

WINDBREAK/SHELTERBELT ESTABLISHMENT

(Feet)

Code 380

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

Linear plantings of single or multiple rows of trees or shrubs or sets of linear configurations.

II. Purposes

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To reduce soil erosion from wind.
- To protect plants from wind-related damage.
- To alter the microenvironment for enhancing plant growth.
- To manage snow deposition.
- To provide shelter for structures, livestock, and recreational areas.
- To enhance wildlife habitat by providing travel corridors.
- To provide living noise screens.
- To provide living visual screens.
- To improve air quality.
- To delineate property and field boundaries.
- To improve irrigation efficiency.
- To increase carbon sequestration.
- To reduce energy use.

III. Conditions Where Practice Applies

This practice applies on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources. Use other tree/shrub practices when wind, noise and visual problems are not the primary resource concerns.

IV. Federal, Tribal, State, and Local Laws

Users of this standard shall comply with applicable federal, tribal, state and local laws, rules, regulations or permit requirements governing windbreak and shelterbelt establishment. This standard does not contain the text of federal, tribal, state, or local laws.

V. Criteria

A. General Criteria Applicable to All Purposes

Determine the location, layout, orientation, and density of the planting necessary to accomplish the purpose and function intended within a 20-year period.

Species must be adapted to the soils, climate, and site conditions.

Species shall be suited for the planned practice purpose(s).

For multiple row windbreaks, plant the shortest species (shrubs) based on 20-year height, or most dense species in the windward row. Interior rows may be any tree species from Wisconsin Forestry Technical Note 4, Tree and Shrub Species for Windbreaks, suited to the soil and climate. The interior species should be at least as tall as the outside rows. A relatively fast grower is desirable to obtain heights as quickly as possible. Inside or leeward row may be the same species as the interior row or rows, a shrub attractive to wildlife, a flowering shrub, or a dense shade tolerant conifer.

For multiple row windbreaks, 50 percent or more of the rows shall be of coniferous species unless soil limitations prevent their use or the desired density will be exceeded.

In the event of marked changes in the soil within the row, the species will be changed to fit the soil.

Site preparation shall be sufficient for establishment and growth of selected species, shall not contribute to erosion, and shall be appropriate for the site conditions. See NRCS Field Office Technical Guide (FOTG) Section IV Practice Standard 490, Forest Site Preparation.

Only viable, high quality and adapted planting stock or seed will be used. See NRCS Wisconsin Forestry Technical Note 4, Tree and Shrub Species for Windbreaks and Shelterbelts.

The planting will be done at a time and manner to insure survival and growth of selected species.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species, or where soils are excessively well drained.

For the protection of the windbreak or shelterbelt, all livestock will be excluded from the area devoted to the practice, and the area will be protected from fire.

Windbreak and shelterbelt plantings will be continuous on one or more sides of the area to be protected from exposure to the prevailing wind direction. The windbreak will be oriented as close to perpendicular to the prevailing wind direction as possible and will usually be located on the north or west sides of the protected area, or both.

The length of the windbreak will be sufficient to protect the site including consideration for the "end effect" and changes in wind direction. Windbreaks/shelterbelts will protect an area downwind equivalent to 10 times their height (H).

The design height (H) for a windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 years for the given site.

B. Criteria for Locations of Windbreaks and Shelterbelts

(See Figure 1 of Wisconsin Forestry Technical Note 4, Tree and Shrub Species for Windbreaks for examples of this criteria.)

For prevention of soil erosion, the windbreak will be oriented as close to perpendicular as possible to the prevailing winds for the critical months of April and May.

For prevention of crop damage by wind-blown particles, orient the windbreak as close to perpendicular as possible to the prevailing winds for the critical month when crop damage is occurring.

Avoid planting trees or shrubs where they will interfere with structures and above or below ground utilities. Rows of trees or tall shrubs will be no less than 30 feet from utility line easements on transmission lines and pipelines to avoid maintenance problems. Maintain a minimum 8-foot clear strip centered over underground electric distribution utility lines. Contact underground utility companies for specific criteria.

Plant windbreaks and shelterbelts so that roots do not interfere with any underground drain tile lines. Refer to the Wisconsin supplement to Part 650, Chapter 14, Engineering Field Handbook (EFH).

To prevent ice hazards caused by shading on roads and driveways, no windbreak row will be less than 30 feet from the edge of the roadway. Windbreaks and shelterbelts south of roads will be placed a distance of 3 times H from the edge of the roadway.

Windbreaks shall not be established within road right-of-ways. Right-of-way distances on a given site can be obtained from the highway department with jurisdiction.

