Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WINDBREAK-SHELTERBELT ESTABLISHMENT AND RENOVATION

DRAFT CODE 380

(ft)

BROAD REVIEW

Drafted technical standard text (as sent for review) is in black and blue fonts.

National minimum requirements are in black font;
Wisconsin specific criteria is denoted with blue font.

DEFINITION

Establishing, enhancing, or renovating windbreaks, also known as shelterbelts, which are single or multiple rows of trees and/or shrubs in linear or curvilinear configurations.

PURPOSE

Use this practice to accomplish one or more of the following purposes:

- Reduce soil erosion from wind
- Enhance plant productivity and health by protecting plants from wind-related damage
- Manage snow distribution to improve moisture utilization by plants
- Manage snow deposition to reduce obstacles, ponding, and flooding that impacts other resources, animals, structures, and humans
- Improve moisture management by reducing transpiration and evaporation losses and improving irrigation efficiency
- Provide shelter from wind, snow, and excessive heat, to protect animals, structures, and humans
- Improve air quality by intercepting airborne particulate matter, chemicals, and odors, and/or by reducing airflow across contaminant or dust sources
- Reduce energy use in heating and cooling buildings, and in relocating snow

- Increase carbon storage in biomass and soils

CONDITIONS WHERE PRACTICE APPLIES

On cropland, pasture, farmstead, associated agricultural land, or designated protected areas (excludes forest land) apply this practice to establish, enhance, or renovate windbreaks where rows of woody plants are desired and suited for the intended purposes.

Apply this practice to any existing windbreaks that are no longer functioning properly for the intended purpose, or where renovation can extend the functional life of a windbreak.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, install, enhance, and renovate windbreaks to comply with applicable Federal, State, and local laws and regulations. Locate and design windbreak plantings to achieve functionality for their intended purposes within 20 years from the time of establishment.

Design windbreak dimensions and configurations to address site conditions. The protected zone on the leeward side of a windbreak is 10 times the maximum design height (H) of the tallest row of trees or shrubs at age 20. Adjust H estimates based on site productivity. See the WI Windbreak Guidance Document(s) as needed for assistance with designs.

Use species and setback distances that allow for the expected mature windbreak size to mitigate potential negative impacts of shading, visibility along travel routes, snow deposition, or concerns for visual quality. Design windbreak length to protect the site and allow for “end effect” (turbulence effects at the end of a windbreak) and minor changes in prevailing wind direction. Determine prevailing wind direction using wind rose data, averaged for the months when the resource concern exists. Adjust wind rose data as needed to account for effects of local topography on wind direction.

Select tree and/or shrub species that are adapted to soils, climate, and other site conditions. Protect trees and shrubs from browsing and damage by wildlife or livestock, if necessary.

Do not use species that are on Federal or State invasive species or noxious weed lists.

Space individual plants based on the growing area needed by each species, with accommodation for maintenance equipment and for the desired configuration of the stems, branches, and canopy to achieve windbreak purposes. Do not plant trees or shrubs where they will interfere with above or belowground structures, utilities, irrigation or moisture management systems, or desired drains. To determine how far to end a windbreak from an intersection, use the Design Intersection Sight Distance table from the Federal Highway Administration. Confirm sight distance with the local roadway authority.

Permit the periodic removal of some products, such as high value trees, medicinal herbs, nuts, fruits, etc., provided the loss of vegetation or harvesting disturbance does not compromise the conservation purpose.

Use Wisconsin Windbreak Guidance Document(s) and the following NRCS Conservation Practice Standards (CPSs) as needed to establish windbreaks:

- Tree/Shrub Site Preparation (CPS 490) for preparing the site prior to plant establishment
- Tree/Shrub Establishment (CPS 612) when establishing trees and/or shrubs
- Irrigation System, Microirrigation (CPS 441) for supplemental water

Additional Criteria to Reduce Soil Erosion and Protect Growing Plants

- Determine the appropriate interval between windbreaks using current soil erosion prediction technology to minimize wind erosion.
- Interval widths must not exceed that permitted by the soil loss tolerance (T) or other planned soil loss objective.
- Account for the effects of other practices used in the conservation management system when calculating interval widths.
- Design windbreaks with adequate height to protect the desired area. The protected zone is 10H on the leeward side and 2H on the windward side.
- Design windbreak density to be 40 to 60 percent during the time of year soil erosion is most likely to occur, taking into account times of year that deciduous trees will not have full leaf cover if they are part of the design.
- Orient a windbreak perpendicular to the wind direction(s) that causes the resource concern or as nearly perpendicular as practical.
- For protection of growing plants, select species for planting that are taller than the height of the crop during the period of vulnerability.

