 18 inches apart vertically. Encourage radial branch development similar to this top view.



Pruning Mature Trees

Prune mature trees on a periodic basis. Make yearly inspections followed by maintenance pruning. Trees that have been neglected for many years **should not** be pruned back all at once. Never remove more than one-third of the total branches at one time because numerous water sprouts will form. These water sprouts are weakly attached to the tree and can result in a malformed tree shape.

When you have decided on a limb to cut, remove it completely without leaving a stub. Cut it just outside the branch collar parallel with the trunk or adjacent larger branch.



Stub is too long. It will heal slowly. | Good, smooth cut.

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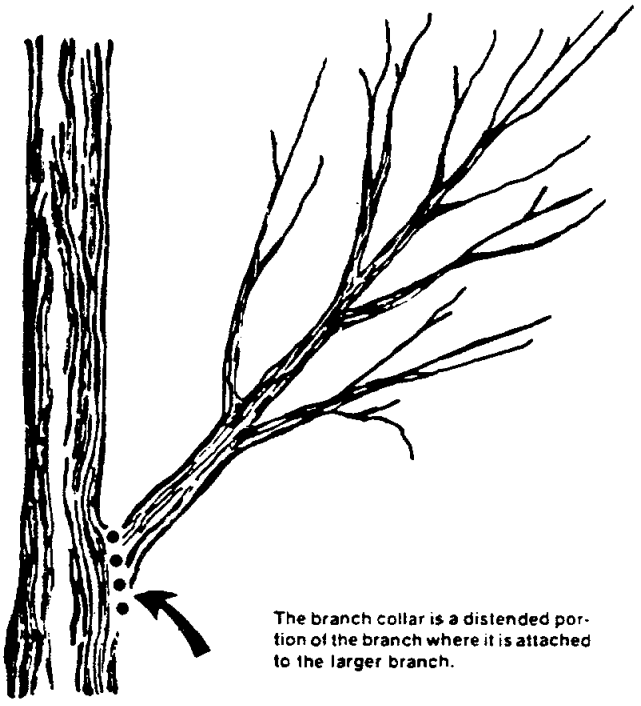


The branch collar is a distended portion of the branch where it is attached to the larger branch.

A chain saw cuts too roughly and should not be used for the final cut.

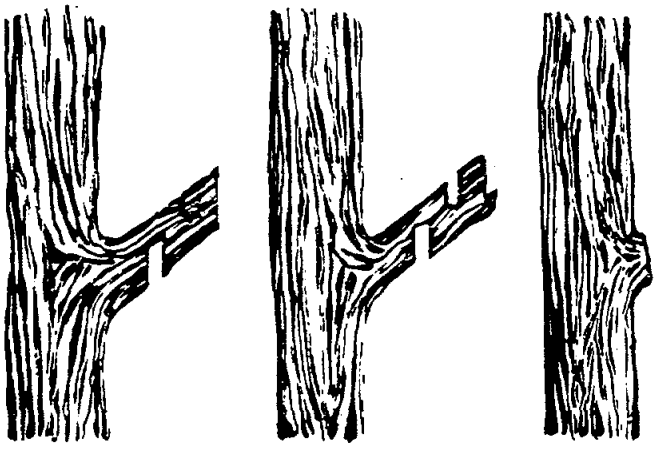
If one branch of a "V" crotch has to be removed, be aware that the true intersection is often lower than you expect because of thick bark at the intersection.

To remove this type of branch, make two preliminary cuts as indicated by 1 and 2. Then remove the major part of the branch. The final cut is made at the true intersection (3).

Remember, trees with narrow "V" crotches are subject to wind, ice and snow damage. **A branch making such a weak union should be removed while young if possible.**

Removing a Heavy Limb

Three cuts are required to remove a heavy limb. The first cut is made 1 to 2 feet away from the base of the limb on the underside. The second cut is made just outside the first cut allowing the branch to fall. The third cut is made just outside the limb collar parallel with the next larger limb or trunk. When making the third cut, support the stub. This method will permit the basal cut to be made smoothly without binding and without peeling the bark.



Under-cut first.

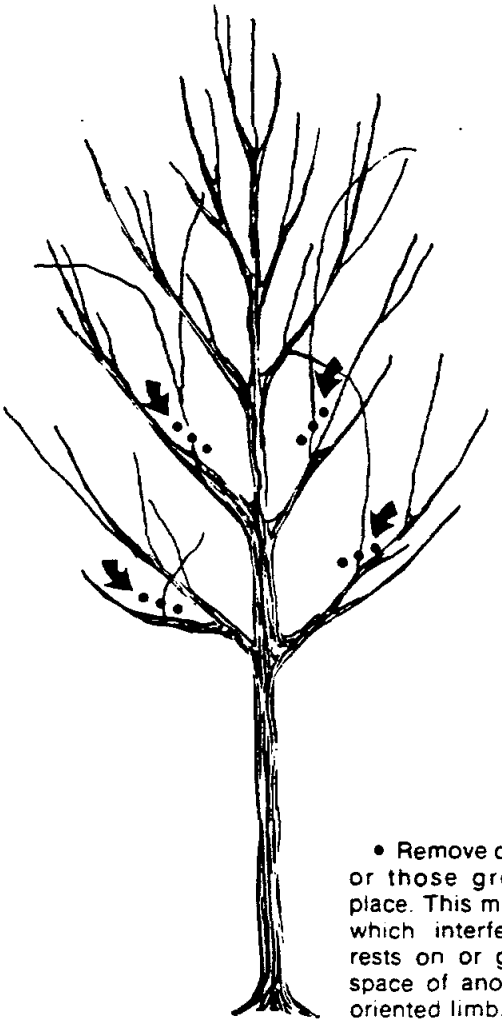
Then cut from top.

Cut to make a smooth surface to facilitate healing.

Bark tearing will result if heavy limbs are removed in one cut.

Deciding Which Limbs To Remove

- Remove deadwood and/or broken branches.



- Remove crossover limbs or those growing out of place. This may be any limb which interferes, rubs on, rests on or grows into the space of another normally-oriented limb.

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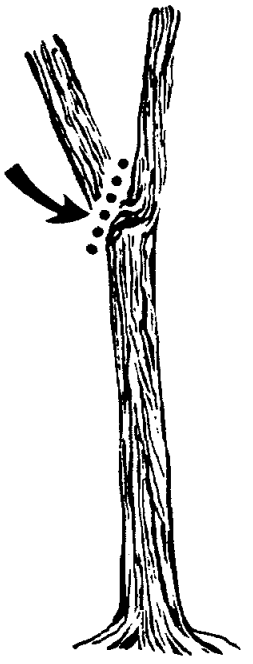
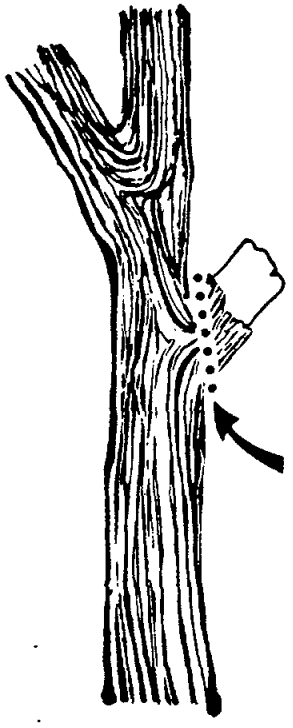
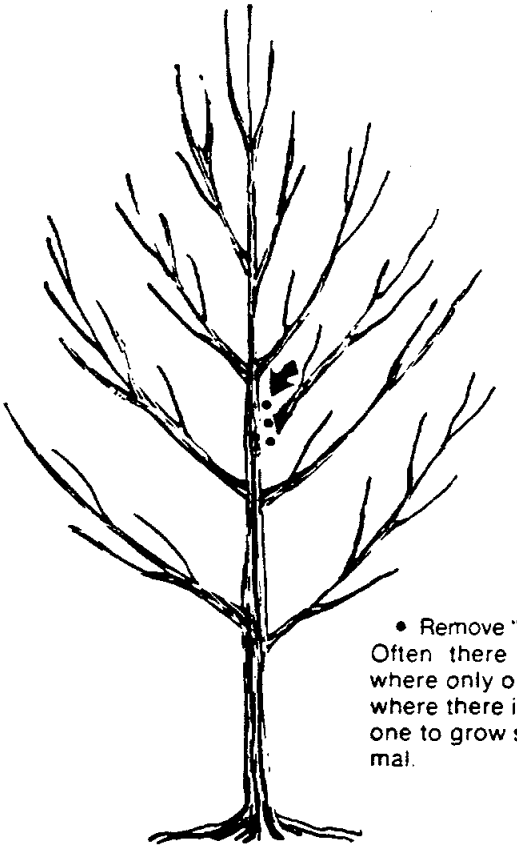
• Remove one of two limbs forming a weak fork or crotch.

