NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

WINDBREAK/SHELTERBELT ESTABLISHMENT

(FEET)

CODE 380

DEFINITION

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSES

- Reduce soil erosion from wind.
- Protect plants from wind related damage.
- Alter the microenvironment for enhancing plant growth.
- Manage snow deposition.
- Provide shelter for structures, animals, and people.
- Enhance wildlife habitat.
- Provide noise screens.
- Provide visual screens.
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors.
- Delineate property and field boundaries.
- Improve irrigation efficiency.
- Increase carbon storage in biomass and soils.
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

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

CRITERIA

General Criteria Applicable to All Purposes

The location, layout and density of the planting will accomplish the purpose and function intended within a 20-year period.

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

The distance that protection extends from the windbreak's leeward side is proportional to its height. The most effective zone of protection extends to a distance 2 to 5 times (2H - 5H) its height, while significant protection extends to 10H.

Species must be adapted to the soils, climate and site conditions. Select windbreak species that minimize adverse affects to crop growth (e.g. shade, allelopathy, competing root systems or root sprouts).

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

Site preparation shall be sufficient for establishment and growth of selected species, not contribute to erosion, and be appropriate for the site. See TREE/SHRUB PREPARATION (490).

Only viable, high quality, and adapted planting stock or seed will be used.

Multiple species, within rows, may be used if heights and growth forms are similar.

Protect plantings from livestock grazing, wildlife damage, and fire.

The planting shall be done at a time and manner to insure survival and growth of selected species. Refer to TREE/SHRUB ESTABLISHMENT (612) for planting guidelines.

This is a draft standard for review and comment purposes only. To obtain the current version of this standard, contact the Natural Resources Conservation Service or download the standard from the electronic Field Office Technical Guide for Missouri. (Italic text indicates state additions to the national standard and blue text indicates a change from current standard)

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 stem, branches and
canopy as required for a specific purpose.

Avoid planting trees or shrubs where they will interfere with structures and above or below ground utilities.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species.

When placing an opening through a windbreak, make openings on an angle to reduce the loss of wind protection. Whenever possible locate access roads at the ends of windbreaks beyond where snowdrifts form.

Where functional subsurface drains pass through windbreak plantings, sealed conduit will be installed through the planting and extend 75 feet beyond the perimeter rows.

Allow, at a minimum, an 8-foot maintenance strip from the outside row of windbreak planting to adjacent property lines or contrasting land use areas.

Additional Criteria for Reducing Wind Erosion and Protect Growing Plants

The windbreak will be oriented as close to perpendicular to the troublesome wind as possible.

The interval between windbreaks shall be determined using current, approved, wind erosion technology. Interval widths shall not exceed that permitted by the soil loss tolerance (T), or other planned soil loss objective. Calculations shall account for the effects of other practices in the conservation management system.

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

Sites, fields, and plants shall be 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.

Base spacing on the level of plant protection desired. Some crops and their annual/acre tolerance to windblown soil are listed below.

- Tolerant (3 tons): barley, oats, rye, wheat
- Moderate tolerance (2 tons): corn, grain sorghum, sunflowers
- Low tolerance (1 ton): apples, cherries, peaches
- Very low tolerance (< 1 ton): alfalfa, cotton, vegetables, potatoes

Select species that are taller than the crops being protected.

Additional Criteria for Managing Snow Deposition

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

For snow distribution across a field, the windbreak 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 50 percent.

The length of the windbreak will extend beyond the area being protected to allow for end drifts.

The windward row will be at least 100 feet (75 feet, south of the Missouri River) from the area to be protected.

Windbreaks will be located so that snow deposition will not pose a health or safety problem or obstruct human, livestock, or vehicular traffic.

Where water erosion and/or runoff from melting snow is a hazard, it shall be controlled by supporting practices.

If snow damage in a windbreak is a potential problem, use the widest row spacing, locate a shrub row windward 40-75 feet from primary windbreak, and/or locate a shrub row on leeward side.

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Additional Criteria for Providing Shelter for Structures, Livestock, and People

The planting will be oriented as close to perpendicular to the troublesome wind as possible.

For wind protection, the minimum barrier density will be 65 percent during the months of most troublesome wind.

