

WINDBREAK/SHELTERBELT ESTABLISHMENT

DESIGN PROCEDURES

(380DP)

I. GENERAL DESIGN GUIDELINES (All Windbreak Types)

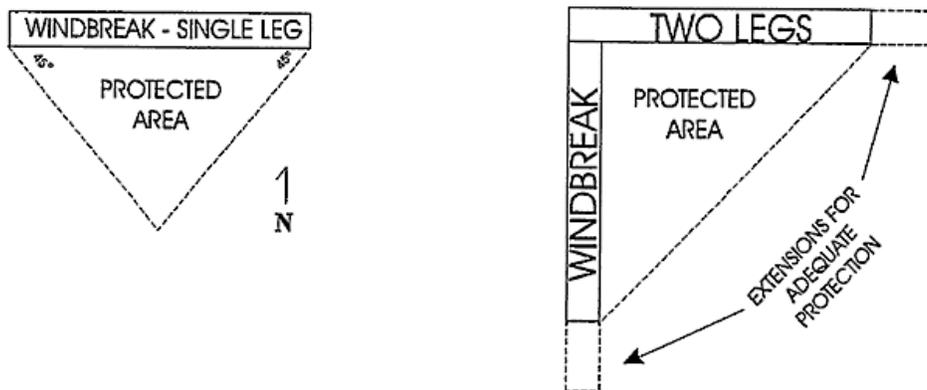
A. Species Selection

1. Planners shall become knowledgeable about species adaptation to a site, species attributes, species density (summer and winter), 20 year and mature height, crown spread, and other information relative to species selected for planting in windbreaks. For this information refer to the Nebraska Field Office Technical Guide (NE FOTG), Section II, Statewide Soil and Site Information, Windbreak Interpretations, CTSG-TOC-Introduction-Descriptions (Conservation Tree/Shrub Groups).
2. Native trees and shrubs that achieve planning objectives will be utilized whenever possible. If non-native plants are to be included in a windbreak, use only those that are non-invasive in the area.
3. Diversity of tree/shrub species is recommended in windbreak designs to minimize insect, disease, animal, weather and other potential pest problems. **No more than two contiguous rows** shall contain the same species unless soil conditions limit the number of choices. Check with a forester if this circumstance arises.
 - a. When foliar diseases of Eastern red cedar or Rocky Mountain juniper are a concern, use the widest recommended spacing between trees in the row and between tree rows (Table 1).
 - b. Twin row high density windbreaks are considered only one row for this purpose.
 - c. More than two rows of red cedar or Rocky Mountain junipers may be utilized for windbreaks **IF** separated by at least two rows of a different species. For example, a six row windbreak could contain 2 rows of red cedar or Rocky Mountain juniper, 2 rows of pine or other species, then 2 more rows of red cedar or Rocky Mountain juniper. **An EXCEPTION exists for livestock windbreaks on sandy soils in Vegetative Zones I and II. Details appear below under II. Design Guidelines - Specific Windbreak Types [II/A/1/i/3]).**
4. Consideration should be given to selecting species that provide food and shelter for wildlife attracted to windbreaks. The aesthetic quality of a well-designed windbreak can greatly increase its value. Consider plant form, size, and density, seasonal color of stems, leaves and flowers, and other attributes that are consistent with the client's goals (Conservation Tree and Shrub Groups, NE FOTG Section II, Windbreak Interpretations).
5. Alternating species of trees or shrubs in the row may be considered under certain circumstances or to reach specified objectives. If species are alternated, they need to have a similar size, density and growth habit.
6. Accumulated deep snow can severely damage some tree and shrub species. Areas where deep snow is expected to accumulate shall be planted to species that can tolerate the snow load pressures or use the widest recommended spacing between tree rows to accommodate greater snow storage.

B. Location

1. The length of the windbreak will be determined based on the area to be protected. It will extend far enough (usually 100-150 feet) to protect the area from the prevailing wind that is of concern (Figure 1).
2. The area protected from wind erosion by a windbreak is an area on the leeward side of the windbreak 10 times the height (10H) of the tallest tree row. An area two times the height (2H) is protected on the windward side. The value of H is the expected 20-year height of the tallest tree row with adequate density for the planning purpose. For example, a tree with a 20 year height of 30 feet would provide wind protection on the leeward side up to 300 feet and on the windward side up to 60 feet.