At road intersections or on curves, plantings will be positioned to avoid visibility hazards. Vision clearance requirements of streets and roads vary between townships, counties, and incorporated communities. Zoning ordinances shall be followed when siting windbreaks.

When windbreaks or shelterbelts are planted to the north or west of a road, the windward row will be no less than 200 feet from the edge of the roadway to reduce snow deposition onto the road.

Windbreaks will be located a minimum of 20 feet from ditches and streams to minimize soil deposition into watercourses.

C. Additional Criteria to Reduce Wind Erosion and Protect Growing Plants

The interval between windbreaks shall be determined using current, approved wind erosion technology. See USDA-NRCS, Wisconsin Field Office Technical Guide (FOTG), Section I, Part II, Estimating Soil Loss From Wind Erosion. Interval widths shall not exceed that permitted by the soil loss tolerance (T), or less than T, where plant protection is a concern. Calculations shall account for the effects of other practices in the conservation management system.

One leg windbreaks are sufficient if harmful winds come from one direction only, but for most of Wisconsin, windbreaks to the north and west of the area needing protection provide best results.

For wind erosion control, temporary measures will be installed to supplement the windbreak until it is fully functional.

Sites, fields, and plants are protected within an area 10 times the design height (H) on the leeward side and two times the design height (H) on the windward side of the windbreak. For design purposes, windbreak height will be based on the estimated height of the windbreak species at 20 years of age. (Refer to Wisconsin NRCS FOTG, Section II, Windbreak and Environmental Planting Interpretations, and Wisconsin Forestry Technical Note 4).

Select species that are taller than the crops being protected.

A field windbreak should be designed to obtain a density at maturity equal to 40 to 60 percent of the density of a solid barrier. One to three rows of trees or shrubs at maturity may provide the density desired depending on species selected and spacing. Do not design windbreaks with greater than 60% density where the purpose is soil erosion control.

Access lanes or roads should cut through the windbreak at an angle to prevailing winds to prevent funneling of wind. Lanes or roads through single row barriers should be avoided. Locate them 100 to 500 feet from the ends of single row windbreaks to prevent deposition onto the lane or road.

Select tree and shrub species using the Windbreak and Environmental Planting Interpretations in Section II of the Wisconsin NRCS FOTG; Wisconsin NRCS FOTG Section IV, Standard 612, Tree and Shrub Establishment; and Wisconsin Forestry Technical Note 4. Species selection should be made to fit the requirements of:

- soils,
- climate,
- desired height ,
- desired density,
- tendency to retain branches,
- rate of growth,

- longevity,
- disease and pest resistance, and
- aesthetic and wildlife value

Use a single species in a row where the soils permit. Do not alternate species within the same row because of growth variations.

Change species in the row when required by marked changes in the soil type.

In multiple row windbreaks use different species for each row to minimize total loss of the windbreak by disease, to increase windbreak longevity, for biological diversity, and for a better overall growth form of the windbreak. For example, a two row windbreak will be one row of conifers and one row of hardwoods.

1. Number of rows in a windbreak or shelterbelt:
 - a. A single row of trees or shrubs is adequate if a good stand and moderate density is maintained.
 - b. Two or more rows will be used where it is difficult to maintain a stand of trees or shrubs because of soil or where two or more rows are needed to meet the desired density.
 - c. Two or more rows may be used when the owner wishes to obtain a level of protection, wildlife benefit, or beautification not provided by minimum one-row designs.
2. Tree spacing within a windbreak or shelterbelt:
 - a. Within the row, minimum and maximum spacing will be:
 - (1) Large broad-leaf trees:
 - Single row: 10 to 15 feet
 - Multiple rows: 10 to 20 feet
 - (2) Small and medium broad-leaf trees and conifers:
 - Single row: 6 to 12 feet
 - Multiple rows: 6 to 15 feet
 - (3) Shrubs, depending on species:
 - 3 to 8 feet

- b. The minimum spacing between rows will be 6 feet for a multiple row, high-density windbreak. Wider spacing will be used to accommodate cultivating and mowing equipment as appropriate.
- c. Windbreaks for orchard protection shall have a mature height of twice that of the orchard trees. For all other crops, windbreaks shall be taller than the crop to be protected.

D. Additional Criteria to Manage Snow Deposition

(See Figure 1 of Wisconsin Forestry Technical Note 4, Tree and Shrub Species for Windbreaks for examples of this criteria.)

The windbreak/shelterbelt will be oriented as close to perpendicular to the snow-bearing wind as possible.

For snow distribution across a field, the density (during expected snow-producing months) shall not be less than 25 percent nor greater than 50 percent. The interval between barriers will not exceed 20H.

For snow accumulation, the minimum barrier density, during expected snow-producing months, will be 60 percent. The maximum density during expected snow-producing months will be 80 percent.

