

**NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS**

WINDBREAK/SHELTERBELT ESTABLISHMENT

1. Scope

The work shall consist of establishing linear plantings of single or multiple rows of trees and shrubs and performing the necessary maintenance to ensure this practice functions as designed. This specification (including references made within to other conservation practice standards and technical notes), and the Form KS-ECS-5, Tree/Shrub Planting, shall be used to design the practice. Practice application will be documented on the Form KS-ECS-5 and in the conservation plan.

2. Species Selection

To determine which trees will grow satisfactorily on which soils and to determine the expected heights after 20 years, refer to the electronic Field Office Technical Guide (eFOTG), Section II, Windbreak and Environmental Planting Interpretations, or Kansas Forestry Technical Note KS-10.

3. Planting Details

Specific planting requirements for site preparation, proper stock handling techniques, establishment methods, and survival percentages are provided in Kansas Forestry Technical Note KS-9.

4. Windbreak/Shelterbelt Design

General information. Windbreaks are most effective when oriented at right angles to prevailing winds. Primary windbreaks for wind protection and snow control are usually located to the north and west of the area needing protection. The minimum number of rows for a primary windbreak will vary depending on the purpose of the planting. (See Design purpose)

Secondary windbreaks are usually located to the south and east of the area protected by the primary windbreak. Secondary windbreaks usually consist of shrubs or short trees designed to reduce the impact of the rare snowstorm from the south or east while allowing summer breezes to penetrate the protected area. A design of one or more rows is acceptable for a secondary windbreak.

The height (H) and density of a windbreak determine its ability to reduce wind speed and define the area of protection. To determine the area of protection, windbreak height (H) is determined by estimating the height of the tallest species at 20 years of age. On the windward side (the side toward the wind), the protected zone extends 2 to 5 times the height (2H-5H). On the leeward side (the side away from the wind), the protected zone may extend 10H to 30H. Estimates of 20-year heights of trees and shrubs needed to calculate areas of protection can be found in Kansas Forestry Technical Note KS-10.

Multiple-row windbreaks should have shrubs and small trees in the outer rows and not planted between taller growing species. For most situations a shrub or conifer will be used in the most windward row of a multiple-row planting to provide additional snow (moisture) for the growing plants within the planting and to "park" the snowdrift in an area that is out of the way.

In designing a windbreak, density of the planting should be adjusted to meet landowner objectives and the purpose of the windbreak. Windbreak density is the ratio of the solid portion of the barrier to the total area of the barrier. The number of rows, the spacing between plants, and species composition are factors that control windbreak density. For additional clarification about windbreak density see; [Agroforestry Note #36, Windbreak Density: Rules of Thumb For Design](#).

Thin or prune windbreaks as needed to maintain proper density and plant health to continue its function.

State and local county regulations must be followed in locating plantings adjacent to highways. Windbreaks will be positioned to avoid causing visibility problems at road intersections, curves, and driveway entrances. Trees or shrubs at maturity should not spread into the rights-of-way of roads. Avoid creating blind corners at road intersections.

To prevent hazards where snow deposition is a concern, plantings made on the north and west sides of a road or highway shall have the north and west tree rows (windward rows) approximately 200 feet from the centerline of the road. When plantings are made on the south and east sides of a road or highway, the rows nearest to the road shall be approximately 80 feet from the centerline of the road.

Avoid plantings under, over, or immediately adjacent to power, telephone, and similar above or below ground facilities, or use species that will not interfere with the facility. Call 1-800-DIG-SAFE before planting to identify if under ground utilities are located near or in the planting site. Consult utilities about required right-of-way distances from tree plantings.

Livestock shall be excluded from all windbreak/shelterbelt plantings.

Fireguards may be maintained on each side of the windbreak. Minimum width of the strips will be 8 feet from drip-lines. It is preferred that they be equal to the average row spacing.

Between-row spacing. Spacing between rows, except for twin row high-density plantings, shall be as follows:

MLRA 72, 77	14 to 30 feet
ALL OTHER MLRA'S	12 to 30 feet

Spacing between rows should be at least 4 feet greater than the width of the maintenance equipment.