Figure 1. Area Protected by Single and Two-Leg Windbreaks



3. State and local county regulations must be followed in locating plantings adjacent to roadways. **Avoid creating blind corners at road intersections.** State regulations generally require that trees be kept at least 150 feet away from intersections to avoid creating blind corners. Exceptions may be required if there is a traffic yield or stop sign or if there are buildings or other obstructions to sight. Check with local road departments for regulations regarding these circumstances.
4. When windbreaks are planted on the north and west sides of a road or highway, the northern and western most tree rows shall be at least 150 feet from the near edge of the road to avoid snow drifting across the road. Plantings can be closer to the near edge of the road when there is another windbreak immediately upwind that will provide complete snow storage. Trees and shrubs that have moderate or greater year round density shall not be planted closer than one-and-a-half times their mature height from the near edge of the road on the south and east sides of a road or highway, because shading during winter months can lead to icy and hazardous road conditions.
5. Most county roadways have a right-of-way (ROW) width of at least 66 feet (33 feet either side of the center). Most state and federal highways are clearly marked with ROW markers. Trees/shrubs will not be planted within the ROW and no closer than isolation strip requirements referred to in Section III, Spacing Between/Within/-Outside of Tree Rows. Please consult with your local county/state officials to determine the correct ROW width.

6. **Omit plantings under, over, or immediately adjacent to power, telephone, and other above ground or below ground utility lines.** Prior to completing the windbreak design and a second time prior to planting the windbreak, a “one call” shall be requested through the utility company’s “One Call System”. Species that will not interfere with the utility lines, and are approved by any easement holder, may be considered for incorporation into the windbreak planting. Contact your local electric utility for information on planting the “right tree” in the “right place”. Where subsurface drains (tile and sewer lines) cross through a windbreak, sealed conduit should be installed a minimum of 100 feet from rows of large spreading trees and 75 feet from small to medium sized trees.

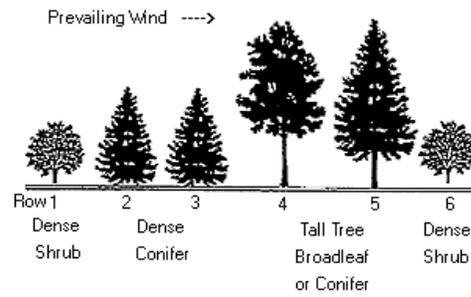
II. DESIGN GUIDELINES (Specific Windbreak Types)

A. Building Site and Livestock Protection Windbreaks

1. Winter Protection

- a. Primary windbreaks designed for wind reduction and snow management are generally placed to the north and west sides of the area to be protected. Prevailing winter winds are from the north and west in Nebraska.
- b. The area on the leeward side of a windbreak for a distance of 1H to 4H will generally receive the maximum snow accumulation. Snow will also accumulate on the windward side of a windbreak for a distance of 1H to 2H.
- c. In large pastures where livestock are to be wintered, location of the windbreak shall be placed to stop snow from drifting into livestock areas.
- d. If possible, livestock protection windbreaks should be located so cattle have access to protection in all directions. With L-shaped belts, protection is available against storms from all directions.
- e. For complete snow storage under severe blizzard conditions, a total windbreak width of at least 120 feet will be necessary.
- f. Livestock feeding areas that are within an area 10H downwind of southerly summer cooling breezes of dense windbreaks (during summer months) can be a concern. These areas may be subject to heat retention/buildup because of restricted airflow that can result in potential death losses and/or reduced weight gains. If this is a primary concern windbreaks on the south side that are within 10H of livestock feeding areas should be designed according to summer protection guidelines. Planners should consider this concern versus the benefit of winter protection.
- g. A typical windbreak profile/design for building site and livestock protection includes the following components (Figure 2):
 - 1) Dense conifer trees to reduce wind velocity,
 - 2) Tall broadleaf or conifer trees to extend the area of protection (summer and/or winter),
 - 3) Low shrubs to trip snow on the windward side; and to provide wildlife habitat and/or aesthetic value on the leeward side.

