Adams State University
Tree Risk Assessment

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Tree Risk Assessment: 2014 Background

In September 2014, Kevin Ruybal, Grounds and Nursery III of Facility Services at Adams State University, approached the Colorado State Forest Service, Alamosa District (CSFS) about inventorying and risk assessing the trees on ASU's south campus. During summer 2014 one of the over-mature and declining cottonwoods (pictured on cover page) failed due to root rot and associated rot at the base and through the main stem of the tree. After several meetings ASUs objectives were understood and assessment began.

- The inventory would be a stand-alone product based in the Geographical Information System (GIS) ArcGIS, version 10.1. GIS software captures, stores, analyzes, manages and presents data linked to a location and includes mapping capability.
- The risk assessment was determined using the Colorado Tree Coalition's Tree Risk Assessment Rating.
- Trees would be specifically analyzed for risks, defects and management needs.

Tree Inventory: Process

- The CSFS used Trimble Junos, a hand-held computer, to record data for each tree.
- Using ArcGIS (GIS software), the CSFS created a customized geodatabase for ASU's risk assessment. The Trimble units were loaded with ArcPad 10.1 software to facilitate data collection with aerial photos.
- After tree data was collected, it was imported from the Trimble into the ArcMap 10.1 software program for analyzing and map production.
- Once the ASU tree risk assessment data was stored on a computer we can:
    - Query data
    - Generate reports within ArcMap and in Microsoft Excel
    - Create maps
    - Update data as frequently as needed
        - ASU may be trained in how to update the data
        - CSFS may keep the data updated via a Service Agreement

Tree Inventory: 2014 Data Fields

The following data fields represent the tree risk assessment collected. The defects for each tree were ground level visually inspected for defects including: large cracks, areas of decay, dead and broken limbs and mushrooms or conk evidence on the bark or cavities. Trees containing these features were evaluated as individual trees and analyzed with the CTC tree risk rating system. Every tree larger than 18" was assessed using these criteria:

- *Likelihood of Failure* - physical conditions of the tree that may lead it to the tree failing.
    - **Improbable** - 1
    - **Possible** - 2
    - **Probable** - 3
    - **Imminent** - 4

  Besides the 1-4 ranking, we also collected data on what condition lead to this decision (USDA Forest Service Community Tree Risk Rating System):
    - **Improbable**
        - Some minor defects present
        - Minor <2" diameter branch or crown dieback
        - Minor <20% defects or wounds
    - **Possible**
        - Stem decay within safe shell limits. (1" of sound wood for each 6 inches of shell diameter).
        - Cracks without decay.
        - Defects affecting 30-40% of the tree's circumference
        - Crown damage or breakage: hardwoods <50%, pines <30%
        - Weak branch union, major branch or co-dominant stem with included bark
        - Stem girdling roots, less than <40% of circumference with compressed wood
        - Root damage, <40% of roots damaged within the critical root zone
    - **Probable**
        - Stem decay or cavity at or exceeding shell safety limits. (1" of sound wood for each 6 inches of shell diameter).
        - Cracks in contact with soil or other defects
        - Defects affecting >40% of the trees circumference
        - Crown damage or breakage: hardwoods >50%, pines >30%
        - Weak branch union with crack or decay
        - Stem girdling roots, less than >40% of circumference with compressed wood
        - Root damage, Root damage, >40% of roots damaged within the critical root zone
        - Leaning tree with recent root breakage or soil mounding, crack or extensive decay
        - Dead tree – standing dead tree without other significant defect
    - **Imminent**
        - Stem decay exceeding shell safety limits **and** severe crack. (1" of sound wood for each 6 inches of shell diameter).
        - Cracks when a stem or branch is split in half
        - Defects affecting >40% of circumference or critical root zone and extensive decay or cracks
        - Weak branch union with crack and decay
        - Leaning tree with recent root breakage or soil mounding and a crack or extensive decay
        - Leaning tree hung up or caught in adjacent tree
        - Dead branches, broken (hangers) or with a crack
        - Dead trees: standing dead with other defects such as cracks, hangers, extensive decay or root damage

        - Visual obstruction
        - Physical obstruction of pedestrian or vehicular traffic
- *Species* – The species of each tree was collected because biological differences in species morphology, architecture, decay susceptibility, included bark and root patterns influences its risk potential.

