Take-home Messages

When Are Support Systems Necessary?

Staking vs. Guying

Best Materials

Placement of Attachments

What Can Go Wrong?

Support Systems for Special Situations

Urban Forestry Research & Outreach (UFOR) Nursery & Lab

trees.umn.edu

Authors

Gary Johnson, Tracy Few, and Eric North

University of Minnesota, Department of Forest Resources

Department of Forest Resources

UNIVERSITY OF MINNESOTA
Driven to Discover®

DEPARTMENT OF NATURAL RESOURCES

This publication was made possible through a grant from the USDA Forest Service.

Staking and Guying Trees In The Landscape

When Are They Needed?

Staking and guying systems are alike in most ways. Both provide temporary, external support to trees that are not stable enough to grow without excessive bending, partially or fully tipping over, or being vulnerable to unintentional vandalism. Instability may be due to a tree that has grown too fast and too tall and cannot remain upright without temporary support, a greatly reduced root system (*think newly planted trees*), trees that have been partially tipped during a violent wind and rain-loading event (*think hurricane, straight-line windstorm*), or trees in high traffic areas (*think trees in playgrounds, near commercial areas, or near sidewalks*).

Most of the time, newly planted trees do not require support systems. Stake by exception rather than by rule. Consider a tree growing without human intervention; it is subjected to all manner of loading events, which contribute to the tree's strength (*just like movement contributes to human strength*). Both

systems are meant to be *dynamic and temporary systems*, systems that move with the tree's normal movement in winds without allowing the tree to tip, rather than *static systems* that become part of the tree's infrastructure, denying the stem and root tissue-building that accompanies movement*. In most cases, support systems should be removed after the first growing season or one year after installation.

***Thigmomorphogenesis**

when trees are subjected to continuous mechanical stresses due to wind movement, their trunks and zones of rapid root taper thicken and enlarge…which is good.

Staking Versus Guying

The major differences between staking and guying systems include 1) where the attachments to the tree trunks are placed, 2) the height and placement of the anchorage stakes, and 3) sometimes, the interface (*aka, connection*) materials.

Stakes can be tall (3 to 5-ish feet above ground), driven into the landscape soil and parallel to the tree trunk, and used for smaller trees or those that offer little wind resistance (Figure 1).

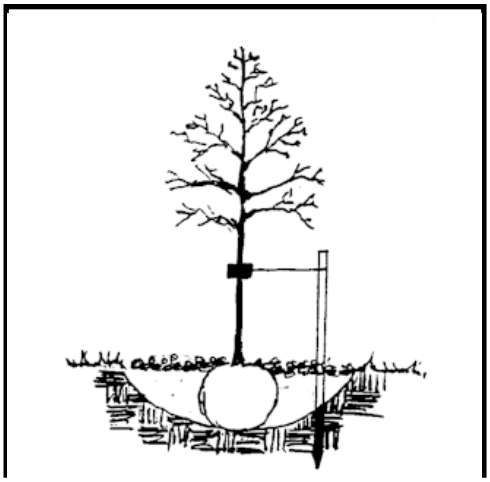

Figure 1. Stakes are driven into the landscape soil, parallel to the tree trunk.

Anchor stakes, those used for guying trees, are shorter and stronger, driven deep into the landscape soil at an angle away from the tree (*think tent stakes*), and are used to provide support for larger trees or trees with greater wind resistance (Figure 2).

Figure 2. Guying systems use *anchor stakes* that are shorter and driven in at angles away from the tree stem with only a few inches visible above ground. These stakes are within the mulch area but outside of the excavated planting hole (left photo) and into solid ground for maximum stability. Anchor stakes placed within the lawn area (right photo) soon create lawn maintenance hassles and/or trip hazards.