Figure 2. Typical Windbreak Profile (Jon Wilson, District Forester, NFS)



- h. The windward row of primary windbreaks, where possible, shall not be closer than 150 feet nor farther than 350 feet from the nearest principal building or area to be protected. When multiple row windbreaks are installed this distance can be measured based on 10H from the tallest tree row. A windbreak with a density of 65 percent provides its best protection within the distance of 10H. The first 150 feet will be the area of maximum snow accumulation.
- i. For **optimum** effectiveness against winter wind and for snow protection a primary windbreak shall be based on the following guidance:
 - 1) Minimum number of rows by Vegetative Zone to achieve optimum winter protection:

Vegetative Zones	I and II-W	6 Rows
Vegetative Zones	II-E and III	5 Rows
Vegetative Zone	IV	4 Rows

- 2) Windward rows will be a year-round moderately-dense to dense conifer or shrub that provides this density from the ground up. The second row will be a year-round moderately-dense to dense conifer. The remaining rows will be any adapted tree or shrub that will help achieve the objectives of the cooperator (i.e., height, wildlife, snow storage, aesthetics, etc.).
 - 3) The following **EXCEPTION** to the generally applied guidance regarding windbreak plantings applies **only** to livestock windbreaks in Vegetative Zones I and II on sandy soils.
 - a. As many as **five rows of the same** species of either eastern red cedar (ERC) or Rocky Mountain juniper (RMJ) may be planted.
 - b. In areas where both species grow well, it is recommended that alternate rows of ERC and RMJ be used.
- Note: Windbreaks for all other land uses will follow the guidelines associated with the windbreak purpose.
- j. There are options for meeting the **minimum** number of rows and species needed to achieve the required windbreak density of 65 percent for winter protection. (See Windbreak Design Clipboard, NE Forestry Technical Note 73 for illustrations of various densities). Options include:

- 1) Two rows on the windward (north and west) side will be year-round medium or high-density conifers or shrubs. At least one of the rows will be a medium or high-density conifer.
- 2) A single twin-row high-density windbreak may be used where sufficient space is not available for two or more normally spaced rows.
 - a) Each twin-row consists of two closely spaced rows of trees or shrubs having similar growth rate, crown characteristics, density and life spans.
 - b) Only Eastern red cedar, Rocky Mountain juniper or shrubs that are moderately-dense to dense year round shall be used in this windbreak design.
 - c) When mature, the twin row will appear and function as a single thick and dense row of trees or shrubs.
- k. A trip row may be planted for additional snow management by reducing the snow loading in the primary windbreak.
 - 1) A trip row is a single row of year-round moderately-dense to dense shrubs or conifers.
 - 2) The trip row is planted on the windward side, 35-50 feet from the primary windbreak.
- l. Plantings on the south and east sides may be desirable in some cases for wind reduction and snow management.
 - 1) Because the prevailing winter wind in Nebraska is from the northwest, a density less than 65 percent may be adequate on the south and east sides of an area to be protected.
 - 2) If complete winter protection on the south and east sides of the area to be protected is a goal, a windbreak density of 65 percent will be planned for the minimum requirements to achieve this density (refer to item **II-A-1-j** above).

2. Summer Protection

- a. A minimum of one row of moderate-to-tall deciduous trees should be included on the south side when summer cooling is an objective.
- b. If both winter and summer protection is desired, the requirements listed for winter protection must also be met.

B. Screen Plantings-Noise and Visual

1. For maximum effectiveness, tree-shrub belts shall be tall, dense, and located close to the noise source rather than close to the area protected. Conifer trees and year round moderately-dense to dense shrubs are most effective where year-round noise screening is desired.
2. Noise screen density shall be at least 65 percent during all times of the year, taller, and as close to the noise source as practicable. Refer to building site windbreaks for minimum number of rows and species required to achieve these density requirements.
3. The length of the noise screen shall be twice as long as the distance from the noise source to the receiver.

4. For high speed traffic noise, the windbreak shall not be less than 65 feet wide. The edge of the tree belt shall be within 50-80 feet from the nearest traffic lane.
5. For moderate speed traffic noise, the windbreak width shall not be less than 20 feet wide. The edge of the belt shall be 20-50 feet from the edge of the nearest traffic lane.
6. Species selected will be tolerant of noxious emissions, sand, and gravel depositions or salt spray from traffic areas.
7. When snow/winter protection is a concern, the design will need to account for this (refer to winter protection guidelines for building site protection windbreaks). A living snow fence upwind from the noise barrier may also be needed to avoid snow deposition from the noise barrier across roads, highways, buildings or other areas of concern.
8. Visual screens shall be located as close to the observer as possible with a density, height and width to sufficiently block the view. Conifers and/or shrubs that are moderately-dense to dense year round are most effective where year-round screening is desired. A single row of trees is sufficient for this type of planting. The 20-year height must be tall enough to screen the unsightly area.