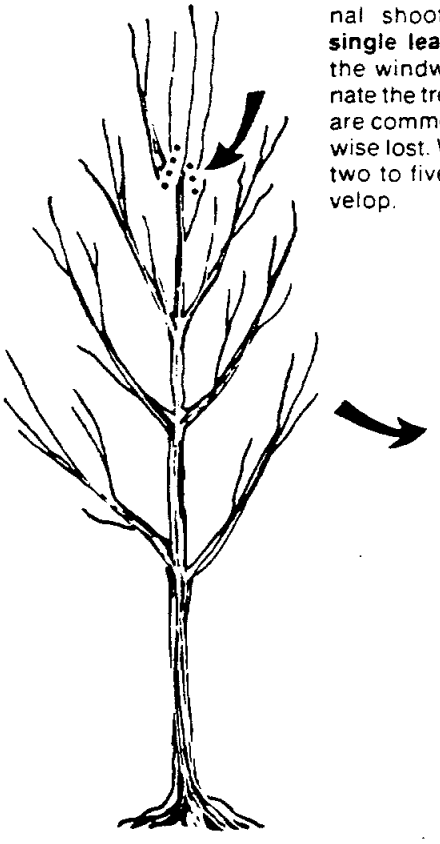




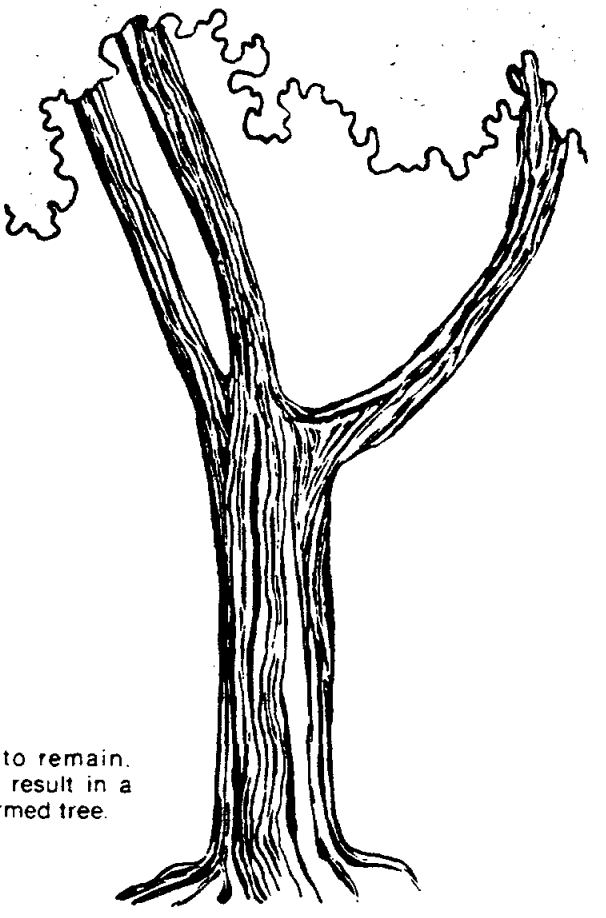
• Remove all stubs, new or old.



• Remove "crowded limbs." Often there are two limbs where only one is needed or where there is room for only one to grow strong and normal.

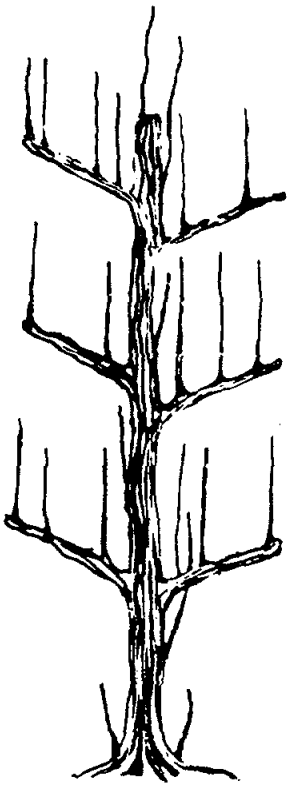


• Remove multiple terminal shoots **leaving only a single leader**, preferably on the windward side, to dominate the tree. Terminal leaders are commonly killed or otherwise lost. When this happens, two to five equal leaders develop.



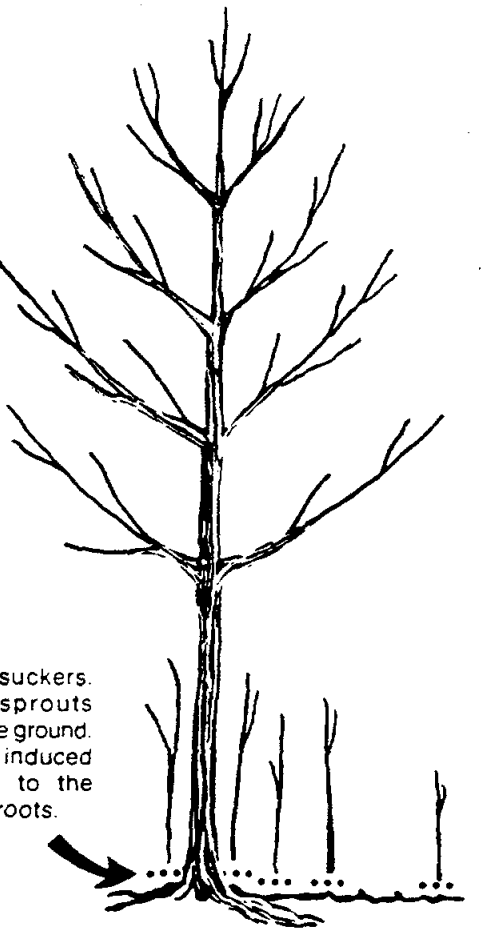
• If allowed to remain, multiple leaders result in a weak and malformed tree.

For more information write or call: PlantAmnesty 906 N.W. 87th, Seattle, WA 98117 (206) 783-9813

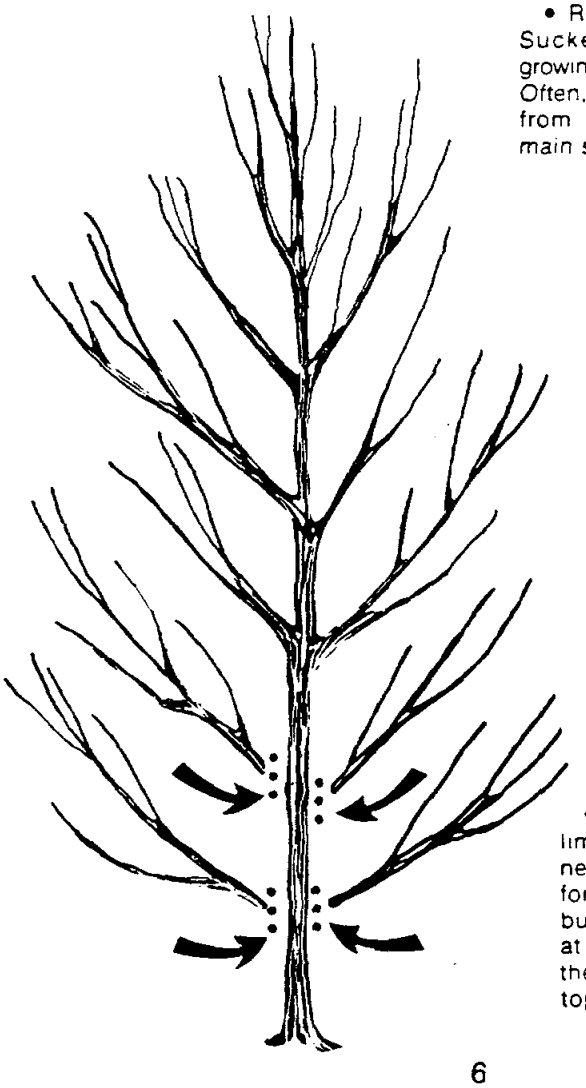


UNLESS THEY ARE THE RESULT OF MAL-PRUNING; THEN SEE "TRIM OR TORTURE" ARTICLE

• Remove water sprouts. Water sprouts left to prevail can result in a weak, malformed tree. Water sprouts, also called adventitious shoots, occur singly or in clusters after a tree has been "opened up" from severe pruning or limb breakage.



• Remove suckers. Suckers are sprouts growing from the ground. Often, they are induced from damage to the main stem or roots.



• Prune the lower limbs of shade trees if needed to make room for "traffic" underneath, but remember to leave at least two-thirds of the total volume of the top.

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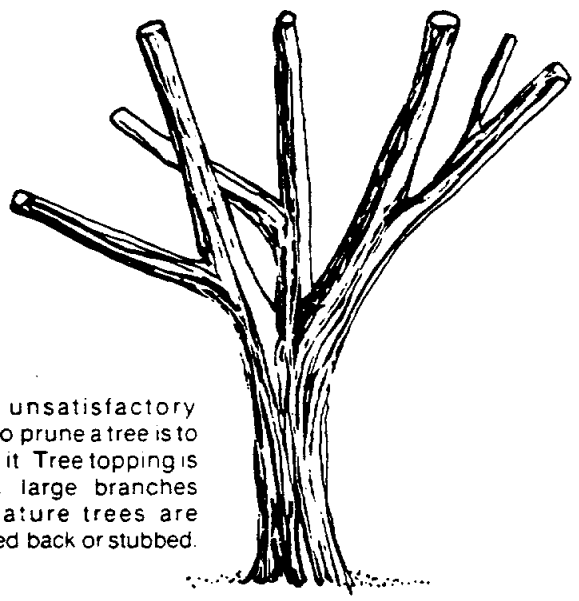
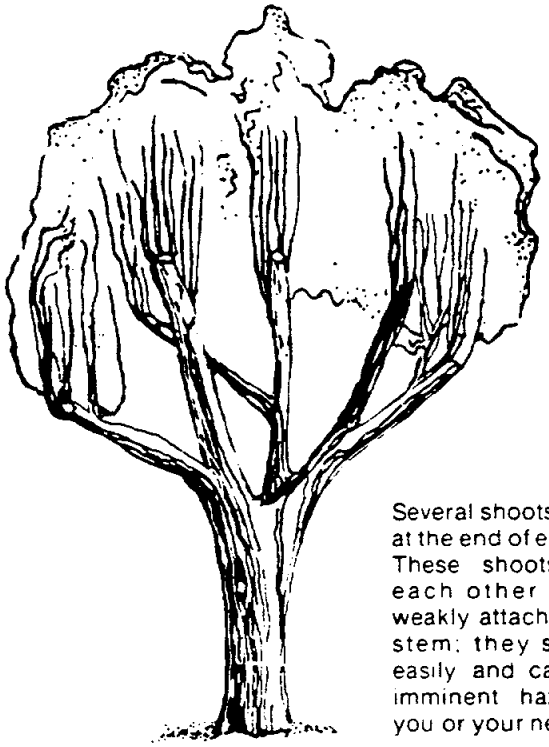
How Not To Prune Mature Trees



An unsatisfactory way to prune a tree is to "top" it. Tree topping is when large branches of mature trees are headed back or stubbed.