Best Materials: Attachment Materials, Stakes, Connection Materials

Attachments. There are a lot of "right" materials to use for both systems. Unquestionably, the most important material decision is the material that comes in direct contact with the tree stems, the attachment material. Wider is better; flexible is better; softer is better. Materials that can cut into the thin bark of either newly-planted or freshly straightened trees should be avoided at all costs (*think wires, thin baling twine, rigid plastic, even wires threaded through old hoses,* Figure 3).

Figure 3. Wire threaded through old garden hose seems like a good option for staking/guying attachments, but if left on for more than one growing season, the wire can still damage the stem. This obviously was left on for more than one growing season but it's a good example of what can happen if someone forgets to remove the attachments in a timely fashion. Girdling such as this can happen within 12 months on fast growing trees.

The acceptable alternatives to these are almost endless: wide fabric strapping, old rubber inner tubes, burlap, old hosiery, old shirt sleeves, or even old yoga pant legs. Yes, some of these options may be a bit of an eyesore or a social embarrassment (*check to make sure undergarments are stain-free before displaying them in your landscape*), but they will prevent any damage to the tree stems, which is most important (Figures 4a and 4b).

Figure 4a. Any attachment material should be broad, smooth, and flexible like this strapping material. Metal grommets can be purchased at any hardware store and are easily installed.

Figure 4b. ArborTie™ to the left, and tree chain to the right are both strong attachment materials. Tree chain is a solid plastic, though, and can cause bark abrasion unless it is installed with a canvas or soft material "sleeve" as depicted in the photo.

Stakes are a bit less critical. Steel garden or fence *stakes* are popular, albeit a bit expensive. The good part is they last for a long time which encourages more planted and supported trees. Metal stakes come in a variety of lengths and strengths. Twelve inch long metal tent stakes can be used as *anchor stakes* for smaller trees, while the traditional stakes, metal T- or U-posts, commonly range in heights from 24 inches to 72 inches (Figure 5).

Figure 5. Steel fence posts like the T-post above (left photo) or U-posts are commonly used as *stakes* and have long and useful lifespans. Tent stakes (right photo) at least 12 inches long can be used as *anchor stakes* for smaller trees.

Other stake or anchor stake options include wooden stakes (*minimum of 2"x2" dimensional lumber*). If you know an arborist you can use pruned branches that are at least 3 inches in diameter (*hint: never use willow branches for stakes unless you want your newly planted tree to be part of a grove of willows*), bent Rebar anchor stakes (minimum of 3/8" diameter), earth anchors, or folding-ring spiral ground anchors (Figure 6). Think creatively and try to use materials that can be re-used rather than discarded (Figure 7).

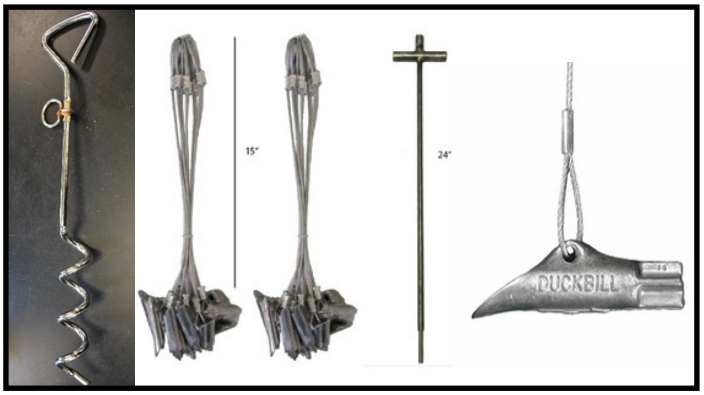

Figure 6. Spiral ground anchors (left photo) are easy to install, remove, and reuse, and are excellent devices for anchor stakes. Duckbill™ earth anchors (*center and right photos*) are extremely strong and stable. They require a tool (*center photo*) to drive them into the ground. When the anchor lead is pulled up, the Duckbill opens like a toggle bolt and is locked in place. Duckbills are very difficult to remove and therefore generally not reusable.

Figure 7. Yup, those are old skis being used as tree stakes… and a picket fence. The ultimate in repurposing.