The following additional data was collected to help give a picture of the health of the trees, tree identification and additional work that may be needed.

- *Diameter at Breast Height (DBH)*
    - DBH is a measurement of the tree trunk diameter at 4.5 feet above the ground.
    - Every tree was assigned a size class based on the tree's diameter.
    - The inventory measured the DBH in two-inch size classes: 0.1-2.9, 3.0-4.9, 5.0-6.9, etc. up to 62".
    - Trees with forks were treated as one tree with an average taken.
    - This can be useful to confirm you are looking at the correct tree.
- *Condition – Overall health of the tree. Condition rating system used is based on CSFS definitions.*
    - **Excellent**- Perfect tree. A tree is rarely ever given this rating.
    - **Good** – Most trees are placed in this condition unless the tree's condition is truly superior to the other trees, or issues are observed.
    - **Fair** – The tree would have some of the following issues; stagnant growth pattern, poor vigor, uneven growth pattern, minor trunk damage, deadwood, etc.
    - **Poor** – The tree would exhibit some of the same issues as above but the problem or condition is more advanced than a tree with a Fair rating.
    - **Very Poor** – The trees were usually barely alive, ugly specimens, heavily damaged, or are being severely impacted by insect or disease.
    - **Dead** – No leaves present during growing season or signs of active vascular system in the winter.
- *Live Crown Ratio* – Good indicator of a tree's ability to produce enough energy for healthy growth. Visual estimate of the proportion of live crown volume with leaves in relation to the entire crown volume. A healthy tree has 60% or greater live crown ratio.
- *General Comments* – other observations about trees.

Tree Risk Background – *adapted from Front Range Urban Forestry Council, Urban Area Defective Tree Evaluation and Analysis*

Every tree is a candidate for failure, if exposed to the proper conditions. Perfectly healthy looking trees can fail when exposed to high winds, heavy snow and ice loads or dry summer days. Tree risks can escape detection, however; cities, public agencies and tree managers cannot afford to plead ignorance when a tree failure causes damage to life or property.

A basic definition of a risk tree is when a tree with a defect is located within striking distance of a target. A risk tree is one that has some structural defect or location that increases the probability of failing and hitting the identified target. These failures can be an individual part of the tree such as branches or a limb, or the complete failure of the trunk or roots. The combination of a defect and target can result in property damage or personal injury or death if a failure occurs. Liability from failure increases where people's presence is invited.

There are three basic components in this defective tree inspection. Two of these, species and defect, deal with the science of horticulture. The third, target, is a policy decision which must be developed internally by the inspecting agency. A tree species profile is regional and usually is developed with the aid of a group of professional tree experts. The target list should be based on location, use and mobility. This Tree Risk Assessment Rating system is designed to assist urban tree managers in providing a safe, friendly environment for users, while working within budgetary limitations.

Many external factors such as snow and ice loads, and prevailing winds will affect a tree's failure potential. Therefore, individual tree evaluations must be conducted. This is especially true while assuring public safety.

Colorado Tree Coalition's Tree Risk Assessment Rating system-

The goal of any defective tree evaluation is to maintain the largest number of trees within budgetary limits, while assuring public safety. The removal of too many trees can destroy the aesthetic qualities of an area, which is what made the area popular to begin with. Careful thought and evaluation should go into determining defective tree management actions.

Once a Defective Program has been selected and begun, it should be maintained in the same manner by all. Changes to the program should be understood and executed by all personnel involved. It is imperative that all players in a program of this type be on the same page and communicate with each other. Remember, we are dealing with living organisms which change daily. Once a program begins, you must keep it up.