Several shoots develop at the end of each stub. These shoots crowd each other and are weakly attached to the stem; they split out easily and can cause imminent hazards to you or your neighbors.

Worst of all, trees headed or topped in this fashion lose their natural form and often are ugly and grotesque. They slowly die because the stubs almost always possess internal decay or may be killed rapidly by disease or internally feeding insects. Previously topped trees are susceptible to damage by ice and wind storms because of the internal decay.

Be aware that unprofessional tree maintenance crews use this approach because it takes little skill and is quick. (See section entitled "How To Select a Tree Service Professional.")

Controlling tree size by pruning is not recommended. You will be better in the long run to plant and grow a tree that "fits its area." If the tree is too large for its intended use, remove it and plant a smaller species. **The practice of "topping" to control tree size or increase vigor cannot be justified.** Unnecessary or severe pruning can reduce a tree's vigor and lead to early death.

Pruning Mature Trees Near Powerlines

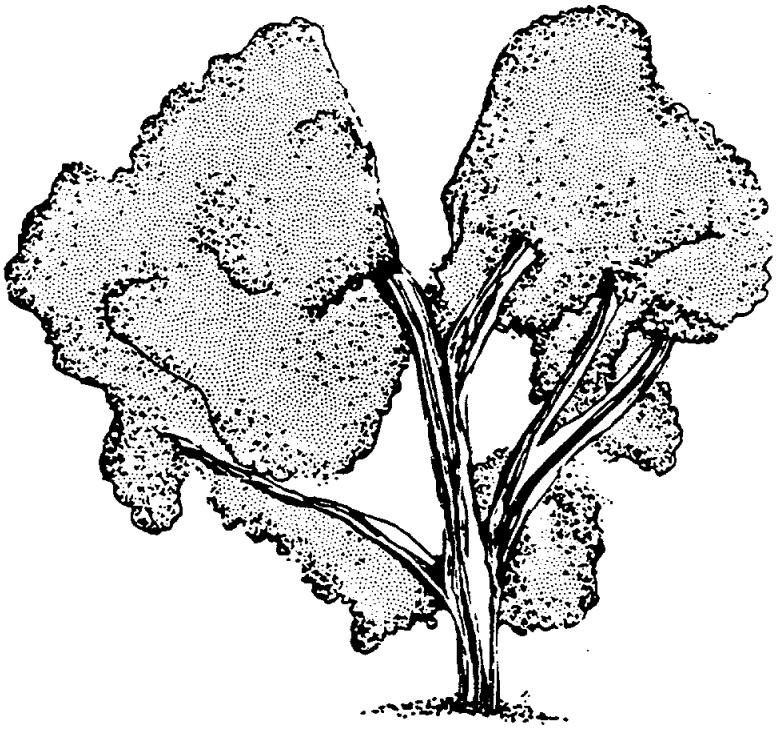
We strongly recommend that you hire a professional tree maintenance service when pruning near overhead powerlines.

Pruning mature trees near powerlines oftentimes presents a problem where large tree branches interfere with the lines. Commonly, power companies "top" trees under the wires because this process is fast and apparently economical. However, this practice is short lived as the numerous sprouts that develop grow back rapidly into the wires. These sprouts, weakly attached to the parent tree, are easily broken.

Side and Directional Pruning

Two other pruning techniques used by professional tree maintenance crews — "side pruning" and "directional pruning" — offer alternatives to "topping." Side pruning is the removal of a large tree's side branches when they interfere with the wires. Usually the opposite side of the tree is pruned to preserve the symmetrical shape.

Directional pruning involves the opening of paths for the wires through the tree crown.



An expert pruner can anticipate the direction of future growth and, by early and correct pruning, favor branches that will grow away from the wires and eliminate the necessity of topping.

While these two pruning methods are initially more expensive than the others, they result in the least disfigurement of the tree. They give the most lasting benefits and **cost the least in the long run.** If these alternatives cannot be used, complete tree removal and replacement with a smaller tree is preferred over "topping."

For more information write or call: PlantAmnesty 906 N.W. 87th, Seattle, WA 98117 (206) 783-9813

Pruning Diseased Trees

You sometimes want or need to prune a tree that is infected with disease in order to arrest the disease's spread or for general sanitation. Under such conditions, great care should be exercised so that the pruning will not actually spread the disease instead of retard it. Saws and pruners used in this work should be dipped in alcohol or household bleach or wiped with a cloth saturated in the solution **between each cut** to kill any pathogen which might be carried on the tool. Dead branches commonly harbor pathogens that are easily carried by cutting tools. In fact, cankers are the major disease of deciduous trees and are usually introduced on tools.

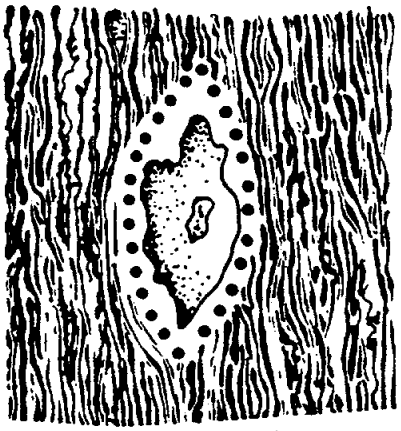
Sanitation pruning should be done back from infected wood. The cut should go through noninfected limbwood. Wood from such pruning should be burned as soon as possible and as close to the site as convenient to minimize the danger of spreading the disease.

Avoid pruning diseased trees in wet weather because the chances of spreading disease spores increases. If the limb you are pruning has died back, it is probably diseased. You should be sure to make your cut in live wood at least 4 to 6 inches below the last indication of dieback. Lightly oil pruning tools after use.

Wound Care and Dressing

Open wounds and long stubs can expose trees unnecessarily to damage from insects and disease. For these reasons, make sure all wounds and stubs are encouraged to heal quickly. Generally, allow wounds to dry as quickly as possible to avoid entrance of decay or insects.

To heal quickly, trim bark wounds back into healthy tissue. Trim so that the wound takes on an elliptical configuration with its long axis parallel to the trunk or limb. Use a sharp, sterile knife to create a clean wound edge. When this is done, the plant's cambium tissue grows from each side eventually meeting in the center. The outer layer of cells becomes corky and bark-like and eventually the wound will not be distinguishable from normal tissue.



Tree dressings have been recently found to be cosmetic. They do not increase the healing of a properly cut surface. Asphaltic black tree dressings can be used on large basal cuts to make the tree "look better." However, any paint used to cover a wet wound or one from which sap is seeping may entrap disease or decay causing fungi so that healing is hampered rather than promoted. House paints will often kill live tree issue thus enlarging the wound.

Acknowledgment

This publication was developed, in part, from information supplied by Kansas State University and Montana State University. It was prepared in cooperation with the University of Idaho College of Forestry, Wildlife and Range Sciences.

The Authors

Don Hanley is Extension forester at the University of Idaho, Moscow, and W. Michael Colt is Extension horticulturist at the Southwest Idaho Research and Extension Center, Caldwell. Arthur D. Partridge is professor of forest resources, UI College of Forestry, Wildlife and Range Sciences, Moscow.

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APPENDIX G: SPECIFICATIONS FOR RESTORATION OF CONCRETE IN HISTORIC STRUCTURES

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DEPARTMENT OF THE ARMY CEGS-03307 (May 1995)

U.S. ARMY CORPS OF ENGINEERS

GUIDE SPECIFICATION FOR MILITARY CONSTRUCTION

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SECTION 03307

RESTORATION OF CONCRETE IN HISTORIC STRUCTURES

05/95

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NOTE: This guide specification covers the requirements for \@restoration of concrete in historic structures@\. This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-720.

****

PART 1 GENERAL

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NOTE: See Additional Notes A through C.