The area to be protected will fall within a leeward distance of 10H.

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

Drainage of livestock waste from the livestock area shall not flow into the windbreak.

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 shall not be less than 65 feet wide. The edge of the planting should be 80-150 feet from the center of the nearest traffic lane. The tallest tree row should be capable of attaining a mature height of at least 45 feet.

For moderate speed traffic noise, the barrier width shall not be less than 20 feet wide. The edge of the planting should be 50-80 feet from the center of the nearest traffic lane. The tallest tree row should be capable of attaining a mature height of at least 30 feet.

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

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 during desired periods.

Use plants that will add color, texture, and diversity to the site.

Additional Criteria for Enhancing Wildlife Habitat

Plant species selection shall benefit targeted wildlife species.

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

Add rows to increase wildlife benefits. A minimum of one evergreen and one shrub row shall be included among the additional windbreak rows. Shrub rows should be located on outside rows.

Use plants of different sizes, growth forms, food-bearing capabilities and densities to increase plant diversity.

The windbreak layout shall include a partial east-west orientation, if possible.

During the winter months, direct sunlight is available on southern rows throughout the day. The opportunity to "sun" in a protected southern exposure decreases food needs for wildlife.

Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, the windbreak shall be no taller than the sprinkler heads.

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

Additional Criteria for Increasing Carbon Storage in Biomass and Soils

Select plants that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Use fast growing species in a mix with long-lived species.

Maintain optimal water and nutrient needs for the planting.

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

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

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Additional Criteria for Improving Air Quality by Reducing and Intercepting Air Borne Particulate Matter, Chemicals and Odors

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, (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 60%.

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

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

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

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.

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

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.

CONSIDERATIONS

Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides used in the area. Avoid carry-over problems.

Plantings should complement natural features.

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.

Plants established in cropping systems should have root systems that do not adversely affect crop growth and/or spread from root sprouts.

Where early wind and snow protection is desired, use close spacing guidelines within the rows.

Vegetation diversity will reduce insect or disease problems, enhance wildlife values, and improve aesthetic resources.

Where odor control is the primary purpose, design layout should consider future expansion facility needs and the placement of natural or artificial barriers near exhaust fans on tunnel-ventilated livestock buildings.

Consider enhancing aesthetics by using evergreen species or species with features such as showy flowers, brilliant fall foliage, or persistent colorful fruits with curvilinear designs and small group plantings adjacent to interior rows to increase visual sight diversity.

Wildlife and pollinator needs should be considered when selecting tree or shrub species. Species diversity, including use of native species, should be considered to avoid loss of function due to species-specific pests. Optimum wildlife usage occurs with 10 or more rows.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout

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its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

Replacement of dead trees or shrubs will be continued until the barrier is functional (90% of the plants surviving with no two adjacent plants missing).

Supplemental water will be provided as needed.

Pruning should be done only for the purposes of removing dead, injured, or diseased wood and for creating desired levels of barrier porosity.

Inspect trees and shrubs every 6 months and protect from adverse impacts including insects, diseases or competing vegetation.

The trees or shrubs will be protected from fire and damage from livestock and wildlife.

Control competing vegetation for the life of the planting or until plants close the area and shade out competition.

Protect plantings from fire. Maintain necessary firebreaks around all plantings.

PRACITCE SPECIFICATIONS

Plant and Row Spacing

Stagger tree spacing so the trees in one row will be planted opposite the opening in the other row.

Example:

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   X     X     X     X
 X     X     X     X     X
   X     X     X     X
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For specific plant and row spacing distances see TREE/SHRUB ESTABLISHMENT (612).

Row spacing should be at least 2 feet wider than any equipment planned for between-row maintenance.

Twin Row High Density. (A windbreak design with each row planted as a closely spaced double row of plants.)

- Each twin row will contain the same species.
- The windbreak will contain a minimum of two twin rows (4 rows total).
- The spacing between twin rows will be 50 to 100 feet to accommodate planned use needs.
- For plant spacing within twin rows, use the closest row spacings listed in TREE/SHRUB ESTABLISHMENT (612).