Connection materials. There are a number of products designed or appropriate to be the connection or interface between the *stem attachment materials* and the *stakes*. Again, you can go simple and use baling twine, jute rope, synthetic twine, or metal wires in some cases (Figure 8). There are some specific products on the market that are designed for this purpose including the Tree-Mate-O™ kit.

Figure 8. Fiber card attachments with wires as interface materials (top photo). The Tree-Mate-O system (bottom photo), with flexible rubber attachments between the trunk and the interface material.

When guying larger trees that have partially tipped, other materials may be necessary for the strength required, including 7-strand cable (Figure 9), synthetic braided rope, and ArborTie™ (Figure 11). Seven-strand cables require the use of cable clamps to hold the cables to the stakes and the attachments. Braided rope can be knotted or spliced at the stakes and attachments, while ArborTie™ is simply tied off both at the stakes and the stem attachments. All are good options where extra strength is necessary. Partially tipped trees cannot be straightened using staking or guying alone. Trees will need to be carefully straighten (an involved process), then staked or guyed to provide additional support if the objective is to return the tree to a fully upright position (see page 9).

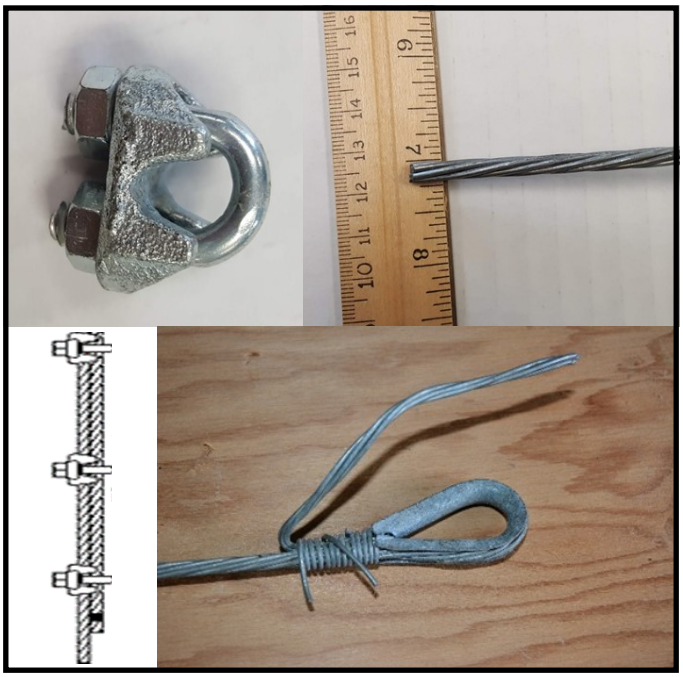

Figure 9. Steel cable to the upper right (*1/4 inch diameter, 7-strand*), with a cable clamp to the upper left. The cable ends are bent into loops, connected to the stake on one end and the stem attachment material on the other. The cable ends may be held in place with cable clamps (*lower left*) or can be "spliced" on thimbles that are then connected to the stem attachment material and the stake (*bottom graphics*). *Spliced cables are much stronger than those with cable clamps but require someone skilled in splicing.*

Placement of Attachments to Tree Trunks and How Many Are Enough?

Placement of Attachments. *Staking Trees.* Tree trunk attachment points are usually placed between 1/3 and 2/3 the distance between the ground line and the lowest set of branches, IF the goal is to keep the trees from tipping but still allowing some desired movement of the stems (Figure 10).

Avoid tightly applied, rigid attachments immediately beneath the tree canopy. In windy situations, the stems are held rigid and erect, the canopy flexes and moves with the winds, and as a result the stem can break at the point of attachment…not what you intended to happen.

Guying Trees. Attachment points are typically placed in the crown of the tree, roughly 3/4 the distance (*that's an arbitrary number*) between the ground line and the top of the tree (Figure 11). Higher attachment points accommodate for the extra wind-sail factor (*the resistance a tree crown offers to winds*) that a tree with a larger crown presents. It's basically a matter of applied physics.