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1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN CONCRETE INSTITUTE (ACI)

\-ACI 201.1R-\ (1992) Guide for Making a Condition Survey of Concrete in Service

\-ACI 211.1-\ (1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

\-ACI 211.2-\ (1991) Standard Practice for Selecting Proportions for Structural Lightweight Concrete

\-ACI 224.1R-\ (1993) Causes, Evaluation and Repair of Cracks in Concrete Structures

\-ACI 301-\ (1989) Structural Concrete for Buildings

\-ACI 304.R-\ (1989) Guide for Measuring, Mixing, Transportation and Placing Concrete

\-ACI 315-\ (1980; Rev 1986) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement

\-ACI 318-\ (1989; Rev 1992; Errata) Building Code Requirements for Reinforced Concrete

\-ACI 347R-\ (1988) Guide to Formwork for Concrete

\-ACI 364.1R-\ (1994) Guide for Evaluation of Concrete Structures Prior to Rehabilitation

\-ACI 437R-\ (1991) Strength Evaluation of Existing Concrete Buildings

\-ACI COMP 20-\ (1993) Repair and Rehabilitation II

\-ACI SP-85-\ (1985) Rehabilitation, Renovation, and Preservation of Concrete and Masonry Structures

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

\-ASTM A 36-\ (1991) Structural Steel

\-ASTM C 31-\ (1991) Making and Curing Concrete Test

Specimens in the Field

\-ASTM C 33-\ (1993) Concrete Aggregates

\-ASTM C 39-\ (1993) Compressive Strength of Cylindrical Concrete Specimens

\-ASTM C 42-\ (1990) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

\-ASTM C 78-\ (1994) Flexural Strength of Concrete

\-ASTM C 109-\ (1993) Compressive Strength of Hydraulic Cement Mortars

\-ASTM C 114-\ (1988) Chemical Analysis of Hydraulic Cement

\-ASTM C 136-\ (1992) Sieve Analysis of Fine and Coarse Aggregates

\-ASTM C 143-\ (1990) Slump of Hydraulic Cement Concrete

\-ASTM C 150-\ (1994) Portland Cement

\-ASTM C 192-\ (1990) Making and Curing Concrete Test Specimens in the Laboratory

\-ASTM C 231-\ (1991) Air Content of Freshly Mixed Concrete by the Pressure Method

\-ASTM C 260-\ (1986) Air-Entraining Admixtures for Concrete

\-ASTM C 295-\ (1990) Guide for Petrographic Examination of Aggregates for Concrete

\-ASTM C 457-\ (1990) Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete

\-ASTM C 494-\ (1992) Chemical Admixtures for Concrete

\-ASTM C 597-\ (1983) Pulse Velocity Through Concrete

\-ASTM C 642-\ (1990) Specific Gravity, Absorption, and Voids in Hardened Concrete

\-ASTM C 803-\ (1990) Penetration Resistance of Hardened Concrete

\-ASTM C 805-\ (1985) Rebound Number of Hardened Concrete

\-ASTM C 823-\ (1983; R 1993) Examination and Sampling of Hardened Concrete in Constructions

\-ASTM C 856-\ (1983; R 1985) Petrographic Examination of Hardened Concrete

\-ASTM C 881-\ (1990) Epoxy-Resin-Base Bonding Systems for Concrete

\-ASTM C 979-\ (1993) Pigments for Integrally Colored Concrete

\-ASTM C 989-\ (1993) Ground granulated Blast-Furnace Slag for Use in Concrete and Mortars

\-ASTM C 1017-\ (1992) Chemical Admixtures for Use in Producing Flowing Concrete

\-ASTM C 1084-\ (1992) Portland Cement Content of Hardened Hydraulic-Cement Concrete

\-ASTM C 1107-\ (1991) Packaged Dry Hydraulic-Cement Grout (Non-shrink)

\-ASTM C 1218-\ (1992) Water-Soluble Chloride in Mortar and Concrete

\-ASTM D 75-\ (1987; R 1992) Sampling Aggregates

U.S ARMY CORPS OF ENGINEERS HANDBOOK FOR CEMENT AND CONCRETE (CRD)

\-CRD-C 300-\ (1988) Membrane-Forming Compounds for Curing Concrete

1.2 GENERAL REQUIREMENTS

The Contractor shall be responsible for all equipment, materials, testing, labor and other items and services required to accomplish the work. Equipment and techniques proposed for use in the work shall not be used until they have been demonstrated and approved. Materials and equipment which have not been approved for use in the work shall not be stored or brought on to Government property. The Contractor's quality control shall conform to Section \=01400=\ CONTRACTOR QUALITY CONTROL. All sampling and testing shall be the Contractor's responsibility, and shall be performed by an approved independent commercial testing laboratory, except as otherwise specified.

1.2.1 Design Requirements

1.2.1.1 Concrete Mixture

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NOTE: If it is determined that the concrete mixture requires plasticizers, the requirements will be added in this paragraph. Slumps for plasticized concrete may range as high as 250 mm (10 in.).

****

The concrete mixture shall match that of the existing concrete to be repaired unless otherwise directed and shall be designed in accordance with [\-ACI 211.1-\] [\-ACI 211.2-\]. The mixture proportions shall include consideration of the finishes required.

1.2.1.2 Formwork Design

Formwork design shall conform to \-ACI 301-\ and \-ACI 347R-\.

1.3 UNIT PRICES

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NOTE: When lump-sum payment is used, this paragraph will be deleted. If patching is a separate pay item, the paragraph will be revised accordingly.

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1.3.1 Measurement of Concrete

The quantity of concrete to be paid for will be the number of cubic meters (cubic feet) placed in the completed and accepted renovated areas..

1.3.2 Payment for Concrete

The quantity of concrete, measured as specified, will be paid for at the contract unit price. The unit price for concrete will include full compensation for furnishing labor; materials; tools and equipment; and for performing work involved in repair of the areas as specified.

1.4 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.
Indicate submittal classification in the blank space using a "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

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Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section \=01300=\ SUBMITTAL PROCEDURES:

SD-04 Drawings\

Architectural Concrete\; *[_____]*\.

Detail drawings conforming to \-ACI 315-\ and \-ACI 318-\. Detail drawings shall show location of architectural concrete elements in the work, building elevations, formwork fabrication details, reinforcements, embedments, dimensions, concrete strength, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, stripping, and finishing.

SD-08 Statements\

Proportions of Mixture\; *[_____]*\.

The results of trial mixture along with a statement giving the maximum nominal coarse aggregate size, aggregate grading, and the proportions of

all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations. Aggregate quantities (by mass) shall be based on the saturated surface-dry condition. The statement shall include a complete petrographic analysis of the aggregates proposed for use in the concrete. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

Qualifications\; *[_____]*\.

A statement certified by the contractor attesting that the experience and qualification of the workers (journeymen) comply with the specifications.

SD-09 Reports\

Sampling and Laboratory Test Reports\; *[_____]*\.

Certified copies of laboratory test reports on analysis of existing concrete composition and new concrete mixtures, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD-13 Certificates\; *[_____]*\.

Certificates of compliance attesting that the materials meet specification requirements.

SD-14 Samples\

Materials\; *[_____]*\.

The Contractor shall submit at least 3 sample specimens for each proposed mixture at least 14 days prior to any placements, in order to demonstrate range of variation of each mixture. Samples of cured concrete and mortar patching specimens for each mixture shall be submitted for comparison with the cleaned structure. Samples of concrete and mortar shall be approximately 30 mm X 30 mm (12 in. X 12 in.) in plan dimension and 25 mm to 38 mm (1 in. to 1-1/2 in.) thick. The samples shall clearly indicate the mixture represented by the specimen, and shall have been produced, placed, finished, textured, and cured in the same manner as proposed for use in the work. The samples shall be checked for matches in

color and shade, finish, texture, and surface defects. The samples shall be compared to that part of the structure on which the mixture is proposed to be used. The samples shall be compared to the thoroughly cleaned structure. The samples and structure surfaces shall be clean and completely dry during the comparison. Following the comparison to dry surfaces, the sample and structure shall be dampened with clean, potable water and the surfaces shall be compared for acceptability to the Contracting Officer.

Demonstrations\; *[_____]*\.

The Contractor shall provide equipment, materials, and labor to demonstrate, materials, equipment, and techniques proposed for use in the work. The demonstrations shall be performed at the site, at a time and location as directed. The demonstration shall include surface cleaning, excavation, surface patching (including finishing, texturing, and curing materials and methods), curing, safety procedures, surface finish and appearance.

1.5 QUALIFICATIONS

The Contractor shall provide qualified workers trained and experienced in restoration of concrete in historic structures and shall submit documentation of 5 consecutive years of work of this type. A list of similar jobs shall be provided identifying when, where, and for whom the work was done.

1.6 EQUIPMENT

Equipment and techniques of operation shall be demonstrated in an approved location and shall be subject to approval. Dependable and sufficient equipment that is appropriate and adequate to accomplish the work specified shall be assembled at the site of the work a sufficient time before the start of the work to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required. The equipment shall be maintained in good working condition.

1.6.1 Cleaning Equipment

Equipment proposed for use in cleaning shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

1.6.1.1 Sandblasting Equipment

Sandblasting equipment proposed for use in cleaning or other operations shall be subject to approval for each specific application. Sandblasting for use in cleaning concrete and other building surfaces is prohibited. Sandblasting equipment may be permitted for use in cleaning reinforcement and other embedded metal items. Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 6.3 mm (1/4 in.). The air compressor shall be portable and shall be capable of furnishing not less than 4.2 cubic meters (150 cubic feet) per minute and maintaining a line pressure of not less than 0.620 Mpa (90 psi) at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the reinforcement and other items to be cleaned, and will maintain the nozzle approximately 25 mm (1 in.) above the surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to provide satisfactory results. The Contractor shall provide protective covers and barriers as required to prevent over-spray on to adjacent surfaces.

1.6.1.2 Water Blasting Equipment

Water blasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The equipment shall not be operated at a pressure which will cause etching or other damage to the concrete surface, except for the surfaces of the interior of the excavation, where operation at higher pressures may be used, subject to specific approval. The equipment shall be operated at a discharge capacity of 0.38 Mpa (55 psi) maximum and 9.5 to 11.4 Lpm (2.5 to 3 gpm) for general surface cleaning operations of the structure, and between 3.5 and 7 Mpa (500 and 1000 psi) and 9.5 to 11.4 Lpm (2.5 to 3 gpm) for cleaning of drill holes and surfaces of excavations. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations. The Contractor shall provide protective covers and barriers as required to prevent over-spray on to adjacent surfaces.

