Appendix XI

WisDOT Standard Specifications;

NRCS Critical Area Planting Code 342;

Wisconsin Agronomy Technical Note 5

Section 627 Mulching

627.1 Description

(1) This section describes furnishing, placing, and anchoring a mulch cover, usually in connection with seeding the surfaces of the roadway.

627.2 Materials

(1) Mulching material consists of straw or hay in an air-dry condition, wood excelsior fiber, wood chips, or other suitable material of a similar nature that the engineer approves, and is substantially free of noxious weed seeds and objectionable foreign matter.

(2) If using tackifier, the department will prequalify it before use. Select tackifiers from the department's erosion control product acceptability list (PAL). The contractor may obtain a copy of the PAL and the prequalification procedure for products not on the PAL from the department.

627.3 Construction

627.3.1 General

(1) Unless directed otherwise, place the mulch on the specified area within 2 days after completing the seeding.

(2) The contractor shall not perform mulching during periods of excessively high winds that might preclude proper mulch placement.

(3) Place the mulch loosely or open enough to allow some sunlight to penetrate and air to slowly circulate, but thick enough to shade the ground, conserve soil moisture, and prevent or reduce erosion.

(4) Maintain the mulched areas and repair all areas damaged by wind, erosion, traffic, fire or other causes.

627.3.2 Placing

(1) The contractor may perform the work as specified in one of the following ways: Method A, Method B, or Method C, or a combination of the 3, unless a specific method is specified in the contract.

627.3.2.1 Method A, Netting

(1) Uniformly spread the mulching material over the designated areas to a loose depth of 1/2 to 1 1/2 inches. Use a specific rate of application; dependent on the character of the material, that results in a cover conforming to the requirements specified above in 627.3.1. Loosen or make fluffy the mulch material from compacted bales before spreading in place. Unless directed otherwise, begin mulching at the top of the slopes and proceed downward.

(2) Securely anchor straw or hay mulch by using engineer-approved netting anchored to the ground with pegs or staples to prevent it from floating as the vegetation grows. Instead of this anchorage, the contractor may secure mulch by heavy biodegradable twine fastened by pegs or staples to form a grid with 6 to 10 feet spacing.

(3) The contractor may use department-approved erosion control mats, listed in the PAL, instead of separately applying mulch and netting.

627.3.2.2 Method B, Tackifier

(1) Treat straw or hay with a tackifier, blow from a machine, and uniformly deposit over designated areas in one operation. Place straw or hay uniformly over the area 1/2 to 1 inch deep, using 1/2 to 3 tons of mulch per acre. Mix and place tackifier according to the PAL. Within the above limits, the engineer will determine, on the job, the application rate of the mulch and the tackifier, and the engineer may vary the rates during mulching to produce the desired results. Use an engineer-approved machine to place the mulch that blows or ejects by constant air stream a controlled amount of mulch and applies a spray of tackifier to partially coat the straw or hay, sufficient to hold together and keep in place the deposited straw or hay. The contractor may apply the tackifier as an overspray in a separate operation after placing the straw or hay.

(2) Apply wood fiber, wood chips, or similar material with engineer-approved blowing machines, or other engineer-approved methods, that place a controlled amount of mulch uniformly over the area 1/2 to 1 1/2 inches deep. Treat areas receiving wood chip mulch, with one pound of available nitrogen per 1000 square feet before or after applying the chips.

(3) Throughout the process, feed the mulch material into the blowing machine to produce a constant and uniform ejection from the discharge spout, and operate in a position to produce mulch of uniform depth and coverage.

627.3.2.3 Method C, Crimping

(1) Spread the straw or hay mulch uniformly over the designated areas to a loose depth of 1/2 to 1 1/2 inches, using 1/2 to 3 tons of mulch per acre, by blowing from a machine, as specified in Method B, or by other engineer-approved methods.

(2) Immediately after spreading, anchor the mulch in the soil by using a mulch crimper consisting of a series of dull, flat discs with notched edges. Space the 20 inch diameter discs at about 8 inch centers. Equip the crimper with a ballast compartment to allow adjusting the weight for depth control.

(3) Impress the mulch into the soil 1 1/2 to 2 1/2 inches deep in one pass of the crimper. The department will not allow mulch crimpers to operate on slopes so steep that damage to the mulch, seedbed, or soil occurs. Anchor the mulch on these areas by one of the following methods: Method A or Method B. Equip and operate tractors to minimize disturbing or displacing the soil. This process may require more than one pass of the crimper to ensure adequate anchoring of the mulch.

(4) The contractor shall not use Method C if it cannot impress the mulch to a minimum of 1 1/2 inch.

627.4 Measurement

(1) The department will measure Mulching acceptably completed by the square yard or by the ton, whichever the contract specifies.

(2) If measured by the square yard, the measured quantity equals the number of square yards of surface area that the contractor applied the mulch.

(3) If measured by the ton, the measured quantity equals the number of tons of mulch provided, placed, and acceptably completed.

(4) Tackifiers or nitrogen used for treating mulch are incidental to the cost of the work.

627.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
627.0200	Mulching	SY
627.0205	Mulching	TON

(2) Payment for Mulching is full compensation for providing all materials, including tackifiers or nitrogen; for all hauling, treating, placing, spreading, and anchoring of the mulch material; and for maintaining the work and repairing all damaged areas.

(3) If the contractor opts to use department-approved erosion control mats instead of separately applying mulch and netting, the department will pay for it at the contract unit price for Mulching only.

Section 630 Seeding

630.1 Description

(1) This section describes preparing seed beds and furnishing and sowing the required seed on slopes, appurtenances, and other areas, and on borrow pits and material disposal sites.

(2) This section also describes furnishing and sowing temporary seed mixture on the slopes and appurtenances of temporary embankments and roadways.

630.2 Materials

630.2.1 Seed

630.2.1.1 General Requirements

(1) Conform to the Wisconsin statutes and Wisconsin administrative code chapter ATCP 20 regarding noxious weed seed content and labeling.

http://docs.legis.wi.gov/statutes/statutes/

http://docs.legis.wi.gov/code/admin_code/atcp/020/20.pdf

(2) Use seed within one year of the test date appearing on the label.

(3) Seed mixtures 70, 70A, 75, and 80 contain wild type forbs and grasses. Wild type is defined as seed that is derived directly from native, wild stock, including seed that was wild collected and placed into production or has been harvested directly from native stands.

630.2.1.2 Purity and Germination

(1) Test seed according to the methods and procedures used for sampling and analyzing seed for purity, germination, and noxious weed seed content specified in the current edition of Rules for Testing Seed, published by the Association of Official Seed Analysts.

630.2.1.3 Inoculation

(1) Inoculate legume seed (white clover, red clover, ladino clover, alsike clover, alfalfa, partridge pea, purple prairie clover, Canada tick-trefoil, and lupine) unless it has been pre-inoculated by the vendor. Follow the inoculation instructions that come with the culture purchases. If applying the seed according to method B, 630.3.3.2, treat seeds requiring inoculation with 5 times the amount of inoculant recommended in the instructions.

(2) Avoid exposure of the culture or inoculated seed to the sunlight, and in no case shall any exposure exceed 1/2 hour.

630.2.1.4 Storing Seed

(1) Store any seed delivered before use in a way that protects it from damage by heat, moisture, rodents, or other causes. Discard and replace any previously tested and accepted seed that becomes damaged.

630.2.1.5 Seed Mixtures

630.2.1.5.1 Right of Way

630.2.1.5.1.1 Permanent

####### 630.2.1.5.1.1.1 Composition

(1) Seed mixtures for use on the right of way and easements shall, unless specified otherwise, be composed of seeds of the purity, germination, and proportions, by weight, as given in the Table of Highway Seed Mixtures and the Table of Native Seed Mixtures.

(2) Use seed of the species and varieties listed below. If no variety is listed, there will be no restriction on the variety furnished, except as follows:

1. Species composed of pure live seed (PLS) shall contain no named or improved varieties. PLS shall be grown in Wisconsin or northern Illinois, northeastern Iowa, or eastern Minnesota. Seed produced out-of-state must be grown in one of the following counties:

1.1 From northern Illinois:

Boone	Bureau	Carroll	Cook	De Kalb	Du Page	Grundy
Henry	Jo Daviess	Kane	Kendall	Lake	La Salle	Lee
McHenry	Ogle	Putnam	Rock Island	Stevenson	Whiteside	Will
Winnebago						

1.2 From northeastern Iowa:

Allamakee	Benton	Black Hawk	Bremer	Buchanan	Cedar	Chickasaw
Clayton	Clinton	Delaware	Dubuque	Fayette	Floyd	Howard
Jackson	Johnson	Jones	Linn	Mitchell	Muscatine	Scott
Winneshiek						

1.3 From eastern Minnesota:

Aitkin	Anoka	Carlton	Carver	Chisago	Dakota	Dodge
Fillmore	Goodhue	Hennepin	Houston	Isanti	Kanabec	La Sueur
Mille Lacs	Mower	Olmsted	Pine	Ramsey	Rice	Scott
Sherburne	Steele	Wabasha	Washington	Winona	Wright	

2. PLS for seed mixtures 70, 70A, 75, and 80 shall be packaged separately by species and clearly labeled with the vendor's name, species common and botanical names, gross weight, percent PLS, year of harvest and any specialized treatments that have been applied to ensure or enhance germination. If PLS is not listed, determine PLS by multiplying the percent germination times the percent purity.

3. Minimum percent purity for native for species is 90 percent. If a listed species is not available, substitutions may be made with engineer's approval and must be documented.

(3) Mix native species at the project site. Clean and debeard seeds having awns or excessive hairs before mixing.

SPECIES COMMON NAME	SPECIES BOTANICAL NAME	ACCEPTABLE VARIETIES
Kentucky Bluegrass	Poa pratensis	Low Maintenance
Red Fescue	Festuca rubra	Creeping
Hard Fescue	Festuca ovina var. duriuscula	Improved
Tall Fescue	Festuca arundinacea	Improved turf type
Salt Grass	Puccinella distans	Fult's
	Puccinella distans	Salty
Redtop	Agrostis alba	
Timothy	Phleum pratense	
Canada Wild Rye[1]	Elymus canadensis	
Perennial Ryegrass	Lolium perenne	
Perennial Ryegrass	Lolium perenne	Improved Fine
Annual Ryegrass	Lolium multiflorum	
Alsike Clover	Trifolium hybridum	
Red Clover	Trifolium pratense	
White Clover	Trifolium repens	
Japanese Millet	Echinochola crusgalli var. frumentacea	
Annual Oats	Avena sativa	
Alfalfa	Medicago sativa	
Bromegrass	Bromus inermis	
Orchardgrass	Dactylis glomerata	
Ladino Clover	Trifolium repens var. latum	Ladino
Agricultural Rye	Secale cereale	
Winter Wheat	Triticum aestivum	

[1] Pure live seed

TABLE 630-1 HIGHWAY SEED MIXTURES

SPECIES	PURITY minimum %	GERMINATION minimum %	MIXTURE PROPORTIONS in percent				
			NO.10	NO.20	NO.30	NO.40	NO.60
Kentucky Bluegrass	98	85	40	6	10	35	
Red Fescue	97	85	25		30	20	
Hard Fescue	97	85		24	25	20	
Tall Fescue	98	85		40			
Salt Grass	98	85			15		
Redtop	92	85	5				
Timothy	98	90					12
Canada Wild Rye		PLS[1]					10
Perennial Ryegrass	97	90	20	30			
Improved Fine Perennial Ryegrass	96	85			20	25	
Annual Ryegrass	97	90					30
Alsike Clover	97	90					4
Red Clover	98	90					4
White Clover	95	90	10				
Japanese Millet	97	85					20
Annual Oats	98	90[1]					20

[1] Substitute winter wheat for annual oats in fall plantings started after September 1.

TABLE 630-2 NATIVE SEED MIXTURES

	SPECIES	SPECIES BOTANICAL NAME	PURITY & GERMINATION minimum %	MIXTURE PROPORTIONS in percent			
				NO. 70	NO. 70A	NO. 75	NO. 80
FORBES	Canada Anemone	*Anemone canadensis*	PLS	2			
	Butterflyweed	*Asclepias tuberosa*	PLS		2		
	New England Aster	*Aster novae-angliae*	PLS	2	2		
	Partridge-pea	*Chamaecrista (Cassia) fasciculata*	PLS		2		
	Purple Prairie Clover	*Dalea (Petalostemum) purpurea*	PLS	2	2	4	
	Canada Tick-trefoil	*Desmodium canadense*	PLS	2			
	Flowering Spurge	*Euphorbia corollata*	PLS		2		
	Wild Geranium	*Geranium maculatum*	PLS	2			
	Western Sunflower	*Helianthus occidentalis*	PLS	3	2		
	Rough Blazingstar	*Liatris aspera*	PLS		2		
	Prairie Blazingstar	*Liatris pycnostachya*	PLS	2			
	Lupine	*Lupinus perennis*	PLS		3		
	Wild Bergamot	*Monarda fistulosa*	PLS	2			
	Horse Mint	*Monarda punctata*	PLS		2		
	Yellow Coneflower	*Ratibida pinnata*	PLS	2	2		
	Blackeyed Susan	*Rudbeckia hirta*	PLS			1	
	Showy Goldenrod	*Solidago speciosa*	PLS	2	2		
	Spiderwort	*Tradescantia ohiensis*	PLS	2	2		
	Golden Alexanders	*Zizia aurea*	PLS	2			
GRASSES	Big Bluestem	*Andropogon gerardi*	PLS	15	15	10	
	Sideoats Grama	*Bouteloua curtipendula*	PLS	15	20	20	25
	Canada Wildrye	*Elymus Canadensis*	PLS	15	15	35	23
	Slender Wheatgrass	*Elymus trachycaulus*	PLS				20
	Junegrass	*Koeleria macrantha*	PLS		5		
	Annual Ryegrass	*Lolium multiflorum*	[1]			10	10
	Switchgrass	*Panicum virgatum*	PLS				10
	Salt Grass	*Puccinella distans*	[1]				2
	Little Bluestem	*Schizachyrium (Andropogon) scoparium*	PLS	15	20	10	10
	Indiangrass	*Sorgastrum nutans*	PLS	15		10	
ALTERNATE FORBES	Sky Blue Aster	*Aster azureus*	PLS	[2]	[2]		
	White Wild Indigo	*Baptisia leucantha*	PLS	[2]	[2]		
	Pale Purple Coneflower	*Echinacea pallida*	PLS	[2]	[2]		
	White Prairie Clover	*Petalostemum candidum*	PLS	[2]	[2]		
	Stiff Goldenrod	*Solidago rigida*	PLS	[2]	[2]		
	Hoary Vervain	*Verbena stricta*	PLS	[2]	[2]		

[1] Provide the minimum purity and germination specified in 630.2.1.5.1.1.1(3) in the table of highway seed mixtures.

[2] The contractor may, if the engineer approves, substitute an alternate forb for a required forb that is not available using the same percentage as specified for the required forb. Use a different alternate forb for each unavailable required forb. Provide documentation showing that a required forb is not available before using an alternate.

630.2.1.5.1.1.2 Mixture

(1) The contractor shall select a seed mixture or mixtures that meet with the engineer's approval, and unless specified otherwise in the contract, shall conform to the following:

1. Use seed mixture No. 10 where average loam, heavy clay, or moist soils predominate.
2. Use seed mixture No. 20 where light, dry, well-drained, sandy, or gravelly soils predominate and for all high cut and fill slopes generally exceeding 6 to 8 feet, except where using No. 70.
3. Use seed mixture No. 10 or No. 20 on all ditches, inslopes, median areas, and low fills, except where using No. 30 or No. 70.
4. Use seed mixture No. 30 for medians and on slopes or ditches generally within 15 feet of the shoulder where a salt-tolerant turf is preferred.
5. Use seed mixture No. 40 in urban or other areas where a lawn type turf is preferred.
6. Use seed mixture No. 60 only on areas, the contract designates or the engineer specifies. Use it as a cover seeding for newly graded wet areas or as a nurse crop for specified wetland seed mixtures. The contractor shall not apply it to flooded areas.
7. Use seed mixture Nos. 70 and 70A on slopes and upland areas the contract designates or the engineer specifies. Use seed mixture No. 70 on loamy soils and seed mixture No. 70A on sandy soils.
8. Use seed mixture No. 75 where native grasses are desired for erosion control.
9. Use seed mixture No. 80 on inslopes where a salt tolerant seed mix containing native grasses is desired.

630.2.1.5.1.2 Temporary

(1) Under the Seeding Temporary bid item, use a temporary seed mixture conforming to 630.2.1.5.1.4. Use oats in spring and summer plantings. Use winter wheat or rye for fall plantings started after September 1.

630.2.1.5.1.3 Nurse Crop

(1) If seeding bare soil with either mixture 70, 70A, 75, or 80, include the Seeding Nurse Crop bid item.

630.2.1.5.1.4 Borrow Pits and Material Disposal Sites

(1) For seeding borrow pits and material disposal sites beyond the right of way, use seed mixtures conforming to seed mixture 10, 20, 70, 70A, or 75 of 630.2.1.5.1.1 or a borrow pit mixture composed of seeds of the species, purity, germination and proportions, by weight as given below:

PERMANENT

SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Alfalfa	98	90
Bromegrass	85	85
Orchardgrass	80	85
Timothy	98	90
Red Clover	98	90
Alsike Clover	97	90
Ladino Clover	95	90
Kentucky Bluegrass	98	85

TEMPORARY

SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Annual Oats	98	90
Agricultural Rye	97	85
Winter Wheat	95	90

NURSE CROP

SPECIES	% MINIMUM PURITY	% MINIMUM GERMINATION
Annual Oats	98	90
Annual Ryegrass	97	90
Winter Wheat	95	90

(2) For the borrow pit mixture use, by weight, 60 percent temporary species seeds and 40 percent permanent species seeds.

(3) For the temporary component, use any combination of temporary seeds listed in the table above.

(4) For the permanent component, use seeds from not more than 4 of the permanent species listed in the table above in any combination.

(5) When nurse crop is required for spring seeding before June 15, use annual oats. For fall seeding after October 15, use winter wheat, or annual ryegrass.

630.3 Construction

630.3.1 General

(1) If not protecting with a mulch cover, perform seeding, except Nos. 60, 70 and 70A mixtures at times of the year when temperature and moisture conditions are suitable for seeding, except during midsummer.

(2) Perform seeding, except Nos. 60, 70 and 70A mixtures, in conjunction with mulching as specified in 627 at any time the engineer allows.

(3) The contractor may perform seeding of Nos. 60, 70 and 70A mixtures at any time soil conditions are suitable, except between June15 and October 15, unless the engineer allows otherwise.

(4) Perform seeding with the selected seed mixture, sown at the specified rate.

630.3.2 Preparation of Seed Bed

(1) Complete grading, shouldering, topsoiling, and fertilizing, if part of the work under contract, before permanent seeding, except the contractor may place the fertilizer and seed mixture in one operation if using equipment designed for the purpose.

(2) Just before seeding, work the area being seeded with discs, harrows, or other appropriate equipment to obtain a reasonably even and loose seedbed. Place topsoil as specified in 625.3.3.

630.3.3 Sowing

(1) Select the method of sowing from either method A, method B, method C, or an appropriate combination of methods A, B, and C. Obtain the engineer's approval for the sowing method and specific procedures used for each seed mixture used before sowing that mixture.

630.3.3.1 Method A

(1) Sow the selected seed mixture using equipment adapted to the purpose, or by scattering it uniformly over the areas to be seeded. Lightly rake or drag to cover the seed with approximately 1/4 inch of soil. After seeding, lightly roll or compact the areas using suitable equipment, preferably the cultipacker type, when the engineer judges the seedbed too loose, or if the seedbed contains clods that might reduce seed germination. The contractor shall not roll slopes steeper than 1:3.

(2) If scattering seed by hand, perform this work with satisfactory hand seeders and only when the air is calm enough to prevent seeds from blowing away.

630.3.3.2 Method B

(1) Sow or spread the seed upon the prepared bed using a stream or spray of water under pressure and operated from an engineer-approved machine designed for that purpose. Place the selected seed mixture and water into a tank, provided within the machine, in sufficient quantities that when spraying the seed on a given area it is uniformly spread at the required application rate. During this process, keep the tank contents stirred or agitated to provide uniform distribution. Spread the tank contents within one hour after adding the seed to the tank. The engineer will reject seed that remains mixed with the water for longer than one hour. The engineer will not require dragging or rolling.

630.3.3.3 Method C

(1) For spring seeding of seed mixtures 70 and 70A into existing ground cover, mow existing vegetation to 4 inches or less in height 2 to 4 weeks before seeding. Ten to 14 days after mowing, spray with vegetation control herbicide conforming to 632.2.12.

(2) For fall seeding of seed mixtures 70 and 70A into existing ground cover, mow existing vegetation to 4 inches or less in height 4 to 6 weeks before seeding. Ten to 14 days after mowing, spray with vegetation control herbicide conforming to 632.2.12. Retreat with vegetation control herbicide 10 to 14 days after initial application if live vegetation persists.

(3) Seed with a rangeland type drill with one or more seed boxes that can be calibrated independently to deliver different sized seeds uniformly at the required rate and equipped with a rear-mounted press wheel for each seed drop tube. If seeding into existing vegetation or thatch, use a rangeland type drill equipped with a no-till attachment that can cut through the vegetation or thatch in front of the V disc and seed drop tube. If the configuration of the area to be seeded allows, apply seed at 1/2 the specified seed rate and apply the second 1/2 in a perpendicular direction.

630.3.3.4 Borrow Pits and Material Disposal Sites

(1) Seed borrow pits, and material disposal sites off the right of way, with the selected seed mixture specified in 630.2.1.5.1.4. Consult with the landowner or the landowner's agent when selecting the seed mixture.