"Living" Snow Fence:

- Snow barriers should extend 100 feet beyond the ends of roadway areas to be protected.
- Use only shrubs and/or evergreens.
- Windward rows will be a maximum of 250 feet from the centerline of the transportation route.
- Windward rows shall not be closer than 100 feet from the centerline of the transportation route.

Density

Control windbreak densities through the type of plants, pruning activities, within row spacing, and/or the number of rows used.

For specific windbreak row minimums and plant types, use the following chart:

Windbreak Type	Number of Rows
farmstead/shelterbelt	3a
feedlot	3a
odor	3ah
screens	
high traffic	6c
med-low traffic	3b
visual	2ad
wildlife	5ah
field2e	
living snow fences	
unsheltered distance <1000 feet	1f
unsheltered distance >1000 feet	2g

a = 1 row must be evergreen
b = 2 row must be evergreen
c = 3 rows must be evergreen
d = 3 rows if all deciduous species are used
e = 2 rows of deciduous tree/shrub or evergreen
f = 1 row of either shrub or evergreen
g = 2 rows - minimum one row of evergreen
h = 1 row must be shrubs

Additional rows may be used to enhance wildlife values, meet landowner objectives, increase diversity, improve natural beauty, or increase barrier density.

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Adapted Species

For adapted species and cultivars, refer to the Missouri Field Office Technical Guide. A partial list of the more commonly used trees and shrubs for windbreaks in Missouri is in Table 1.

REFERENCES

How windbreaks Work; University of Nebraska Extension; EC 91-1763-B. 1991

Manual of Woody Landscape Plants; Stipes Publishing Company; 1983.

Planning Tree Windbreaks in Missouri; UMC Agricultural Guide No. 5900; 1997.

Plants/People/And Environmental Quality; U.S. Dept of Interior; 1972.

Windbreak Technology; Elsevier Science Publishers B.V.; 1988.

Windbreak Establishment; University of Nebraska Extension; EC 91-1772-B. 1991

Windbreaks for Snow Management; University of Nebraska Extension; EC 96-1770-X. 1996

Windbreak and Wildlife; University of Nebraska Extension; EC 91-1771-B. 1991

Air Quality and Shelterbelts: Odor Mitigation and Livestock production, A Literature review. USDA National Agroforestry Center Research Project. Spring 2000.

Designs for Windbreak Walls for Mitigating Dust and Odor Emissions from Tunnel Ventilated Swine Buildings. North Carolina State University. 2000.

The Benefits of Planting Trees Around Poultry Farms. Bulletin 159. University of Delaware. December 2001.

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Table 1. Partial List of Trees and Shrubs Capable of Growing on Many Soil Types throughout Missouri. [(a)]

SPECIES	ESTIMATED HEIGHT AT 20 YEARS (feet)	MATURE GROWTH SHAPE
American plum	8-15	spreading
American sycamore	26-35	spreading, open
Arborvitae	16-25	columnar/pyramidal
Bald cypress	26-35	pyramidal
Black locust	16-25	narrow, oblong
Common hackberry	16-25	broad, arching
Cornelian cherry dogwood *	12-20	rounded
Cutleaf staghorn sumac	<8	spreading, open
Eastern cottonwood	>35	broad, vase-shaped
Eastern redcedar	16-25	columnar/pyramidal
Eastern white pine *	26-35	pyramidal
Gray dogwood	8-15	spreading
Green hawthorn	16-26	spreading, rounded
Horsechestnut *	16-26	rounded
Kentucky coffetree	26-35	rounded
Lace-bark elm *	26-35	rounded
Norway spruce *	26-35	pyramidal
Pin oak	26-35	pyramidal
Red Maple	26-35	oval/rounded
Red pine *	26-35	spreading/cylindrical
Rough-leaved dogwood	8-15	spreading
Silky dogwood	<8	spreading
Silver maple	>35	oval/rounded
Swamp white oak	26-35	rounded
Sweetgum	26-35	pyramidal
Thornless honeylocust	26-35	oval/rounded
White fir *	26-35	pyramidal
Yellow poplar	>35	oval-rounded

(a) Refer to Section II eFOTG for specific compatibility.
(*) Not native to Missouri

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