Some species require specific between-row spacing recommendations, due to rapid growth rate and overtopping growth form. Rows of conifers and deciduous trees should not be planted within 25 feet of planted cottonwoods, hybrid poplars, silver maple, honeylocust, Siberian elm, or hybrid willows, nor should they be alternated with these species within the row.

In-row spacing.

Table 1. In-row Spacing (Feet)

Species	Single Row Planting	Multiple Row Planting	High-Density Planting
Shrubs	3-6	3-6	3
Conifers (Pines, E. Red cedar, RM Juniper)	8-12	8-16	8
Small Broadleaf Trees	8-12	8-16	-
Medium to Tall Trees	8-15	10-20	-

Design purpose:

Erosion control. Windbreaks designed to control wind erosion should have a average density of 50 percent during the period when the soil is subject to soil erosion. As this period occurs most often in the spring of the year when most deciduous trees are leafless, suggests that the windbreak contain a coniferous species or a dense shrub row.

A single, complete row of trees or shrubs may be used. Additional rows may be used to meet other objectives or density requirements. See Table 1 for in-row spacing for single and multiple row plantings.

In most cases, a single windbreak will not protect the entire field. Additional windbreaks parallel to the first will need to be established at intervals across the field. Typically, the distance between windbreaks should range from 10H to 20H and can be determined from wind erosion calculation formulas.

Farmstead/feedlot protection. Windbreaks designed to provide protection to objects and areas should have a density greater than 50 percent. For wind protection, the windbreak row with the tallest tree species should be approximately 2H to 5H from all primary objects or areas needing wind protection.

For areas needing both snow and wind protection, the windward row should be at least 150 feet from areas needing protection. The area to be protected will fall within a leeward distance of 10H. On the windward side, there should be at least 50 feet between the windbreak and the road or other objects that might be within the zone of the windward drift. The ends of the windbreak should extend at least 100 feet beyond the area needing protection.

Access roads should be planned around the ends of the rows. If necessary, to go through the planting, angle the opening so as not to cause the winds to “funnel” through the opening. These angle access roads, if feasible, should be located 100 to 500 feet from the ends of the windbreak.

A primary windbreak for farmstead/feedlot protection shall contain the following minimum number of rows:

MLRA's 72, 77	4 rows
MLRA's 73, 74, 75, 78, 79, 80A	3 rows
MLRA's 76, 84A, 106, 107, 112	2 rows

Where a sufficient area does not exist or the terrain is too rough for a multiple row planting, a primary windbreak planting may consist of two rows of eastern red cedar or Rocky Mountain juniper. A secondary planting on the south and east sides may consist of a single row of any adapted tree or shrub. For in-row spacing, see Table 1 for single and multiple row plantings.

Snow distribution: Windbreaks designed exclusively for uniform distribution of snow across the field for soil moisture enhancement should have a density of 25 to 50 percent.

Tree pruning and/or removal may be needed to maintain desired windbreak density.

Maximum snow deposition will usually be located down wind in an area two to five times the height of the most windward dense row.

When relying upon a single row, extra maintenance is required to ensure that no gaps develop in the windbreak.

Windbreaks designed for snow spreading may be spaced up to a maximum 20H apart across the field.

A single row of trees (conifers, trees and shrubs) in a location perpendicular to the prevailing wind will provide good snow distribution across a field to a distance of 10 to 15H.

As windbreak density approaches 50 percent, there will be an increased piling of snow and less distribution of snow across the field.

Living snow fences for roads and highways: Windbreaks designed for living snow fences should have a minimum density of 50 percent. Windbreaks that exceed 60 percent density may trap so much snow (snow accumulation) as to damage the species within the planting. Consider adding a row of shrubs or dense conifers 100 to 200 feet to the windward side to trap snow before it reaches the main windbreak. The area between the “snow trap row” and windbreak may be planted to native grasses or annual food plots. The establishment of a trap row can reduce snow damage to the windbreak.