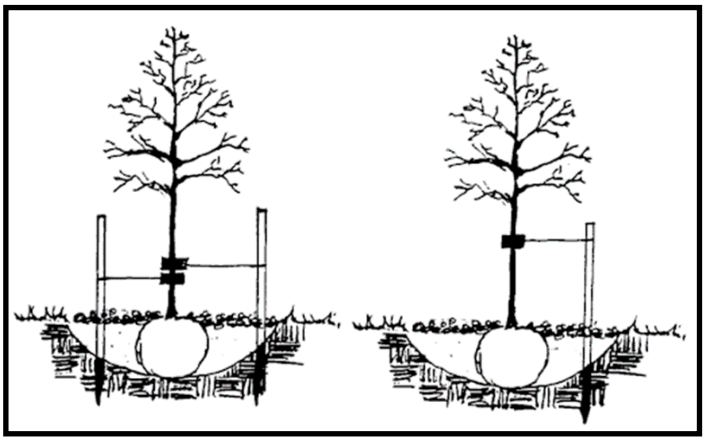

Figure 10. Tree trunk attachments should be placed at a distance between 1/3 (*left illustration*) and 2/3 (*right*) from the ground line to the first set of branches. This is for ordinary support systems, those that are installed to keep the tree from tipping over after planting.

Figure 11. Guying larger trees requires that points of attachment are higher up in the canopy in order to keep taller trees with denser canopies from tipping. Note that the attachment allows the stem to move in the wind without tipping over.

If the support system is primarily to straighten a floppy stem, then determining the placement of the stem attachment is a bit different (Figure 12). Begin low on the stem and pull the stem upright on the opposite side of the lean. Keep moving up the stem until a point is reached where the stem above your hand is as straight as the stem below it. That will be the point of attachment and there is no mathematical formula for it.

Figure 12. Floppy stems like this one are not normal, but they do happen. In this case, the 1/3 to 2/3 distance from the ground to the first branches rule didn't work. There's a good chance that this support system will need much taller stakes (*or maybe anchor stakes*) since the points of attachment will be much higher than shown here. Unfortunately, that tree trunk will not fully straighten on its own (*a Dave Hanson photo*).

How Many Attachments Are Enough?

If either types of staking systems are necessary, always begin with the minimum…one stake. Place the stake on the windward side of the tree since it's usually the wind that is causing the tree to lean (Figure 1).

If the tree is still unstable, it's most likely due to a root system too small to keep the tree upright and may require a double or triple staking system (Figure 13). If a double system is needed, place one attachment on the windward side, and one on the leeward. Triple systems have the attachments equally spaced around the tree.

Triple support systems are usually reserved for larger, unstable trees, or in situations where vandalism is chronic. In cases where vandalism is an issue, stout stakes are often used (Figure 14).

For multi-stemmed trees treat each stem as an individual tree. For example, if your multi-stemmed tree has three stems, each of the three stems would have its own stake or guy anchor.

Figure 14. Three stakes, all larger than the tree trunk with pretty aggressive attachments (*left photo)* are designed to discourage vandalism to the trees (*a Jim Blake photo*). Larger trees, especially evergreens (*right*), commonly require a three anchor stake system for stability.

Figure 13. Double staking (*top left*), double guying (*top right*), triple staking (*center*). Bottom two photos (*Jill Johnson photos)* show a creative use of cotton strapping and the T Post Top'r®, a safety top and electric fence insulator. Note that all attachments are separate and loose enough to allow some stem movement.

What Can Go Wrong?

Most of the problems with staking or guying trees can be summarized by this: memory problems. Staking systems when necessary are designed to be in place for one growing season, sometimes a full year. Attachments that are installed too tight to the tree trunks can soon become girdling attachments (*aka, strangling wires or ropes*) potentially killing portions of the trees above the stake or producing excess sprouts (Figure 16). This is a particular problem when the trees are planted in good soil and regularly watered. Those trees grow so fast that within a year, ropes and wires become imbedded and weaken the stems (Figure 15).