Windbreaks/shelterbelts will be located so that snow deposition will not pose a health or safety hazard or obstruct human, livestock, or vehicular traffic. Normally, they should be located north of E-W roads and west of N-S roads. Where possible, extend the windbreak/shelterbelt at least 50 feet beyond the snow drift problem area to maximize protection.

The windward row will be a minimum of 200 feet and a maximum of 300 feet from the centerline of roads. Trees should be planted no closer than 200 feet from corners or intersections in order to allow for traffic visibility.

Two and three-row windbreaks/shelterbelts will be located so that the inside (leeward) row is no less than 65 feet from the primary area to be protected except for roads.

Windbreaks/shelterbelts of four or more rows will be located so that the outside (windward)

row is not less than 100 feet from the primary area to be protected, except for roads.

Water erosion and/or runoff from melting snow shall be controlled by supporting conservation practices where site conditions require protection.

E. Additional Criteria to Provide Shelter for Structures, Livestock, and Recreational Areas

The planting will be oriented as close to perpendicular to the prevailing wind as possible. For wind protection, the minimum barrier density will be 65 percent during the critical design period and the area to be protected will fall within a leeward distance of 10h.

Three or more rows of trees and shrubs will be used. A two-row design is permissible only when space does not permit a three-row design with minimum spacing between rows.

Spacing between individual plants shall be based on the needed growing space for plant type and species, the accommodation of maintenance equipment and the desired characteristics of the stems, branches and canopy as required for a specific purpose.

1. Minimum spacing between rows will be:
 - Between shrub rows: 10 feet.
 - Between rows of spruce, pine, cedar, or small broad-leaved trees such as willow: 12 feet.
 - Between rows of large broad-leaved trees such as hybrid poplar or oak: 14 feet.
 - Recommended minimum, mixed species: 14 feet.
2. Maximum spacing between rows will be 20 feet.
3. Minimum and maximum spacing within the row will be:
 - Large broad-leaved trees: 10 to 20 feet.
 - Conifers and small broad-leaved trees: 6 to 12 feet.
 - Shrubs, depending on species: 3 to 6 feet.

NOTE: The spacing within the row and between rows are approximate. It is difficult to plant trees at an exact spacing. This

should be kept in mind when spot checking for compliance.

Drainage of accumulated snowmelt from the windbreak shall not flow across the livestock area.

Barnyard runoff water will be diverted around trees and shrubs in the planting with a diversion (NRCS FOTG Standard 362, Diversion), or through the planting in a non-perforated underground outlet (NRCS FOTG Standard 620, Underground Outlet).

F. Additional Criteria for Noise Screens

Noise screens shall be at least 65 percent dense during all times of the year, as tall as, and as close to the noise source as practicable.

The length of the noise screen shall be twice as long as the distance from the noise source to the receiver.

For high-speed traffic noise, the barrier width shall not be less than 65 feet wide. For moderate speed traffic noise, the barrier width shall not be less than 20 feet wide.

Species selected will be tolerant to noxious emissions, sand and gravel deposition, and salt spray from traffic areas.

G. Additional Criteria for Visual Screens

Visual screens shall be located as close to the observer as possible with a density, height and width to sufficiently block the view.

H. Additional Criteria for Providing or Enhancing Wildlife Habitat or Travel Corridors

Plant species selection shall benefit targeted wildlife species.

A windbreak/shelterbelt can be used as a travel corridor to connect existing patches of wildlife habitat.

Design dimensions of the planting shall be adequate for targeted wildlife species.

I. Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, within-field windbreaks shall be nearly as tall as the sprinkler heads.

The barrier shall not interfere with the operation of the irrigation system.

J. Additional Criteria to Improve Air Quality by Reducing and Intercepting Airborne Particulate Matter, Chemicals and Odors

The windbreak interval shall be less than or equal to 10H depending on site conditions and related supporting conservation practices.

Windbreak density on the windward side of the problem source, (i.e., particulate, chemical or odor) shall be greater than 50% to reduce the airflow into the source area.

Windbreak density on the leeward side of the problem source, and windward of the area to be protected, shall be greater than 65%.

Windbreaks should be placed at a minimum of four fan diameters downwind from the fans or 50 feet, whichever is further

Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception, adsorption and absorption of airborne chemicals or odors.

Where site and facility conditions merit and allow, place plantings around the entire perimeter of the odor source. Livestock buildings and manure storage areas are best located within the quiet zone, 50 to 100 feet downwind of the windbreak. Windbreaks should also be at least 50 to 100 feet from access roads and driveways to prevent snowdrifts from blocking farm vehicles during winter and creating visual impairment zones.