This technique provides a good systematic method that can easily be repeated for future comparison on the trees future risk potential. There are two portions to the assessment and calculated this will provide an assessment rating for each tree. All classes are measured on a scale of 1 – 4, with larger numbers having more value in risk assessment ranking. The Assessment classes are added together. The Management classes are added together. The Assessment is then multiplied by the Management for a prioritized rating.

1. **Risk Assessment Classes** – What is the current risk?
    a. *Likelihood of Failure* – Physical conditions of the tree that may lead it to falling.
        i. *Improbable* - the tree or branch is not likely to fall during normal weather conditions and may not fall in many severe weather conditions within the specified time frame. 33 trees.

ii. *Possible* - failure could occur, but is unlikely during normal weather conditions within the specified time frame. 118 trees.
iii. *Probable* - may be expected under normal weather conditions within the specified time frame. 22 trees.
iv. *Imminent* - Failure has started or is most likely to occur in the near future, even if there is no significant wind or increased load. This is a rare occurrence for a risk assessor to encounter, and it may require action to protect people from harm.

b. *Likelihood of Target Impact* – Chances of hitting a specific target. A 1 ranking poses the lowest risk and a 4 ranking is the highest risk. All trees received a ranking of 4.
c. *Consequences of Failure* – Amount of damage that failing tree may cause. A 1 ranking is least damaging and a 4 ranking is most damaging. All trees received a ranking of 4.

2. **Risk Management Classes** – Balance of risk assessment, affected targets, budget and action.
   a. *Target* – Low Use to Very High Use area and the type of area affected. Concern should begin with human activity, followed by value of non-human targets. A 4 ranking denotes the heaviest use. All trees received a ranking of 4.
   b. *Species* – Biologically differences in species morphology, architecture, decay susceptibility, included bark and root patterns influences its risk potential. A 1 ranking is a less susceptible species than a 4 ranking.
      i. *Hybrid Cottonwood* = 4
      ii. *Prairie Sky Poplar* = 4
      iii. *Siberian Elm* = 4
      iv. *Green Ash* = 3
   c. *Action* – Next step that should be taken for each tree.
      i. *Re-Evaluate Next Inspection Cycle* - usually an agreed upon time frame (agreed upon during the communication with the management team) set in years. – 1 ranking: 31 trees.
      ii. *Re-Evaluate Next Growing Season* - usually within the middle of the growing season of the year following inspection. This will allow the assessor to observe health conditions of the tree such as live crown and twig growth. – 2 ranking: 1 trees.
      iii. *Remedial Care* - the process of diminishing the risk without removing the entire tree. – 3 ranking; 128 trees.
      iv. *Removal* - the removal of the tree when current mitigation procedures are unlikely to diminish the risk. – 4 ranking; 13 trees.

Prioritizing Trees for Management

In risk assessment, two of the three factors were all the same with the highest ranking, so the risk assessment is solely based on the Likelihood of Failure. In risk management, two of the three factors were all the same with the highest ranking, so the risk management was based on the Action.

Priority	Likelihood of Failure			Action			
	Improbable	Possible	Probable	Re-Evaluate Next Inspection Cycle	Re-Evaluate Next Growing Season	Remedial Care	Removal
Priority 1-Very High			**X**				**X**
Priority 2 – High			**X**			**X**	
Priority 3 – Moderate		**X**				**X**	
Priority 4 – Low	**X**			**X**			

Priority 1-Very High – Removal of trees. 13 trees.
Priority 2 – High – Crown Cleaning. 11 trees.
Priority 3 – Moderate - Crown Cleaning. 117 trees.
Priority 4 – Low – Start Routine Pruning. 32 trees.