630.3.3.5 Seeding Rates

630.3.3.5.1 Right of Way

(1) Use the following sowing rate for seeds in pounds per 1000 square feet:

- Seed mixture No. 10 at 1.5 pounds
- Seed mixture No. 20 at 3 pounds
- Seed mixture No. 30 at 2 pounds
- Seed mixture No. 40 at 2 pounds
- Seed mixture No. 60 at an equivalent seeding rate of 1.5 pounds[1]
- Seed mixture No. 70 or 70A at 0.4 pounds
- Seed mixture No. 75 at an equivalent seeding rate of 0.7 pounds[1]
- Seed mixture No. 80 at an equivalent seeding rate of 0.8 pounds[1]
- Temporary seeding at 3 pounds
- Nurse crop seeding at 0.8 pounds

[1] Determine the actual seeding rate by multiplying the equivalent seeding rate by the sum of the unadjusted and adjusted percentages of the various species in the seed mixtures as sown.

(2) The unadjusted percentage equals the minimum percent of purity and germination specified in the table of seed mixtures contained in 630.2.1.5.1.1.1 for the applicable species.

(3) Obtain the adjusted percentage for each of the PLS species by dividing the specified percentage of the species by the product of the percent of purity and the percent of germination for each of the PLS species as delivered.

630.3.3.5.2 Borrow Pits and Material Disposal Areas

(1) For seeding borrow pits and material disposal off the right of way, sow the seed mixtures specified in 630.2.1.5.1.4 at the following rates per pound per 1000 square feet:

- Seed mixture No. 10 at 0.75 pound
- Seed mixture No. 20 at 1 pound
- Seed mixture No. 70 or 70A at 0.4 pounds
- Seed mixture No 75 at 0.7 pounds
- Borrow pit mixture at 1.5 pounds

630.3.3.6 Establishment Period for Native Seeding

(1) During the growing season after planting seed mixture 70 or 70A, mow all seeded areas twice as the engineer directs. Mow vegetation back to 6 inches when it has reached a height of at least 12 inches.

(2) During the growing season after planting seed mixture 70 or 70A, eradicate the following species from the seeded areas as soon as they become evident:

SPECIES COMMON NAME	SPECIES BOTANICAL NAME
Musk thistle	Carduus nutans
Spotted knapweed	Centaurea maculosa
Canada thistle	Cirsium arvense
Bull thistle	Cirsium vulgare
Field bindweed	Convolvulus arvensis
Leafy spurge	Euphorbia esula
Sweetclover	Melilotus species
Wild parsnip	Pastinaca sativa

(3) Eradicate by hand pulling or by applying a vegetation control herbicide conforming to 632.2.12 to individual plants.

630.4 Measurement

(1) The department will measure the Seeding bid items by the pound acceptably completed.

(2) The department will measure quantities based on net weights of seed shipments, or on quantities weighed on department-approved scales the contractor furnishes.

(3) The department will make deductions for all quantities wasted or not actually incorporated in the work according to the contract.

(4) The department will determine the equivalent pounds of seed furnished and applied by dividing the actual pounds of seed applied by the sum of the unadjusted and adjusted percentages of the various species in the seed mixture sown.

(5) The department will use the unadjusted and adjusted percentages determined in 630.3.3.5.1.

630.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
630.0100 - 0199	Seeding (mixture)	LB
630.0200	Seeding Temporary	LB
630.0300	Seeding Borrow Pit	LB
630.0400	Seeding Nurse Crop	LB

(2) Payment for the Seeding bid items is full compensation for providing, handling, and storing all seed; for providing the required culture and inoculating seed as specified; and for preparing the seed bed, sowing, covering and firming the seed. If the landowner does not want the pit or material disposal site seeded, or seeded with any of the mixtures allowed, the department will not pay for fertilization or seeding of those areas.

6-40.1 Topsoil

Topsoils are those humus-bearing soils that can sustain plant life. Upon completion of the finish grading, they are spread over the graded earth surfaces where seeds are to be sown or sod is to be placed, to provide a growing medium for the development of turf.

To motivate contractors to spread topsoil as early as possible, the engineer may at times want to consider allowing a contractor to spread topsoil on the sideslopes before placement of "bluetop" grade stakes. This consideration assumes the rough grading is performed to reasonably close conformity with the slope stakes and reasonable care is taken to maintain an aesthetically pleasing, shoulder-to-topsoil transition at the bluetop location. Minor variations in the bluetop elevation or location will not materially affect either the function or appearance of the project for this purpose. This will permit the contractor to perform topsoiling operations to better fit the contractor's schedules and should expedite the other associated landscaping operations.

The topsoil is placed and uniformly spread over the areas to a uniform depth of 3 inches, unless otherwise specified. During spreading and shaping of the placed topsoil, all clods and lumps are to be broken down so the placed topsoil is of a fine, uniform texture. Where topsoil is placed on steep slopes, to preclude the formation of planes of slippage the surface of the underlying soil should be roughened to permit bonding with the topsoil. If slippage planes develop, sloughing of the placed topsoil may occur at any time during wet periods before sufficient root growth has developed to retain the mass in place. Also, where there is a significant difference in texture of topsoil and subsoil, such as clay over sand, it is better to blend the soils to obtain a more uniform growing medium.

Subbase areas of the inslope should be left bare unless the subbase material is highly susceptible to erosion by wind or rain. In this case, topsoil should be placed over the subbase material; however, precautions should be taken to apply no more than the designated quantity so drainage from the subbase will not be impeded or destroyed by blocking the drainage with impervious material. Materials from marsh disposal have a tendency to retain water and should not be used to cover subbase material at the inslope.

Standard spec 625.3.3 contains special requirements for urban areas where a lawn-type turf is desired. During finishing operations all loose or waste stones that will not pass a one-inch sieve must be removed. Topsoil for use over these areas must pass a one-inch sieve and at least 90% must pass a No. 10 sieve. Some topsoils containing large, hard clods may need to be pulverized or screened.

Table 1 defines the various soil classifications (sand, silt, clay) on the basis of particle size. Topsoil recently treated with herbicides to prevent plant growth may not allow seed germination or support plant growth. If herbicide contamination is suspected, the engineer should contact the Bureau of Highway Operations.

It may be possible to treat small amounts of topsoil to neutralize the effect of the herbicide. For large amounts, treatment may not be cost-effective, the topsoil will have to be rejected, and an alternative source of topsoil found.

Occasionally, such as where shallow (less than 6 feet) fills are being built, to ensure the stability of the fill, the contractor will have to excavate more topsoil than the amount necessary to cover the graded surfaces. This excess volume is regarded as excavation below subgrade and is eligible for payment as common excavation. To minimize the amount of excess, the engineer may direct the contractor to remove the topsoil from the shallow fill sites before stripping other areas. The engineer is encouraged to discuss with the contractor early on in the project the amounts of topsoil necessary and available.

Table 1 Soil Classification Particle Sizes

Soil Class	Diameter Range (inch)
Clay	< 0.00008
Silt	0.00008 - 0.002
Very fine sand	0.002 - 0.004
Fine sand	0.004 - 0.01
Medium sand	0.01 - 0.02
Coarse sand	0.02 - 0.04
Very coarse sand	0.04 - 0.08

6-40.1.1 Topsoil Testing

In an effort to improve the success of standard spec 630.2.1.5.1.1.2, soil pH analysis and analysis of prior herbicide use should be performed. Topsoil and salvaged topsoil can be tested to determine if the pH range will sustain grass. In addition, soil that is suspected of prior herbicide use can also be tested.

When topsoil and/or salvaged topsoil is accepted from a wetland, low land, or conifer (evergreen trees) area, an analysis should be performed to find out if appropriate pH levels exist. Often the pH level is so low that the soil will not sustain plant growth without addition of lime.

An analysis for the presence of herbicides should be performed when topsoil and/or salvaged topsoil is accepted from areas which have been in agricultural crop production. Before performing any analysis, try to obtain field history data information from the land owner(s) about the crop production/herbicides use of the land to be used as a source for topsoil. The land owners are required to retain this information. This data should indicate which herbicides were used in the field.

If any of the herbicides listed below were used in the field's history information, it may cause problem in establishing grass. A soil analysis may have to be performed if history information is not available. This applies especially if the parcel had field corn, sweet corn, or soybeans the year before.

Table 2 below indicates which type of crop is associated with what type of herbicide. The numbers in the table indicate the number of months the particular herbicide will have an impact on grass establishment.

The result of the soil analysis for trizine may also indicate presence of the majority of the herbicides as listed in the table.

Testing soils for the presence of herbicides is expensive, so testing requests must be limited. A complete outline of herbicide persistence (residue) in soil is available in Pest Management in Wisconsin Field Crops-1998 (A3646), Appendix Table (Page 184). It is authored by C.M. Boerboom, J.D. Doll, R.A. Flashinski, C.R. Grau, J.L. Wedberg.

This material is available from:

Wisconsin County Extension Office or Cooperative Extension Publication

Room 170

630 W. Mifflin Street, Madison, WI 53703

Phone # (608) 262-3346.

Table 2 Herbicide Effects on Grass Establishment

Herbicide	Effect on Grass Establishment (Months)		
	Field Corn	Sweet Corn	Soybean
Atrazine	24	24	
Bicep II/Bicep Lite II	24	24	
Bullet/Lariat	24	24	
Command 4EC/3ME	16		12
DoublePlay	24		
Guardsman	24	24	
Harness Xtra	24		
Lightning	12		
Marksman	24		
Princep	24	24	
Surpass 100	24		

6-40.1.2 Topsoil Sampling Guidelines

Topsoil may be sampled either from a stockpile, or in-place.

6-40.1.2.1 Sampling from a stockpile:

1. Do not obtain sample from the stockpile face. First remove the surface of the pile at the point of sample then obtain material from inside the stockpile. This will be more representative of the material in the stockpile.
2. Obtain material from at least three different locations from the stockpile. These samples will be combined into one sample that will be 3 to 4 times larger than the final sample size required.
3. Mix the large sample and remove from it enough material to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.
4. Fill out the DT1499 Sample Shipping Tag and enclose the form in the box. Make sure to write the word "Topsoil" on the outside of the box before submitting.

6-40.1.2.2 Sampling topsoil in-place:

1. The procedure for sampling topsoil in-place is the same as for sampling existing topsoil that is planned to be used, or sampling topsoil that has been placed.
2. Remove the surface of the topsoil so that the sample taken will not be from the surface and is representative of the material in place. For existing topsoil, ensure that the sample is as free as possible of plant material (grass, roots, etc.).
3. Obtain material from at least three different locations. These samples will be combined into one sample that will be 3 to 4 times larger than the final sample size required.
4. Mix the large sample and remove from it enough material to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.
5. Fill out the DT1499 Sample Shipping Tag and enclose the form in the box. Make sure to write the word "Topsoil" on the outside of the box before submitting.
6. Send topsoil samples to:

   Tom Brokaw

   3502 Kinsman Blvd.

   Madison, WI 53704

   Phone # (608) 246-7934

6-40.1.3 Topsoil Acceptance

The department encourages contractors to topsoil, seed, and install long-term erosion control measures as soon as practicable. Consequently, the department may entertain contractor requests for partial acceptance upon completion of significant portions of that work. If the contractor requests partial acceptance, the engineer needs to inspect the work and make sure it was completed correctly and all erosion control measures are installed

properly. If partial acceptance is granted, the department assumes maintenance responsibility for the work under standard spec 105.11.1. If the topsoil is washed out or damaged due to erosion, the department pays for that restoration as specified in standard spec 625.5. The department does not reimburse the contractor for washouts or damage caused by contractor operations.

6-40.2 Fertilizer

Fertilizers Type A and Type B have been developed to ensure adequate fertilization of seed or sod located over most soil types in Wisconsin. Selection of Type A or Type B is made by the region design section based upon soil type and the mixture of seed to be sown. Refer to standard spec 629.

Where fertilizer is required, it should be spread upon the soil at the required rate and worked into the soil during the preparation of the seedbed, unless seeds are sown with a hydro-seeder, in which case, the fertilizer may be applied in the water along with the seed.

The rates of fertilizer application for Type A and Type B are 7 lbs. per 1,000 ft^2, as set forth in standard specs, when they are applied at the minimum percentage of components of nitrogen, phosphoric acid and soluble potash (N-P-K) required. However, the standard specs permit the application of fertilizers containing percentages of components greater than the minimum specified. When fertilizers containing percentages of N-P-K components greater than minimum are to be paid for, the quantity to be measured can be obtained by multiplying the weight used by the ratio of the actual percentage of N-P-K components used to 32% for Type A, or to 50% for Type B.

Example 1

Type A fertilizer is supplied which contains 40% N-P-K, instead of the minimum 32% The adjusted application rate would be:

$$7 \times \frac{32}{40} = 5.6 \text{ lbs.} / 1{,}000 \text{ ft}^2 \text{ applied}$$

Actual use =2,200 lbs. of a Type A fertilizer containing 40% N-P-K.

$$2{,}200 \text{ lbs. } \times \frac{40}{32} = 2{,}750 \text{ lbs.} = 27.5 \text{ CWT to be paid.}$$

Example 2

Type B fertilizer is supplied which contains 70% N-P-K, instead of the minimum 50%. The adjusted application rate would be:

$$7 \times \frac{50}{70} = 5 \text{ lbs.} / 1000 \text{ ft}^2 \text{ applied}$$

Actual use = 2,400 lbs. of a Type B fertilizer containing 70% N-P-K.

$$2{,}400 \text{ lbs. } \times \frac{70}{50} = 3{,}360 \text{ lbs.} = 33.6 \text{ CWT to be paid.}$$

In addition to the total N-P-K requirements for type A and B fertilizers, standard spec 629.2.1.2 contains specific minimum requirements for nitrogen, phosphoric acid, and potash as individual components.

6-40.2.1 Agricultural Limestone

Agricultural limestone treatment is applied at the rate specified in standard spec 629.3.2 for the particular index zone (neutralizing index). The index zone is a material property that varies with the material source location.

Agricultural limestone treatment is paid by the ton. To determine the quantity to be measured for payment, the base application rate of 100 lbs. per 1,000 ft^2 from Index Zone 60-69 is used. The actual weight of lime used is multiplied by 100 and divided by the application rate.

Example 3

Index Zone = 95
Application Rate = 70 lbs. per 1,000 ft^2 from Table in standard spec 629.3.2
Actual usage = 3,600 lbs.
Payment =

$$3{,}650 \text{ lbs. } \times \frac{100}{70} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs.}} = 2.6 \text{ tons to be paid.}$$

6-40.3 Seeding

In the past, seeding and final finishing were usually delayed by the contractor until the entire project had been graded and substantially completed. The contract was accepted shortly thereafter, at which time the contractor was relieved of responsibility for maintenance. Generally, only minor amounts of reseeding were necessary and contractors took care of the restoration at their cost.

In our continued efforts to minimize erosion and the associated negative environmental impacts, we now allow seeding to be done as shown in Table 3 below.

Table 3 Seeding Guidelines

Seed Mixes	Can Be Sown	Mulch Required?[1]	Mgr. Approval Required?
10,20,30 & 40	Anytime, except midsummer and late fall	Yes	No
10,20,30 & 40	Midsummer or late fall	Yes	Yes
60	Anytime, except from 7-15 to 10-15		
60	From 7-15 to 10-15	Yes	Yes
70 & 70A	Anytime, except from 6-15 to 10-15	Yes	No
70 & 70A	From 6-15 to 10-15	Yes	Yes
Temporary seed	Anytime on temporary or permanent slopes	Yes on permanent slopes	No

[1] WisDOT Guidelines Recommend the use of mulch on all disturbed permanent slopes.

[2] WisDOT Guidelines Recommend the use of temporary seed at half the normal rate on all permanent slopes to promote quick re-vegetation. Use winter wheat or winter rye during the late fall (see No. 9 below).

The specification is broad and general in nature and subject to interpretation as to the calendar dates of midsummer. Midsummer could be regarded as falling between July 15 and August 15; however, the important point is that erosion needs to be controlled any time, mid-summer or otherwise, by the application of temporary or permanent measures.

Liberal use of temporary erosion control measures and emphasis on early completion of roadway finishing has led to substantially more reseeding either anticipated, as in the case of a temporary seeding bid item, or unanticipated, resulting from our emphasis and direction to complete early finishing. Because of our direct involvement in the prosecution of the fertilizing and seeding work, and the intermix of temporary and permanent seeding it has become very difficult to clearly distinguish the pay or no pay status of areas of seeding or reseeding done by the contractor. Therefore, in the interest of sound erosion control practice and consistent contract administration, we will pay for all re-fertilizing and reseeding within the limits designated in the contract or ordered by the engineer, unless caused by the contractor's negligence.

6-40.3.1 Late Seeding

Use the following guidelines when determining how late to seed in the fall. While effective erosion control is important, it is also improper practice to jeopardize permanent seeding by placing it when it will almost surely die.

1. Seed germinates only when the soil temperature and moisture are adequate.
2. The seed plant is most vulnerable when it has just germinated. Drought and/or freezing can kill a newly germinated grass plant.
3. Determine when the area is prone to receive its first “killing” frost, then allow a safety factor.
4. Weigh the risk. Is it worth gambling? Are environmental or customer sensitive areas a factor?
5. “Dormant Seeding” is acceptable in some cases and is desirable with seed mixes 70 and 70A. Non-germinated seed will normally remain dormant and germinate in the spring.
6. If there is a “killing-freeze”, it is likely that all new germinated seed plants will die, as they have not had enough time to establish themselves.
7. As a rule, it is risky if permanent seed is planted between September 30th and November 15th for the central part of the state. Adjust according to farther north or south project locations.
8. Late seeding can be helped by a heavier application of mulch. Instead of the normal 1/2" to 1-1/2", increase it to 2" to 2-1/2". This will allow for added protection of the grass plants during cold weather.
9. These guidelines DO NOT apply for temporary seed. WisDOT guidelines call for the use of temporary seed at half the normal rate on all permanent slopes, but the use of temporary seed as an erosion control measure, during late fall, is encouraged. Temporary seed is more likely to germinate in cold conditions, and is so inexpensive that

any risk is minimal.

6-40.3.2 Failing to Water

Perhaps as many as 90% of seeding disappointments are due to a failure to keep the seedlings moist after they germinate. Seed can lay dormant in the soil for months without water, but once germination begins the tender young seedlings will die without moisture. Best advice: water frequently and don't let the top inch of soil dry out until the grass is well established.

For this reason the bid item of water should be considered for urban seeding where a lawn type turf is desired. Water should continue for a period of at least 30 days when rainfall is not adequate to maintain soil moisture.

6-40.3.3 Temporary Seeding

Temporary seeding is the establishment of a temporary vegetative cover on disturbed areas by seeding with an annual herbaceous plant, usually grass, which is quick to germinate.

Temporary seeding is used for both temporary and permanent stabilization measures to include:

1. Disturbed areas that will not be brought to final grade for more than 30 days.
2. Borrow pit and waste area sites.
3. Other disturbed areas such as sides of sediment basins, temporary road banks, intercepting embankments, etc.

Temporary seeding should be included on all projects where exposed soils are expected and/or re-vegetation is required. It is the least expensive of all erosion control measures, germinates quickly, and is highly effective.

Temporary seeding is an important tool to prevent erosion not only at the time of final seeding but it can also be used on sites that will stand idle over the winter months. Also remember that temporary seed may be used on sites that do not have topsoil placed yet. However, sandy soils tend to be too dry for good temporary cover to establish. When final seed-bed preparation occurs, disking or tilling may have to occur to allow for permanent vegetation growth. Past experience has indicated that annual oats and rye work best onsite with this application.

When erosion control is a crucial action item, permanent and/or temporary seed with mulch maybe placed in the late fall. But, WisDOT's normal application rate for mulch of 1/2" to 1-1/2" should be increased to 2" to 2-1/2". This will allow for added protection of the seed during the winter months.

6-40.3.4 Mixtures Containing Pure Live Seed

6-40.3.4.1 Background and Definitions

This is the method for determining sowing rate and method of measurement for seed mixes Nos. 60, 70, 70A, 75 and 80 containing seeds to be supplied and applied PLS (Pure Live Seed).

Purity The percentage of the specified species or variety that is actually contained in a given quantity of the seed.

Germination The percentage of the designated species or variety that will actually sprout.

Pure Live Seed (PLS) The percentage purity multiplied by the percentage germination equals the percentage of pure live seed.

The commonly used cool season grasses are specified as having a minimum purity and germination. Unless purity and germination of seed specified PLS are both 100%, the amount of seed required to be sown will always be greater than the amount specified and measured.

6-40.3.4.2 Determining the Sowing Rate for Seed Mix No. 60

Step1: Total the percentages of species or varieties in the mix with a specified minimum purity and germination. Convert to a decimal form.

Step 2: Divide the percentage of each species or variety designated PLS by the percentage PLS shown on the seed certificate for that species or variety.

Step 3: Total the numbers obtained in Step 2.

Step 4: Add the numbers from Steps 1 and 3.

Step 5: Multiply the result from Step 4 by the specified rate per thousand square feet of the mix to determine the actual pounds to sow per thousand square feet.

Step 6: Divide the total actual weight sown by the amount from Step 4. This will be the amount to be paid for as Seeding, Wetlands (mix No. 60).

Example for Seed Mix No. 60

Species	Purity	Germination	Percentage of Mix (Actual)	Percentage of Mix (PLS)
Timothy	98	90	12	
Canada Wild Rye	PLS			12.0%
Annual Ryegrass	97	90	35	
Alsike Clover	97	90	4	
Red Clover	98	90	4	--
Japanese Millet	97	85	8	
Annual Oats	98	90	25	___
TOTALS			88 %	12.0%

Step 1: Unadjusted %= 88% = 0.88

Step 2: The PLS used in this example is hypothetical. The actual PLS must be taken from the label of the seed supplied. For this example, the percentage PLS for Canada Wild Rye is 65%.

12.0÷ 65 = 0.185

Step 3: 0.185

Step 4: 0.88 + 0.185 = 1.065

Step 5: The application rate per standard spec 630.3.3.5 is 1.5 pounds per 1,000 square feet

1.5 x 1.065 = 1.60 pounds per 1,000 square feet actual sowing rate

Step 6: Say 113 pounds were sown

113 ÷ 1.065 = 106 pounds measured for payment.