Additional Criteria to Manage Snow Deposition

Orient the windbreak as close to perpendicular to the prevailing snow-bearing wind as practical. Locate and design windbreaks so that snow deposition will not pose a health or safety problem, management constraint, or obstruct human, animal, or vehicular traffic. The windward edge of the windbreak should be a minimum of 5H from any area where snow deposition may be a potential health or safety problem. Windbreak density during expected snow-producing months must be at least 50 percent.

Where it is desirable for wind to blow snow off road surfaces and limit ice formation, design windbreaks using greater setback distances and allow for maximum mature windbreak height as well as 20-year height.

To reduce hazard of black ice and snow drift, the windward row will be a minimum of 175 feet and a maximum of 300 feet from the fogline (white line) or edge of the road if there is no fogline. Increase this distance as necessary to prevent winter shade on the roadway at the mature tree height.

Control soil erosion and/or runoff from melting snow by adjusting the siting of new windbreaks prior to establishment or by using appropriate supporting practices, if necessary.

Additional Criteria for Managing Snow Distribution

To encourage more even distribution of snow across a site, windbreak density during expected snow-producing months should be 25 to 50 percent with the interval between windbreaks not exceeding 20H.

Additional Criteria to Provide Shelter for Animals, Structures, and Humans and to Reduce Energy Use in Structures

Use windbreaks as needed to reduce wind or snow impacts to animals, structures, and humans, or to reduce energy use.

For snow and wind impacts, orient the windbreak as close as possible to perpendicular to the prevailing wind. To protect a structure, the structure must be a minimum of 5H (to ensure area for snow drift accumulation) and no greater than 10H from the windward edge of the windbreak. The density for windbreaks that protect animals from cold and wind must be at least 65 percent during the months when the wind is most responsible for the resource concern. The density for windbreaks designed to reduce winter energy use in structures must be at least 50 percent.

Prevent snowmelt drainage from a windbreak from flowing across an area of animal confinement. Prevent drainage of animal waste into a windbreak.

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

Use tree and shrub species with foliar and structural characteristics that optimize interception, adsorption, and absorption of airborne particles, chemicals, or odors.

Coniferous evergreen trees and/or shrubs are generally preferred. Select windbreak species that are tolerant of identified spray drift and other pollutants to the extent that these impacts are predictable.

Odor/Particulates

Design odor-protecting windbreaks on both the windward side and leeward side of the area that needs protection, to both decrease wind speed and encourage odor particle deposition, and create wind turbulence that disperses and dilutes odor particles. Provide adequate distance from the windward side of the windbreak to the windward side of a structure to accommodate snow deposition, at least 5H.

Table 1: Two-Windbreak System for Odor Protection Purposes

	Windward of Odor Source	Leeward of Odor Source
Mechanically ventilated structure	>50% density 5H-10H	>65% density distance at least 4x fan diameter or 50', whichever is farther, typically 2H-5H
Naturally ventilated structure & Manure storage areas	>50% density 10H-15H	>65% density >4H

Chemicals

Use windbreaks to help USDA certified-organic and transitioning-to-organic producers meet National Organic Program requirements for suitable buffers or barriers between certified organic production areas and nonorganic production areas on the same farm or neighboring farms that utilize National Organic Program prohibited substances. Windbreak density must be at least 50 percent at the time of year when chemical drift is a concern.

Additional Criteria for Carbon Capture and Storage

Plant windbreaks with a larger footprint to increase carbon capture and storage in biomass and soils. Where practical, while meeting the primary objective of the windbreak, adjust plant spacing and species selection to increase above and belowground productivity for increased carbon capture and storage.