Removal – Tree is removed.
Crown Cleaning – Selective removal of dead, diseased, broken or weakly attached branches from a tree crown. This removes larger deadwood, reduces weight on branch ends, and removes other defective parts of trees that could impact people and property. This typically involves the removal of dead branches >2" diameter.
Routine Prune – Creates a proactive and preventative pruning rotation for healthy trees with minor defects. Once established, trees need to be pruned in regular 3 to 5 year intervals to encourage healthy branch structure. A regular pruning cycle can prevent future needs of crown raising and defective pruning. Some trees at ASU will need annual pruning care to restore a healthy branching structure and to prevent the tree from developing an undesirable form. This should include crown cleaning of any dead branches.

Recommended Corrective Action

This final step is when priority recommendations are implemented. Corrective Action should be completed as soon as possible. This action may require entire tree removal, pruning of the defective part of the tree, target moving or removal or other means of reducing the risk. Schedule trees with a moderate or low rating for planned periodic inspections. The tree's risk rating may change over a short period of time. Scheduling evaluations will build the basis for future ratings. If immediate corrective action in areas of very high or high risk is not possible, post the area and close it to public access.

The following corrective actions are listed in order of priority. This list can be used to further refine the corrective action priorities based on budget additional safety concerns or work load.

Four techniques are available to manage the risk trees at ASU:

1. **Move the target** – This can provide a temporary solution until other options are available. This can provide a permanent solution if the publics' use of the area is not affected.
2. **Provide tree maintenance to remove the risk –** This includes pruning deadwood out of the tree that may fall.
    a. **Crown Cleaning –** Selective removal of dead, diseased, broken or weakly attached branches from a tree crown. This removes larger deadwood, reduces weight on branch ends, and removes other defective parts of trees that could impact people and property. This typically involves the removal of dead branches >2" diameter.
3. **Close public access around the risk** – This should only be considered a temporary solution at ASU due to the high use of the area.
4. **Removing the tree** – These trees pose a direct safety threat. The only other option is moving the target.

Management Timeline

- 2014
    1. Implement Priority 1 & Priority 2 recommendations.
    2. Implement an updating process in the GIS software database for when management actions are taken. Possible work study student in geography.
- 2014 – 2015
    1. Implement Priority 3 & Priority 4 recommendations.
    2. Begin pruning any remaining defects in the identified trees.
    3. Make sure all management work is updated in the database.
- 2015-2016
    1. Begin crown raising.
    2. Conduct tree inventory of entire ASU campus.
    3. Start all ASU trees on a routine pruning plan (e.g. every 5 years).
    4. Make sure all management work is updated in the database.
- 2016-2017
    1. Re-evaluate tree risk assessment and additional maintenance needs.

Ensure work specifications are according to current applicable ANSI A300 Standards.

Current Tree Situation and Recommendations

The purpose of the 2014 Adams State University tree risk assessment was to determine the composition of the urban forest, its current condition and the management needs. The table below is a summary of the tree risk assessment data; in total 173 are over 18" in diameter had data collected.