1.6.2 Excavation Equipment

The equipment used to excavate concrete shall be handheld manual or power type with a low-impact energy output and shall have gad points. The use of chisel points is prohibited. Surface grinders for use in preparing concrete and metal surfaces shall be small, hand-held equipment with a slow to moderate operating RPM, using stone grinding wheels. Saw cutting

equipment shall use circular diamond blades. The blade shall be at least 3.2 mm (1/8 in.) thick, with blade diameter selected as appropriate for the application. Excavation equipment shall be subject to approval.

1.6.3 Drilling Equipment

Equipment used to drill holes in concrete for patch anchors and other applications shall be standard handheld masonry drills, commonly used for drilling small holes in concrete and masonry. The drill shall be a small, powered, handheld type, using rotary drilling mode only. Impact and rotary impact type drills are prohibited.

1.6.4 Finishing and Texturing Equipment

Hand tools used for placing, finishing and texturing concrete and mortar shall be commercially available and commonly used in concrete construction and repair. Equipment used for finishing and texturing concrete and mortar surfaces shall be a type commonly used in the concrete construction and repair industry for that application. Surface grinders, impact tools, and other equipment shall conform to the requirements specified herein, except as specifically required by the type of finish and texture, and subject to approval.

1.6.5 Compressed Air Supplies

Compressed air shall provide clean, oil and moisture free compressed air at the surface to be cleaned. The compressed air line shall have at least two (2) in-line air filters to remove oil and moisture from the air supply. The compressed air supply shall be tested during each shift for the presence of oil and moisture.

1.6.6 Material Handling and Associated Equipment

1.6.6.1 Equipment for Mixing, Transporting, and Placing Job Materials

Equipment used for mixing, transporting, placing, and confining all concrete and mortar placements shall be suitable for the intended purpose and be capable of satisfactorily mixing material, and supporting placement operations in an uninterrupted manner. Equipment shall be maintained in a clean, good operable condition at all times. Equipment used in the work shall be subject to approval. Defects, and deficiencies in operation or capacity shall be resolved prior to use in the work. Equipment used for batching, mixing, conveying, and placing of materials shall be clean, free of old materials and contaminants, and shall conform to the material manufacturer's recommendations.

1.6.6.2 Associated Equipment

Associated equipment such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools shall be provided as required to ensure a continuous supply of material and operation control. Mechanical or radio communication systems shall be used between elements of mortar production and placement operation which are more than 30 m (100 ft.) apart.

1.7 SAMPLING AND LABORATORY TESTING OF MATERIALS

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NOTE: Guidance for preparation of criteria to be used in inspection of laboratory facilities is contained in ASTM E 548.

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Sampling and testing shall be performed by an approved independent commercial testing laboratory, or by the Contractor subject to approval. Should the Contractor elect to establish testing facilities, no work requiring testing shall be permitted until the Contractor's facilities have been inspected and approved. All sampling and testing shall be the Contractor's responsibility, and shall be performed at no additional cost to the Government.

1.7.1 Existing Concrete Testing

Representative samples of existing concrete shall be taken from areas of the structure to be repaired at indicated locations. The samples shall be taken in accordance with \-ASTM C 42-\ and \-ASTM C 823-\ and tested in accordance with [\-ASTM C 39-\, \-ASTM C 42-\, \-ASTM C 114-\,\-ASTM C 295-\, \-ASTM C 457-\, \-ASTM C 856-\, \-ASTM C 1218-\, [and] \-ASTM C 642-\] [, and \-ASTM C 1084-\]. Aggregates in the existing concrete shall be evaluated in accordance with \-ASTM C 136-\ and \-ASTM C 295-\. The air content of the existing concrete shall be determined in accordance with \-ASTM C 457-\ and \-ASTM C 642-\.

1.7.2 Cement

Job cement for repair concrete and mortars shall be tested as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification. The mill test reports and

certification of compliance shall clearly reference the applicable ASTM documents and present the test result data. Job cement shall conform to the specified requirements, and where the job cement consists of a blend of cement and pozzolan, the pozzolan shall conform to the specified requirements for pozzolan, and the blend of cement and pozzolan shall conform to \-ASTM C 1107-\ and all other specified requirements.

1.7.3 Aggregate

Aggregate samples for repair concrete and mortars for laboratory testing shall be taken in conformance with \-ASTM D 75-\ and tested in accordance with \-ASTM C 33-\, \-ASTM C 136-\, and \-ASTM C 295-\.

1.7.4 Epoxy-Resin Grout

Epoxy-resin grout shall be tested for conformance with \-ASTM C 881-\.

1.8 EVALUATION OF SAMPLE SPECIMENS

Sample panels of each mixture proposed for use in the work shall be submitted for approval. No concrete of mortar shall be used in the work until the samples and the represented mixture has been approved. Materials proposed for use in producing concrete and mortar shall not be brought on to Government property until the samples and mixtures have been approved. Samples for each side of the structure shall be evaluated both close up and at a distance under both wet and dry conditions. Each patch location and each side of the structure may require a separate or different mixture.

1.9 GENERAL REQUIREMENTS

1.9.1 Strength Requirements

Each class or mixture of concrete and mortar proposed for use in the work shall have a 28-day compressive strength matching the compressive strength of the adjacent existing concrete in the structure as determined by \-ASTM C 39-\ for concrete and \-ASTM C 109-\ for mortar. The compressive strength of the existing concrete shall be determined from testing of samples for each portion of the work in accordance with \-ASTM C 42-\. Test specimens of existing concrete shall be taken from a sound and intact representative portion of the structure, at locations indicated.

1.9.2 Air Entrainment

Each class or mixture of concrete and mortar proposed for use in the work shall have a total air content matching the total air content of the

adjacent concrete. Air content of the proposed mixture shall be determined in accordance with \-ASTM C 231-\. When air-entrained concrete is required for resistance to freezing and thawing, the concrete shall contain an air-entraining admixture conforming to \-ASTM C 260-\ and having an air content as indicated in \-ACI 301-\ (Table 3.4.1).

1.9.3 Special Properties

Concrete may contain admixtures, such as pigments, water reducers, high-range water reducers, or set retarders to provide special properties to the concrete. Use of all admixtures shall be subject to approval.

1.9.4 Cementitious Content

Each class or mixture of concrete and mortar proposed for use in the work shall have a cement content matching the cement content of the adjacent existing concrete in order to provide uniform strength, weathering characteristics, and appearance of repaired surfaces in relation to existing surfaces.

1.9.5 Slump

Slump shall be determined in accordance with \-ASTM C 143-\, and shall be within the following limits:

Structural Element	Slump in millimeters	
	Minimum	Maximum
Walls, columns, and beams	50	100
Foundation walls, substructure walls, footings, pavement, and slabs	25	75
Any structural concrete approved for placement by pumping	None	150

Structural Element	Slump in Inches	
	Minimum	Maximum
Walls, columns, and beams	2	4
Foundation walls, substructure walls,	1	3

footings, pavement, and slabs		
Any structural concrete approved for placement by pumping	None	6

*Where use of admixtures conforming to \-ASTM C 1017-\ are approved to produce flowing concrete, these slump requirements do not apply.

1.9.6 Technical Service for Specialized Concrete

The service of a technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating, and finishing of concrete and mortar, until field controls indicate specialized concrete of specified quality is furnished.

1.10 PROPORTIONS OF MIXTURE

Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in \-ACI 211.1-\, using at least three different water-cement ratios. Trial mixtures shall be proportioned to produce concrete matching the qualities specified. In the case where ground granulated iron blast-furnace slag conforming to \-ASTM C 989-\ is used, the mass of the slag will be substituted in the equations for the term P which is used to denote the mass of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The concrete and mortar patching mixtures shall be designed using the lowest practical water/cement (W/C) ratio. The temperature, slump, and air content of the concrete and mortar mixtures in each trial batch shall be reported. For each water/cement ratio at least three test specimens for each test age shall be made and cured in accordance with \-ASTM C 192-\ and \-ASTM C 109-\. They shall be tested at 7 and 28 days in accordance with \-ASTM C 39-\ for concrete and \-ASTM C 109-\ for mortar. From these test results a curve shall be plotted showing the relationship between water/cement ratio and strength. For each strength of concrete the maximum allowable water/cement ratio shall be that shown by these curves to produce an average strength as specified in paragraph AVERAGE STRENGTH. Materials, physical and chemical properties, and composition of concrete and mortar patch mixtures shall match the existing concrete to be repaired, except that patching mixtures shall have the lowest total chlorides content practical and shall conform to ACI recommendation for maximum permitted total chloride content.

1.10.1 Average Strength

In meeting the strength requirements specified, the selected mixture shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 3.5 Mpa (500 psi) of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

1.10.1.1 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 3.5 Mpa (500 psi.)

1.10.1.2 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the calculated standard deviation and a modification factor from the following table:

No. of tests (1)	Modification factor for standard deviation
less than 15	See Note
15	1.16
20	1.08
25	1.03
30 or more	1.00

(1) Interpolate for intermediate numbers of tests.
When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be specified strength plus 3.5 Mpa (500 psi.)

1.11 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Cement shall be furnished in suitable bags used for packaging cements. Labeling of packages shall clearly define contents, manufacturer, batch identification, etc. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than six (6) months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Epoxy shall be stored in accordance with the manufacturer's recommendations.