As windbreak density increases total snow storage capacity does not increase proportionally. It will cause the snowdrift to be deeper closer to the windbreak.

Tree pruning and/or removal maybe needed to maintain desired windbreak density.

A living snow fence should be located perpendicular to prevailing winter winds and be placed so that the area to be protected is on the leeward side of the windbreak. Living snow fences are typically located north of east-west roads and west of north-south roads. The windward row shall be a minimum of 200 feet from the centerline of the road.

Maximum snow deposition will usually be located downwind in an area that is 2H to 5H of the most windward dense row.

The living snow fence planting shall contain, as a minimum, two rows with at least one of the rows being a conifer. In native rangelands a minimum of 2 rows of deciduous shrubs may be used without a conifer component. Rangeland grass condition, topography, and area to be protected must be considered in living snow fence planning. Other rows can be conifers, deciduous trees or shrubs. Twin row high-density plantings may be used. The ends of the windbreak should extend at least 100 feet beyond the area needing protection.

When relying on two rows, extra maintenance is required to ensure a 90 percent survival so that no gaps develop in the windbreak.

The in-row spacing will be determined by following the recommendations listed under the multiple row planting column in Table 1. Tree species between row spacing and desired density will be considered when determining row spacing.

Screen plantings – noise barriers. Windbreaks designed for noise barriers should have a minimum density of 80 percent. Noise barriers reduce noise by deflecting the noise away from the observer, by absorbing some of the noise before it reaches the observer or both. For maximum effectiveness, plantings should be placed as close as possible to the noise source.

For reducing high speed vehicle traffic noise, barriers should be greater than 65 feet wide, and for moderate traffic speed noise, barriers should be >25 feet wide. Plantings made on the north and west sides of a road or highway shall have the north and west windward tree rows approximately 200 feet from the centerline of the road. Plantings on the south and east sides of a road or highway, the row nearest the road shall be approximately 80 feet from the centerline of the road. The center tree row will be at least 45 feet tall. Shrubs 6 to 8 feet tall next to traffic lanes should be backed by rows of trees 30 to 50 feet tall.

Noise barriers must be twice as long as the distance from the observer to the noise source. Where year-round noise reduction is desired, conifers should constitute the majority of the plantings.

No matter how severe the noise, noise barriers shall not be positioned where the barriers will cause snow deposition or drifting on the road sufficient to create a safety hazard to the traveling public. For many of these situations, a living snow fence system is often needed upwind from the observer, thereby reducing the amount of snow that could cause a problem.

Screen plantings – visual barriers. Windbreaks designed for visual barriers should have a density of 60 to 80 percent. Plantings should be at least one row of conifers or at least three rows of deciduous trees or shrubs or a combination of both. Visual barriers should be designed with species that are aesthetically pleasing to the observer.

Living barriers against airborne odor movement.

Minimize the movement of odor away from an odor-producing source to a sensitive area. Tree varieties and placement for the windbreak shall be managed to maximize odor interception and dilution of air, and reduce odor leaving the source. Windbreak density on the windward side of the problem source shall be greater than 50 percent. Windbreaks designed for odor interception (downwind from the problem source) should have a density of 60 percent.

Where site conditions allow, place plantings around the entire perimeter of the odor source.

Select species based on high leaf surface roughness (plants with leaf hairs, leaf veins, small leaf size), complex leaf shapes, large leaf circumference to area ratios, and medium to rapid growth rates.

Adjust windbreak porosities/densities to meet air movement needs for naturally ventilated livestock confinement systems.

Keep the inner row of windbreak plantings from all buildings and waste storage areas at least 10 times the exhaust fan diameter or 50 feet, whichever is farther.

Use wide “between row spacing” to increase particle surface area contact and foliage light levels.

Chemical Drift.

Windbreaks reduce chemical drift hazards in two ways – by reducing wind velocities across the field where the chemicals are applied and by intercepting chemicals that have moved off site onto the leaves, twigs, and bark of the windbreak plants.