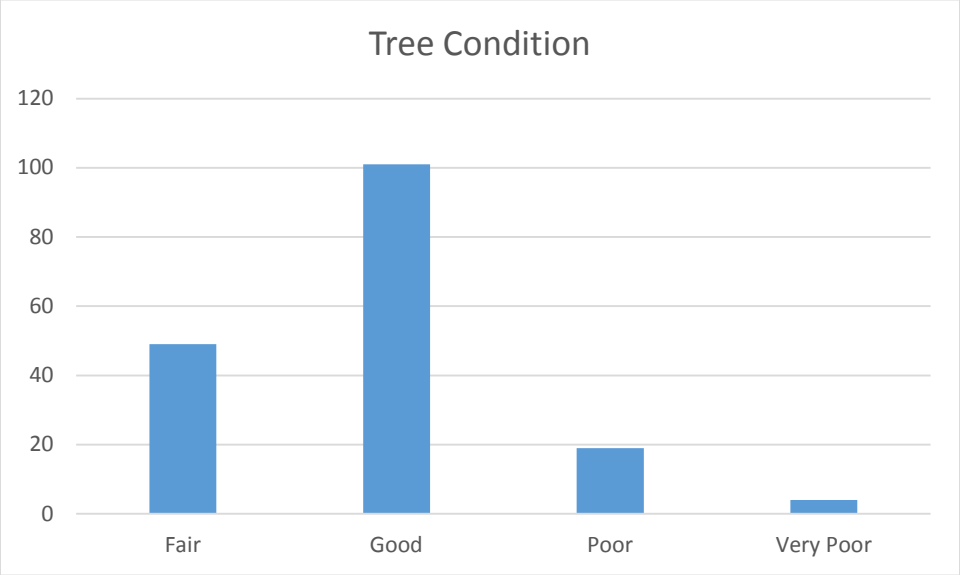
Field Observations

Many of the major limbs of these trees have died, and epicormic (sucker) sprouts and small branches are the only thing keeping the trees alive. This makes it difficult to prune effectively, thus the recommendation to begin removing and replacing the trees.

Cottonwood, Poplar and Siberian Elm are naturally weak-wooded trees that when exposed to drought stress and old-age can weaken considerably and create a risk in certain situations. Poor structure (multiple stems, narrow branch unions, old storm damage, etc.) only adds to the problem. It would be wise to proactively manage these trees at ASU to avoid the damage and potential injury that the failing trees could cause.

Overall Tree Condition (i.e. tree health) - All species.

The combined overall health of the assessed trees was found to indicate a majority of the trees are in 'Good' condition. This means that the trees are fine and are surviving the harsh growing conditions (i.e. climate and soils) of ASU. The rating of the trees ranked less than 'Good' could potentially improve to 'Good' through management actions such rotational pruning.



Overcrowding – Some trees are planted too close to each other. Trees grow most healthy when they are not spaced close together and compete for water, sunlight or nutrients. Good spacing between trees to decrease competition is determined by the tree's crown width at maturity. For example, a mature Lanceleaf Cottonwood is 30'-40' wide so they should be planted 30'-40' apart.

1. *Solution* - Do not automatically replace a tree in the same location one was removed from. That location may no longer make sense. In crowded locations removing a tree will have the added benefit of decreasing the competition between remaining trees and make them healthier. Currently these trees root systems may now be dependent on each other and general thinning may facilitate wind throwing those trees that remain, so only remove Priority 1 trees and do not thin to decrease competition.
2. *Solution* – Ensure proper spacing when planting new trees.
3. *Solution* – Trees requiring full sunlight should not be planted in the shade of other trees.

Overcrowded Trees

Well-spaced trees. These have more full crowns, are healthier and have less deadwood to remove.

Saturated Soil – The soil in the grass was very wet. Tree roots need both air and water in order to properly function and grow. Tree roots need air space to exchange air and breathe. Saturated soils decrease the roots ability to breathe and may cause roots to die and decompose. Soils that are moister are much more easily compacted, which also decreases the roots ability to breathe. Good root growth occurs when the soil is 50 percent particles, 25 percent air and 25 percent water. Cottonwoods must have plenty of water to thrive but it needs to be determined what that happy median is for these cottonwoods.

1. *Solution* – Partner with a professor to study moisture content of top 24" of soil, which is where most of the roots are located.
2. *Solution* – Depending on soil moisture study, consider decreasing the amount of lawn watering.

Ruts from vehicle traffic that may indicate over-watering.

Trees such as these two in the center of the picture should be removed because over 50% of their crowns (leaf area) are dead and adjacent to areas where they could cause damage or injury if they fail. There are several of these occurring at ASU that should be scheduled for removal as soon as possible.

Many of the cottonwoods are showing smaller percentages of dieback, but do not need to be removed and will likely live for many more years. Many of these contain deadwood larger than 2” diameter and should have a crown cleaning.

The ground at the base of this tree is raised higher than the ground nearby. This indicates that the trees roots may not be holding the tree down adequately. This tree was recommended for removal.

Stem decay at the base of this tree exceeding shell safety limits. This tree was recommended for removal.