C. Field Windbreaks (Windbreaks Designed for Wind Erosion Control, and Snow Distribution)

1. General Design Considerations

- a. A field windbreak, one to three rows wide, should provide sufficient density for wind erosion control and/or snow distribution. Additional rows and the widest recommended spacing between tree rows may be used to achieve landowner objectives, such as enhancing wildlife habitat or increasing the natural beauty of the area. In most situations **five rows** will meet all of these objectives.
- b. Field windbreaks should be located at right angles, if feasible, to the prevailing or most damaging wind direction. Property lines, other windbreaks, tillage operations, field layout, other conservation practices, and natural features on the landscape shall be taken into account in the design.
- c. Incidental grazing of adjacent crop fields may be allowed after trees are established when livestock can be managed to avoid rubbing, or browsing that decreases the density of the lower portion of the trees or shrubs.

2. Design for Wind Erosion Control

- a. A windbreak density of 40-60 percent is required for wind erosion control. See Windbreak Design Clipboard, NE Forestry Technical Note 73 for illustrations of various densities.
- b. When windbreaks are part of a wind erosion control system, the interval between belts will be based on the desired wind erosion control objectives. Erosion calculations will be based on current wind erosion prediction technology in Section I of the FOTG, "Erosion Prediction".
- c. The area protected from wind erosion by a windbreak is an area, on the lee side of the windbreak, 10 times the height (10H) of the tallest tree row. An area two times the height (2H) is protected on the windward side. The area can be "adequately" protected from wind erosion with a combination of windbreak, ridges and crop residue/cover crop, cross wind trap strips, cross wind stripcropping, herbaceous wind barriers, etc.

- d. To achieve a windbreak density of 40 percent, which is the minimum required for wind erosion control while achieving even snow distribution, the following will be needed:
 - 1) No less than a single, complete row of moderately dense or dense trees or shrubs during the winter season may be used.
 - 2) Two or more rows of broadleaf trees and/or low density shrubs (during the winter).

3. Design for Snow Distribution

- a. To achieve even snow distribution the maximum distance between windbreaks shall not exceed 20 times the height (20H) of the tallest tree row.
- b. When even snow distribution is the primary purpose of the field windbreak, the planned density shall be from 25-50 percent and the following will be needed:
 - 1) No more than a single complete row of moderately-dense or dense trees during the winter season may be used.
 - 2) No more than two rows of broadleaf trees and/or low density shrubs (during the winter).

D. Living Snow Fences for Roads and Highways

- 1. Locate living snow fences to intercept blowing snow. They should be located north of east-west roads and west of north-south roads. Living snow fences should, where possible, extend at least 50 feet beyond the snow drift problem area.
- 2. The outside (windward) row shall be a minimum of 150 feet or a maximum of 250 feet from the leeward edge of the nearest traffic lane.
- 3. A minimum windbreak density of 65 percent is required for a living snow fence.
 - a. Refer to building site and livestock protection windbreak for requirements to achieve a 65 percent density. Also refer to Windbreak Design Clipboard, NE Forestry Technical Note 73.
 - b. Two rows of year round moderately-dense to dense shrubs may be used to achieve a 65 percent density.
- 4. A multiple set of twin-row high density windbreaks may be used.

III. SPACING BETWEEN/WITHIN/OUTSIDE OF TREE ROWS (All Windbreak Types)

A. Spacing Guidelines

- 1. Refer to Table 1, Spacing Guidelines for Windbreaks, for spacing between plants in the row and spacing between the rows.
- 2. Spacing between tree rows should be at least 4 feet wider than maintenance equipment. Spacing between rows can be adjusted beyond the spacing listed in Table 1 when necessary to match maintenance equipment.
- 3. Tree species with an overtopping habit of growth shall not be planted within 20 feet of a conifer row. Siberian elm, cottonwood, honeylocust, silver maple, and tree willows are examples of trees with this habit of growth. Minimum spacing between rows of Siberian elm or cottonwood and adjacent rows of any species shall be at least 20 feet.