6-40.3.4.3 Determining the Sowing Rate for Seed Mix No. 70 and 70A

Step 1: The actual pounds Pure Live Seed (PLS) may be listed on the seed package label. If so, proceed to Step 3.

Step 2: If, instead of the actual pounds PLS, the seed package lists gross weight and percent PLS, convert the percent PLS to decimal form and multiply the gross weight by the percent PLS to get pounds PLS in the package.

Step 3: Divide the gross weight of the package of each species by the pounds PLS in the respective package.

Step 4: For each species, convert the percent PLS in the seed mix to decimal form and multiply the percent PLS of that species in the seed mix by the seeding rate per thousand square feet to find the PLS rate of that species.

Step 5: For each species, multiply the result from Step 3 by the result from Step 4 to find the gross weight of that species to apply per thousand square feet.

Step 6: Add the results for each species from Step 5 to determine the gross weight of the seed mix to apply per thousand square feet.

Example for Seed Mix No. 70 (The seed mix in this example is hypothetical.)

Species	Of Mix (PLS)	Gross Weight	Percent PLS
Yellow Coneflower	5	50 lb.	70
Wild Bergamot	5	50 lb.	70
Butterflyweed	5	60 lb.	60
Prairie Blazingstar	5	40 lb.	80
Little Bluestem	35	50 lb.	90
Sideoats Grama	35	50 lb.	90
Canada Wildrye	10	50 lb.	95

Step 1.

The actual pounds Pure Live Seed (PSL) may be listed on the seed package label. If so, proceed to Step 3.

Step 2	Gross Weight	X	% PLS	=	PLS Weight
Yellow Coneflower	50 lb.	X	0.7	=	35 lb.
Wild Bergamot	50 lb.	X	0.7	=	35 lb.
Butterflyweed	50 lb.	X	0.6	=	36 lb.
Prairie Blazingstar	50 lb.	X	0.8	=	32 lb.
Little Bluestem	50 lb.	X	0.9	=	45 lb.
Sideoats Grama	50 lb.	X	0.9	=	45 lb.
Canada Wildrye	50 lb.	X	0.95	=	47.5 lb.

Step 3	Gross Weight	÷	PLS Weight	=	Conversion Factor
Yellow Coneflower	50 lb.	÷	35 lb.	=	1.43
Wild Bergamot	50 lb.	÷	35 lb.	=	1.43
Butterflyweed	60 lb.	÷	36 lb.	=	1.67
Prairie Blazingstar	40 lb.	÷	32 lb.	=	1.25
Little Bluestem	50 lb.	÷	45 lb.	=	1.11
Sideoats Grama	50 lb.	÷	45 lb.	=	1.11
Canada Wildrye	50 lb.	÷	47.5 lb.	=	1.05

Step 4	% Species in Mix	X	Seeding Rate/1,000 Sq. Ft.	=	PLS Weight/1,000 Sq. Ft.
Yellow Coneflower	0.05	X	0.4	=	0.02 lb.
Wild Bergamot	0.05	X	0.4	=	0.02 lb.
Butterflyweed	0.05	X	0.4	=	0.02 lb.
Prairie Blazingstar	0.05	X	0.4	=	0.02 lb.
Little Bluestem	0.35	X	0.4	=	0.14 lb.
Sideoats Grama	0.35	X	0.4	=	0.14 lb.
Canada Wildrye	0.10	X	0.4	=	0.04 lb.

Step 5	Conversion Factor	X	PLS Weight/1,000 Sq. Ft.	=	Gross Weight/1,000 Sq. Ft.
Yellow Coneflower	1.43	X	0.02 lb	=	0.03 lb.
Wild Bergamot	1.43	X	0.02 lb	=	0.03 lb.
Butterflyweed	1.67	X	0.02 lb	=	0.03 lb.
Prairie Blazingstar	1.25	X	0.02 lb	=	0.03 lb.
Little Bluestem	1.11	X	0.14 lb	=	0.16 lb.
Sideoats Grama	1.11	X	0.14 lb	=	0.16 lb.
Canada Wildrye	1.05	X	0.04 lb	=	0.04 lb.

Step 6	Gross Weight/1,000 Sq. Ft.
Yellow Coneflower	0.03 lb.
Wild Bergamot	0.03 lb.
Butterflyweed	0.03 lb.
Prairie Blazingstar	0.03 lb.
Little Bluestem	0.16 lb.
Sideoats Grama	0.16 lb.
Canada Wildrye	0.04 lb.
TOTAL	0.48 lb.

Therefore, the actual gross weight of seed that needs to be applied per 1,000 square feet is 0.48 pounds in order to get the required PLS rate of 0.4 pounds per 1,000 square feet which will be measured for payment.

6-40.3.5 Testing Seed

WisDOT can test standard seed mixes for germination rates, seed type, and ratios if the engineer suspects a problem. This is an effort to continuously improve recommended seed mixes, and to determine the reason of failure on standard seeding projects. It will also provide the project manager with an opportunity to require some of the standard seed mixes to be tested. Contact Leif Hubbard at (608) 267-6884 with soil and seed related questions.

6-40.3.6 Seed Sampling Guidelines

Take seed samples from two locations representing seed that will be used on the specific project. Sample locations include sampling from the seed bags, or from the seeding equipment.

The seed used contains many species, and these may tend to stratify in the bag or seeding equipment. Care should be taken to ensure that the sample is representative of the seed overall. This may be accomplished by mixing the seed by hand before taking a sample, or by obtaining parts of the sample from different layers from within the bag or equipment.

Take a sample large enough to be placed in one of the department's cement sample boxes. Ensure that the sample is bagged and sealed (twist tie) before placing it in the box.

Fill out the "WisDOT Seed & Topsoil Testing Request Form" and enclose the form in the box. Include the information that is requested on the form, along with a copy of the seed ticket from the bag sampled. Also, please write "Seed" on the outside of the box before submitting.

Send seed samples to:

Tom Brokaw
3502 Kinsman Blvd.
Madison, WI 53704
Phone # (608) 246-7934

6-40.3.7 Native Seeding Mixtures

Seeding Mixtures 70 and 70A are primarily composed of native grasses and wildflowers. They are intended to be used in areas where it is desirable to re-establish native species on the project, either for aesthetic or environmental reasons. They are particularly appropriate in instances where the DNR liaison requests a native seed mix that is compatible with plant communities beyond the right-of-way. They were not, however, intended to be used primarily for erosion control or for other large-scale uses on highway rights-of-way for several reasons:

They are relatively expensive because of the wildflower component. It is not necessary that an erosion control seed mix contain wildflowers, especially when the areas are often not visible from the highway so they cannot be enjoyed by travelers. If the seeding takes place on the inslopes, periodic mowing may preclude the wildflower plants from flowering anyway, depending on the timing of the mowing in relation to the phenology of the plant.

Wildflower seed germinates most effectively if it is dormant-seeded in the fall so that it goes through a cold stratification process over the winter to soften up the hard seed coat. This may require that temporary seed be used in the likely event that ground cover for erosion control needs to be established earlier in the season.

Diverse native grass/wildflower mixes like 70 and 70A require 2-3 years of management after seeding. These mixes should only be planted if Regional PDS staff are willing to commit the resources necessary to do this management and SPO staff are willing to make the same commitment for any necessary follow-up

management.

Seeding Mixture 75 is designed to be used for erosion control purposes and can be seeded at any time during the growing season. This mixture consists almost entirely of native grasses along with a couple of inexpensive, easy-to-grow wildflower species. It should be used in conjunction with the Seeding Nurse Crop item as described in standard spec 630.

Seeding Mixture No. 80 consists of a combination of relatively salt tolerant native and non-native species and is intended to be used on inslopes. The species in this mixture are non-invasive so it should be especially suitable for areas where the DNR liaison or others have concerns about adjacent natural areas. This mix should also be used in conjunction with the Seeding Nurse Crop item.

6-40.3.8 Seeding with a No-Till Rangeland Type Drill (Method C)

No-till rangeland type drills are typically equipped with 3 seed boxes: one for cool season seeds such as lawn-type grasses and nurse crop species, one for light fluffy seeds such as most native grass seeds, and one for small seeds such as most wildflower seeds. Each box is capable of being calibrated independently from the other boxes. A press wheel is mounted to the rear of each drop tube to firm the soil over the seed.

When seeding into existing vegetation or thatch, the drill should be equipped with a no-till attachment consisting of coulters which slice through the vegetation or thatch in front of the furrow openers and seed drop tubes. This no-till attachment is not necessary when seeding into bare soil.

As an alternative to using a drill with 3 separate seed boxes, each seed type (cool season, light fluffy and small) may be seeded separately with the drill being recalibrated for each seed type.

6-40.4 Sodding

Standard spec 631.2.1 requires that sod must be indigenous to the general locality in which it is used. In other words, the sod should grow naturally under the same general climatic and soil conditions as those at the site of the work. For example, sods grown on peaty soils would not be acceptable for use on sandy soils. Varieties of grasses that require a high degree of maintenance should not be planted either.

Sodding is the quickest method of securing a vegetative cover on graded areas of the roadway. However, due to the high cost of sodding it is generally used only on those areas where serious erosion might occur before turf could be established by seeding, or in urban areas.

The inspector will lay out the areas to be sodded and determine that the soil forming the bed upon which the sod is to be placed is properly prepared. If erosion has taken place, the gullies are to be backfilled and compacted by the contractor. The finished bed should have a uniformly even surface and be shaped, especially for flumes and ditches, to the required dimensions. Before laying the sod, the soil surface should be loosened to a fine texture and to a depth of at least 1" in order to provide a condition suitable for the penetration of the grass roots. If the soil is dry, water should be applied to properly condition the bed.

During the laying of the sod, the inspector should check on the work to ensure the following:

- The sod is laid as tight as possible
- Joints are properly made
- Edges of the sod where water is apt to flow over it are properly embedded in the soil
- Laid sod is tamped or rolled to make continuous contact with the underlying soil
- The sod is properly held in place with stakes

Sod placed on slopes steeper than 1 unit vertical to 4 unit horizontal, and all sod placed on flumes, ditches, or other areas that may be subjected to a concentrated flow of water, regardless of the slope, is required to be staked. It is important that sufficient stakes are used to ensure retention of the sod in place until the grass roots have developed and entered the underlying soil, anchoring the sod in place. Only stakes made of wood can be used, and they must be driven to within 1/2" of the surface of the sod to avoid interference with subsequent mowing.

Sod may be anchored with a jute fabric (class II, Type A) of specified weight.

Refer to standard spec 631.3 for requirements for fertilizing, rolling, tamping, and watering the placed sod. Also refer to SDD 8E4 for details on sod and sod-masonry ditch checks, and to SDD 8E5 for sodded flume details in FDM chapter 16.

6-40.5 Mulching

6-40.5.1 Material

The purpose of mulch is to break up rainfall, prevent compaction of the soil surface, lessen the erosive effects of

water and wind, moderate soil temperatures, supply shade for germinating seedlings, and prevent excessive evaporation of water from the soil.

Standard spec 627.2 permits the use of straw, hay, wood chips, wood excelsior fiber, or other material that is suitable. All mulch must be substantially free of noxious weed seeds and objectionable foreign material. Rotten or partially decayed straw or hay is not acceptable. Short-stemmed straw is not acceptable for crimping purposes but should work well for tacking.

Standard spec 627.2 further provides that straw or hay used for mulch shall be in an air-dry condition. As a guide, any straw or hay having 10% or less of moisture will be considered air-dry. It is important that the straw or hay be air-dry when weighed for payment by the ton. Generally, baled hay or straw coming from sheds, barns, under tarps, or even interiors of stacks will be air-dry unless exposed to rain prior to weighing. Should the engineer believe the straw or hay contains moisture greater than 10%, the moisture can be determined by randomly obtaining handfuls of hay or straw from bales and stuffing them into a soil sample bag. The sample should be weighed to obtain the net mass and then heated at moderate heat in an oven or suitable container to drive off the moisture. Moisture content is then determined by the following formula:

$$\text{Moisture Content (\%)} = \frac{\text{Wet Mass of Sample - Air Dry Mass of Sample}}{\text{Air - Dry Mass of Sample}} \text{ X } 100$$

6-40.5.2 Equipment

Equipment used in mulching operations should be specifically designed for applying, tacking, or crimping mulch. Equipment that is of inadequate capacity, jerrybuilt, poorly designed, badly worn, or malfunctioning is not acceptable.

6-40.5.3 Application

Mulch shall be applied to seeded areas within two days after completion of the seeding in order to conserve the moisture necessary for germination of the seed within the soil.

The contractor has the option to use one of the following three methods, unless restricted to a specific method by the contract. Contracts with counties should specify the mulching method to be used if the standard county practices differ from ours. If the special provisions do not address mulching methods, the WisDOT standard specifications are to be followed. When mulching areas of slopes that are too steep for tilling or otherwise inaccessible to a tiller, the contractor must anchor the mulch, using method A or B.

6-40.5.3.1 Method A: Netting

This method allows spreading mulch in place to a loose, uniform depth of 1/2 to 1 1/2 inches, and then anchoring by means of approved netting or twine secured by pegs or staples. When using this method, begin mulching at the top of the slopes, and proceed downward. Usually, the contractor selects a lightweight plastic netting rather than twine. This lightweight netting ultimately degrades under action of sunlight.

The contractor may use department-approved erosion control mats, listed in the PAL, instead of separately applying mulch and netting.

6-40.5.3.2 Method B: Tackifier

With this method, mulch is blown by machine to a uniform depth of 1/2 to 1 inch, using 1/2 to 3 tons of mulch per acre. The mulch covering should be loose enough to allow some sunlight to penetrate and air to circulate, but thick enough to shade the ground, conserve soil moisture, and prevent or reduce erosion. Mulch material from compacted bales should be loosened or fluffed before or during the placing so that no matted lumps of the material are placed on a seeded area. A spray of non-asphaltic tack sufficient to hold the mulch in place achieves anchoring.

Straw or hay mulch is usually applied with a mulch blower. The mulch blower is equipped with one or more nozzles, a storage tank, and a pump. It allows for combined application of a non-asphaltic binder with the mulch. Experience indicates that the blower must be equipped with at least three operating nozzles when combined application of binder is permitted.

Hydro-seeders are used for spraying a non-asphaltic tackifier over mulch that has been previously placed. Positive agitation must be provided in the tanks during application to assure a homogeneous mixture of water, tackifier, dye, and mulch when applied simultaneously.

Tackifiers, if used, must be pre-qualified by the department prior to use. Tackifiers shall be selected from the erosion control product acceptability list (PAL) developed and maintained by the department. A copy of the PAL may be obtained at:

http://www.dot.wisconsin.gov/business/engrserv/docs/pal.pdf

Specifications, application rates, and general information on tackifiers are contained within the PAL.

The inspector must verify that the correct proportions of binder and water are mixed uniformly. Likewise, the rate of application of binder and tackifier must be checked and verified. Increased rates of application may be required based on inspection of the mulch after placing and tacking.

6-40.5.3.3 Method C: Crimping

This method involves spreading the mulch uniformly to a loose depth of 1/2 to 1 1/2 inches by blowing from a machine or other means. Anchoring will be by a mulch tiller specially designed for crimping mulch into the soil. Experience to date indicates that anchoring mulch by tilling is a superior method for most soils. For desirable results, especially in heavier soils such as clays, the mulch should be applied and tilled into the soil while the topsoil and seedbed are still in a loose and friable condition. Tiller ballast should be added or discarded to achieve the required penetration.

One pass of the tiller is usually sufficient, but short-strand straw or hay may require several passes. Several passes may also be needed to anchor the mulch next to shoulders, in medians or in areas exposed to frequent or high-velocity winds.

When wood excelsior fiber is used for mulch, the fiber need not be anchored as required for other mulch types. The wood fiber tends to swell and expand and the many tiny fibers and barbs interact to secure the mulch in place.

Plastic nettings designed for use over mulches to secure the mulch in place can be used in areas where crimping is not feasible or where tacking agents cannot be applied or are ineffective.

A mulch tiller is used for crimping mulch. An agricultural disc is not a mulch tiller. A mulch tiller has flat, notched disks, whereas a farm disk has curved smooth disks and is designed to turn over soil. An agricultural disk should not be used for crimping mulch because it will bury the mulch rather than pressing it into the soil.

Random checks should subsequently be made as necessary to assure continued conformance. Areas that have been crimped may need additional passes of the tiller to secure the mulch depending on soil conditions and exposure to wind. Inspection of mulched areas must be made to assure that areas that have not been crimped have been secured by another method.

6-40.5.4 End Results

Mulch should remain on the seedbed until the grass has grown through the mulch. Mulch lost before acceptance is assumed to have been improperly placed and must be replaced by the contractor at the contractor's expense. Mulch properly placed and anchored, but lost from exceptional or severe rain or wind shall be replaced by the contractor and paid for by the department to encourage early landscaping and erosion control. Mulch replaced by the contractor must undergo inspection to assure the mulch is properly secured.

6-40.5.5 Mulch Inspection

An inspector must be present during initial applications to inspect the straw and hay for moisture content, state of deterioration, and length of straw. The inspector must also check the equipment for suitability and operational capability.

6-40.5.6 Diary Entries

Appropriate information relating to mulching should be entered into the grading or erosion control diary. Entries relating to the following are suggested:

- Kind of mulch
- Condition of mulch, including air-dry context or moisture percent if 10% or more, average length and state of deterioration if any
- Kind and condition of equipment, number of nozzles, etc.
- Method of application
- Binding or tacking agent used, if any
- Actual rate of application of tacking agent
- Dates of initial and random inspections
- Condition of mulch after anchoring or tacking.
- Amounts lost to wind and replaced by contractor at the contractor's expense
- Items of interest, special problems, recommendations, etc.

6-40.6 Trees, Shrubs and Vines

WisDOT Bureau of Highway Operations has a staff of landscape architects who have expertise in all areas of vegetation management. They should be invited to participate in the preconstruction conference for projects that have a significant amount of planting involved. They are also available to answer questions and assist with field checking of staking, inspections of plants and planting operations, advising on care requirements during the plant establishment period, determining plant survival, etc.

6-40.6.1 Materials

Planting of trees, shrubs, and vines under the contract will be made with plant stock grown by and furnished from nurseries, unless the contract provides for the use of collected or plantation-grown stock.

The plant material to be used in the planting project is perishable and therefore requires special care and handling. Acceptable plant material as described in standard spec 632 has been grown, dug, stored, packaged, and transported in a manner designed to keep it alive and in good condition. The intent of the specifications is that all reasonable means should be used during the term of the contract to keep the plant material in good condition.

It is recommended the engineer have available a copy of the American Standards for Nursery Stock; a Plant Hardiness Zones map, published by the U. S. Department of Agriculture, and the latest AASHTO Inspection Guide for Landscape Planting. The AASHTO guide is not a contract document, but can provide helpful information. These standards, maps, and guides are available in the region and from the Bureau of Highway Operations landscape architects.

The contractor is to furnish a list of sources for all plant material at least 15 days before the delivery of the material. The addresses on this list should be checked against the Plant Hardiness Zone map to make sure that all plants come from within the specified acceptable area.

Nursery-grown, plantation-grown, or "collected" stock, are three levels of plant culture. Nursery-grown stock has generally been better managed, grown under more controlled conditions, and received more care than plantation or collected stock. Plantation-grown stock has been systematically planted in friable soils free of stones, but has received only a minimum of aftercare. The most common examples of plantation-grown stock are evergreens grown for Christmas trees. Collected stock has been taken from wild or native stands and generally is subject to greater shock when transplanted than the same kind when nursery-grown.

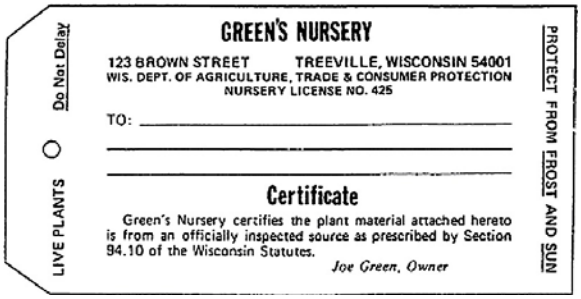
6-40.6.2 Certification for Nursery Stock

A Certificate of Compliance should accompany each shipment of nursery-grown planting material received on the project, and is to be filed with the engineer.

Wisconsin Statutes Section 94.10(5) sets out the requirements for labeling nursery stock. Shipments of nursery stock must be labeled with the name and address of the person selling or distributing the shipment. Nursery stock sold at retail must bear a tag or label giving the common or botanical name of the plants.

Each nursery or dealer is responsible for obtaining their own tags. An example of an approved label-type certificate is shown in Figure 1.

Figure 1 Example Certification for Nursery Stock



6-40.6.3 Inspection

Usually, a general inspection of the plant stock is made at the nursery or source of supply or a central collection area by a plant specialist. If the specialist has not inspected the project plant stock, the engineer or inspector may use the checklist shown in Figure 2 as a guide to acceptance or rejection. When inspection is made at the source, approved stock is usually tagged. An approval tag may be attached to each large size tree; however, small size trees and shrubs may have only representative samples of each species and size tagged.

Regardless of any prior approval, the inspector will examine each shipment of plant stock upon its arrival at the

job site, noting the condition of plants and compliance with contract requirements, and obtaining accompanying certificates of inspection relative to injurious insects and diseases. Plants that are not satisfactory upon arrival should be rejected.

Figure 2 Checklist for Inspection of Trees, Shrubs and Vines

If a plant specialist has not inspected the stock before its delivery to the project site, the engineer or inspector should check each plant at the time of delivery for the following desirable characteristics:

___1. Size and quantity meet contract requirements for the species

___2. Natural, uniform leaf or needle color.

___3. Well-developed, firm, moist buds uniformly spaced out to the end of branches on dormant stock. The cambium layer just under the bark should be green and moist.

___4. No visible decay in the roots, trunk, or branches.

___5. No sun scald, as shown by lighter-colored areas of bark. The cambium layer just under the light-colored bark will be dry and brown if the plant has been sun scalded.