Maintain site fertility. Minimize soil disturbance during windbreak establishment, maintenance, and renovation. Manage without tillage, where possible, to reduce impacts on soil organic matter. Limit the use of petroleum-based herbicides and fertilizers.

Use the WI Windbreak Guidance Document to choose species with desirable carbon characteristics (fast growth, long-lived, and/or durable wood products).

Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, design edge-of-field windbreaks taller than the spray height. Windbreak density must be at least 50% during time of year when irrigation is applied.

Design the windbreak to not interfere with the operation of the irrigation system. Design pass-throughs for irrigation equipment wheels.

Additional Criteria for Windbreak Renovation

Renovate windbreaks by planning and implementing treatments to adjust the design, width, length, species composition, and density to achieve functionality for the intended purposes within 20 years from the time of establishment. Protect desirable vegetation as well as soil and site conditions during renovation. Control erosion, runoff, compaction, and displacement.

Thin trees and/or shrubs as needed to reduce plant competition, alter windbreak density, remove dead, injured or diseased vegetation, or provide access for maintenance. Identify woody and herbaceous invasive species that are on federal or state invasive species or noxious weed lists, and plan for removal, replacement (if required for windbreak effectiveness), and continued management of new infestations from existing seedbank.

Use NRCS Tree/Shrub Pruning (CPS 660) for branch or root pruning. Cut trees and/or shrubs that regrow from their base (i.e., coppicing) close to the ground when vigorous regrowth is desired.

Retain vegetative residues (the woody material left on the ground after removal) onsite except where fire hazard or threats from diseases and insect pests are of concern or where prescribed burning will take place to meet other management objectives. Place retained woody material so that it does not interfere with the intended purpose or other management activities. Use NRCS Woody Residue Treatment (CPS 384) to treat woody debris as necessary to assure that it does not present an unacceptable fire, safety, environmental, or pest hazard. When woody residue or other debris requires onsite burning, use NRCS Prescribed Burning (CPS 338).

Add rows of trees and/or shrubs adjacent to or within an existing windbreak to increase windbreak density as needed to achieve the purpose. Plant individual trees and/or shrubs to fill gaps or replace declining plants. Before adding trees or shrubs, evaluate existing growing space, shade level, and root competition to determine that conditions are acceptable for the growth of new plantings.

Where herbicide application will occur, evaluate and interpret risks using the Windows Pesticide Screening Tool (WIN-PST) or other approved tools or guides, or use NRCS Pest Management Conservation System (CPS 595).

CONSIDERATIONS

Considerations for Species Selection

Plan and design windbreaks to be visually pleasing while meeting the purposes for the planned area. Design plantings to complement natural landscape features. Consider including trees and shrubs that produce edible fruits and nuts, provided that windbreak function is not impacted and that edible produce will not be contaminated with chemicals or odor particulates.

Visual quality can be enhanced by using evergreen species or species with features such as showy flowers, brilliant fall foliage, or persistent colorful fruits. Avoid using potentially invasive species.

In cropping systems, select windbreak species that minimize adverse effects on crop growth (e.g., shade, allelopathy, competing root systems, or root sprouts). Avoid aggressive species that may invade neighboring cropland. Avoid using plants that may be alternate hosts to undesirable pests, e.g., cedar apple rust. Consider species diversity (ideally, genus-level diversity), including the use of native species, to avoid loss of function due to species-specific pests. Where feasible, plant native species that benefit wildlife, including pollinators and natural enemies of crop pests.

Use conifer windbreaks to reduce impacts of prevailing winter winds and reduce energy use.

Considerations for Windbreak Design

Windbreaks are not usually fully functional immediately after installation. Plan other practices as appropriate to control wind erosion in adjacent fields until a windbreak is fully functional.

Use one or more “legs” (i.e., windbreak extensions oriented at right angles to the main windbreak), where practical, to provide protection from changing winds and to increase the area of the protected zone.

Windbreaks established for odor and chemical drift reduction are more effective as the amount of foliage surface area increases. Wide, multiple-row plantings offer greater interception potential than smaller plantings.

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 practices.

Where windbreaks will be installed to protect a structure and wildland fire danger is a concern, consider using Firewise USA® recommendations for spacing and management of the windbreak.