Due to the potential damage that chemicals cause to tree/shrubs, it is not recommended to design windbreaks specifically to intercept chemical drift.

Wildlife habitat enhancement.

If the primary purpose of the planting is to improve wildlife habitat, refer to Conservation Practice 645, Upland Wildlife Habitat Management. However, the designs of windbreaks for other purposes can be modified to make the practice more beneficial to wildlife.

Considerations for the improvement of windbreaks for wildlife habitat include, but are not limited to:

- Include a variety of trees and shrubs in the planting. This will provide habitat for a large number of species, reduce the chances of disease or insect pest problems, and will increase the distribution of food throughout the growing season.
- Provide dense areas (thickets) of suckering shrubs and conifers to provide winter thermal protection. If wildlife habitat is a concern, shrub rows can be planted as close as 6 feet between the rows to aid in establishing thickets.
- Add additional rows that provide food and cover on the lee side of the planting.
- Consider planting or leaving herbaceous vegetation such as grass, grain, or stubble as a border, 20-50 feet wide along the edges of windbreaks. This provides nesting, loafing, and foraging cover for wildlife.
- Provide travel corridors by extending the windbreak legs or by installing a hedge row planting.

Specialty designs

Twin row high density. The “twin row” refers to two closely spaced rows of trees or shrubs having the same growth rate, crown characteristics, and life span. Both rows of a twin row shall consist of conifer-type species such as eastern red cedar, Rocky Mountain juniper or deciduous shrubs. Deciduous tree species are not suited and should not be used for this type of plantings.

“High density” refers to the close spacing of the trees or shrubs in each twin row. The two rows of a twin row shall be spaced 6 to 10 feet apart or the closest between row spacing possible considering the type of planting equipment used. Refer to Table 1 for in-row spacing recommendations.

There can be one to four sets of twin rows depending on the objectives. The open space between the twin rows can vary from 25 to 100 feet.

5. Species Composition

With the exception of eastern red cedar or Rocky Mountain juniper, not more than two rows should be planted to the same species, unless site conditions limit the number of available species.

For multiple row plantings, consider at least two or more rows of conifers.

Often a single species will be planted in each row. Generally, this makes subsequent maintenance and renovation easier. However, single row, single species plantings are considerably more prone to failure from drought, disease, and/or insects.

Mixing compatible species within the row can reduce the severity of some insect and disease infestation and spread. Alternating species, either trees or shrubs, within the same row is recommended only if they have similar growth rate, crown characteristics, life span, and are consistent with landowner objectives.

In the leeward rows, trees and shrubs may be planted in groups or segments of rows (5 or more plants of one species in a series) to enhance wildlife values or the visual resources of the site.

6. Maintenance Details

Maintenance requirements are provided in Kansas Forestry Technical Note KS-9.

References:

Living Snowfences in Kansas, Troy L. Bratton, Kansas Forest Service, January 2006.
<http://www.oznet.ksu.edu/library/FORST2/L744.PDF>

Catching the Snow with Living Snow Fences, Dan Gullickson, Scott J. Josiah, Paul Flynn, University of Minnesota Extension Service and Minnesota Department of Transportation, 1999.

Controlling Blowing and Drifting Snow with Snow Fences and Road Design, Ronald D. Tabler, Tabler and Associates, Niwot, CO, August 2003

Windbreak/Shelterbelt-Odor Control, IS-MO380, eFOTG, Section IV, Windbreak/Shelterbelt Establishment-380, NRCS Missouri.

Tree Planting Guide, <http://www.oznet.ksu.edu/library/forst2/l596.pdf>

Weed Control Options In Tree Plantings, <http://www.oznet.ksu.edu/library/FORST2/L848.PDF>

Working Trees For Agriculture, <http://www.unl.edu/nac/workingtrees/wta.pdf>

Windbreak Density: Rules Of Thumb For Design, Agroforestry Notes, AF Note-36, September 2007,
<http://www.unl.edu/nac/agroforestrynotes/an36w03.pdf>