___6. A good root system. Roots should not be on or close to the surface, crowded, twisted, or encircling the plant.

___7. No frost cracks. These are long, vertical splits in the bark that will allow insects and fungi to enter the plant.

___8. No signs of injury; such as abrasions, cuts, or breaks.

___9. Correct pruning, with no protruding stubs, cutting of the bark, or decay at the cut.

___10. No diseases. These may appear as discharges of sap; discolored leaves, needles, or bark; abnormal growth of branches, etc.

___11. No insects. Evidence of insects may be clusters of eggs, feeding patterns on bark and leaves, and holes drilled into the bark.

___12. Proper habit of growth.

a. Shade trees and flowering trees should be balanced, symmetrical, with a single leader. Side branches should be well developed.

b. Evergreens should have full foliage with uniform density.

c. Shrubs should have at least the minimum number of branches for the species and be uniformly branched.

___13. Trees with wrapped trunks should be unwrapped at time of delivery and immediately checked for defects under the wrap. If unwrapping is not allowed, the trees should be rejected.

___14. A firm, intact ball on balled and burlapped stock. The trunk should not be free to move inside the ball.

___15. Necessary certificates should accompany the shipment.

Failure of plant stock to pass this checklist is cause for rejection. Rejected plant stock should be immediately reloaded onto the delivery vehicle and not allowed to remain on the project.

The following items and procedures should be considered or employed when accepting plant material on arrival:

- A nursery inspection tag should accompany each shipment.
- The stock should be protected from the wind, sun, and other detrimental climatic effects during transit. According to standard spec 632.2.2.9, all stock must be dug, handled, packed, transported, and planted in the appropriate manner as applicable to BR, B&B, B&P, CG, or MT stock. These acronyms are defined below:

BR Bare root stock

B&B Balled and burlapped stock

B&P Balled and potted stock

CG Container grown stock

MT Machine transplanted stock

- The earth ball of B&B material should be firm and unbroken. Remove burlap from a random plant. If cut ends of several large fleshy roots appear on the surface of the earth ball, break the ball and examine the root system. If there are very few fibrous roots, chances of plant survival are reduced, especially in evergreens.

- B&B plant material should always be handled by the ball with no exceptions.
- Dormant deciduous plant material should have green tissue just under bark on all parts of the plant top. Check by cutting a small secondary branch and laying back a small piece of bark.
- Roots of bare root material should be of an average minimum spread as described in the American Standards for Nursery Stock.
- Permission to substitute plants should be extended only after consultation with the landscape architect to ensure the substituted plants are suitable for the purpose intended.

6-40.6.4 Measurement

The information in Table 4 below is derived from the American Standard for Nursery Stock.

Table 4 Method of Measurement for Various Tree Types

Tree Type	Method of Measurement
Shade and flowering trees (caliper measurement)	Take caliper measurement of trunk at 6 in above ground level [1] if diameter is 4 in or less. If greater than 4 in, take trunk caliper measurement at 12 in above ground level.
Shade and flowering trees (height measurement)	Measure height vertically from ground level to top of tallest trunk.
Deciduous shrubs	Measure height vertically from ground level to top of tallest branch.
Coniferous evergreens (upright growth)	Measure height vertically from top of ball to top middle of leader.
Coniferous evergreens (creeping or low spreading growth)	Measure horizontally the widest spread of the branches from one side to the other, measure the least spread, and average the results.
Vines	Measure from top of root to end of stem.

[1] Ground level refers to the top of the ball for B&B plants or the plant root collar for bare root and containerized plants.

6-40.6.5 Storage

All plant stock not planted on the day of delivery to the job site is required to be properly stored and protected from the sun and wind in the manner specified for temporary storage in standard spec 632.3.2. Special care should be taken so that roots of bare root plants are covered at all times except at planting time when brief exposure is necessary. Do not allow several bare-root plants to be distributed to their individual planting locations and left with their roots unprotected before they are planted. The fine hair roots will dry out very quickly when exposed to sun and wind.

Earth balls of B&B stock should be completely covered with approved moist mulch material. Evergreens being stored for more than a week should be spaced and have tops untied to prevent yellowing which occurs when they are stored too close together. Potted plants should be spaced to provide air circulation, have the top spread, be protected from the wind if possible, and watered when necessary. It is important that stored plants receive proper care until all are planted.

6-40.6.6 Location Staking

The location of trees and shrubs shown on the plans will be staked or otherwise indicated in the field by the engineer, and the contractor's planting will be inspected for compliance. The plan location should be accurately staked in the field using a base line or other methods for large areas.

Trees should not be planted at locations that would be hazardous to occupants of vehicles leaving the roadway. Generally, newly planted trees with an ultimate trunk diameter of more than 4 in should have a minimum setback of 36 ft from the edge of the traffic lane - 50 to 60 ft is desirable. If the trees are located behind walls, abutments, or other obstructions that separate the roadway from the trees, they may be planted closer.

The staking of plant locations should be done early so that staking is completed or nearly so before planting operations begin. The plant locations should be scaled off the plan. A full size plan rather than a "D" size plan will work better for this. If plant locations conflict with some existing feature such as power lines or if the plant would be in an undesirable location, for example, in a ditch that did not appear on the plan, or would be located within the minimum setback, the necessary adjustment in location should be made. These adjustments should be noted on the plan and brought to the attention of the engineer before planting begins.

6-40.6.7 Planting

During planting operations, the inspector should determine that the performance of the work complies with the

specified requirements. Specific attention should be paid to the following:

- Proper size of excavated plant holes
- Correct placing of plants
- Backfill of plant holes with specified materials
- Correct manner of placing backfill material around plants
- Proper application of fertilizer
- Adequate watering
- Any required pruning, mulching, wrapping, staking, or guying of plants

As a general rule, planting should be done in a manner that storage time is reduced to a minimum. Where many plants are involved and the planting time is drawn out, it is usually best to concentrate on getting the material planted, leaving guying, wrapping, and mulching for later. An exception to this may be evergreens, which offer much wind resistance and which should be braced or guyed as required at or soon after planting time. Constant wind action usually breaks small roots, keeping the tree from becoming established, defeating the purpose of the earth ball.

Usually, machine transplanting should be done as early in the spring as possible.

Evergreens desirably should be planted either in the spring before the buds open, or in September. Deciduous trees desirably should be planted before the buds have opened in the spring or after the leaves have dropped naturally in the fall. Project conditions may require adjustments to these ideal planting times.

Potted plants are usually planted last because an adequate root system is contained in the pot, and with proper care they can be held for some time without ill effect. In some cases, potted shrubs have been potted by the contractor and should be held for a specified period to ensure a live, healthy plant at the time of planting.

Care should be taken to set the plant at its proper elevation. This should be as close as possible to that at which it was previously growing. If the hole is too deep, backfill it until the plant will rest at its proper height. The depth of the hole should be carefully measured for large B&B stock to eliminate unnecessary handling that loosens the roots from the ball. It is better for a plant, especially a tree, to be planted slightly too high than for it to be planted too low. Soil under large balled and burlapped trees should be firm; otherwise, loose soil will turn to mud after watering and the tree will settle into the hole.

Backfilling of bare root plants should be done carefully so that the soil fills in between small roots. The plant should be worked around slightly to cause soil to filter down between the roots. Firming by stamping with a boot should be avoided because this breaks many small roots. The required watering will also compact the soil and assist in eliminating air pockets.

Standard spec 632.3.7 requires that backfill material for plant holes must be a combination of six parts native topsoil and one part compost. Holes for MT plants must be filled half-full with a slurry of one part water and one part compost just before placing the tree.

In planting potted plants, the elevation should be based on the plant root crown rather than the pot. Plantable fiber pots should be planted intact, with several gashes made in the pot to speed up deterioration. If the top of the pot will not be covered by the mulch material, the top portion should be cut off after planting, but before mulching. If plastic or metal pots, which do not readily decompose, are used, the pot should be removed from each plant as it is planted.

The contractor, upon completion of the planting, must remove and dispose of all excess excavation, waste materials, or other debris resulting from the planting.

6-40.6.8 Pruning

The philosophy for pruning at planting time has changed dramatically in recent years. It is now not acceptable to prune up to half of the growth from a plant to compensate for root loss incurred during the digging operation at the nursery. Research has shown that leaving as much leaf surface as possible on the newly planted plant increases it's photosynthesis capability that allows it to overcome the shock of transplanting much more quickly. The only recommended pruning operation at planting time is the removal of broken, dead or rubbing branches.

Pruning to improve the structure of the plant should wait at least one growing season or to the end of the final year of a multi-year plant establishment period. Plants should be pruned so that after pruning the plant still retains the character and appearance typical of the species. The thinning of small branches of some species of low growing trees may be warranted at this time. For instance, lower branches of crab apple trees may need to be removed to accommodate rodent control material, and the interior branches of hawthorns may need to be thinned to allow air and light to penetrate.

The following procedures should be employed when pruning:

- Evergreens normally should not be pruned; however, all dead or broken branches and all leaders, except one, should be removed.
- All broken, dead, or rubbing limbs of deciduous trees should be removed.
- Cuts should be made as close as possible to the branch collar at the base of the limb without injuring the collar.
- Painting of pruning cuts is no longer required, except on oaks to prevent oak wilt.
- Pruning tools should be suitable for the purpose and sharp enough to make a clean, smooth cut.

6-40.6.9 Anti-Desiccant

If specified, an emulsion formulated to reduce water loss by transpiration should be sprayed on the needles of evergreens at or before the time of planting, on the roots of BR stock before shipment, and on MT stock before transplanting unless deciduous trees are dormant. When dry, the anti-desiccant will leave an odorless, colorless, thin film of wax on the roots, needles, and branches. Comparison with unsprayed plants and experience with the process are the best ways the inspector has to detect if anti-desiccant has been applied.

6-40.6.10 Landscape Planting Surveillance and Care

The contractor is obligated to care for plantings, and must be made aware of the responsibilities as described in standard spec 632, especially standard spec 632.3.19. This subsection pertains to watering, weeding, spraying, etc., after the initial planting. This work is an important part of the planting project that ensures the survival of the plants and protects the taxpayer's investment.

Mulching, watering, wrapping, guying, bracing, and application of rodent protection and anti-desiccant materials, when required, are a definite part of the bid item for which the contractor is remunerated. The contractor's obligation to perform this work is as clear cut and binding as that of furnishing and planting the plant material.

Ties used to secure wrappings should not be of nylon, plastic, or other materials that do not degrade rapidly.

Payment for the care of the plant material after planting is not included in the bid price for the plants. It is paid for under a separate bid item entitled Landscape Planting Surveillance and Care (see standard spec 632.3.19). The care cycles described should occur every 10 to 14 days. For estimating purposes, the number of cycles is typically figured on the basis of 1 cycle in late May, 2 cycles each month from June through September and 1 cycle in early October. The actual number of cycles may vary depending on whether adequate rainfall or drought occurs.

If the contractor fails to adequately perform landscape surveillance and care as described in standard spec 632.3.19, the engineer should assess daily damages using the administrative item 806.0632 Failing to Perform Landscape Surveillance. The daily damages are intended to offset the cost of hiring an outside source to perform the work. The dollar value to be used is provided in the contract special provisions. Daily damages specified in the special provision should be dependent upon the value of planting items in the contract, as shown in FDM 27-25-10.

Replacement of dead plants during the appropriate planting season is still incidental to the bid item for furnishing and planting that species and size.

6-40.6.11 Establishment Period and Payment

The contractor will be responsible for care of plants and necessary replacements for a 2-year establishment period, unless a 1-year period is specified in the contract.

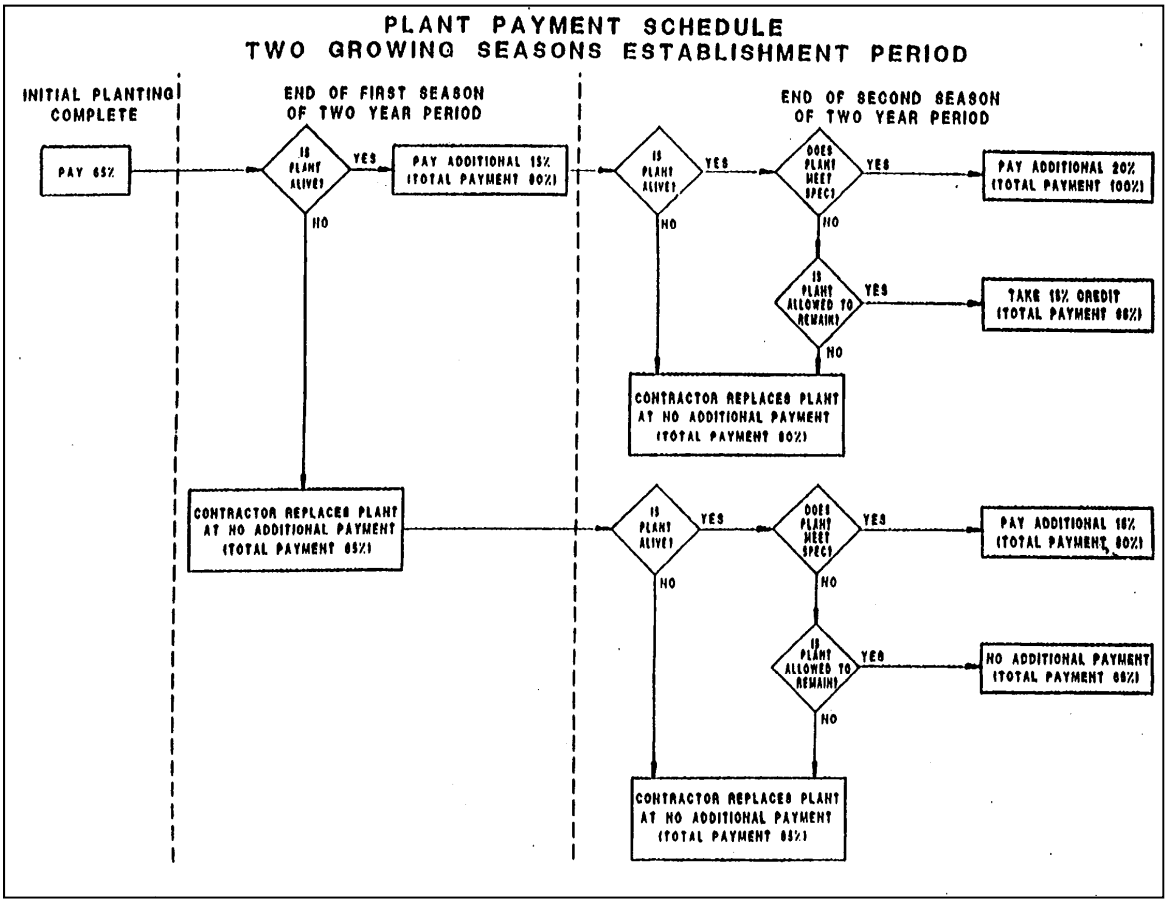
The 2-year establishment period must extend until October 15 of the second full growing season. The 1-year establishment period must extend until October 15 of the first growing season, if planting is done in the spring; the period must extend until October 15 of the succeeding year, if the planting is done in the fall.

When a 2-year plant establishment period has been specified, care and general condition of plantings should be monitored at least every month from the time the plants leaf out in the spring, until they lose their leaves in the fall. A comprehensive inspection should be conducted in late August or early September following the first growing season. Any dead plants should be tagged or marked. These are to be replaced by the contractor during that fall planting season. Another inspection should be conducted the following spring in case any plants die during the winter, with replacements again being made at that time.

The contractor must complete all replacements by June 1 of the year the final inspection is made so that all plants are top quality and in prime condition as of the inspection date. The final inspection is normally conducted late in August or early in September of the final year of the plant establishment period using the criteria set forth in standard spec 632.3.20 for determining plant acceptability and qualification for payment. Partial and final payments will be in accord with standard spec 632.5.

A diagrammatic flow chart in Figure 3 shows the payment schedule for plants installed under a two-year growing season establishment period. Future payments made under the plant payment schedule in the standard specifications for a two growing season establishment period should follow this chart.

Figure 3 Plant Payment Schedule



CRITICAL AREA PLANTING

(Acre)
Code 342

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical, or biological conditions that prevent the establishment of vegetation with normal practices.

II. Purposes

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

- Stabilize and restore riparian areas.
- Stabilize stream and channel banks and shorelines.
- Stabilize areas with existing or expected high rates of soil erosion by water or wind.
- Rehabilitate and revegetate degraded sites that cannot be stabilized using normal establishment techniques.

III. Conditions Where Practice Applies

This practice applies to highly disturbed areas such as:

- active or abandoned surface mine sites,
- urban conservation sites,
- road construction areas,
- conservation practice construction sites,
- areas needing stabilization before or after natural disasters such as floods, tornados, and wildfires,
- eroded banks of natural channels, banks of newly constructed channels, and lake shorelines, and
- areas degraded by human activities.

IV. Federal, Tribal, State and Local Laws

Critical area planting practices shall comply with all federal, tribal, state and local laws, rules or regulations. The landowner and/or operator is responsible for securing required permits. This standard does not contain the text of the federal, tribal, state or local laws.

V. Criteria

A. General Criteria Applicable To All Purposes.

1. Site Assessment

   A site investigation shall be conducted to identify any physical, chemical, or biological conditions that could affect the successful establishment of vegetation. The site investigation shall include evaluation of: soil characteristics, soil fertility, slope, *aspect*[1], moisture regime, climatic patterns, proximity to natural plant community, and site history.

   Areas to be planted will be cleared of unwanted materials and smoothed or shaped, if needed, to meet planting and landscaping purposes.

   Compacted layers will be ripped and the soil re-firmed prior to seedbed preparation.

   On tilled or disturbed sites, prepare a firm seedbed. The seedbed shall contain enough fine particles for uniform shallow coverage of seed and contact with moisture and nutrients. For details on seedbed preparation, refer to Wisconsin Agronomy Technical Notes 5, Establishing and Maintaining Native Grasses, Legumes, and Forbs; and 6, Establishing and Maintaining Introduced Grasses and Legumes.

2. Specie Selection and Seed Quality

   Species selected for planting shall be suited to current site conditions, intended use, and be resistant to diseases and insects common to the site location.

[1]Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

Selected species will have the capacity to achieve adequate density and vigor to stabilize the site within an appropriate period.

Native herbaceous or woody vegetation selected for planting shall be suitable for the site.

Species identified as restricted or prohibited by law shall not be planted.

Certified Seed shall be used, and seeding rates will be based on *Pure Live Seed* (PLS). Seed tag information such as purity and germination and any computations to adjust seeding rates must be submitted to document actual seeding rates. *Actual adjusted seeding rates* will be based on the equivalent of 100 percent PLS, determined by multiplying the percent purity by total percent germination.

Untested introduced and native grass and forb seed are not approved for planting.

When certified seed is unavailable or difficult to locate, *non-certified* seed can be used, after testing for varietal purity, germination, and other mechanical qualities, such as inert matter and other crop or weed seeds.

If more than 20 percent of legume seed is hard seed, increase the seeding rate for legumes by the percentage of hard seed.

Introduced and native legume seed shall be inoculated immediately prior to planting. Rhizobia inoculant shall be specific to the legume seeded. When more than one legume specie is used, each specie will be inoculated separately.

3. Seeding Periods

The specific date that provides the best chance for success will vary from south to north and from year to year with prevailing moisture and temperature conditions. Late summer seeding is generally riskier than spring seeding. Planting at either end of the allowable range is riskier than the middle of the range. Refer to Figure 1 for planting zones and Tables 1 and 2 for seeding dates.

Seeding outside of the recommended dates must be approved by the Area Resource Conservationist or State Agronomist.

Frost seeding is not an authorized seeding method when using this standard.

Dormant seeding can be used when planting introduced species. When using dormant seedings in concentrated flow areas, the site must be mulched according to the engineering design (if applicable) and Wisconsin NRCS Field Office Technical Guide, Section IV, (WI FOTG) Conservation Practice Standard 484, Mulching.

4. Nutrient and Soil Amendment Requirements

When seeding *introduced species*, soil fertility and pH level will be amended to satisfy the needs of the plant species to be established. Fertilizer and lime recommendations will be determined by a soil test, and all nutrients will be applied following WI FOTG Standard 590, Nutrient Management. If no soil test is available, apply a minimum of 150 pounds of 20-10-10 fertilizer and 2 tons of 80-89 lime or equivalent per acre. Soil amendments may be waived at the discretion of a certified conservation planner. The basis for waiving the use of soil amendments shall be documented in the client's case file.

For establishment of *native species*, use of soil amendments are not required.

5. Seedbed Preparation

Prior to planting into cropland fields, verify that herbicides previously applied to the site will not "carry over" and damage the new seeding.

Site preparation shall be adequate to assure weed suppression and to promote germination and growth of the species planted.

Planting equipment type, use, and timing shall be appropriate for the site conditions, soil characteristics, and type of seeds (size, etc.) selected to assure uniform placement and germination.

Refer to Wisconsin Agronomy Technical Notes 5 and 6 for detailed guidance for specific situations.

6. Mulching, Temporary Cover, and Companion Crop

Mulching, temporary cover, and companion crops are vital practices utilized to support the establishment of a critical area planting. Temporary cover and companion crops suppress weed growth and limit soil erosion during the establishment period. Use depends on the site conditions, method of planting, and seed mixture.

For further details on mulching, temporary cover and companion crop recommendations, refer to Wisconsin Agronomy Technical Notes 5 and 6.

B. Criteria for Seed Mixture Development

Seeding rates are based on seeds per square foot of Pure Live Seeds. Refer to Tables 3 and 4 for common species and seeding rates.

Additional approved species for critical area planting can be found in Wisconsin Agronomy Technical Notes 5 and 6. Species not listed in the technical notes must be approved in advance by the State Agronomist.

a. Introduced Grass and Legume Plantings on Critical Sites

Custom and standard mixtures will comprise of at least 50 percent grass seed, consisting of at least 25 percent sod forming grass seed per square foot.

A minimum of 160 seeds per square foot is required for either a solid stand of grasses or a combination of grasses and legumes. Increase seeding rate by 15 percent when dormant seeding occurs.