Solution: *always use wider, flexible materials for attachments, and check the points of attachment at the end of the growing season to see if they are still necessary and/or need to be adjusted (loosened) to prevent damage to the tree trunk.*

Figure 15. Synthetic baling twine (left) was attached too tightly to this tree stem and within 11 months had become imbedded in the stem. ArborTie (right), a wonderful attachment material can become a tree killer if left on for two long.

Figure 16. Excessive sprouting that is common on trees where attachment materials have been left on too long and "girdled" the tree trunk (see Figure 15) and killed the tree above the girdled portion of the tree trunk.

The other problem happens when staking or guying systems are installed too rigidly and then left on for too long. Remember *thigmomorphogenesis* from page 2? Motion is necessary and builds strong stems and root systems. Support systems that don't allow movement and left on for too long encourage tall, floppy trees (Figure 12) rather than strong, resilient ones.

Support Systems for Special Situations

"Splinting" a new leader. It happens. The young or established tree loses its central leader to a wind or ice storm (Figure 17), to insects (*e.g. white pine weevil*), large birds trying to perch on flexible evergreen tops, or maybe the top is just floppy. Rather than hoping a new leader forms (*that happens some of the times)*, new leaders can be immediately established with a specialized support technique termed *splinting.*

Step One. Prune off the broken leader (if it's broken, not just floppy) back to the next branch that is flexible enough to be pulled upward. (Figure 18). Spring is the best time of the year to do this because that is when the branches and leaders are most flexible.

Figure 17. The top of this young white pine was broken by wet snow and strong winds.

Figure 18. The broken leader has been pruned back to the first flexible side branch.

Step Two. Attach a rigid pole – the splint pole - (*bamboo, fiberglass, wood*) to the stem/trunk of the tree at least 3-4 feet below the branch to be bent upward, and at least 2 feet higher than the pruned off leader. Use soft, flexible materials such as cotton ropes or strips of old clothing to attach the pole to the stem. Once this is completed, pull the new leader (*or floppy top*) up and attach that to the pole. Attachments should be placed approximately every 8-10 inches. (Figure 19).

Step Three. If the splinting is applied in early to late spring, the splint pole should be removed by the end of the summer and the repositioned branch will continue to grow as the new leader.