Budget

Initially ASU should address the risks observed during data collection. Then a five-year safety pruning cycle would help in the proactive management of these trees. Breaking the area into affordable segments and doing a portion of the safety pruning/removals on an annual basis will help alleviate problems with unexpected tree failures which can be catastrophic to life and property. Additionally, this method helps spread the costs of tree maintenance over a period of time, rather than getting hit with emergency removal costs and associated problems all at once, which can happen when the trees are managed reactively.

Local rates for tree services were investigated. These prices are averages, but due to the location, amount of material to be removed and complexity of some of the trees this could be more.

- **Removal** - $600 - $1,500 per tree, with expenses calculated at $1,000.
    - 13 trees recommended for an expense of $13,000
- **Crown Cleaning** – $400 - $900 per tree, with expenses calculated at $650.
    - 128 trees recommended for an expense of $83,200.
    - Consider contracting this to a firm with ISA Certified Arborists who work with crews on the ground.
- **Routine Prune** - $150 - $400 per tree, with expenses calculated at $275.
    - 32 trees recommended for an expense of $8,800.

See page 7 for pruning definitions.

Expenses may be decreased by having some of the work done by ASU Facility Services. Trees rated as Priority 3 – Moderate risk whose expense for pruning would be equal to the expense for removal should be considered for removal to decrease long term expenses.

Replacement Program

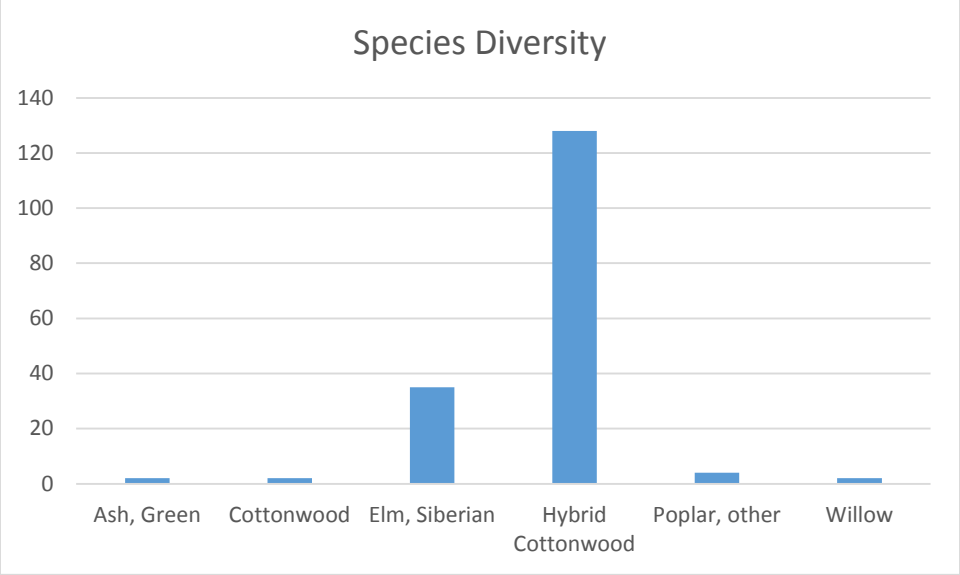
Once again the removal of too many trees can destroy the aesthetic qualities of an area, which is what made the area popular to begin with. A replacement plan should be established before trees are removed.

1. Do not automatically replace a tree in the same location one was removed from. That location may no longer make sense to have a tree. In crowded locations removing trees will decrease the competition between remaining trees and make them healthier.
2. Consider replacing trees 10'-15' from buildings with smaller trees that only get 10'-20' tall. This will decrease the long term opportunity for trees to fall on buildings and make pruning easier. http://www.alamosatrees.net tree index listing for small trees contains species appropriately suited for growing in Alamosa.