Standard mixes listed in Table 5 will meet the minimum seed mixture criteria.

b. Native Herbaceous Plantings on Critical Sites

Native species are generally not recommended for critical area plantings due to their slow establishment and because they are clump grasses, not the preferred sod-forming grasses. Native plantings are not permitted in concentrated flow channels.

1) A minimum of 60 seeds per square foot for solid native grass plantings is required.

2) For native grass and forb/legume mixtures, a minimum of 40 seeds per square foot of grass and a minimum of 20 seeds per square foot for the forb/legume component is required. The minimum of 20 forb/legume seeds per square foot is not required when the solid stand native grass mixture comprise of 60 grass seeds per square foot is utilized.

Canada/Virginia wildrye and sideoats grama shall not exceed a maximum of 20 percent of the required grass seeds per square foot in custom seed mixtures.

C. **Additional Criteria to Stabilize Stream Channel Banks and Shorelines**

Wisconsin FOTG Standard 580, Streambank and Shoreline Protection, shall be used to stabilize the toe and/or bank hydrologic zones before vegetation establishment.

1. Bank and Channel Slopes

Identify, mark, and protect desirable existing vegetation during practice installation.

On sites with a disturbed soil profile, topsoil will be stockpiled and spread over areas to be planted as needed to meet planting and land shaping needs.

Channel side slopes shall be shaped to a stable slope to facilitate establishment and maintenance of desired vegetation.

Slopes steeper than 2H:1V shall not be stabilized using vegetation alone. A combination of vegetative and structural measures will be used on these slopes to ensure adequate stability.

Grazing shall be permanently excluded on high hazard sites, such as cut banks, areas of seepage or other potentially unstable areas.

2. Species Selection

Plant material used for this purpose shall:

- be adapted to the hydrologic zone into which they will be planted.
- be adapted and proven in the regions in which they will be used.
- when mature, produce plant communities that are compatible with those already existing in the area.
- protect the channel banks but not restrict channel capacity.

D. Additional Criteria to Stabilize Areas of Erosion By Wind and Water

1. The amount of plant biomass and cover needed to reduce wind and water erosion to the planned soil loss objective shall be determined using the current approved wind and/or water erosion prediction technology.

2. Do not use tillage where desirable vegetation is already present or where soil disturbance will increase the potential for erosion or cause sedimentation to environmentally sensitive areas.

3. Use a companion crop as added protection.

E. Additional Criteria to Rehabilitate and Revegetate Degraded Sites That Cannot Be Stabilized Using Normal Establishment Techniques

Slope Stabilization

1. On sites that are too steep for regular seeding equipment to operate, the use of hydroseeding and mechanically blown mulch is recommended. For more information regarding hyrdoseeding, refer to Wisconsin Agronomy Technical Note 6.

2. Grade to a stable slope when shaping and eliminate all overfalls. For slopes steeper than 2H:1V, enhanced stabilization activities such as soil bioengineering may be required. These practice concepts shall follow approved design procedures located in the NRCS Engineering Field Handbook, Chapter 18.

3. The toe of the slope, or the outlet of the concentrated flow channel, shall be stable before attempting seeding on the slope.

4. Concentrated flow may need to be diverted from the critical area during the establishment period.

5. All gullies and deep rills will be filled and leveled during seedbed preparation.

6. A minimum of 4 inches of friable soil material or topsoil shall be added and mixed to exposed rocky, sandy, gravelly, shaley material, or extremely fine textured subsoil.

7. Sod placement shall be limited to areas that can naturally supply needed moisture or sites that can be irrigated during the establishment period.

8. Sod will be placed and anchored using techniques to ensure that it remains in place until established.

Figure 1
Planting Zones

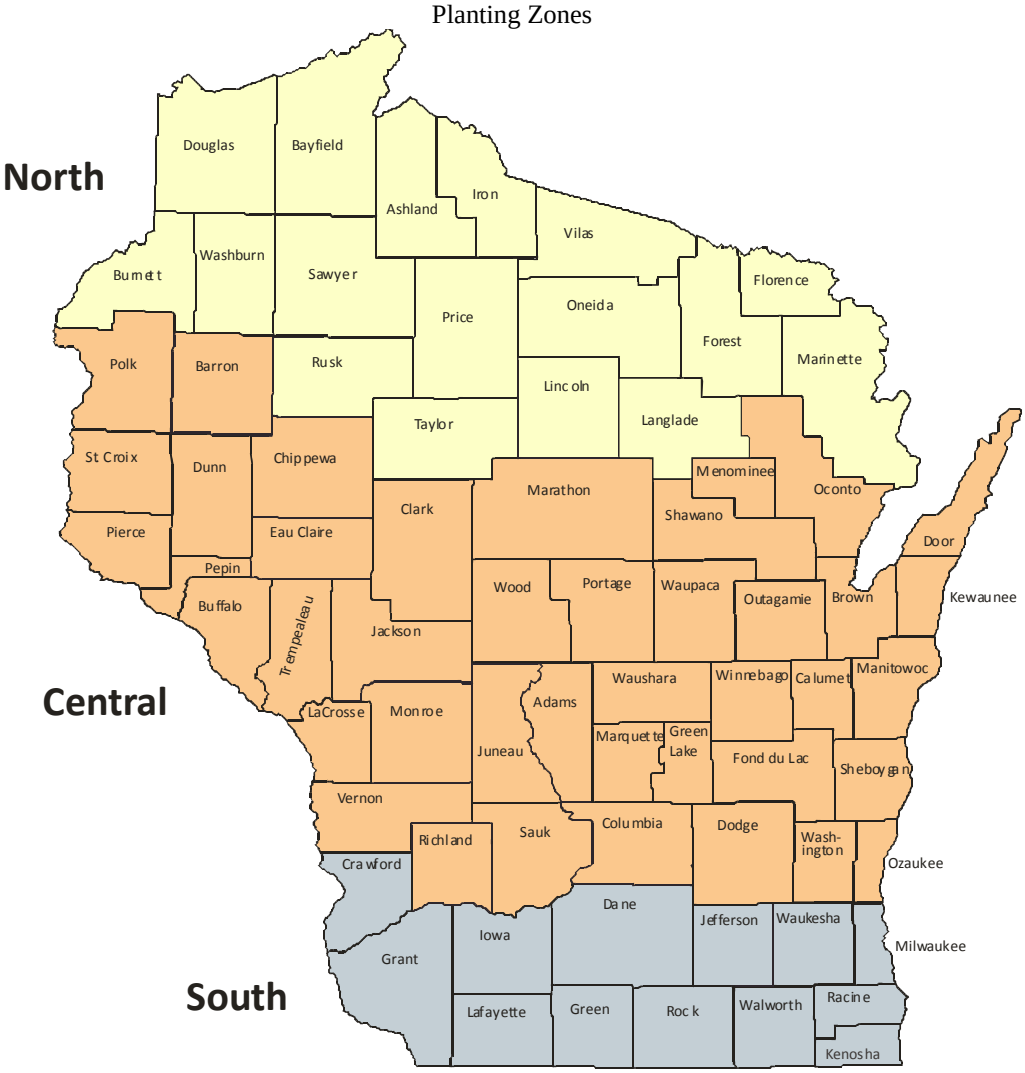


Table 1
Seeding Date/Ranges for Native Mixtures and Companion Crops

Zone	Spring Seeding
Northern	Thaw - 7/15
Central	Thaw - 6/30
Southern	Thaw - 6/30

Table 2
Seeding Date/Ranges for Introduced Grasses, Legumes, and Companion Crops

Planting Zone	Spring	Late Summer	Dormant
North	5/1 - 6/15	7/15 - 8/10	11/1 - Freeze up
Central	4/15 - 6/1	8/1 - 8/21	11/1 - Freeze up
South	4/1 - 5/15	8/7 - 8/29	11/1 - Freeze up

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. Minimize activities which disturb wildlife during the primary nesting season May 15 through August 1.

B. Consider seeding at a lower rate and making 2 passes to ensure uniform coverage. Check seed boxes regularly to ensure even distribution.

C. Heavy traffic and/or compacted soil areas may need special site preparation prior to seeding.

D. Sprigs, root stocks, crowns, cones, culms, and sod may be considered where appropriate to accelerate the establishment of cover.

E. Woody shrubs or trees may be used only after initial stabilization. Plant in accordance with the purpose of the planting. See WI FOTG Standards 612, Tree/Shrub Planting; and 580, Streambank and Shoreland Protection. Also see NRCS Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection and Chapter 18, Soil Bioengineering for Upland Slope Protection.

F. Consider using carriers such as vermiculite, sawdust, and soybean meal to increase volume and weight for uniform seed distribution.

G. Consider limited or no use of herbicides one year prior to seeding. If herbicides must be used, ensure there is no potential for carryover and follow label recommendations. Follow WI FOTG Standard 595, Integrated Pest Management, for pesticide use and safety.

H. Consider sodding to establish vegetation on steep slopes. For further details on this special erosion control measure, refer to Wisconsin Agronomy Technical Note 6.

I. Consider establishing a buffer of trees and/or grasses next to intermittent or perennial streams.

J. Consider planting native vegetation and/or local *genotypes* when restoring riparian corridors to its pre-settlement conditions.

K. High seed counts per square foot much above the recommended minimums may lead to excessive competition and poor establishment of some species. Seeds per square foot should not exceed 25 percent of the minimum requirement, with the exception of mixtures designed for wet mesic and wet sites.

L. Consider the use of *soil bioengineering* techniques to arrest and prevent slope failures and erosion. For approved design procedures, refer to Chapter 18 of the NRCS Engineering Field Handbook (EFH).

M. Consider alternatives to reduce or eliminate the delivery of sediment and associated pollutants into the riparian zone by implementing upland treatment practices.

VII. Plans and Specifications

Prepare plans and specifications for each field or management unit according to the Criteria and Operation and Maintenance sections of this standard. Specifications shall describe the requirements for applying this practice to meet the intended purpose using the appropriate specification and/or job sheets. The following elements shall be addressed in the plan, as applicable, to meet the intended purpose.

- Site preparation.
- Fertilizer application.
- Methods of seeding/planting.
- Selection of species.
- Analysis of seed quality.
- Seeding rate (adjusted based on pure live seed calculations).
- Target number of plants per square foot after emergence.
- Mulching (if applicable).
- Temporary cover (if applicable).
- Companion crop (if applicable).
- Weed control activities during the establishment period.

Specifications shall be recorded using Wisconsin Job Sheets 134, How to Establish and Maintain Introduced Grasses and Legumes; and 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes.

VIII. Operation and Maintenance

A. Noxious weeds and other undesirable species must be controlled at all sites. During the first year, mow plantings at 14 to 21-day intervals or when weeds are 12-14 inches high and before the development of mature seed. Mowing height

should be 4 inches for introduced and 7 inches for native plants. Small grain companion crops should be mowed at boot stage and prior to heading. Spot spraying or hand pulling may be needed for some invasive species such as thistles and purple loosestrife.

B. Sites may require on-going periodic maintenance consisting of mowing, burning, or herbicide treatment.

C. Sites should be inspected periodically to ensure site stabilization objectives are being met.

IX. References

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Packard, S. and Mutel, C. 1997. The Tallgrass Restoration Handbook for Prairies, Savannas and Woodlands. Society for Ecological Restoration.

Rock, H. W. 1971. Prairie Propagation Handbook. Boerner Botanical Gardens.

USDA, NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook.

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

USDA, NRCS, Wisconsin Agronomy Technical Note 5, Establishing and Maintaining Native Grasses, Forbs, and Legumes.

USDA, NRCS, Wisconsin Agronomy Technical Note 6, Establishing and Maintaining Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 134, How to Establish and Maintain Introduced Grasses and Legumes.

USDA, NRCS, Wisconsin Job Sheet 135, How to Establish and Maintain Native Grasses, Forbs, and Legumes.

X. Definitions

Actual Adjusted Seeding Rates (V.A.2.) – an increase in seeds per square foot or pounds per acre, when the PLS is less than 100 percent.

Aspect (V.A.1.) – The exposure of the site to direct sunlight, prevailing winds, and other factors that influence plant growing conditions. For example, a north slope tends to be cooler and moister while a south-facing slope tends to be drier and warmer.

Soil Bioengineering (VI.L.) – Practice of combining mechanical, biological, and ecological concepts to arrest and prevent shallow slope failures and erosion.

Certified Seed (V.A.2.) – Seed that meets the standards established by the designated official seed certifying agency for the purpose of ensuring species/variety, species/varietal purity and mechanical quality. The Wisconsin Crop Improvement Association is the official seed certifying agency for Wisconsin.

Genotype (VI.J.) – A group of individual plants which share a specified genetic makeup. For example, all big bluestem plants that are genetically adapted to grow and mature in the climatic conditions found in the driftless region could be considered a genotype.

Introduced Species (V.A.4.) – Plant species that historically were not native to North America and were brought here from other parts of the world, for example, smooth bromegrass and alfalfa.

Native Species (V.A.4.) – Plants species that historically would have been found growing in North America such as big bluestem or green needle-grass.

Non-Certified Seed (V.A.2.) – Seed that is grown, processed, tested and labeled for species/variety and mechanical quality factors, but is not certified by an official seed certifying agency.

Pure Live Seed (PLS) (V.A.2.) – PLS is a means of expressing seed quality, based on the percentage of seed in a seed lot that is both pure and viable. PLS is calculated by multiplying the percentage of total viable seed (germination + hard seed + dormant seed) by the percentage of pure seed divided by 100.

Untested Seed (V.A.2.) – Seed that has no assurances of testing for species/variety and mechanical quality, i.e., species/variety purity, inert matter, other crop or weed seeds and germination potential. Untested seed legally cannot be labeled.

Table 3
Common Species and Seeding Rates for Critical Area Plantings

Common Name	Scientific Name	Moisture Regime	Single Species Seeding Rate (PLS) Lbs./Ac.	Seeds/Lb.	Seeds/Square Ft./Lb./Ac.
Native Grasses					
Big Bluestem[1]	Andropogon gerardii[1]	D, DM, M, WM	11	165,000	3.8
Canada Wild Rye	Elymus canadensis	DM, M, WM	12	83,200	1.9
Indian Grass[1]	Sorghastrum nutans[1]	D, DM, M, WM, W	10	192,000	4.4
Little Bluestem	Schizachyrium scoparium	D, DM, M	8	240,000	5.5
Prairie June Grass	Koeleria macrantha[1, 2]	D, DM, M	0.5	2,308,672	53
Sideoats Grama	Bouteloua curtipendula	D, DM, M	8	127,000	2.9
Switch Grass[1]	Panicum virgatum[1]	D, DM, M, WM, W	7	389,000	8.9
Virginia Wild Rye	Elymus virginicus	M, WM, W	17	67,200	1.5
Introduced Grasses					
Chewings Red Fescue[2]	Festuca rubra L. ssp. fallax[2]	D, DM, M	5	350,000	8
Creeping Red Fescue[1, 2]	Festuca rubra[1, 2]	DM, M, WM	5	350,000	8
Festulolium	Festuca x Lolium	DM, M, WM	10	227,000	5.2
Italian or Annual Ryegrass	Lolium perenne L. ssp. multiflorum	DM, M, WM	20	227,000	5.2
Kentucky Bluegrass[1, 2]	Poa pratensis[1, 2]	D, DM, M, WM, W	8	2,177,000	50
Orchard Grass	Dactylis glomerata L.	D, DM, M, WM	10	653,000	15
Perennial Ryegrass	Lolium perenne	DM, M, WM	20	227,000	5.2
Redtop[1, 2]	Agrostis gigantea[2]	M, WM, W	4	4,990,000	114.5
Smooth Bromegrass[1, 2]	Bromus inermis[1, 2]	D, DM, M, WM	20	136,000	3.1
Tall Fescue	Schedonorus arundinaceus	D, DM, M, WM	12	227,000	5.2
Timothy	Phleum pratense	DM, M, WM, W	8	1,230,000	28.2
Legumes					
Alfalfa	Medicago sativa	D, DM, M	12	219,000	5.0
Alsike Clover	Trifolium hybridum	M, WM, W	3	680,000	15.6
Birdsfoot trefoil	Lotus corniculatus	DM, M, WM, W	7	375,000	8.6
Red Clover	Trifolium pratense	DM, M, WM	10	275,000	6.3
White Ladino Clover	Trifolium repens	DM, M, WM	3	871,650	20

[1] Species approved for seeding individually at the recommended Pure Stand Rates based on Pure Live Seeds (PLS) depending on the erosiveness of the site.

It is required that at least 50% of the seeds per square foot of mixtures planted to introduced and native species on critical areas are composed of grasses, and 25% of the seeds per square foot are sod-forming grasses for introduced species.

If more than 20% of the legume seed is hard seed, increase the seeding rate for legumes by the percent of hard seed.

Seeds per square foot for a particular specie can be calculated by multiplying the number of seeds per pound of the specie by the rate of the specie in pound(s) per acre divided by 43,560 square feet.

[2] Sod-forming grass plants.

Table 4
Seeding Chart for Native Grass Species

Common Name	Scientific Name	Percent of Mixture	Pure Stand Seeding Rate	Seeds per Square Foot
Big Bluestem	Andropogon gerardii	0-100	11 lbs/ac	42
Canada Wildrye	Elymus canadensis	0-20	12 lbs/ac	23
Indian grass	Sorghastrum nutans	0-100	10 lbs/ac	44
Little Bluestem	Schizachyrium scoparium	0-20	8 lbs./ac	44
Sideoats Grama	Bouteloua curtipendula	0-20	8 lbs/ac	23
Switchgrass	Panicum virgatum	0-100	7 lbs/ac	63
Virginia Wild Rye	Elymus virginicus	0-20	17 lbs/ac	26
Praire June Grass	Koeleria macrantha	0-20	0.5 lbs/ac	26
Hairy Grama	Bouteloua hirsuta	0-25	1 lb/ac	26

Canada Wild Rye, Virginia Wild Rye and Sideoats Grama when combined will not comprise of more than 20% of the total grass seeds per square foot. Pure stand seeding rates for Big Bluestem and Indiangrass must be increased by 5 lbs/acre to meet the minimum seeds per square foot as required by this standard. Refer to Table 3 for suggested moisture regimes per specie.

Table 5
Seeding Mixtures Suitable for Critical Area Plantings

Seed Calculator Code*	Moisture Regimes	Common Name	Scientific Name	Seeding Rate in lb/ac PLS	Seeding Rate in Seeds/Ft^2 PLS	Capacity Retardance	Type of Site**
342-1	*Dry-Mesic* and *Mesic* Sites	Smooth Bromegrass	Bromus inermis	10	31	B	EB, WW,CSB
		Creeping Red Fescue	Festuca rubra	3	24		
		Alfalfa	Medicago sativa	3	15		
		Red Clover	Trifolium pratense	3	19		
		Kentucky bluegrass	Poa pratensis	1.5	75		
342-2	Dry-Mesic and Mesic Sites***	Smooth Bromegrass	Bromus inermis	15	47	B	EB,WW
		Alfalfa	Medicago sativa	7	35		
		Timothy	Phleum pratense	3	85		
342-3	Dry-Mesic and Mesic Sites	Kentucky bluegrass	Poa pratensis	1	50	B	CSB, EB, WW
		Smooth Bromegrass	Bromus inermis	10	31		
		Timothy	Phleum pratense	2	56		
		Tall Fescue	Schedonorus arundinacea	2	10		
		Perennial Ryegrass	Lolium perenne	5	26		
342-4	Dry-Mesic and Mesic Sites	Smooth Bromegrass	Bromus inermis	20	62	B	EB, WW, CSB
		Creeping Red Fescue	Festuca rubra	5	40		
		Alfalfa	Medicago sativa	8	40		
		Red Clover	Trifolium pratense	4	25		
342-5	Dry-Mesic and Mesic Sites	Smooth Bromegrass	Bromus inermis	30	93	B	EB, WW, CSB
		Alfalfa	Medicago sativa	14	70		
342-6	Dry-Mesic, Mesic, and Wet Mesic Sites	Smooth Bromegrass	Bromus inermis	7	22	B	CSB, EB, WW
		Timothy	Phleum pratense	2	56		
		Creeping Red Fescue	Festuca rubra	1	8		
		Kentucky Bluegrass	Poa pratensis	1	50		
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
342-7	Mesic Sites***	Smooth Bromegrass	Bromus inermis	7	22	B	EB, WW
		Creeping Red Fescue	Festuca rubra	2	16		
		Kentucky bluegrass	Poa pratensis	3	150		
		Birdsfoot trefoil	Lotus corniculatus	2	17		
342-8	Mesic Sites***	Smooth Bromegrass	Bromus inermis	15	47	B	WW,EB
		Creeping Red Fescue	Festuca rubra	2	16		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-9	Mesic Sites***	Kentucky Bluegrass	Poa pratensis	3	150	C	WW,EB
		Creeping Red Fescue	Festuca rubra	4	32		
		Perennial Ryegrass	Lolium perenne	10	52		
342-10	Mesic Sites	Smooth Bromegrass	Bromus inermis	14	43	B	EB, WW, CSB
		Timothy	Phleum pratense	3	85		
		Red Clover	Trifolium pratense	3	19		
		Perennial Ryegrass	Lolium perenne	4	21		
342-11	Mesic Sites	Smooth Bromegrass	Bromus inermis	32	99	B	EB, WW
		Creeping Red Fescue	Festuca rubra	8	64		
342-12	Mesic Sites	Kentucky bluegrass	Poa pratensis	4	200	C	EB, WW
		Creeping Red Fescue	Festuca rubra	3	24		

Seed Calculator Code*	Moisture Regimes	Common Name	Scientific Name	Seeding Rate in lb/ac PLS	Seeding Rate in Seeds/Ft^2 PLS	Capacity Retardance	Type of Site**
342-13	Mesic Sites	Smooth Bromegrass	Bromus inermis	14	43	B	EB, WW, CSB
		Timothy	Phleum pratense	4	113		
		Red Clover	Trifolium pratense	3	19		
342-14	Mesic Sites	Smooth Bromegrass	Bromus inermis	15	47	B	EB, WW, CSB
		Timothy	Phleum pratense	3.5	99		
		Alsike Clover	Trifolium hybridum	2	32		
342-15	Mesic Sites	Smooth Bromegrass	Bromus inermis	15	47	B	EB, WW
		Timothy	Phleum pratense	3.5	99		
		Birdsfoot trefoil	Lotus corniculatus	3	26		
342-16	Wet Mesic Sites	Tall Fescue	Schedonorus arundinacea	5	26	B	CSB, EB, WW
		Timothy	Phleum pratense	3	85		
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
		Smooth Bromegrass	Bromus inermis	6	19		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-17	Wet Mesic Sites	Redtop	Agrostis gigantea	1	115	C	WW, CSB, EB
		Timothy	Phleum pratense	3	85		
		Red Clover	Trifolium pratense	5	32		
342-18	Wet Mesic Sites	Timothy	Phleum pratense	3	85	B	WW, CSB, EB
		Perennial Ryegrass	Lolium perenne	3	16		
		Red Clover	Trifolium pratense	3	19		
		Smooth Bromegrass	Bromus inermis	6	19		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-19	*Wet Mesic* Sites	Redtop	Agrostis gigantea	1	115	C	WW,CSB, EB
		Timothy	Phleum pratense	1	28		
		Red Clover	Trifolium pratense	4	25		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-20	*Wet* Sites***	Redtop	Agrostis gigantea	2	229	C	WW
		Alsike Clover	Trifolium hybridum	2	31		
		Kentucky Bluegrass	Poa pratensis	2	100		
342-21	Wet Mesic Sites	Redtop	Agrostis gigantea	3	344	C	WW
		Alsike Clover	Trifolium hybridum	3	47		

*These codes represent the mixtures used in the Wisconsin Seed Calculator.
**EB = Embankments; WW = Waterways; CSB = Channel and Streambanks
***Mixtures can be used on other site descriptions when not listed.