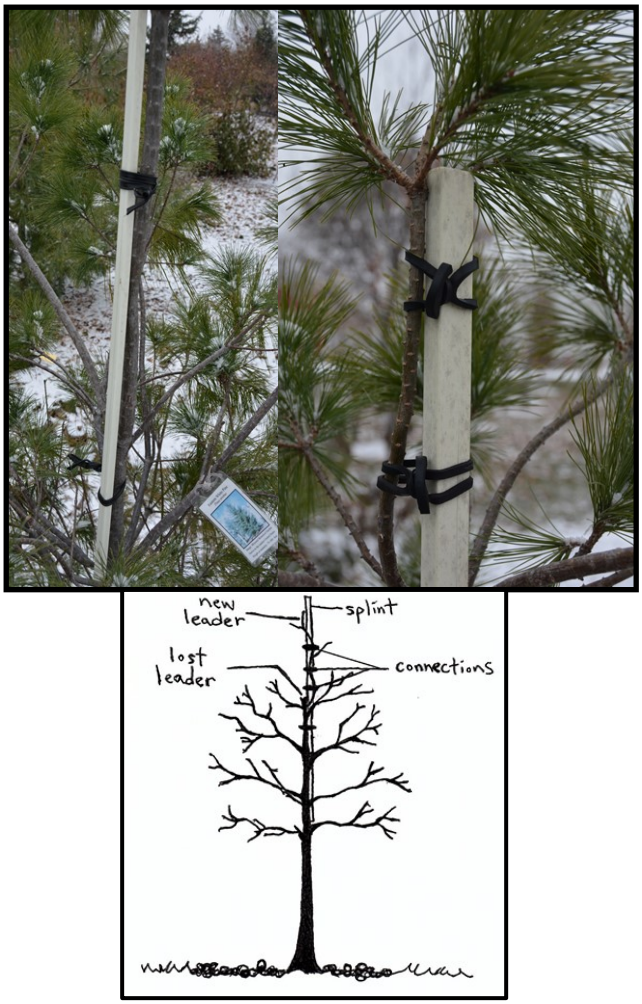

Figure 19. Attach the splint pole to the tree stem (*top left photo*) and the bent branch (*top right photo*) to form a new leader. The attachments are flexible rubber (*Stretch-Lock™, from Plantra*). Splints are used to develop a new lead using a rigid pole attached to a young branch with flexible ties (*bottom photo).*

"Splinting" a floppy or deformed tree stem. It happens. Everything about the young tree is good except the stem is growing in a zig-zag pattern and/or is too floppy to grow straight. Again, splinting can be used to correct the growing habit of the tree, if it's young and flexible. The process is the same as the previous splinting description **except** the pole used in this case is as tall as the straightened tree. Bamboo works well for this and is readily available in garden centers and home improvement stores. (Figure 20).

A *triangulated staking system* for smaller conifers (evergreens). There are a lot of advantages to this system for conifers that are less than 6-ish feet tall. First, if you forget to remove the stakes for a couple of years, it's no big deal because the stakes aren't attached to the tree.

Figure 20. This young hickory has been splinted to force a straight and strong growth habit. The attachments to the pole (*right photo*) are Stretch-Locks™.

Second, it works well to stabilize conifers planted on windy sites. And third, there's no need to stick hands and arms into the painful, needled branches of a spruce or an eastern red cedar just to attach the staking system to the tree stems.

This system uses three, strong stakes that can be driven into the ground at an angle around the "skirt" (*the widest part of the evergreen tree near the bottom*), and lashed together at the top (Figure 21). The strength of this staking system is that it embraces the tree, which works well for an evergreen tree with lots of branches and foliage, not so great for a shade tree.

Figure 21. The triangulated staking system uses poles strong enough that they can be driven into the ground near the bottom of the tree (*left photo*) and lashed together at the top (*right photo*). More than three poles may be used if necessary.

Straightening tipped trees. If a tree has been tipped over in a windstorm (*aka, windthrown*), there is a technique for straightening it and providing a support system long enough for its root system to reestablish and stabilize the tree. Having said that, it's a lot more complicated than just pulling the tree upright, which can cause even more root damage or break the stem. The success of this technique depends on several key factors:

- It must be a true windthrow, that is, the roots must be pushing up through the heaved soil as in Figure 22. If the tree is leaning or horizontal and there is no evidence that the roots are pushing up and heaving the soil, then the tree stem probably broke off below ground and is essentially lost.

Figure 22. A windthrown tree. Note the heaved soil near the base of the tree. This tree was about 18 feet tall.

- It is most successfully done when the trees are relatively small: up to 15-20 feet in height and a stem diameter of six inches or less. Larger trees may be straightened, but it usually takes an experienced person or company with special equipment to perform the operation.
- The roots must still be alive. If they have dried out or if it has been several days after the windstorm, the chances of success are greatly reduced.
- The soil must be moist. Straightening trees in dry soil conditions, especially if the soil is clay in nature, is generally not a very successful operation.
- The tree should be in good health. If the tree was diseased, infested with insect pests, decayed, or otherwise stressed, the chances of survival are not very good.
- Shallow-rooted species (e.g., maples) may be straightened with more success than deep-rooted species (e.g., walnut).