Diversity

Plant diversity in a town, unit, subdivision or park is extremely important to the overall health and quality of the urban forest. The CSFS recommends that no tree species exceed 10% of the total tree population. Plant diversity is recommended in order to keep insect and disease outbreaks from destroying an entire tree population. For example, two infectious fungal diseases and one recent insect outbreak have wiped out native tree populations in the United States. The two diseases are the chestnut blight on American chestnut and the Dutch elm disease in American elm. The emerald ash borer, an insect, is currently killing all ash trees in the Midwest and the Northeast. These pests are exotic and have been introduced to our native populations which have no natural defenses to fight off the attacks.

- ASU needs to work on increasing the overall variety and diversity of the trees planted. http://www.alamosatrees.net is a thoroughly researched resource for species appropriately suited for growing in Alamosa.



Pruning Appendix –

Proper Pruning Techniques

- Improper pruning opens up a tree to insect and disease problems and causes decline.
- Learn how to make proper pruning cuts (Figs. 9 and 10).
- Prune for strong structure early in the life of a tree (Fig.11); select for one main trunk and select permanent branches that are attached to the trunk at close to a 90 degree angle "L", and remove branches that form a "V" shaped union, or that appear to be squeezed against another branch (called included bark) (Fig.12).
    - "V" shaped unions and included bark unions are VERY weak and are more likely to break in heavy snow or wind.
    - When trees are pruned for structure when young, pruning wounds are kept small and growth is easier to direct.
- Avoid pruning within the first year of planting as trees need to allocate their energy to root development during that time.
- Remember the rule of "3's" when pruning
    - When removing a branch, try to select branches that are a least 1/3 of the size of the stem that it is being removed from
    - In general, only prune 1/3 of a tree's living mass annually; if more than this is removed, it causes tremendous stress on the tree.
    - Proper pruning cuts create wounds as well and the tree has to expend large amounts energy to compartmentalize and close wounds; if more than 1/3 of a tree's living mass is removed at one time, stress is very likely to follow.
- Prune dead and diseased wood at any time of the year.
- Pruning in the winter time is a good rule of thumb as the tree is less active and it is easier to see branch structure and defects.
    - Avoid pruning during freezing weather conditions.
- Avoid pruning during drought conditions.
    - Again, pruning cuts demand energy from a tree, and if it is already water stressed from drought, pruning will only add to the stress and cause more decline.
- Always keep your pruning tools sharp and clean; when dull tools are used, cuts are jagged and trees cannot easily close wounds.
- A note on "healing": trees cannot actually heal tissue – They build walls of cells around wounds to compartmentalize decay.
    - If pruning cuts are made improperly, this defense mechanism is disabled and decay can then travel throughout the entire tree; this is why **trees should never be topped!**
    - Topping also causes weakly attached branches to re-sprout from topped areas; these branches are not only growing from a branch that will quickly begin to decay, but they typically form "V" shaped unions, which are very weak and more likely to break in wind or heavy snow
    - For more detailed information on why not to top trees. Please visit- http://www.arborday.org/trees/NineNum1.cfm.
- The National Arbor Day website has an excellent interactive pruning lesson that teaches proper pruning techniques at http://www.arborday.org/trees/pruning