A fast-growing willow or poplar row may offer early protection while the windbreak is becoming established. Fast-growing trees present greater maintenance challenges as they might be large and produce large amounts of woody residue when removed; monitor for timely removal from the windbreak.

Consider establishing a native grass/forb (pollinator) field border between the outer windbreak row and the crop. Reference the current WI CPS 386 Field Border and CPS 420 Wildlife Habitat Planting.

Considerations for Managing Snow

Consider additional actions for situations where a windbreak alone does not provide enough snow storage. Add windbreak rows or obtain supplementary storage with temporary or herbaceous wind barriers, constructed or living snow fences, or by retaining standing crop residues within the fetch (storage) area. Retain standing crop rows or residues to enhance the effectiveness of windbreaks in uniformly distributing snow across a field. Refer to the current WI CPS 589 Cross Wind Trap Strips.

To control end drifts, extend the length of the windbreak beyond the protected area, add supplemental windbreak legs, use greater setback distances, and/or use temporary or herbaceous wind barriers.

Secondary windbreaks made up of shorter tree species can be used to address snow control when winds come from directions different than the prevailing wind.

Considerations for Wildlife Habitat

When compatible with the purposes and criteria for application of this practice, modify windbreak design to better address identified wildlife needs. Windbreak dimensions, density, and species composition can be designed to provide food and/or shelter for desired wildlife species, and windbreaks can be located as wildlife travel corridors to connect existing patches of habitat. Consider windbreak proximity to roads and potential conflicts between wildlife and vehicles.

Address pollinator and beneficial organism needs when selecting or siting tree or shrub species and when planning windbreak management. Ground-dwelling pollinators may find habitat in an untilled area within the windbreak. Windbreaks may provide habitat for species that pollinate or consume pests in nearby crops. Early-blooming trees can provide nectar sources for pollinators and pest predators in the spring before herbaceous sources are available. Consider adding plantings of suitable, noncompetitive forbs and legumes that bloom at times when trees are not flowering; this action may favor a greater diversity of native pollinators and natural enemies of crop pests by providing additional nectar and pollen sources.

Considerations for Windbreak Renovation

Windbreak renovations may require a period of years to fully implement.

Where insect pests and plant diseases are not of concern, treat woody debris by mulching or chipping to increase soil organic matter and reduce herbaceous weed competition. Debris and other vegetation requiring removal during renovation could become biofuel for energy generation.

PLANS AND SPECIFICATIONS

Prepare specifications for windbreak establishment in accordance with this standard for each site and purpose in the implementation requirements document. At a minimum, include—

- Maps, drawings, and/or narratives identifying and describing areas planned for windbreak establishment, including location and distances to adjacent features, structures, and known utilities.
- A planting plan, including—
  - Dimensions and configuration of plantings, including the number of rows of trees and/or shrubs and their spacing (both in-row and between rows);
  - Species to use (both common and Latin name);
  - Type and size of plant material;
  - Planting or seeding rates;
  - Required survival density;
  - Site preparation, if any;
  - Season of planting;
  - Sequence of planting, if applicable;
  - Fertilizer and weed control, if needed;
  - Type of plant protection, if needed; and,
  - Moisture management during establishment, if needed.
- Contingency plans to achieve project goals in case of drought, insect/disease impacts, undesired plant invasions, animal pressure, or other occurrences that may limit vegetation establishment.
- The landowner is responsible for notifications and for obtaining all necessary permits for the project prior to installation.

Prepare specifications for this practice and record using the approved Wisconsin Implementation Requirements for CPS 380.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan and review it with the landowner or operator prior to practice installation. The O&M plan ensures the practice will function as intended throughout its expected life. The plan will include normal repetitive activities that occur during use of the practice (operation), and repair and upkeep (maintenance). At a minimum, include—

- Inspecting the planting at least annually and after major storm events or other disturbances to identify needs for repair and maintenance.
- Maintaining protection for trees and/or shrubs during establishment, and removing protective structures (e.g., tube shelters, cages) when plants are large enough to withstand environmental stressors.