1.12 WEATHER LIMITATIONS

Concrete, mortar, and epoxy adhesives shall not be placed when weather conditions detrimentally affect the quality of the finished product. No concrete or mortar shall be placed when the air temperature is below 5 degrees C (40 degrees F) in the shade. When air temperature is likely to exceed 35 degrees C (90 degrees F), concrete and mortar shall have a temperature not exceeding 35 degrees C (90 degrees F) when deposited, and the surface of the placed concrete shall be kept damp with a water fog until the approved curing medium is applied. Materials proposed for use in the work shall not be produced and placed during periods of rain or other precipitation. Material placements shall be stopped and all in-place material shall be protected from exposure during periods of rain or other precipitation.

PART 2 PRODUCTS

2.1 MATERIALS

Materials, physical and chemical properties, and composition of new concrete shall match that of existing concrete to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or non-performing.

2.1.1 Admixtures

Air entraining admixtures shall conform to \-ASTM C 260-\, water-reducing or -retarding admixtures shall conform to \-ASTM C 494-\, and pigments for integrally colored concrete shall conform to \-ASTM C 979-\ and \-ASTM C 1017-\. Admixtures shall not contain added chlorides.

2.1.2 Aggregates

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NOTE: If a specific type or size of aggregate is required for a desired finish, whether it be for a facing mix or the entire thickness, the additional requirements will be added in this paragraph.

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Aggregates shall match existing aggregates as determined by samples and testing and shall otherwise conform to \-ASTM C 33-\.

2.1.3 Bonding Agents

Bonding agents for use in bonding concrete and mortar patching materials to concrete and steel are specifically prohibited for use in the work.

2.1.4 Cementitious Materials

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.1.4.1 Cement

Cement composition shall match that of cement used in existing concrete to be repaired as determined by samples and testing and shall conform to the basic requirements of \-ASTM C 150-\, Type [I] [II], [low alkali]. Cement shall have non-shrink (shrinkage compensating) properties and shall conform to \-ASTM C 1107-\, Class B or C, expansive cement type.

2.1.4.2 Pozzolan

Pozzolan shall conform to \-ASTM C 618-\, Class F, including limit on available alkalis, "Table 2 - Supplementary Optional Chemical Requirements," and uniformity requirements, "Table 4 - Supplementary Optional Physical Requirements."

2.1.5 Epoxy Anchor Adhesives

An epoxy-resin grout shall be used to bond steel anchors to concrete, and shall be a 100 percent solids, moisture insensitive, low creep, structural adhesive. The epoxy shall conform to \-ASTM C 881-\, type IV; grade and class selected to conform to the manufacturer's recommendations for the

application. The epoxy adhesive shall be conditioned, proportioned, mixed, and applied in accordance with the manufacturer's recommendations, except as otherwise specified herein or indicated on the drawings.

2.1.6 Reinforcing Steel

Reinforcing steel shall conform to \-ASTM A 36-\, sizes as indicated, unless otherwise directed.

2.1.7 Tie Wire

Tie wire shall be soft Monel Metal or 18-8 stainless steel.

2.1.8 Metal attachments

Anchors for spall repairs shall be threaded stainless steel, size as indicated. Other plates, angles, anchors, and embedments shall conform to \-ASTM A 36-\, and shall be prime painted with inorganic zinc primer.

2.1.9 Formwork

Formwork for special effects shall be as indicated or directed, and shall be subject to specific approval.

2.1.10 Form-Release Agents

Form-release agents shall be the manufacturer's standard, nonstaining, nonpetroleum based, compatible with surface finish and subsequent surface treatments.

2.1.11 Cleaning Solution

The cleaning solution shall consist of a 1:1 to 1:1.5 (water: liquid chlorine bleach) mixture of clean potable water and liquid chlorine bleach. Rinse water shall be clean potable water.

2.1.12 Water

Water used in cleaning concrete surfaces, used in producing concrete and mortars, and used for curing concrete shall be potable.

2.1.13 Curing Materials

2.1.13.1 Burlap

\-FS CCC-C-467-\

2.1.13.2 Impervious Sheets

\-ASTM C 171-\, type optional, except that polyethylene film, if used, shall be white opaque.

2.1.13.3 Membrane-Forming Compounds

\-CRD-C-300-\, non-pigmented, containing a fugitive dye

PART 3 EXECUTION

3.1 EVALUATION AND ANALYSIS

Evaluation and analysis shall conform to the requirements specified herein, and the requirements specified in Section \=01400=\ CONTRACTOR QUALITY CONTROL.

3.1.1 Evaluation and Analysis of Existing Concrete

Concrete renovation shall be undertaken only after a complete evaluation and analysis of the areas to be repaired is completed. This shall include sampling and testing of the existing concrete to determine its composition and qualities. A condition survey of the area to be repaired shall conform to \-ACI 201.1R-\ and \-ACI 364.1R-\. Strength evaluation shall be per \-ACI 437R-\. Cracks shall be evaluated per \-ACI 224.1R-\. Examination and sampling procedures shall conform to \-ASTM C 823-\.

3.1.2 Evaluation and Acceptance of New Concrete

3.1.2.1 Frequency of Testing

Samples for strength, slump, air content, and shrinkage tests of each concrete mixture placed each day shall be taken not less than once a day, and at least once for each 0.33 cubic meters (10 cubic feet) of concrete; nor less than once for each 50 square meters (500 square feet) of surface area for slabs or walls. Samples for strength, slump, air content, and shrinkage tests of each mortar mixture placed each day shall be taken not less than once a day, and at least for each 0.25 cubic meters (9 cubic feet) of mortar. If this sampling frequency results in less than 3 strength tests for a given class of concrete or individual mixture design, tests shall be made from at least 3 randomly selected trucks (or batches) or from each truck (or batch) if fewer than 3 truck

loads (or batches) are used. Field cured specimens for determining form-removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.1.2.2 Testing Procedures

Strength test specimens for acceptance tests shall be molded and cured in accordance with \-ASTM C 31-\. Strength test specimens and testing for mortar shall conform to \-ASTM C 109-\. Cylinders shall be tested in accordance with \-ASTM C 39-\ and beams shall be tested in accordance with \-ASTM C 78-\. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at another specified test age. Tests for total air content and slump shall be made on fresh samples of the concrete and mortar. Tests shall be performed on site, on samples taken at the location of placement. Slump shall be determined in accordance with \-ASTM C 143-\. Air content shall be determined in accordance with \-ASTM C 231-\. Testing for shrinkage shall be determined in accordance with \-ASTM C 1107-\.

3.1.2.3 Evaluation of Results

Concrete and mortar shall have a compressive strength at 28 days as determined by \-ASTM C 39-\ and \-ASTM C 109-\ respectively, which matches the present compressive strength of concrete in the structure within a tolerance of -0 MPa/ + 3.5 Mpa (-0 psi/ +500 psi.) Concrete and mortar strengths will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength. For flexural strength concrete, the strength level of the concrete will be considered satisfactory if the averages of all sets of five consecutive strength test results equal or exceed the required flexural strength, and not more than 20 percent of the strength test results fall below the required strength by more than .35 Mpa (50 psi.) The required minimum strength shall be the strength determined from testing of samples taken from the structure.

3.1.2.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test specimen falls below the specified strength requirement by more than 3.5 Mpa (500 psi), or if tests of field-cured specimens indicate deficiencies in protection and

curing, steps shall be taken to assure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with \-ASTM C 597-\, \-ASTM C 803-\, or \-ASTM C 805-\ may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with \-ASTM C 42-\. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure is dry under service conditions, the cores shall be air-dried, temperature 16 to 27 degrees C (60 to 80 degrees F), relative humidity less than 60 percent, for seven days before testing and shall be tested dry. If the concrete in the structure is more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with \-ASTM C 42-\. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of \-ACI 318-\. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

3.2 PREPARATION OF CONCRETE SURFACES

3.2.1 Initial Surface Cleaning

The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. The materials, equipment, and methods proposed for use in cleaning shall be demonstrated in a 1 m X 1 m (3 ft. X 3 ft.) square test section. The location of the test section, and the completed test section shall be subject to approval. The cleaning process shall be adjusted as required and the test section rerun until an acceptable process is obtained. Following an initial inspection and evaluation of the structure and surfaces, the structure shall be given an initial surface

cleaning. The initial surface cleaning shall be completed prior to start of excavation, and sampling and testing for mixtures. The initial cleaning shall provide for the complete cleaning of all exterior concrete surfaces of the structures. The initial cleaning shall thoroughly clean the concrete surface to remove all traces of moss, dirt, and other contaminants. The cleaning shall provide a clean concrete surface to allow determination of the concrete's color and shades, finish and texture, and other properties. The "initial cleaning" shall consist of initial surface washing, followed by treatment with the cleaning solution, and then followed by a final water rinse. The initial surface washing shall consist of washing the surface with clean, low pressure water (pressure of less than 0.38 Mpa (55 psi) and 9.5 to 11.4 Lpm (2.5 to 3 gpm) discharge) and manual surface scrubbing using handheld natural or plastic bristle brushes, followed by a clean water rinse. Following completion of the initial surface washing of the entire structure (or side of structure) the concrete shall be dried prior to application of the cleaning solution. The concrete surfaces of the structure shall be coated with the cleaning solution at an application rate of 3.8L (1 gal.) of solution per 1 to 3 square meters (10 to 30 square feet) of treated surface using low pressure spraying equipment. The application rate of the solution shall be adjusted as directed to ensure that the entire surface has been thoroughly wetted with the solution. A manual surface scrubbing with handheld natural or plastic bristle brushes shall be used on heavily soiled areas. Following treatment with the cleaning solution the treated surfaces shall be rinsed with clean, low-pressure water. Water and all liquid materials used in the work shall be contained at the building perimeter and collected and disposed of in an approved manner.