Windbreaks for odor and chemical control increase in effectiveness as the amount of foliage available for intercept increases. Multiple row plantings offer greater interception potential than do smaller plantings.

K. Additional Criteria for Increasing Carbon Storage in Biomass and Soils

Maximize width and length of the windbreak to fit the site.

For optimal carbon sequestration, select plants that have higher rates of sequestration of biomass in soils.

Plant and manage the appropriate plant spacing for the site that will maximize above and below ground biomass production

Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt.

When using trees and shrubs for greenhouse gas reductions, prediction of carbon sequestration rates should be made using current, approved carbon sequestration modeling technology.

L. Additional Criteria to Reduce Energy Use

Orient the windbreak as close to perpendicular to the troublesome wind as possible.

Use proper plant density to meet energy reduction needs.

Use plants with a potential height growth that will be taller than the structure or facility being protected.

VI. Considerations

Additional recommendations relating to design that may enhance the use of, or avoid problems with, this practice but are not required to ensure its basic conservation functions are as follows.

- A. To improve tree and shrub survival and growth, use of mulch, weed control mats, or weed control fabric should be considered. See Wisconsin NRCS FOTG Standard 484, Mulching, for more information.
- B. To enhance aesthetics, use evergreen species or species with features such as showy flowers, brilliant fall foliage, or persistent colorful fruits.
- C. Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides typically used in the surrounding area.
- D. Plants that may be alternate hosts to undesirable pests should be avoided.
- E. All plantings should complement natural site features.
- F. Tree or shrub rows should be oriented on or near the contour where water erosion is a concern. Where water erosion and/or runoff from melting

snow is a hazard, it should be controlled by supporting conservation practices.

- G. Wildlife should be considered when selecting tree or shrub species.
- H. Consideration should be given to adverse offsite effects.
- I. Plants established in windbreaks or shelterbelts should have root systems that do not affect crop growth and/or do not spread from root sprouts or have allelopathic affects. Do not plant species considered to be invasive or noxious.
- J. Species diversity, including use of native species, should be considered to avoid loss of function due to species-specific pests.
- K. When planning windbreaks and shelterbelts, consider other NRCS FOTG Section IV standard practices as part of the wind erosion control system including 329, Residue Management, No Till and Strip Till; 345, Residue Management, Mulch Till; 344, Residue Management, Seasonal; 340, Cover Crop; 328, Conservation Crop Rotation; and 585, Stripcropping.

VII. Plans and Specifications

Locate the practice on the conservation plan map and document on Wisconsin Job Sheet 144, Farmstead Windbreak/Field Windbreak. Documentation will include number and location of rows, species in each row, spacing in rows and between rows and location in reference to area to be protected.

In lieu of a conservation plan, provide a location map and completed Wisconsin Job Sheet 144, Farmstead Windbreak/Field Windbreak, in the case file.

Specifications for applying this practice shall be prepared for each site and documented in the conservation plan.

IX. Operation and Maintenance

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice and repair and upkeep of the practice.

To assure the survival of planted trees and shrubs, competing vegetation is to be controlled for a minimum of three years following windbreak planting.

Replacement of dead trees or shrubs will be continued until the barrier is functional.

Supplemental water will be provided as needed.

Thin or prune the barrier to maintain its function.

Inspect trees and shrubs at least annually and protect them from adverse impacts including insects, diseases, or competing vegetation. The trees or shrubs will also be protected from fire and damage from livestock and wildlife.

Periodic applications of nutrients may be needed to maintain plant vigor.

Plantings must be protected from farm and recreational vehicle traffic. Posting, flagging, and fencing can be used to exclude vehicles.

Commercially available tree shelters can be used to protect plantings from wildlife damage, protect from direct herbicide spray, and prevent damage by vehicles by making the trees more visible.

X. References

USDA, NRCS, Wisconsin Forestry Technical Note 4, Trees and Shrubs for Windbreaks and Shelterbelts.

Wisconsin Job Sheet 144, Farmstead Windbreak/Field Windbreak.

USDA, NRCS, Wisconsin Field Office Technical Guide, Section I, Erosion Prediction-Part II, Estimating Soil Loss From Wind Erosion.

USDA, NRCS, Wisconsin Field Office Technical Guide, Section II, Windbreak and Environmental Planting Interpretations.

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

USDA, NRCS National Engineering Handbook (NEH), Part 650, Engineering Field Handbook.

Bentrup, Gary 2008. Conservation Buffers: Design Guidelines for Buffers, Corridors, and Greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: USDA, Forest Service, Southern Research Station.

Brandle, J.R. et al, 1988. Windbreak Technology. Agric. Ecosyst. Environ. Vol. 22-23.