The Steps for Straightening:

1. Begin the straightening process soon after the windstorm has subsided, at least within a couple of days. If you can't straighten it immediately, keep the root system and soil moist with irrigation and a mulch such as loose straw, tarps, or burlap.
2. Excavate under the heaved-up root system to the depth of the lifted mass of roots and soil (Figure 23). This allows the root and soil mass to settle back to a normal depth once the tree has been straightened. Never pull or winch a tree into an upright position without excavating under the heaved-up roots. Without the excavated area for the root and soil mass to settle in, it will be pulled up and out of the ground, which will result in more broken roots.

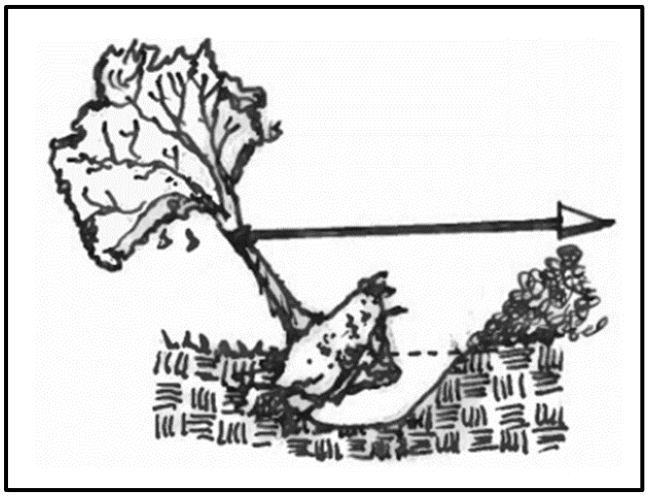

Figure 23. After the soil under the windthrown root system has been excavated, carefully pull the tree to an upright position with a winch and wide, protective strapping around the tree stem.

Install a triangular guying system, water thoroughly, backfill with loose soil to fill any open areas around the roots, water again and mulch the entire rooting area (Figure 24). Make sure that you include the guying anchors within the mulched area.

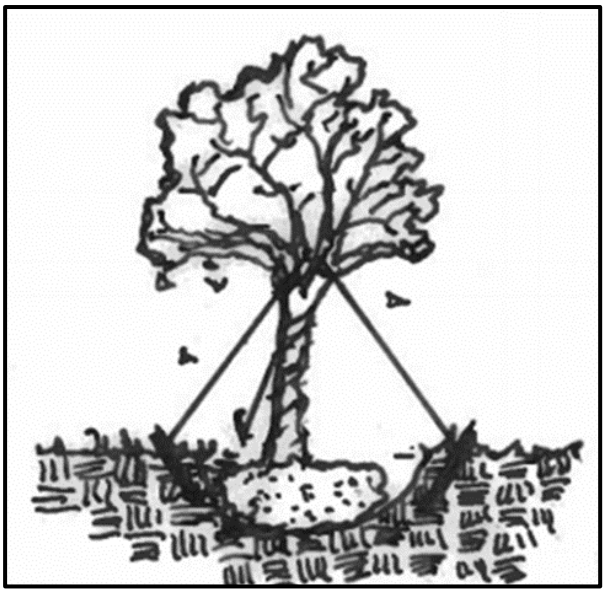

Figure 24. The straightened tree with a guying support system.

4. Post-care. This tree is now similar to a newly planted tree with a root system that is not in proportion to the rest of the tree. It may take a few years for that root system to become normal again and in the interim, it will need to be watered regularly (at least once per week for the first year), and mulched. Expect the new leaves formed for the next few years to be smaller than normal, and it is common for some of the upper branches and twigs to die back a bit (aka, "defensive die back).

February, 2021

The Authors

Gary Johnson, Professor Emeritus of urban and community forestry, University of Minnesota, Department of Forest Resources.

Tracey Few, City of Saint Paul, MN, Parks and Recreation Department.

Eric North, Assistant Professor of urban and community forestry, University of Minnesota, Department of Forest Resources.

Ashley Reichard, graphic design and formatting. Urban and Community Forestry Volunteer Programs Coordinator, University of Minnesota, Department of Forest Resources

Unless otherwise noted, all photos and graphics provided by the authors.