United States Department of Agriculture
Natural Resources Conservation Service

Wisconsin Agronomy Technical Note 5

Establishing and Maintaining Native Grasses, Forbs and Legumes

INTRODUCTION

This technical note may be used to guide prairie restoration seedings for the purposes of Wisconsin Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG) Conservation Practice Standards 327, Conservation Cover; 645, Wildlife Upland Habitat Establishment; 512, Forage and Biomass Planting, and occasionally 342, Critical Area Planting. Other ecological science and certain engineering standards may refer to this technical note. Each standard has a specific purpose and requirement for vegetation establishment.

BACKGROUND

A prairie is a diverse plant community characterized by the number of grass, legume, shrub, and forb species. In Wisconsin, a typical prairie averages six species per square foot. Exceptionally rich sites can average as many as eight species per square foot. High quality remnants of original prairie can harbor 40 to 80 species per acre.

Prairie restoration is the art and science of reconstructing a diverse native plant community. Constructing an exact copy of the tall grass prairie plant community is not very likely. However, the more common components of the prairie can be established and will evolve into a prairie with many of the same visual and ecological components of a natural undisturbed prairie.

The vast majority of native herbaceous plants are warm season species with the exception of a few cool season native grasses and forbs. Warm season plants (C4) produce most of their annual biomass during hot summer months from late June through early September. The growth of this group of plants does not begin until the minimum air temperature reaches 60 to 65 degrees Fahrenheit and soil temperatures reach 50 degrees Fahrenheit. Optimum biomass production occurs when daytime temperatures elevate to 85 degrees Fahrenheit. At higher temperatures C4 plants have a greater potential photosynthetic rate and use nitrogen and phosphorus more efficiently. Native plants survive and adapt better than introduced species under conditions of high temperatures.

TABLE OF CONTENTS

LIST OF TABLES

SITE ASSESSMENT

Prairies are generally divided into five soil moisture regimes: Wet, Wet-Mesic, Mesic, Dry-Mesic, and Dry. There is often no sharp division between moisture regimes and one group may blend into another or multiple groups and should be considered when planning a successful prairie.

Some plant species are restricted to certain soil moisture regimes, while other plant species can be present on several if not all of the soil moisture regimes.

Wet organic soils are the most challenging when establishing most native plant species due to site conditions as well as competition from cool season and invasive plants. Wet organic soils pose issues with management activities such as mowing and spraying in a timely manner, a prerequisite to a successful planting.

PRAIRIE SOIL MOISTURE REGIMES AND SITE CONDITIONS

Wet Prairie

Wet prairies occur on mineral soils with poor drainage. They can also be found on some frequently flooded sites.

Wet-Mesic

Wet-Mesic Prairies are transitional between Wet Prairie and Mesic Prairies. Most Wet-Mesic Prairies occur on somewhat poorly drained mineral soils.

Mesic Prairie

Mesic Prairies will be found on most moderately well and well drained mineral soils that have moderate to very high Available Water Capacity. Mesic Prairies may occur on some somewhat poorly drained soils with low or very low Available Water Capacity or perched water tables.

Dry-Mesic Prairie

Dry-Mesic Prairies are transitional prairies between Dry Prairie and Mesic Prairie. They occur on some somewhat excessively drained and some well drained soils.

Dry Prairie

Dry Prairies occur mostly on well to excessively drained soils.

SPECIE SELECTION AND SEED QUALITY INFORMATION

- Evaluate the winter hardiness of species being selected for planting.
- Species identified as restricted or prohibited shall not be planted.
- Plant all the desired species at one time.
- Select species based on the site conditions for soil type and moisture regime.
- Seed as many forbs from the appropriate tables in this technical note as the budget will allow.
- If the objective is to create pollinator habitat, select species so that the prairie will be in flower throughout the growing season. Select at least three species from each bloom period (early, mid, late).
- Bunch grasses are recommended when pollinator habitat is planned.
- Due to the aggressive nature of the following plants, it is recommended to limit the seeding rates of the following species:
  - June Grass (2 oz/ac or 7 seeds/sq. ft.)
  - Switchgrass (16 oz/ac or 9 seeds/sq. ft.)
  - Blackeyed Susan (2 oz/ac or 5 seeds/sq. ft.)
  - Purple Coneflower (3 oz/ac or 2 seeds/sq. ft.)
  - Bergamot (2 oz/ac or 4 seeds/sq. ft.)
- Legumes must be inoculated with the appropriate bacteria for the specific species being planted. Inoculant must not be exposed to sunlight or allowed to dry out prior to planting native legumes.
- If more than 20 percent of the legume seed is hard seed, increase the seeding rate for legumes by the percent of hard seed in the seeding mixture.
- When using Standards 327, Conservation Cover; and 342, Critical Area Planting, Canada and Virginia Wildrye and Sideoats Grama, when combined, will not comprise of more than 20 percent of the total grass seed per square foot.
- The minimum seeding requirements are based on seeds per square foot.
- Increase seeds per square foot by 15 percent when dormant and frost seeding occurs.
- Use non-sod forming grass species in locations where shrubs and trees are planned.
- Where an existing native remnant prairie is near a planting site, it may be desirable to use locally harvested genotype seed. If this seed is

harvested locally it may be difficult to test for germination or purity in order to determine PLS. The use of locally harvested untested seed for USDA program participants must be approved by the Wisconsin NRCS State Agronomist.

- The order of preference for seed source selection is:

  1. Local genotypes.
  2. Genotypes from the same latitude.
  3. A named variety from the same latitude.
  4. Other named varieties.

- Use of local genotypes is the first preference because plants grown on or near the restoration site will be best adapted to the conditions of the site. It is especially important to use local genotypes when working with remnant prairies; introducing species from other areas may contaminate the local native plant gene pool.
- Seed purchased should be harvested within a 250 mile radius of the area where the planting will occur.
- Ideally, 40 percent of the total seeds per square foot should consist of forbs and or legumes.
- Below are species with multiple scientific names. The underlined specie is the most recognized genus and specie in Wisconsin and is referenced in vegetative Standards 327, Conservation Cover; 342, Critical Area Planting; and 512, Forage and Biomass Planting.

  – **False Boneset:** Brickellia eupatorioides, Kuhnia eupatorioides

  – **Great St. John's Wort:** Hypericum ascyron, Hypericum pyramidatum

  – **Heath Aster:** Symphyotrichum ericoides, Aster ericoides

  – **Joe-Pye Weed:** Eutrochium maculatum, Eupatoriadelphus maculates and Eupatorium maculates

  – **Porcupinegrass:** Hesperostipa spartea, Stipa spartea

  – **Silky Aster:** Symphyotrichum sericeum, Aster sericeus

  – **Smooth Blue Aster:** Symphyotrichum laeve, Aster laevis

  – **Softstem Bulrush:** Schoenoplectus tabernaemontani, Scirpus validus

  – **Stiff Goldenrod:** Oligoneuron rigidum, Solidago rigida

  – **Upland Boneset/Tall Boneset**: Eupatorium sessifolium, Eupatorium altissimum

  – **Wild Quinine:** Parthenium integrifolium, Parthenium auriculatum

Table 1
Recommended Varieties of Warm Season Grasses

Specie	Variety	Area of Adaptability
Big Bluestem	Bison	North
	Bonilla	Central
	Champ	South
	Pawnee	South
	Rountree	Central and South
Indiangrass	Holt	Central and South
	Rumsey	South
	Tomahawk	North
Switchgrass	Blackwell	South
	Cave-in-Rock	South
	Dacotah	North
	Forestburg	Central
	Nebraska 28	Central
	Pathfinder	South
	Sunburst	Central
	Trailblazer	South
Little Bluestem	Blaze	Statewide
	Aldous	South
	Camper	Central and South

PURE LIVE SEED (PLS)

PLS is a means of expressing seed quality. PLS is the percentage of seed (i.e. good viable seed) that has the potential to germinate for a measured one pound weight of any seed lot. Nearly all species recommended for conservation plantings by NRCS uses Pure Live Seed (PLS) expressed in pounds or ounces per acre which is calibrated to seeds per square foot as the basis for the calculation of seeding rates. PLS provides a basis for comparing the quality of seed lots of the same species that differ in purity and germination. PLS is calculated by multiplying the purity percentage by the total germination percentage.

Seeding rates in this Technical Note are shown in pounds or ounces of Pure Live Seed (PLS) and is calibrated to seeds per square foot. All seed shall be of high quality and labeled in accordance as required by the Wisconsin Seed Law. Seed should always be

purchased on a PLS basis. Seed tags should specify the percentage of Total Viable Seed (TVS) germination/dormant/hard and purity to determine the correct seeding rates as specified in the seeding plan.

Example: Pure Live Lupine seed

	Pure Seed:	99.93%
	Inert Matter:	0.06%
	Other Crop:	0.01%
Lupine	Weed Seeds:	0.00%
Lupinus perennis	Germination:	11.00%
Harvest ID: 018040-01	Hard Seed:	0.00%
Test Date: 2/24/2012	Dormant Seed:	85.00%
	Tetrazolium:	0.00%
Name and # of Noxious Seed:	NONE FOUND	

Pure seed x TVS = PLS
99.93% x 96.0% = 95.9%

The PLS for Lot Number 018040-01 is 95.9.

CRITERIA FOR SEED MIXTURE DEVELOPMENT

Seed mixtures developed from this section will be composed of a grass component only or a grass and forb/legume component, depending on the standard criteria and purpose of the planting.

It is important to reference program rules when determining seed mixtures. Some programs have preapproved required mixtures to meet program and cost requirements.

STANDARD 327 CONSERVATION COVER

NATIVE OR WARM SEASON PLANTINGS

1. Basic Prairie Plantings

   - A minimum of 3 grasses seeded at a minimum rate of 20 grass seeds per square foot and a minimum of 3 forbs and or legumes seeded at a minimum rate of 2.0 seed per square foot.

2. Restoration of Native Prairie Plantings

   - A minimum of 5 grasses consisting of a minimum of 15 grass seeds per square foot and a minimum of 10 forbs comprising of at least one legume in the mixture amounting to a minimum of 8 seeds per square foot.

3. Untested Local Genotype Seed

The use of local genotype seed for USDA program seedings must be approved by the NRCS State Agronomist. Approval will only be considered for sites where the use of local genotype seed is necessary to address or maintain the ecological value of an area as identified in a NRCS conservation plan or similar planning document.

In order to obtain the highest quality seed possible:

- The harvesting of seeds will be supervised by someone experienced in the harvest of native seeds.
- All seed will be cleaned.
- Seed will be separated and properly stored by specie so that it can be mixed later at the planned rates.
- Collected seed will be tested for germination and viability unless a variance is granted by the NRCS State Agronomist.
- Use the following guidance for locally collected prairie seed that is untested.

a) Seed will be planted at a minimum seeding rate of 50 seeds per square foot. Limit seeding rates so that one specie does not comprise more than 20 percent of the seeds/square foot. When a specie is seeded at a seeding rate so that its number of seeds planted per square foot makes up more than 20 percent of the total planted seeds per square foot; only the seeds per square foot that fall within the 20 percent requirement will be counted toward the total required number of seeds per square foot.

   The seeding rate of plant species known to germinate aggressively in new plantings such as Switchgrass, Purple Cone Flower, Blackeyed Susan and Bergamot shall be limited to 15 percent or less of the total seed per square foot planted.

b) At least 25 seeds per square foot must be native grasses or sedges and a minimum of 10 seeds per square foot of forbs and legumes.

c) At least five species of grasses and 10 species of forbs and at least 1 legume must be seeded. In situations, where the number of species required are unavailable during the harvest of untested genotype, the

mixture may be supplemented with certified pure live seed to satisfy this requirement.

d) A final list of the species planted and the ounces of each specie actually planted must be provided to the NRCS office for review and approval.

4. Pollinator Herbaceous Plantings

- At least 1 and a maximum of 2 bunch grass species seeded at a maximum rate of 10 seeds per square foot and a minimum of 9 forbs and or legumes consisting of at least 3 species from each bloom period (early, mid, late) seeded at a minimum rate of 30 seeds per square foot.

Short bunch grasses are preferred over tall bunch grasses.

Recommended short bunch grasses are: Sideoats Grama, Prairie Junegrass, Little Bluestem, Woolgrass, and Prairie Dropseed.

Recommended tall bunch grasses are: Switchgrass, Indiangrass and Big Bluestem.

STANDARD 512 FORAGE AND BIOMASS PLANTING

5. Warm Season Pasture and Hayland Plantings

- The minimum seeds per square foot by specie is as follows: Big Bluestem (42), Indiangrass (44), Switchgrass (63).

For pasture and hayland purposes, warm-season grasses will be established in stands of single species only.

6. Warm Season Biomass Plantings

- Switchgrass is currently the only approved specie for biomass production in Wisconsin. The minimum seeding rate is 63 seeds per square foot.

STANDARD 342 CRITICAL AREA PLANTING

7. Native Herbaceous Plantings on Critical Sites

- A minimum of 60 seeds per square foot for solid native grass plantings is required.
- For grass and forb/legume mixtures, a minimum of 40 seeds per square foot for the grass component and a minimum of 20 seeds per square foot for the forb/legume component is required. The minimum of 20 forb/legume seeds per square foot is not required when native grass seed per square foot is greater than or equal to 60.

Native species are generally not recommended for critical sites due to slow establishment and because native plants grow in clumps and are not sod forming.

SEEDING DATES

Native plantings can be seeded either late fall, winter(frost seeding) or spring .

Warm season plants require a soil temperature of at least 50 degrees Fahrenheit before they will germinate. Spring is the traditional time to seed these plants and plantings are successful when recommendations are followed. Spring conditions favor warm season grasses over forbs and legumes. Under normal spring conditions moisture conditions are considered ideal or adequate.

If site conditions in the spring are not adequate due to weather, fall seedings offer an excellent opportunity for seeding native species. Fall seedings favor forbs due the cold weather stratification. The majority of forbs are stratified before purchase of seed. Fall seeding of natives in Wisconsin is considered a dormant seeding and must be seeded after the growing season has ended to ensure that the seed does not germinate before freeze up.

Frost seeding in late winter is permissible in Wisconsin and has been proven successful. These seedings are made in late winter, mid-February to early March during the freeze and thaw cycle. Seedings should not occur when snow cover is greater than 2 inches. Frost seeding timeframes will vary according to weather conditions and from year to year.

Seeding shall be carried out within the dates specified for the appropriate planting zone. See **Figure 1** and **Table 2** to determine the recommended seeding dates.

Seeding outside of the established dates may be approved by the NRCS State Agronomist or Area Resource Conservationist. All variance requests shall provide documentation of the current soil moisture conditions and proposed timeframes for seeding to be completed.

TEMPORARY COVER AND COMPANION CROPS

Temporary Cover

All land will be established to permanent vegetative cover during the first year of the land use conversion when possible. Temporary cover, during the first year, may be used if: 1) required seeds or plant stock are not available, 2) the normal planting period for species has passed or 3) where chemical residue will not allow establishment of permanent cover immediately. If temporary cover is used, the permanent vegetative cover must be established by the end of the normal planting period of the following year.

Temporary Seeding Recommendations

1. Fields where planting is delayed due to lack of suitable seed or late planting, select one of the following species:

   - Forage sorghum – ½ bu./ac. (5/15 - 7/15
   - Sorghum - Sudangrass hybrid – 1 bu./ac. (5/15 - 7/15)
   - Sudangrass – 1 bu./ac. (5/15 - 7/15)
   - Winter wheat - 2 bu/ac. (8/1-10/1)
   - Winter cereal rye - 2 bu/ac. (8/1-10/15)
   - Oats - 2 bu/ac. (4/1-9/1)
   - Annual ryegrass - 20 lbs/ac. (4/1-9/1)

   A temporary cover will typically not be necessary on those areas where at least 50 percent of the ground is covered with either crop residue or vegetative cover.

   Temporary cover crops must be clipped or destroyed before plants develop a viable seed, preventing excessive competition to the permanent seeding. Winter wheat and winter cereal rye must be terminated by tillage or herbicides before planting the permanent seeding.

2. For fields with triazine herbicide carryover, select one of the following species:

   - Forage sorghum – ½ bu./ac. (5/15 - 7/15)
   - Sorghum - Sudangrass hybrid – 1 bu./ac. (5/15 - 7/15)
   - Sudangrass – 1 bu./ac. (5/15 - 7/15)

   A bioassay test may be used to better determine chemical carryover.

Companion Crops

Companion crops can be used to reduce the amount of erosion on critical sites. The companion crops listed below are compatible with most native grass and forb plantings; will grow quickly under cooler conditions, suppress weeds and will not compete with the slower growing grasses and forbs.

Canada wildrye (*Elymus canadensis)* for mesic sites or Virginia wildrye (*Elymus virginicus)* for wet sites can be seeded at a rate of 1.0 pound PLS/acre. In addition, sideoats grama (*Bouteloua curtipendula)* can be seeded as a companion crop at a rate of 1.0 - 2.0 pounds PLS/acre on dry to dry mesic and mesic sites.

Sideoats grama or the wildrye species seeded as companion crops for the purpose of wildlife habitat and critical area plantings can be counted toward the minimum seeds per square foot, up to 20 percent of the required grass seed per square foot.

Oats (2 bu/ac) can be used as an alternative companion crop and is recommended on critical erosive sites that can be mowed before boot stage. Winter wheat or winter cereal rye is not the preferred companion crop due to the aggressive tillering nature of these plants.

SPECIAL EROSION CONTROL MEASURES

Since warm-season plants may be slow to establish, special erosion control measures will be needed on certain sites due to landscape conditions.

- Temporary cover crops may be seeded to obtain the required cover, prior to seeding.
- Seed site using no-till seeding methods.
- Divert surface water from location until vegetation has been established.
- Tillage and planting should occur on the contour only.
- Increase seeding rates by 25 percent to expedite cover establishment.
- Surface apply a mulch or solid manure on critical areas.
- Use a small grain companion crop.
- Plant species identified as aggressive in this technical note located in the section “Specie Selection and Seed Information”.

Figure 1
Planting Zone Map

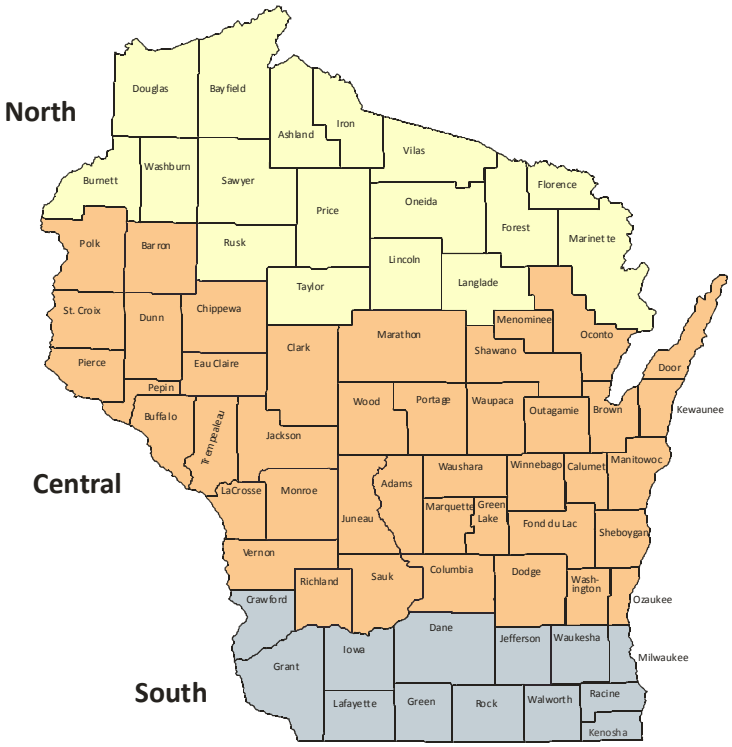

Table 2
Seeding Date/Ranges for
Warm Season Native Mixtures

Zone	Spring Seeding	Fall Dormant Seeding*
Northern	Thaw - 7/15	10/8 - Freeze Up
Central	Thaw - 6/30	10/15 - Freeze Up
Southern	Thaw - 6/30	10/20 - Freeze Up

*Dormant seeding is not allowed when using Practice Standard 342, Critical Area Planting.