B. Widest Recommended Spacing between Tree Rows

1. The widest recommended spacing between tree rows will increase the time that it takes for canopy cover to occur from larger trees.
2. Canopy cover between tree rows may never occur for smaller trees and shrubs by employing the widest recommended spacing between tree rows. This may present long-term management concerns in the area between the rows for competitive herbaceous vegetation.
3. Using the widest recommended spacing in Table 1 may also present positive opportunities such as: more area to trap snow, more space and cover to attract and protect wildlife, more room for maintenance operations, fuller trees, less needle die off, etc.

C. Isolation Strip (Outside of Windbreak)

1. An isolation strip shall be included in windbreak design. An isolation strip is the area between an exterior (windward or leeward) row of the windbreak and the adjacent land-use boundary or fence.
2. The isolation strip shall be at least 8 feet wide and at least 4 feet wider than maintenance equipment.
3. When planting next to road right of ways, power lines, or other areas where easements prohibit trees, shrubs, or any type of obstructions, the isolation strip shall be wide enough to allow for the width and height of the trees at maturity.
4. To allow for growth of the tree and/or shrub, it is preferable that the strip be equal in width to the spacing between adjacent tree and shrub rows and no closer than the predicted drip line of the outside tree row at maturity.

D. Twin-row High Density Design

1. Use the minimum spacing between trees in the row from Table 1.
2. Spacing between tree rows for twin row high-density designs will be 6 to 10 feet. Use 10 feet spacing between tree rows when continuous roll fabric is used.
3. The spacing between multiple sets of twin row high-density windbreaks may vary from 25 to 50 feet, depending on the objectives of the plantings.

Table 1. Spacing Guidelines for Windbreaks

Windbreak Position	² Windbreak Component	In-Row Spacing Between Trees (ft.)	¹ Between-Row Spacing (ft.)
Windward Rows (Rows 1 or 2)	Eastern red cedar, Rocky Mountain juniper, and arborvitae	8-12	14-24
Leeward Rows (Rows 3+)	Eastern red cedar, Rocky Mountain juniper, and arborvitae	10-14	14-24
Windward Rows (Rows 1 or 2)	Pines	10-14	16-24
Leeward Rows (Rows 3+)	Pines	12-18	16-24
Windward Rows (Rows 1 or 2)	Spruce and Fir	10-16	16-24
Leeward Rows (Rows 3+)	Spruce, Fir, and Cypress	16-20	16-24
Leeward Rows (Rows 3+)	Low broadleaf trees less than (<) 20 ft. tall	8-14	14-24
Leeward Rows (Rows 3+)	Medium-to-tall broadleaf trees greater than (>) 20 ft. tall	12-20	20-24
Windward or Leeward Rows	Shrubs less than (<) 10 ft. tall	3-6	12-18
Windward or Leeward Rows	Shrubs greater than (>)10 ft. tall	5-10 ft	12-18
Twin Row High Density	Eastern red cedar, Rocky Mountain juniper, or moderately-dense to dense shrubs	Varies by species (see above) 3-14 ft	6-10

¹ Spacing between tree rows can be increased beyond the maximum spacing listed in this column if needed for maintenance equipment width. Spacing shall be at least four feet wider than maintenance equipment. Spacing may be increased to a maximum of thirty feet if necessary to meet wildlife habitat objectives.

² Tree and shrub height is based on 20-year height listed in NE FOTG, Section II, Windbreak Interpretations, Conservation Tree/Shrub Groups.

IV. PLANTING, REPLANTING AND MAINTENANCE OF WINDBREAKS

- A. Refer to Tree and Shrub Plant Procedures Guide, NE FOTG, 380TPP for planting guidelines.
- B. Refer to Nebraska Forestry Technical Note 63 for replanting guidelines.
- C. Refer to 380TPP, Section VII for guidelines on maintenance of windbreaks.

V. SUPPORT REFERENCES

Kucera, Michael and James Harder. 2002. Guide for Evaluation of Survival for Conservation Tree and Shrub Plantings. Nebraska Forestry Technical Note 63, USDA, NRCS, Lincoln, NE, 3 p. <http://efotg.sc.egov.usda.gov/references/public/NE/ForestryTechNote63.pdf>

National Agroforestry Center. 2009. Windbreak Design Clipboard. Nebraska Forestry Technical Note 73, USDA, NRCS, Lincoln, NE, 2 p.