3.2.2 Areas to be Removed

Unsound, weak, or damaged concrete shall be removed. Loose particles, laitance, spalling, cracked, or debonded concrete and foreign materials shall be removed with hand tools unless otherwise noted. Surfaces of the structure, and surfaces adjacent to the excavation shall be protected from damage which may result from excavation, cleaning, and patching operations.

3.2.3 Exposed Reinforcement

Concrete shall be removed from around exposed or deteriorated reinforcing steel. Steel shall stand free of concrete at least 25 mm (1 in.) minimum to provide mechanical bond with patch material.

3.2.4 Excavation in Concrete

Deteriorated areas indicated to be repaired shall be excavated to sound

concrete. The use of concrete and masonry saws for outlining the excavation shall not be used. The excavation shall be accomplished by use of manual methods and low-energy, handheld equipment. The sides of the excavation shall be approximately perpendicular to the exposed surface, dovetailed back 15 degrees from perpendicular to the exposed surface at the bottom in order to key in the patch. The bottom (or back) of the excavation shall be approximately parallel with the exposed surface of the patch. The surfaces of the excavation shall be finished to remove excessive variations and roughness and shall be shaped to provide a patch with uniform dimensions. Feathering at edges shall not be permitted. The excavation shall be accomplished to minimize the appearance of bond lines between the patch and the adjacent concrete and other abutting surfaces. Surfaces of the structure and surfaces adjacent to the excavation shall be protected from damage which may result from excavation operations.

3.2.5 Cleaning of Excavations

The surfaces of the excavation shall be cleaned by water blasting and manual scrubbing methods. Sandblasting shall not be used to clean concrete surfaces. The surfaces of excavations shall be cleaned of dust, dirt, laitance, corrosion, or other contamination. Cracks and voids shall be flushed out with clean water and allowed to dry. Concrete surfaces to be in contact with the freshly placed concrete shall be maintained in a continuously damp condition for at least 24 hours prior to concrete placement. Immediately before placement, areas to be patched shall be cleaned and rinsed, followed by blowing dry with filtered, dry, compressed air to remove excess water, and to provide a surface in a saturated, surface-dry, damp condition. Surfaces of the structure and surfaces adjacent to the excavation shall be protected from damage which may result from cleaning operations.

3.2.6 Previously Repaired Cracks

Old caulking or grout shall be removed from previously repaired cracks where it is failing. Loose particles shall be removed from cracks. Cracks shall be cleaned, rinsed with water followed by blowing with filtered, dry, compressed air.

3.3 REINFORCING STEEL

3.3.1 Cleaning

Exposed reinforcing steel shall be mechanically cleaned to bare metal. Exposed steel in areas to be patched shall be painted with two coats of zinc-rich primer paint.

3.3.2 Repairing

The Contracting Officer shall be notified of any steel members which have significant loss in cross-sectional area due to corrosion, cutting, or other damage. Damaged portions shall be mechanically cut away. Reinforcing steel to match existing shall be installed where existing reinforcing is badly corroded or damaged. Lap splices shall be as required by code. If necessary, bars shall be fastened with tie wires.

3.4 FORMWORK ERECTION

Formwork shall be erected in accordance with the detail drawings to ensure that the finished concrete members conform accurately to the indicated dimensions, lines, elevations, and finishes. Deflection shall not exceed 1/360th of each component span or distance between adjacent supports. Deflections and tolerance shall not be cumulative. Form liners shall be installed as necessary to provide the required finish. Forms shall be coated with form release agents before reinforcement is placed.

3.5 CONCRETE REPAIR

3.5.1 General

Repairs shall be accomplished in accordance with \-ACI SP-85-\, \-ACI COMP 20-\, \-ACI 301-\, and \-ACI 304-\. Cracks shall be repaired, if required, per \-ACI 224.1R-\. Detailing shall be per \-ACI 315-\. Repaired surfaces shall match adjacent existing surfaces in all respects. Formwork as necessary to reconstruct concrete to match adjacent surfaces shall be provided. Voids shall be filled flush with adjacent surfaces. Products shall be used in accordance with the manufacturer's instructions.

3.5.2 Spalls

Spalls less than 25 mm (1 in.) deep, where indicated to be repaired, shall be drypacked with an approved patching mortar. Spalls greater than 25 mm (1 in.) deep shall be excavated and patched with concrete.

3.5.3 Patch Anchors

Surface areas to be patched which do not have reinforcement or other metal embedments which will be embedded in the patching concrete and mortar shall be provided with patch anchors. Patch anchors shall be provided to ensure that the patch is tied to the existing concrete structure. Patch anchors shall be provided within the excavation at a frequency of at least one

patch anchor per 0.10 square meter (square foot) of patch plan surface area; specific locations for patch anchors shall be as indicated. Small handheld, low-speed rotary masonry drills shall be used to produce holes in the existing concrete, within the limits of the excavations for the patch anchor installation.

3.5.3.1 Holes

Holes shall be drilled into the existing concrete substrate material of the excavation using rotary (non-hammer) drills. Holes shall have a diameter 3.2 mm (1/8 in.) larger than the anchor diameter. The holes shall be drilled to a depth of 100 mm (4 in.), except as otherwise indicated or directed. Drill holes shall be produced to ensure that the holes do not penetrate completely through the concrete, and will provide at least 25 mm (1 in.) of cover around the drill hole. Holes shall be cleaned by water blasting to remove drill dust and other debris and then blown dry with filtered, dry, compressed air. Drill holes shall be conditioned in accordance with the epoxy adhesive manufacturer's recommendations.

3.5.3.2 Anchor Installation

Anchors shall be cleaned to remove all contaminants which may hinder epoxy bond. Epoxy adhesive shall be pressure injected into the back of the drilled holes. The epoxy shall fill the holes so that when the anchors are inserted, the epoxy completely fills the holes and excess epoxy is not exuded from the holes. Anchors shall be inserted immediately into the holes. The anchors shall be set back from the exterior face at least 25 mm (1 inch.) Anchors shall be installed without breaking or chipping the exposed concrete surface.

3.5.3.3 Cleanup

Excess epoxy and spills shall be removed from the surface of the excavation. The surface of the excavation shall be left in a clean and uncontaminated condition. Spills on adjacent surfaces shall also be removed and surfaces repaired as required.

3.5.4 Mixing Epoxy-Resin Grout Components

Epoxy-resin grout components shall be mixed in the proportions recommended by the manufacturer. The components shall be conditioned to 20 degrees C (70 degrees F) to 30 degrees C (85 degrees F) for 48 hours prior to mixing. The two epoxy components shall be mixed with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. The polysulfide curing agent component shall be

added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. The rate of stirring shall be such that the entrained air is at a minimum.

3.5.4.1 Tools and Equipment

Tools and equipment used further in the work shall be thoroughly cleaned before the epoxy-resin grout sets.

3.5.4.2 Health and Safety Precautions

Full-face shields shall be provided for all mixing and blending operations for placing operations as required. Protective coveralls and neoprene-coated gloves shall be provided for all workers engaged in the operations. Protective creams of a suitable nature for the operation shall be supplied. Adequate fire protection shall be maintained at all mixing and placing operations. Smoking or the use of spark- or flame-producing devices shall be prohibited within 15 m (50 ft.) of mixing and placing operations. The mixing, placing, or storage of epoxy-resin grout or solvent shall be prohibited within 15 m (50 ft.) of any vehicle, equipment, aircraft, or machinery that could be damaged from fire or could ignite vapors from the material.

3.5.5 Application of Concrete and Patching Mortar

Concrete and mortar shall be placed to rebuild spalled or damaged areas to match the original surface finish, level, texture, and color. Concrete shall be cured as specified herein. The finished appearance of the patch shall match the adjacent existing surface.

3.6 CURING AND PROTECTION

3.6.1 General

All concrete and mortar patching shall be cured by an approved method for at least 7 days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete and mortar shall be maintained at a temperature above 10 degrees C (50 degrees F) for the first 3 days and at a temperature above 0 degrees (32 degrees F) for the remainder of the specified curing period. Materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to placing concrete and mortar. No fire or excessive heat shall be permitted near or in direct contact with the concrete and mortar at any time. Curing shall

be accomplished by any of the following methods, or combination thereof, as approved:

3.6.1.1 Moist Curing

Concrete and mortar to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials stain or discolor concrete and mortar surfaces which are to be permanently exposed, the concrete and mortar surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 50 mm (2-in.) minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene coated burlap, or saturated burlap.

3.6.1.2 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except a styrene acrylate or chlorinated rubber compound meeting \-CRD C-300-\ requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage of 20 square meters per 3.8L (200 square feet per gallon.) Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.6.2 Epoxy Adhesives

Epoxy adhesives shall be protected and cured in accordance with the

manufacturer's recommendations. The adjacent surfaces and ambient conditions shall be maintained within the manufacturer's recommendations. The patch anchors and epoxy adhesive shall be protected from displacement and disturbances.

3.7 CONCRETE AND MORTAR FINISHES AND COLOR

Concrete and mortar finishes and color shall match the finish and color of the existing adjacent concrete. Finishing shall be accomplished at the time of concrete placement or immediately after formwork removal. Concrete elements which are to have a finish other than the surface produced from standard formwork, shall be accomplished in accordance with paragraph: Finishing and Texturing.

3.7.1 Finishing and Texturing

The exposed surfaces of concrete and mortar patching shall match the finish, texture, and surface detail of the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance. The finishing and texturing shall be accomplished in such a way as to help conceal bond lines between the patch and adjacent surfaces. The texturing shall provide replication of all surface details, including tooling and machine marks. The equipment used in finishing and texturing shall be a low-impact energy type which will not weaken the patch or damage the patch bond and the adjacent concrete. Equipment used for finishing and texturing shall be demonstrated on sample panels of concrete and mortar to demonstrate performance and suitability of the equipment and methods. Equipment and methods shall be subject to approval.