GENERAL PRE-PLANT SEEDING RECOMMENDATIONS

Pre-Planting Weed Control

Pre-plant weed control is a critical step in the establishment of native plant materials. Weeds compete with seedlings for moisture, light and nutrients. Inadequate weed control causes more stand failures than any other single factor. Ideally, 6 months to a year prior to planting native species, consider this window as a pre plant weed control year. During that year a concerted effort should be made to control persistent perennials such as Canada thistle or knapweed. During the pre-plant weed control time period, evaluate the seed bed for the presence of weed seedlings. Where a significant number of weeds or invasive plants emerge consider tillage summer fallow, herbicide summer fallow, or a combination of tillage and herbicide summer fallow. Herbicide summer fallow is recommended for sites prone to erosion. For sites not susceptible to erosion, tillage or in combination with herbicide are recommended. The most effective strategy involves the integrated use of two or more weed control activities during the same growing season. Perennial weeds cannot be controlled effectively with herbicides after natives are planted.

Herbicide Carryover

Prior to planting check to ensure that any herbicides used on the previous crop will not “carry over” and

negatively impact newly seeded prairie plants. Residues of some herbicides such as Atrazine may prevent the establishment of some native plant materials for up to two years. If the residual effects of herbicides are possible, delay planting until after the recommended interval to allow residual herbicide levels to dissipate.

Fertilizing

For establishment of native species, soil testing and application of soil amendments is not a requirement; however, for maximum forage production (nutritional forage quality) and maximum biomass production for bio-energy, the application of nutrients will be based on the guidelines below.

The recommendations in this section are based on native grasses planted for hay, pasture, biomass production, and not for wildlife purposes. For pasture and hay land plantings of natives, a soil test is recommended prior to establishing vegetation. A current soil test is defined as test results no older than 4 years from the time last tested to the date of the planned seeding. Guidelines for soil testing can be found in Publication A2100, Sampling Soils for Testing. All nutrients will be applied following Wisconsin NRCS FOTG, Section IV, Standard 590, Nutrient Management.

Nitrogen should not be applied to warm season plantings until the second growing season to avoid stimulating weed growth. Applications of nutrients should not be made until spring growth has reached four to six inches.

Seedbed Preparation

When native materials are planted into undisturbed ground, the crop residue should be uniformly distributed over the soil surface prior to planting to minimize the smothering of new seedlings and to provide conditions for the operation of planting equipment. Planting native material into undisturbed soybean residue is preferred. Soybeans produce a moderate amount of crop residue that can be effectively managed and tend to leave the soil in a mellow condition that is well suited to no-till planting of prairie plants. Native material planted into undisturbed corn residue has proven successful at times. It is recommended that soil disturbance is necessary to ensure uniform germination by exposing soil, orienting and burying the corn residue, leaving 50-70 percent residue prior to planting.

Ground that has been tilled will require a firm seedbed prior to planting. A firm seedbed is important when planting native material. A firm seedbed helps conserve moisture evenly and ensures good seed to soil contact. Recently tilled ground should be firmed with a roller packer. The seedbed is firm enough when a footprint penetrates ¼ to ½ inch deep.

Sites tilled and packed are normally in a suitable condition for most seeding methods and with most types of native seed planters.

Seeding into existing sod will present special challenges. While the root and top growth of the old vegetation provide excellent erosion control, this biomass can make it difficult to achieve good seed placement. When planting native material into existing sod comprising of introduced species, the introduced species should be totally eradicated. The options available for eradicating introduced species include: tillage, tillage and herbicide, burn and herbicide, grazing, and mowing. Anytime tillage is performed, a firm seedbed is strongly recommended.

Seedbed preparation for frost seeding must occur before freeze-up. The fall before seeding occurs, evaluate the seedbed conditions to ensure that the remaining crop residue is well distributed and soil surface is level following tillage. Packing is not necessary; the weight of winter precipitation such as rain, ice and snow will naturally pack the soil, firming the seedbed. Undisturbed soybean residue is an ideal scenario for frost seeding. Frost seeding should not occur on existing sod or undisturbed corn ground. The corn stubble must be fall tilled to bury at least 30 percent of the residue and expose soil followed by a leveling tool.

A site that contains a significant remnant native plant population, consideration should be given to managing the site that would favor maintaining the species rather than eliminating them and reseeding. Stand improvement of existing natives will require a management program that allows the new seedlings to become established while maintaining the existing vegetative stand. Options available include: mowing and removing the biomass and interseeding, burn and interseed with persistent mowing until new seedlings become established. These options will require patience and persistence.

Planting Equipment and Seeding Methods

The equipment used to seed native materials should provide a consistent rate of seed flow and place the seed at a uniform depth in close contact with the soil. The characteristics of some native seeds require the use of specialized equipment or modification of

standard agricultural equipment such as grain drills. Some native seed are awned, light, fluffy, smooth, small, large and irregular in shape. Little Bluestem, Indiangrass, Big Bluestem all have light fluffy chaffy seed. Switchgrass has a small hard seed that will have several hundred thousand seeds per pound and Eastern Gamagrass has a large irregularly shaped seed and has about 8,000 seeds per pound. Any of these seed characteristics can result in uneven rates of seed flow and undesirable skips in seed rows in standard gravity fed grain drills. This makes it extremely important for the producer to understand planting methods commonly used and the need to have specialized equipment available to properly plant native species.

Whether a person is using conventional or no-till seeding methods, planting depth for native seeds should not exceed ¼ of an inch in depth. Either technique will be successful if specific guidelines are followed. There are advantages and disadvantages for using either seeding method.

Conventional seeding normally entails seedbed preparation involving some degree of tillage. The new planting is established by broadcasting or drilling into a partial or clean seedbed. The advantages and disadvantages of conventional seeding methods are:

- Advantages: may incorporate nutrients and provide the opportunity to destroy perennial weeds.

- Disadvantages: soil erosion increases greatly, erosion can wash new seedlings out or sediment can bury them, higher field preparation cost, weed competition can be greater especially from annual weeds, the need of a companion crop for erosion control and reduce weed competition.

No-till seeding is the planting of grasses, forbs and or legumes in the absence of tillage using planting tools capable of drilling into an undisturbed soil surface, interseeding into existing herbaceous cover or prior year crop residue. The advantages and disadvantages of no-till planting are:

- Advantages: soil erosion is minimized, reduced energy usage, no companion crop required, greater moisture availability, can seed under adverse conditions, carbon sequestrating approves, and proper seed placement ensured.

- Disadvantages: increased herbicide use, no-till drill required, nutrients cannot be incorporated.

Drill Seeding

Drill seeding is probably the most commonly used method of planting seed of any type. Seed is metered out from multiple seed boxes containing specialized components to mix, stir and meter seed, each adapted to planting different seed types. The soil opening and planting operation is followed by a set of packers, with no further soil preparation after seeding is completed. Drills may be classified as conventional or no-till type. A prepared seedbed is needed when using a conventional planter or drill. A no-till type drill can operate under both disturbed and undisturbed site conditions.

Whether a conventional or no-till type drill is used, prior to planting, calibrate the drill or seeder according to the manufacturer's instructions. Use a carrier material (or a small amount of seed if the carrier is not used) to test and adjust the seeding rate, distribution pattern, and planting depth.

Broadcast Seeding

Broadcast seeding is the planting or sowing seeds across an area by scattering seed either by mechanical means or by hand. Most common used mechanical broadcast planters are the rotary, cyclone and fertilizer cart with a spinning plate to evenly distribute seed material. Aerial seeding using an airplane or helicopter are common methods by which seed is broadcasted.

Broadcast planters work on the principle of centrifugal force and the inherent weight of the seed to distribute the seed uniformly across the site. When planting light, fluffy and chaffy seed, a carrier should be mix with the seed such as pelletized lime, fertilizer, damp sand, cracked corn, saw dust, vermiculite, etc. When fertilizer is used as a seed carrier, the seed must be spread immediately after mixing to prevent "salt effect" damage to the seed.

A prepared seedbed is critical to guaranteeing good seed to soil contact for uniform germination. Before and after seeding, a cultipacker or similar tool should be used to help incorporate, improve seed to soil contact and improve germination. Under certain conditions, broadcasting in an undisturbed seedbed can be successful for example on soybean stubble, when frost seeding, or fall dormant seedings. Broadcasting seed onto undisturbed ground consisting of large amounts of non-fragile residue is not recommended.

Calibration of broadcast spreaders is not as accurate as with drill seeding. To calibrate a broadcast seeder

determine your bulk seeding rate per acre and convert to an anticipated seeds per square foot. Place several tarps at multiple locations across the path of the seeder. Operate the seeder across the tarps and check each tarp for the average seed count per square foot, increasing or decreasing the rate of seed flow.

Frost Seeding

Frost seeding is the broadcasting of seed late winter through early spring. In Wisconsin, frost seeding normally should occur mid February to early March. The exact seeding date is not predetermined and will vary from year to year depending on climate.

Seed surface applied, absence of snow or onto snow cover of less than 2 inches. Seeding onto snow cover greater than 2 inches increases the risk for seeding failure. Frost seeding should not occur immediately before a predicted thaw event that could produce significant runoff. The soil surface is usually "honeycombed" with small cracks at this time during the year. The freeze/thaw cycles that occur at this time of year will embed the seed into the soil where it can germinate as growing conditions become more favorable. When the freeze-thaw cycle ends, seed according to the recommended spring seeding dates.

Frost seeding is allowed when using Practice Standards 327, Conservation Cover; and 512 Forage and Biomass Planting. Frost seeding is not allowed when using Standard 342, Critical Area Planting.

Dormant Seeding

Seed is broadcasted, no-tilled or conventional drilled into an undisturbed or disturbed partial or clean seedbed after the growing season and before freeze-up. The seed remains dormant until the following spring. A firm seedbed is required for disturbed or tilled sites. The advantages and disadvantages are:

- Advantages: seeding at a time of year when labor is more available, seedlings take advantage of early spring moisture, soil erosion is minimized.
- Disadvantage: seeding rates should be increased.

Dormant seeding is allowed when using Practice Standards 327, Conservation Cover; and 512, Forage and Biomass Planting. Dormant seeding is not allowed when using Standard 342, Critical Area Planting.

POST-PLANTING WEED CONTROL

Planting Year Post Emergence Weed Control Mowing – New Seedings

Mesic and wet sites in particular are prone to weed competition. Currently, there are limited herbicides available to control weeds in a prairie restoration planting without potentially impacting native legumes and most forbs. To combat this problem, repeated mowing is essential throughout the establishment period.

The first year following seeding, mow growing plants to a height of 7 inches whenever the canopy reaches a height of 12 inches. Depending on rainfall and growing conditions, three mowings may be required. In a normal growing season, mowing should occur around the middle of June, early to mid July as well as the first part of August. It may be necessary to remove the clippings to avoid smothering the seedlings. Utilize a rotary mower or flail chopper to uniformly distribute mowed material over the field surface. It is essential to monitor the canopy height to avoid the accumulation of excess clipped material over top of seedlings and to ensure sunlight reaches the soil surface for the new seeding. Use of this mowing strategy will stress the weeds and will not harm the prairie plants in this first year.

Second Year Weed Control

Routinely evaluate the stand in the second year to determine if mowing for weed control is necessary. When necessary to control weed canopy, mow the planting to a height of 7 inches as often as required. The strategy in year two will mirror year one maintenance activities. Establishment of your native planting will have precedent over nesting season concerns. Once the prairie is established, wildlife habitat concerns should be mitigated with seasonal or spot treatment activities that will minimally impact wildlife.

DETERMINING SUCCESS OF THE PLANTING

In determining stand adequacy, there are two major considerations: 1) adequate protection of the soil resource, and 2) adequate stand for the planned purpose.

It may be difficult to determine if the prairie restoration is successful, particularly during the seeding year. Most native species are long-lived, but develop slowly. It may take two to five years for a

stand to be fully successful. For native plantings determined to be questionable or inadequate, a final evaluation deciding whether to reseed should not be done until after the third growing season. It is often said prairie sleeps the first year (sets root structure), creeps the second year (starts to spread slowly) and leaps in the third year (distinct and prominent). Patience is a virtue.

POST ESTABLISHMENT MANAGEMENT

Any planned maintenance (except for noxious weed control) after the establishment period, should be done before May 15 or after August 1 to protect nesting cover and reduce disruption of nesting activities.

Spot Treatment By Clipping

Spot clipping can be used to control annual weeds and to suppress other weeds. Spot clipping must be done before the target plant forms viable seed and must continue throughout the growing season. Spot clipping is not an effective control for biennial and perennial weeds but can be used to contain these plants until other control treatments can be implemented.

Spot Treatment With Herbicide

It is often necessary to spot treat invasive plants in a prairie. Introduced grasses and legumes and other aggressive weeds can severely impact a prairie when these undesirable plants are not controlled. The timing of herbicide product application is an important factor to protect prairie plants. Improper herbicide selection or application timing can severely damage a prairie planting. Early spring spot treatment with herbicides is often highly effective in addressing aggressive weeds while native plants are dormant. Spot treatment should be timed to treat weeds during active growth periods. Effective herbicide spot treatment can prevent the target plants from setting seed and spreading in the prairie.

Spot Treatment By Hand Pulling/Digging

Hand pulling or digging can be an effective control if the entire root is removed from the soil. Hand pulling/digging is most effective in the spring when the soil is moist and loose from the winter freeze/thaw cycles.

Prescribed Burning – Established Cover

Burning is a good tool for long-term stand management of native vegetation. Burning may be used to manage weeds once the prairie has been established if there is enough material to carry a fire. Time of burning and frequency will impact the species that are present on the site. Fall burns and to a lesser extent early spring burns, will tend to promote forbs. Late spring burns tend to stimulate the growth of warm season grasses and suppress cool season plants. Burn when the cool season plants are growing and the warm season plants are dormant or starting to grow to control cool season species. Do not conduct sequential prescribed burns on a given site at the same time of year. This tends to reduce stand diversity and can create a negative impact on desirable prairie plants. For longevity and plant diversity, burning should be conducted periodically, every other year to every fifth year.

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Table 3
Common Species and Recommended Seeding Rates

Name	Scientific Name	Moisture Regime	Single Species Seeding Rate (PLS)		
Native Grasses			**Lbs./Ac.**	**Seeds/Lb.**	**Seeds/Ft^2/Lb./ Ac.**
Big Bluestem	Andropogon gerardii	D, DM, M, WM	11	165,000	3.8
Canada Wildrye	Elymus canadensis	DM, M, WM	12	83,200	1.9
Fowl Mannagrass	Glyceria striata	WM, W	0.5	2,560,000	58.7
Indiangrass	Sorghastrum nutans	D, DM, M, WM, W	10	192,000	4.4
Little Bluestem	Schizachyrium scoparium	D, DM, M	8	240,000	5.5
Prairie Cordgrass	Spartina pectinata	M, WM, W	8	105,600	2.4
Prairie Dropseed	Sporobolus heterolepis	D, DM, M	3	256,000	5.9
Prairie Junegrass	Koeleria macrantha	D, DM, M	0.5	2,308,672	53
Sideoats Grama	Bouteloua curtipendula	D, DM, M	8	127,000	2.9
Switchgrass	Panicum virgatum	D, DM, M, WM, W	7	389,000	8.9
Virginia Wildrye	Elymus virginicus	M, WM, W	17	67,200	1.5
Rush			**Oz./Ac.**	**Seeds/Oz.**	**Seeds/Ft.^{2}/Oz./ Ac.**
Woolgrass	Scirpus cyperinus	W	1.5	1,700,000	39

Table 4
Wisconsin NRCS Authorized Native Plant List
(Grasses, Rushes, Sedges)

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime
Grass	Big Bluestem	Andropogon gerardii	10,313	0.24	D, DM, M, WM
Grass	Bluejoint	Calamagrostis canadensis	280,004	6.428	WM, W
Grass	Canada Wildrye	Elymus canadensis	5,200	0.12	DM, M, WM
Grass	Fowl Mannagrass	Glyceria striata	159,996	3.673	WM, W
Grass	American Mannagrass	Glyceria grandis	79,976	1.836	WM, W
Grass	Hairy Grama	Bouteloua hirsuta	70,000	1.607	D, DM
Grass	Indiangrass	Sorghastrum nutans	12,000	0.28	D, DM, M, WM, W
Grass	Prairie Junegrass	Koeleria macrantha	144,292	3.312	D, DM, M
Grass	Little Bluestem	Schizachyrium scoparium	15,000	0.344	D, DM, M
Grass	Porcupinegrass	Hesperostipa spartea	11,000	0.253	D, DM
Grass	Prairie Cordgrass	Spartina pectinata	6,600	0.152	M, WM, W
Grass	Prairie Dropseed	Sporobolus heterolepis	16,000	0.37	D, DM, M
Grass	Sand Dropseed	Sporobolus cryptandrus	332,125	7.625	D, DM, M
Grass	Sideoats Grama	Bouteloua curtipendula	7,938	0.183	D, DM, M
Grass	Switchgrass	Panicum virgatum	24,313	0.562	D, DM, M, WM, W
Grass	Virginia Wildrye*	Elymus virginicus*	4,200	0.096	M, WM, W
Rush	Common Rush	Juncus effusus	1,000,007	22.957	WM, W
Rush	Green Bulrush	Scirpus atrovirens	459,994	10.56	WM, W
Rush	River Bulrush	Schoenoplectus fluviatilis	4,299	0.0987	M, WM, W
Rush	Softstem Bulrush	Schoenoplectus tabernaemontani	31,015	0.712	WM, W
Rush	Woolgrass	Scirpus cyperinus	1,700,000	39.027	W
Sedge	Longhair Sedge	Carex comosa	30,013	0.689	WM, W
Sedge	Fox Sedge	Carex vulpinoidea	99,970	2.295	WM, W
Sedge	Bottlebrush Sedge	Carex hystericina	30,013	0.689	WM, W

**Virginia wildrye (Elymus virginicus) is better adapted than Canada wildrye (Elymus canadensis) for wet site condition seedings in the south planting zone (Figure 1).*

Table 5
Wisconsin NRCS Authorized Native Plant List
(Forbs, Legumes, Shrubs)

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime	Blooming Period
Forb	Angelica	Angelica atropurpurea	5401	0.124	W	Middle
Forb	Bergamot	Monarda fistulosa	77,800	1.786	DM, M, WM	Middle – Late
Forb	Biennial Beeblossom	Gaura biennis	2,700	0.062	M	Middle – Late
Forb	Bird's Foot Violet	Viola pedata	26,000	0.597	D, DM	Early, Middle, Late
Forb	Black-Eyed Susan	Rudbeckia hirta	99,600	2.287	D, DM, M, WM	Middle – Late
Forb	Blue Vervain	Verbena hastata	93,000	2.134	WM, W	Middle – Late
Forb	Blue-Eyed Grass	Sisyrinchium campestre	45,000	1.033	D, DM, M	Early – Middle
Forb	Boneset	Eupatorium perfoliatum	160,000	3.67	WM, W	Middle – Late
Forb	Bottle Gentian	Gentiana andrewsii	280,000	6.428	M	Middle – Late
Forb	Butterfly Milkweed	Asclepias tuberosa	3,480	0.08	D, DM, M	Middle
Forb	Cardinal Flower	Lobelia cardinalis	400,000	9.18	WM, W	Middle – Late
Forb	Common Ironweed	Vernonia fasciculata	20,000	0.459	WM, W	Late
Forb	Compass Plant	Silphium laciniatum	650	0.015	DM, M, WM	Middle – Late
Forb	Culver's Root	Veronicastrum virginicum	750,000	17.218	M, WM, W	Middle
Forb	Cupplant	Silphium perfoliatum	1,400	0.032	M, WM, W	Middle – Late
Forb	Downy Gentian	Gentiana puberulenta	435,000	9.986	DM, M	Late
Forb	Downy Wood Mint	Blephilia ciliata	400,000	9.18	DM, M, WM	Middle – Late
Forb	Evening Primrose	Oenothera biennis	90,000	2.07	D, DM, M	Late
Forb	False Boneset	Brickellia eupatorioides	24,000	0.551	D, DM	Middle – Late
Forb	False Toadflax	Comandra umbellata	700	0.016	D, DM, M, WM	Early – Middle
Forb	Few Leaf Sunflower	Helianthus occidentalis	12,960	0.298	DM, M	Middle – Late
Forb	Flowering Spurge	Euphorbia corollata	8,000	0.184	D, DM, M, WM	Middle – Late
Forb	Foxglove Beard Tongue	Penstemon digitalis	115,000	2.64	M, WM	Early – Middle
Forb	Goat's Rue	Tephrosia virginiana	2,500	0.057	D, DM	Early – Middle
Forb	Golden Alexanders	Zizia aurea	11,000	0.25	M, WM, W	Early
Forb	Golden Ragwort	Packera aurea	73,000	1.68	M, WM, W	Early – Middle
Forb	Great Blue Lobelia	Lobelia siphilitica	500,000	11.478	W	Middle – Late
Forb	Great St. Johnswort	Hypericum ascyron	200,000	4.59	M, WM	Middle
Forb	Green Milkweed	Asclepias viridiflora	3,600	0.083	D, DM	Early – Middle
Forb	Grooved Yellow Flax	Linum sulcatum	94,000	2.158	D, DM	Early, Middle, Late
Forb	Harebell	Campanula rotundifolia	900,000	20.66	D, DM	Middle – Late
Forb	Harelequin Blue Flag Iris	Iris versicolor	1,300	0.029	W	Early – Middle
Forb	Heath Aster	Symphyotrichum ericoides	140,000	3.214	D, DM, M, WM	Late
Forb	Hoary Vervain	Verbena stricta	32,000	0.734	D, DM	Middle – Late
Forb	Joe-Pye Weed	Eutrochium maculatum	95,000	2.18	W	Middle – Late
Forb	Large Beard Tongue	Penstemon grandiflorus	14,000	0.321	DM	Middle
Forb	Marsh Milkweed	Asclepias incarnata	4,800	0.11	W	Middle
Forb	Meadow Anemone	Anemone canadensis	8,000	0.184	M, WM	Early – Middle
Forb	Mountain Mint	Pycnanthemum virginianum	220,000	5.05	DM, M, WM, W	Middle – Late
Forb	New England Aster	Symphyotrichum novae-angliae	69,900	1.605	M, WM	Late
Forb	Nodding Beggartick	Bidens cernua	21,000	0.482	WM, W	Late
Forb	Nodding Wild Onion	Allium cernuum	7,680	0.176	DM, M	Middle
Forb	Ox-Eye Sunflower	Heliopsis helianthoides	6,480	0.149	M	Middle – Late
Forb	Pale Purple Coneflower	Echinacea pallida	4,580	0.105	DM, M	Middle
Forb	Pale Spiked Lobelia	Lobelia spicata	900,000	20.661	D, DM, M, WM	Middle
Forb	Pasque Flower	Pulsatilla patens	18,000	0.413	D, DM	Early
Forb	Prairie Alum-Root	Heuchera richardsonii	750,000	17.22	D, DM, M, WM	Early – Middle