Fig. 9 – The Basic Pruning Cut

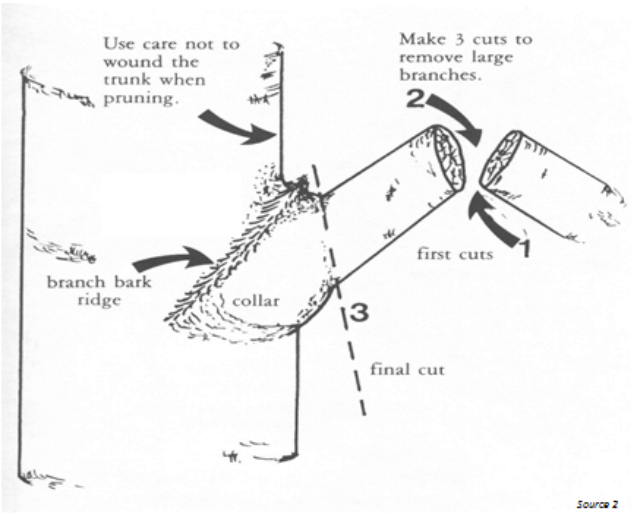
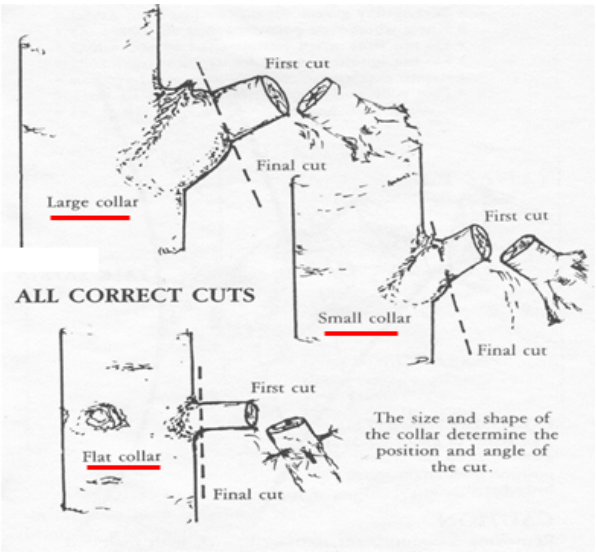
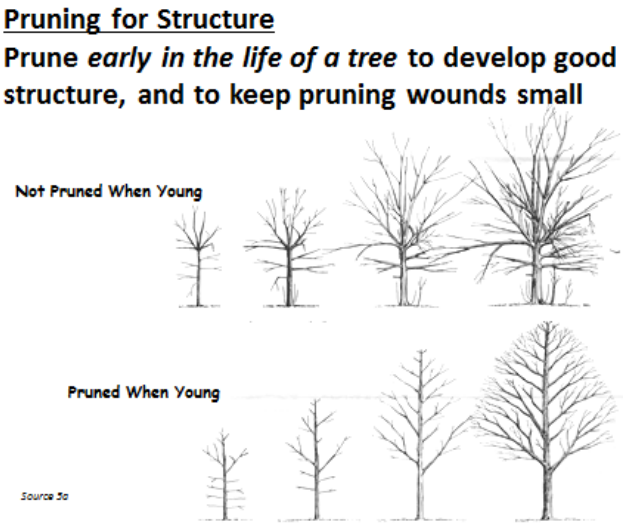


Fig. 10 – How to Make Proper Pruning Cuts



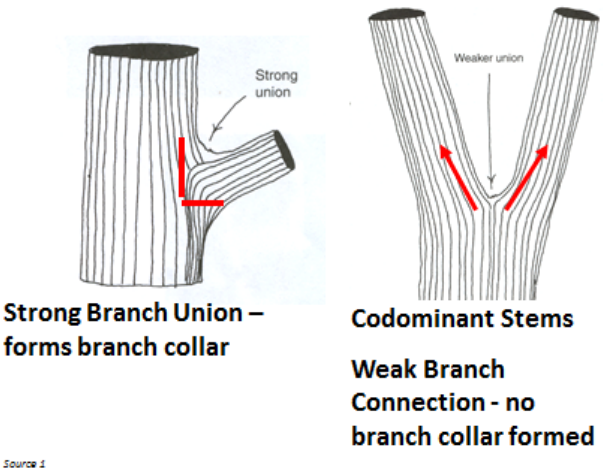
Source: Pruning Trees Near Electric Utility Lines. Dr. Alex L. Shigo

Fig. 11 – Prune for Good Structure



Source: National Arbor Day Foundation

Fig. 12 – Strong vs. Weak Branch Union



Source: Dr. Ed Gilman, University of Florida

ASU Tree Risk Assessment

0 105,000 210,000 420,000 630,000
Feet

Prepared By:
Colorado State Forest Service
Alamosa District

Legend

- Priority 1 - Very High
- Priority 2 - High
- Priority 3 - Moderate
- Priority 4 - Low
- ASU Campus