- Protecting trees and shrubs from adverse impacts including insects, diseases, competing vegetation, fire damage, spray drift, animals, etc.
- Applying maintenance practices and activities at times that minimize wildlife disturbance during the reproductive period for desired species, where wildlife habitat is a consideration.
- Monitoring tree or shrub establishment or renovation and replacing dead trees or shrubs as needed until the windbreak is functional.
- Providing supplemental water if needed during the establishment period.
- Managing competing vegetation during establishment, including removal of species on federal and state invasive species or noxious weeds lists.
- Thinning or pruning the windbreak to remove dead, injured, or diseased wood and to maintain windbreak function.
- Applying nutrients periodically to maintain plant vigor following approved fertilizer recommendations.

Renovate a windbreak that has lost its functionality due to impacts of storms, disease, insects, or other natural events, or because trees have reached their life expectancy and are deteriorating.

REFERENCES

Bentrup, G. 2008. Conservation Buffers—Design Guidelines for Buffers, Corridors, and Greenways. General Technical Report SRS-109. USDA Forest Service, Southern Research Station, Asheville, NC.

Bentrup, G., J. Hopwood, N. L. Adamson, and M. Vaughan. 2019. Temperate Agroforestry Systems and Insect Pollinators: A Review. Forests 10(11): 981.

Brandle, J.R., D.L. Hintz, and J.W. Sturrock, eds. 1988. Windbreak Technology. Agriculture, Ecosystems, and Environment, Volumes 22-23. Amsterdam, The Netherlands: Elsevier Science Publishers.

Hill, D.B. 1998. Pollination and Honey Production in the Forest and Agroforest. In North American Conference on Enterprise Development Through Agroforestry: Farming the Agroforest for Specialty Products, October 4-7, 1998, Minneapolis, MN, pp. 133-138.

Iowa Environmental Mesonet. IEM Site Information-Wisconsin ASOS Wind Rose Data. https://mesonet.agron.iastate.edu/sites/locate.php?network=WI_ASOS. Accessed 9/1/2022.

Johnson, H.S. and J.R. Brandle. 2003. Shelterbelt Design, Landcare Notes LC0136. State of Victoria, Department of Sustainability and Environment, Melbourne, AU.

Kort, J. and R. Turnock. 1999. Carbon Reservoir and Biomass in Canadian Prairie Shelterbelts. Agroforestry Systems 44: 175-186.

Liang, Y., K. VanDevender, and T. Tabler. 2011. Vegetative Shelterbelts on Poultry Farms for Air Emission Management, FSA-1071. University of Arkansas, Fayetteville, AR.

National Fire Protection Agency. Firewise USA - Preparing homes for wildfire. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire. Accessed 9/1/2022.

Rebain, S.A. comp. 2010 (revised March 23, 2015). The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation, Internal Report. U.S. Department of Agriculture, Forest Service, Forest Management Service Center, Fort Collins, CO.

306 Schoeneberger, M.M. 2009. Agroforestry: Working Trees for Sequestering Carbon on Agricultural Lands.
307 Agroforestry Systems 75: 27–37.

308 University of Missouri Agroforestry Center. 2018. *Training manual for applied agroforestry practices.*
309 Gold, M., Hemmelgarn, H., Ormsby-Mori, G., and Todd, C., Eds.
310 https://centerforagroforestry.org/landowners/resources/training-manual-for-applied-agroforestry-
311 practices/. Accessed 9/1/2022.

312 Vaughan, M. and S.H. Black. 2006. Sustaining Native Bee Habitat for Crop Pollination. Agroforestry Note
313 32. USDA National Agroforestry Center, Lincoln, NE.

314 Williams, N.M. and R. Winfree. 2013. Local Habitat Characteristics but not Landscape Urbanization Drive
315 Pollinator Visitation and Native Plant Pollination in Forest Remnants. Biological Conservation 160: 10-18.

316 Wisconsin Administrative Code, Department of Natural Resources, Chapter NR 40, Invasive Species
317 Identification, Classification and Control.

318 Wisconsin Department of Transportation, Facilities Development Manual.
319 https://wisconsindot.gov/pages/doing-bus/eng-consultants/cnslt-rsrces/rdwy/fdm.aspx

320 Wisconsin Statute 66.0407, Noxious weeds.