3.8 JOINT SEALING

Joint sealing shall be as specified in Section \=07920=\ CAULKING AND SEALANTS.

3.9 FINAL CLEANING

No sooner than 72 hours after completion of the curing period and after joints are sealed, faces and other exposed surfaces of concrete shall be washed down with water applied with a soft bristle brush, then rinsed with clean water. Discolorations which cannot be removed by these procedures, shall be considered defective work. Cleaning work shall be done when temperature and humidity conditions are such that surfaces dry rapidly. Adjacent surfaces shall be protected from damage during cleaning operations.

3.10 PROTECTION OF WORK

Work shall be protected against damage from subsequent operations.

3.11 DEFECTIVE WORK

Defective work shall be repaired or replaced, as directed, using approved procedures.

3.12 FINAL INSPECTION

Following completion of the work, the structure shall be inspected for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects. The finish, texture, color and shade, and surface tolerances of the patches shall be inspected to verify that all requirements have been met. All surfaces exhibiting defects shall be repaired as directed.

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ADDITIONAL NOTES

NOTE A: For additional information on the use of all CEGS, see CEGS-01000 CEGS GENERAL NOTES

NOTE B: Where the words "as indicated" are used, assure that sizes, positions or other designated information is indicated on the design drawings

NOTE C: Some jobs may require the pressure injection of cracks with epoxy-resin grout. In such instances, the following paragraphs should be inserted: In Part 2:

2.1.14 Epoxy-Resin Grout

Epoxy-resin grout shall be a two-component material, 100 percent solids by weight, formulated to meet the requirements of \-ASTM C 881-\, Type I or II. Type I material shall be used when materials or atmospheric temperatures are 20 degrees C (70 degrees F) or above. Type II material shall be used when materials or atmospheric temperatures are below 20 degrees C (70 degrees F). Epoxy-resin grout shall have the ability to structurally rebond cracks, delaminations, and

hollow plane conditions in concrete; shall be insensitive to the presence of water, and shall have the capability to penetrate cracks down to 5 mils in width. Materials shall have been used in similar conditions for a period of at least five years.

2.1.15 Epoxy Injection Ports

Injection ports for epoxy-resin grout shall be designed for the intended use as detailed in this section and shall be made according to the recommendation of the epoxy manufacturer.

In Part 3:

3.5.4.3 Epoxy Pressure-Injection of Cracks

Cracks shall be pressure-injected using a two-component epoxy system with an in-line mixing and metering capability. System shall be capable of injection pressures up to a maximum of 1 Mpa (150 psi) to ensure complete penetration of the crack. An adequate surface seal shall be applied to the crack or joint to prevent the escape of epoxy. Entry points shall be established along the crack. The crack shall be filled with a 100 percent solid epoxy adhesive. The adhesive shall be injected into the crack at the first entry point with sufficient pressure to advance the epoxy to the next adjacent port. The original port shall be sealed and injection moved to the port at which the epoxy appears. The process shall continue until each joint and crack has been injected for its entire length. Epoxy shall be allowed to cure in accordance with manufacturer's instructions. Sealing materials shall then be removed and surface finished to match adjacent existing surface.

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--End of Section--

APPENDIX H: MISCELLANEOUS MAINTENANCE INFORMATION

FROM: HENSLEY, DAVID L., PROFESSIONAL LANDSCAPE MANAGEMENT STIPES PUBLISHING L.L.C. 1994

Table 4-3. Maintenance Task Estimating

Area and Operation	Average Frequency per Year	Average Minutes per 1,000 sq. ft.	Area and Operation	Average Frequency per Year	Average Minutes per 1,000 sq. ft.
TURF MANAGEMENT			Fertilization (broadcast)	2	5
Mowing 16" hand mower	30	10	Mulch	1	30
19" power	30	9	Spray for pest control	2	30
21" self-propelled	30	6	TREES		Min./small tree
36" self-propelled	30	4	Pruning	2	20
48" rider	30	45 Min./acre	Fertilization		
72" rider	30	36 Min./acre	broadcast	2	5
Fertilization	2	3	deep root feed	1	30
broadcast (PTO powered)	2	.25	Pest control—spray	3	15
36" spreader			Injection	1	10
Preemergent herbicide application	1	15	SEASONAL COLOR BEDS		Min./1,000 sq. ft.
Postemergent herbicide application back-pack sprayer	2	15	Bed preparation	1	200
15" boom, power	2	4	Planting (flats)	1	600
30" boom, power	2	8	Weeding (no mulch)	15	60
Rake			Cultivation (no mulch)	15	30
hand	1	60	Mulch	1	30
power	1	10	weeding (in mulch)	7	20
Vacuum—30" machine	3	10	Pest control (spray)	3	10
Overseeding (machine)	1	30	Preemergent herbicide (broadcast)	1	5
Aeration (core aerator)	1	30	Fertilization (broadcast)	2	5
Edging shrub bed—hand	10	Min./1,000 linear feet - 60	Policing—debris removal—hand	25	15
power—walks	30	5	machine—vacuum	5	10
power—shrub beds	10	10	Plant removal and clean-up	1	400
Trim around objects			PAVED AREAS		Min./1,000 sq. ft.
string trimmer	25	10	Walks		
chemical	2	10	Sweeping—hand	15	25
SHRUB AREAS		Min./1,000 sq. ft.	Vacuum	15	4
Weeding			Blower	25	2
hand	15	60	Snow removal	?	
postemergent spot spray	3	15	hand	?	60
Preemergent herbicide application	2	5	power	?	12
Policing-debris removal hand	30	15	Drives and Parking	?	
machine—vacuum	30	7	Cleaning—vacuum	10	3
Pruning	2	60	Snow removal	?	10

Cooperative Extension, Washington State University/King County

SOUND Gardening

Gardening with an eye on water quality

Lawns

If you have a yard, you probably have a lawn.

Lawns must be carefully managed. In order for lawns to look good, they require a relatively high degree of maintenance. Regular applications of fertilizer and consistent summer watering are essential for good quality turfgrass. Some gardeners, in an attempt to achieve a perfect lawn, make excessive use of fertilizers and often needless use of pesticides. Such applications are not only a waste of money, they can also pose a hazard to the environment.

Lawn areas often retain less rain and irrigation water than other types of plantings. Lawn chemicals and fertilizers, which dissolve in water, run off into surface water. When these substances reach the Sound, marine plants and animals can be seriously affected.

The SOUND Gardening approach to lawns is: the less lawn you have, the fewer chemicals you apply, and the less water you allow to run off, the cleaner the Sound will be.

- ★ Manage lawns properly so as to minimize the need for pesticides.
- ★ Do not overfertilize. Apply the required amount at the right time.
- ★ Do not routinely apply herbicide in conjunction with fertilizer.
- ★ Reduce the size of the lawn by replacing some turf with ground covers or shrubs.

SOUND Lawn Care

Establishment

Planting recommended species and cultivars for Western Washington will go a long way toward preventing problems. Perennial rye grasses and fine-leafed fescue will perform satisfactorily in this climate if properly managed. Bent grasses and Kentucky bluegrasses are ***not*** recommended for home lawns.

Fertility

Maintain the proper level of fertility; avoid overfertilizing. Formulations containing combinations of slow and quick release components are normally preferable. Use a 3-1-2 ratio fertilizer. Apply 1 to 4 pounds of actual nitrogen per 1000 sq./ft. of lawn annually in several applications. One application should be in late fall or early winter. Organic fertilizers, such as composted manure, may be used but are a relatively less concentrated source of nutrients than synthetic chemical fertilizers. When you follow a basic fertilizer scheme, your lawn will be better able to resist the few pest problems that do exist in Western Washington.

Water

Keep the lawn properly watered. Tailor your watering to the weather and to soil texture. Lawns on sandy soils will require more frequent watering than those on finer-textured soils. Enough water should be applied each time to wet the soil to the depth of the root zone. You can check this by probing the lawn with a garden trowel. Allow the soil to dry somewhat at the surface between waterings. This will encourage the development of a deeper root system. Proper watering should also allow your lawn to better resist problems.

Lime

The annual application of lime may help turfgrass performance by reducing soil acidity and encouraging the activity of micro-organisms. Apply 25 to 30 pounds per 1000 square feet in the fall.

Mowing

Mow your lawn throughout the year at the recommended height for your species of turf grass. Do not seasonally adjust mower height. Grass clippings may be left on the lawn and should reduce the need for fertilizer application. They do not contribute significantly to thatch accumulation. Make sure your blades are sharp. Dull mowers lead to brown grass leaf tips, often resulting in unnecessary applications of fertilizers and/or pesticides.

Mowing Heights

Turf-type tall fescue - 2"
Perennial rye grass and fine-leaf fescue - 1 - 1 1/4"
Bent grass - 1/2" - 3/4"

(Note: Western Washington lawns that haven't been renovated or reseeded in ten years probably consist primarily of invasive, native bent grasses and annual bluegrasses.)

Aerification

Lack of aeration may be one of the reasons that lawns often do not do well. It inhibits the infiltration of water and nutrients and indirectly may be the cause of weed problems. Aerification can counter the effects of compaction. It is done by taking plugs out of the lawn, 3 inches deep and 3 to 4 inches apart. This can be done by hand or by renting a special purpose machine. Aerifying allows more water to get to the roots and less to run off.