Plant Type	Common Name	Scientific Name	Seeds/oz	Seeds/sq ft @ 1 oz/ac	Moisture Regime	Blooming Period
Forb	Prairie Blazing Star	Liatris pycnostachya	11,970	0.275	D, DM, M, WM	Middle – Late
Forb	Prairie Cinquefoil	Potentilla arguta	200,000	4.591	D, DM, M	Middle – Late
Forb	Prairie Dock	Silphium terebinthinaceum	1,110	0.025	DM, M, WM	Middle – Late
Forb	Prairie Loosestrife	Lysimachia quadriflora	90,000	2.07	M, WM, W	Middle
Forb	Prairie Milkweed	Asclepias sullivantii	4,500	0.103	D, DM, M, WM	Early – Middle
Forb	Prairie Parsley	Polytaenia nuttallii	4,000	0.0918	D, DM, M, WM	Early – Middle
Forb	Prairie Phlox	Phlox pilosa	19,000	0.436	DM, M	Early – Middle
Forb	Prairie Smoke	Geum triflorum	27,000	0.62	D, DM	Early
Forb	Prairie Sunflower	Helianthus pauciflorus	4,580	0.105	D, DM, M	Middle – Late
Forb	Prairie Tickseed	Coreopsis palmata	11,970	0.275	D, DM	Middle – Late
Forb	Prairie Violet	Viola pedatifida	28,000	0.643	D, DM, M	Early, Middle, Late
Forb	Purple Coneflower	Echinacea purpurea	6,600	0.15	D, DM, M	Middle
Forb	Purple Meadow-Rue	Thalictrum dasycarpum	11,000	0.252	M, WM, W	Middle
Forb	Rattlesnake Master	Eryngium yuccifolium	7,980	0.183	DM, M, WM	Middle – Late
Forb	Rosinweed	Silphium integrifolium	3,990	0.092	DM, M, WM	Middle – Late
Forb	Rough Blazing Star	Liatris aspera	13,470	0.309	D, DM, M	Late
Forb	Sawtooth Sunflower	Helianthus grosseserratus	15,000	0.344	D, DM, M, WM, W	Middle – Late
Forb	Shootingstar	Dodecatheon meadia	75,000	1.722	D, DM, M, WM	Early
Forb	Showy Goldenrod	Solidago speciosa	95,000	2.18	D, DM, M	Late
Forb	Silky Aster	Symphyotrichum sericeum	56,000	1.29	D, DM	Late
Forb	Sky-Blue Aster	Symphyotrichum oolentangiense	82,000	1.882	D, DM, M	Late
Forb	Smooth Blue Aster	Symphyotrichum laeve	47,830	1.098	DM, M, WM	Late
Forb	Sneezeweed	Helenium autumnale	130,000	2.98	WM, W	Middle – Late
Forb	Spiderwort	Tradescantia ohiensis	7,980	0.183	D, DM, M, WM	Early – Middle
Forb	Spotted Jewelweed	Impatiens capensis	1,600	0.037	M, WM, W	Middle – Late
Forb	Spotted Mint	Monarda punctata	93,700	2.151	D, DM	Middle – Late
Forb	Stiff Goldenrod	Oligoneuron rigidum	45,850	1.053	D, DM, M	Late
Forb	Sweet Black-Eyed Susan	Rudbeckia subtomentosa	45,850	1.053	DM, M, WM	Middle – Late
Forb	Thimbleweed	Anemone cylindrica	20,000	0.459	D, DM	Early – Middle
Forb	Turk's Cap Lily	Lilium superbum	5,000	0.115	M, WM	Middle
Forb	Upland Boneset	Eupatorium sessilifolium	50,000	1.15	M	Late
Forb	Whorled Milkweed	Asclepias verticillata	4,000	0.092	D, DM	Middle – Late
Forb	Wild Garlic	Allium canadense	560	0.013	M, WM	Middle
Forb	Wild Quinine	Parthenium integrifolium	6,790	0.156	DM, M, WM	Middle – Late
Forb	Winged Loosestrife	Lythrium alatum	3,000,000	68.87	WM, W	Middle – Late
Forb	Wood Betony	Pedicularis canadensis	33,000	0.758	D, DM, M	Early
Forb	Yellow Cone Flower	Ratibida pinnata	26,940	0.618	D, DM, M, WM	Middle – Late
Forb	Yellow Star Grass	Hypoxis hirsuta	80,000	1.837	DM, M, WM	Early, Middle, Late
Legume	Canada Milk Vetch	Astragalus canadensis	15,960	0.366	M, WM	Middle
Legume	Cream Wild Indigo	Baptisia bracteata	1,700	0.039	M	Early
Legume	Illinois Tick Trefoil	Desmodium illinoense	4,500	0.103	DM, M	Early – Middle
Legume	Leadplant	Amorpha canescens	16,950	0.389	D, DM, M	Middle
Legume	Purple Prairie Clover	Dalea purpurea	19,950	0.458	D, DM, M	Early, Middle, Late
Legume	Round-Headed Bush-Clover	Lespedeza capitata	9,960	0.229	D, DM	Late
Legume	Showy Tick-Trefoil	Desmodium canadense	4,500	0.103	M	Middle – Late
Legume	White Prairie Clover	Dalea candida	15,850	0.364	D, DM, M	Middle
Legume	White Wild Indigo	Baptisia alba	1,585	0.036	DM, M, WM	Middle
Legume	Wild Lupine	Lupinus perennis	990	0.023	D, DM, M	Early – Middle
Shrub	New Jersey Tea	Ceanothus americanus	7,000	0.161	DM, M	Middle - Late

Table 6
Sample Seed Mix for Basic Dry Prairie
(Seed Calculator Code 327-1)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.0
Yellow cone flower	Ratibida pinnata	1.00	0.6
Purple prairie clover	Dalea purpurea	2.00	0.9
Big bluestem	Andropogon gerardii	16.00	3.8
Little bluestem	Schizachyrium scoparium	28.00	9.6
Indiangrass	Sorghastrum nutans	16.00	4.4
Sideoats grama	Bouteloua curtipendula	28.00	5.1

Table 7
Sample Seed Mix for Basic Dry Mesic Prairie
(Seed Calculator Code 327-2)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Purple prairie clover	Dalea purpurea	2.00	0.9
Bergamot	Monarda fistulosa	1.00	1.8
Yellow cone flower	Ratibida pinnata	1.00	0.6
Big bluestem	Andropogon gerardii	8.00	1.9
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	16.00	4.4
Switchgrass	Panicum virgatum	8.00	4.5
Sideoats grama	Bouteloua curtipendula	16.00	2.9

Table 8
Sample Seed Mix for Basic Mesic Prairie
(Seed Calculator Code 327-3)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Yellow cone flower	Ratibida pinnata	1.00	0.6
Blackeyed Susan	Rudbeckia hirta	1.00	2.2
Bergamot	Monarda fistulosa	1.00	1.8
Big bluestem	Andropogon gerardii	16.00	3.8
Switchgrass	Panicum virgatum	8.00	4.5
Little bluestem	Schizachyrium scoparium	20.00	6.9
Indiangrass	Sorghastrum nutans	16.00	4.4
Canada wildrye	Elymus canadensis	16.00	1.9

Table 9
Sample Seed Mix for Basic Wet Mesic Prairie
(Seed Calculator Code 327-4)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Bergamot	Monarda fistulosa	1.00	1.8
Yellow cone flower	Ratibida pinnata	1.00	0.6
New England aster	Symphyotrichum novae-angliae	1.00	1.6
Switchgrass	Panicum virgatum	16.00	8.9
Prairie cordgrass	Spartina pectinata	8.00	1.2
Big bluestem	Andropogon gerardii	24.00	5.8
Virginia wildrye	Elymus virginicus	16.00	1.5
Indiangrass	Sorghastrum nutans	16.00	4.4

Table 10
Sample Seed Mix for Basic Wet Prairie
(Seed Calculator Code 327-5)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Common ironweed	Vernonia fasciculata	1.00	0.5
Cupplant	Silphium perfoliatum	2.00	0.1
Blue vervain	Verbena hastata	1.00	2.1
Switchgrass	Panicum virgatum	16.00	8.9
Prairie cordgrass	Spartina pectinata	8.00	1.2
Big bluestem	Andropogon gerardii	16.00	3.8
Indiangrass	Sorghastrum nutans	16.00	4.4
Virginia wildrye	Elymus virginicus	20.00	1.9

Table 11
Sample Seed Mix for Dry Prairie Restoration
(Seed Calculator Code 327-6)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	Potentilla arguta	0.50	2.3
Silky Aster	Symphyotrichum sericeum	1.00	1.3
Leadplant	Amorpha canescens	1.00	0.4
Spotted mint	Monarda punctata	0.50	1.1
Prairie tickseed	Coreopsis palmata	1.00	0.3
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.0
Hoary vervain	Verbena stricta	1.00	0.7
Yellow cone flower	Ratibida pinnata	1.00	0.6
Spiderwort	Tradescantia ohiensis	2.00	0.4
Purple prairie clover	Dalea purpurea	4.00	1.8
Big bluestem	Andropogon gerardii	4.00	1.0
Sideoats grama	Bouteloua curtipendula	24.00	4.4
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	8.00	2.2
Prairie June Grass	Koeleria macrantha	2.00	6.6
Sand dropseed	Sporobolus cryptandrus	2.00	15.3

Table 12
Sample Seed Mix for Dry Mesic Prairie Restoration
(Seed Calculator Code 327-7)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	Potentilla arguta	0.25	1.1
Leadplant	Amorpha canescens	1.00	0.4
Silky Aster	Symphyotrichum sericeum	1.00	1.3
Purple prairie clover	Dalea purpurea	3.00	1.4
Rough blazing star	Liatris aspera	0.50	0.2
Roundheaded Bushclover	Lespedeza capitata	3.00	0.7
Bergamot	Monarda fistulosa	1.00	1.8
Yellow cone flower	Ratibida pinnata	1.00	0.6
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.1
Spiderwort	Tradescantia ohiensis	1.00	0.2
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	8.00	2.2
Prairie June Grass	Koeleria macrantha	2.00	6.6
Prairie dropseed	Sporobolus heterolepis	2.00	0.7
Switchgrass	Panicum virgatum	4.00	2.2
Sideoats grama	Bouteloua curtipendula	24.00	4.4

Table 13
Sample Seed Mix for Mesic Native Prairie Restoration
(Seed Calculator Code 327-8)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Yellow cone flower	Ratibida pinnata	0.50	0.3
Blackeyed Susan	Rudbeckia hirta	0.50	1.1
Sky blue aster	Aster oolentangiense	0.50	0.9
Ox-eye sunflower	Heliopsis helianthoides	1.00	0.1
Bergamot	Monarda fistulosa	0.50	0.9
Culvers root	Vernonia virginicum	0.25	4.3
Purple prairie clover	Dalea purpurea	1.00	0.5
Rosinweed	Silphium integrifolium	1.00	0.1
Prairie blazing star	Liatris pycnostachya	1.00	0.3
New england aster	Symphyotrichum novae-angliae	0.50	0.8
Big bluestem	Andropogon gerardii	16.00	3.8
Switchgrass	Panicum virgatum	8.00	4.5
Little bluestem	Schizachyrium scoparium	24.00	8.3
Canada wildrye	Elymus canadensis	8.00	1.0
Indiangrass	Sorghastrum nutans	16.00	4.4

Table 14
Sample Seed Mix for Wet Mesic Prairie Restoration
(Seed Calculator Code 327-9)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Blackeyed Susan	Rudbeckia hirta	1.00	2.2
Bergamot	Monarda fistulosa	1.00	1.8
Yellow cone flower	Ratibida pinnata	1.00	0.6
Prairie blazing star	Liatris pycnostachya	1.00	0.4
Common Ironweed	Vernonia fasciculata	1.00	0.5
Cupplant	Silphium perfoliatum	4.00	0.1
Golden Alexanders	Zizia aurea	1.00	0.3
Great St John's Wort	Hypericum ascyron	0.25	1.1
White wild indigo	Baptisia alba	1.50	0.1
New England aster	Symphyotrichum novae-angliae	1.00	1.6
Switchgrass	Panicum virgatum	16.00	8.9
Prairie cordgrass	Spartina pectinata	4.00	0.6
Big bluestem	Andropogon gerardii	20.00	4.8
Canada wildrye	Elymus canadensis	16.00	1.9
Indiangrass	Sorghastrum nutans	12.00	3.4

Table 15
Sample Seed Mix for Wet Prairie Restoration
(Seed Calculator Code 327-10)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Culver's root	Veronicastrum virginicum	0.25	4.3
Common ironweed	Vernonia fasciculata	0.50	0.2
Cupplant	Silphium perfoliatum	2.00	0.1
Marsh milkweed	Asclepias incarnata	2.00	0.2
Joe pye weed	Eutrochium maculatum	1.00	2.2
Blue vervain	Verbena hastata	2.00	4.3
Showy tick trefoil	Desmodium canadense	3.00	0.3
Boneset	Eupatorium perfoliatum	0.50	1.8
Golden alexanders	Zizia aurea	2.00	0.5
Switchgrass	Panicum virgatum	8.00	4.5
Prairie cordgrass	Spartina pectinata	4.00	0.6
Big bluestem	Andropogon gerardii	4.00	1.0
Canada wildrye	Elymus canadensis	8.00	1.0
Indiangrass	Sorghastrum nutans	4.00	1.1
Fowl mannagrass	Glyceria striata	4.00	14.7
Fox sedge	Carex vulpinoidea	4.00	9.2

Table 16
Seed Mix for Dry Mesic Karner Blue Prairie Restoration
(Seed Calculator Code 327-11)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Sq. Foot
Prairie cinquefoil	Potentilla arguta	0.50	2.2
Leadplant	Amorpha canescens	1.00	0.4
Silky Aster	Symphyotrichum sericeum	1.0	1.3
Purple prairie clover	Dalea purpurea	4.00	1.8
Rough blazing star	Liatris aspera	1.00	0.3
Wild lupine	Lupinus perennis	6.00	0.1
Bergamot	Monarda fistulosa	0.50	0.9
Yellow cone flower	Ratibida pinnata	1.00	0.6
Stiff Goldenrod	Oligoneuron rigidum	1.00	1.1
Pale Purple Coneflower	Echinacea pallida	2.00	0.2
Sideoats grama	Bouteloua curtipendula	20.00	3.7
Little bluestem	Schizachyrium scoparium	24.00	8.3
Indiangrass	Sorghastrum nutans	8.00	2.2
Prairie June Grass	Koeleria macrantha	1.00	3.3
Prairie dropseed	Sporobolus heterolepis	2.00	0.7
Switchgrass	Panicum virgatum	4.00	2.2

Table 17
Sample Seed Mix for Native Pollinator Seeding for Dry Mesic Sites
(Seed Calculator Code 327-12)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Little Bluestem	Schizachyrium scoparium	16	5.5
Sideoats Grama	Bouteloua curtipendula	16	2.9
Illinois Tick Trefoil	Desmodium illinoense	5	0.5
Spiderwort	Tradescantia ohiensis	5	0.9
Purple Prairie Clover	Dalea purpurea	6	2.7
Yellow Coneflower	Ratibida pinnata	1	0.6
Prairie Blazing Star	Liatris pycnostachya	3	0.8
Rattlesnake Master	Eryngium yuccifolium	6	1.1
Showy Goldenrod	Solidago speciosa	4	8.7
Stiff Goldenrod	Oligoneuron rigidum	3	3.2
Smooth Blue Aster	Symphyotricum laeve	2	2.2
Prairie Cinquefoil	Potentilla arguta	2	9.2

Table 18
Sample Seed Mix for Native Pollinator Seeding for Mesic Sites
(Seed Calculator Code 327-13)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Little Bluestem	Schizachyrium scoparium	16	5.5
Sideoats Grama	Bouteloua curtipendula	16	2.9
Foxglove Beardtongue	Penstemon digitalis	4	10.6
Spiderwort	Tradescantia ohiensis	6	1.1
Golden Alexanders	Zizia aurea	6	1.5
Yellow Coneflower	Ratibida pinnata	1	0.6
Purple Prairie Clover	Dalea purpurea	6	2.7
Prairie Blazing Star	Liatris pycnostachya	4	1.1
Rattlesnake Master	Eryngium yuccifolium	6	1.1
New England Aster	Symphyotrichum novae-angliae	3	4.8
Stiff Goldenrod	Oligoneuron rigidum	3	3.2
Smooth Blue Aster	Symphyotrichum laeve	3	3.3

Table 19
Sample Seed Mix for Native Pollinator Seeding for Wet Mesic Sites
(Seed Calculator Code 327-14)

Common Name	Scientific Name	PLS Oz/Ac	Seeds/Square Foot
Big Bluestem	Andropogon gerardii	16	3.8
Indiangrass	Sorghastrum nutans	16	4.4
Foxglove Beardtongue	Penstemon digitalis	4	10.6
Spiderwort	Tradescantia ohiensis	6	1.1
Golden Alexanders	Zizia aurea	5	1.3
Yellow Coneflower	Ratibida pinnata	1	0.6
Prairie Blazing Star	Liatris pycnostachya	3	0.8
Rattlesnake Master	Eryngium yuccifolium	6	1.1
New England Aster	Symphyotrichum novae-angliae	3	4.8
Blue Vervain	Verbena hastata	4	8.5
Common Ironweed	Vernonia fasciculata	3	1.4
Cupplant	Silphium perfoliatum	3	0.1

Table 20
Seeding Chart for Native Grass Species

Grass	Percent of Mixture	Pure Stand Seeding Rate	Seeds per Square Foot
Big Bluestem, Andropogon gerardii	0-100	11 lbs/ac	42
Canada Wildrye, Elymus canadensis	0-20	12 lbs/ac	23
Indiangrass, Sorghastrum nutans	0-100	10 lbs/ac	44
Little Bluestem, Schizachyrium scoparium	0-20	8 lbs./ac	44
Sideoats Grama, Bouteloua curtipendula	0-20	8 lbs/ac	23
Switchgrass, Panicum virgatum	0-100	7 lbs/ac	63
Virginia Wildrye, Elymus virginicus	0-20	17 lbs/ac	26
Prairie Junegrass, Koeleria macrantha	0-20	0.5 lbs/ac	26
Hairy Grama, Bouteloua hirsuta	0-25	1 lb/ac	26

Canada Wildrye, Virginia Wildrye and Sideoats Grama when combined will not comprise of more than 20 percent of the total grass seeds per square foot. Pure stand seeding rates for Big Bluestem and Indiangrass must be increased by 5 lbs/acre to meet the minimum seeds per square foot as required by this standard. Refer to Table 3 for suggested moisture regimes per specie.

Table 21
Biomass Planting Recommendations

Forage Suitability Group	Species	Lbs. PLS/Acre	Seeds per Square Foot
Biomass/Biofuel			
Group: 1-9	Switchgrass Varieties: Blackwell Cave-in-Rock Pathfinder Sunburst	 7 7 7 7	63

Table 22
Solid Native Grass Plantings
(Seed Calculator Code 327-15 A to C, 512 H7 to H9)

Seed Calculator Code	Mixtures	Pounds PLS per Acre	Seeds per Square Foot	Moisture Regime
327-15A, 512-H7	Switchgrass (Panicum virgatum)	7.0	63	DM-WM
327-15B, 512-H8	Big Bluestem (Andropogon gerardii)	11.0	42	
327-15C, 512-H9	Indiangrass (Sorghastrum nutans)	10.0	44	

Table 23
Summary of Seeding Requirements for Standards 327, 342, and 512 (Native Species)

Standard 327 - Conservation Cover									
Mix Type	Grasses		Forbs/Legumes[a]		Seeding Periods				Notes
	No.	Seeds/Ft^2	No.	Seeds/Ft^2	Spring	Late Summer	Dormant[b]	Frost[b]	
Basic Prairie[c]	≥3	≥20	≥3	≥2	X	NR	X	X	At least 50% of mix must be grasses (mix can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).
Prairie Restoration[c]	≥5	≥15	≥10	≥8	X	NR	X	X	At least 1 forb must be legume and at least 50% of seeds per square foot must be grasses (mix can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).
Pollinator Habitat	1-2	≤10	≥9	≥30	X	NR	X	X	- At least 3 early, 3 mid, and 3 late blooming forbs. - Grasses must be bunch-type and maximum of 10 seeds per square foot.
Untested Local Genotype Seed	≥5	≥25	≥10	≥10	X	NR	X	X	- At least 50 seeds per square foot total. - Grasses must be at least 50% of mix. - If single specie makes up more than 20% of mix, only count 20% towards the total seeds per square foot. - At least 1 forb must be legume.

(a) If more than 20% of legumes are hard seed, increase rate by % hard seed.
(b) Increase rate 15% for frost and dormant seedings.
(c) Maximum rates/acre for the following species: Switchgrass (1 lb.), Prairie Junegrass (2.0 oz.), Black-eyed Susan (2.0 oz.), Bergamot (2.0 oz.), or Purple Coneflower (3.0 oz.)

Standard 342 - Critical Area Planting									
Mix Type	Grasses		Forbs/Legumes		Seeding Periods				Notes
	No.	Seeds/Ft^2	No.	Seeds/Ft^2	Spring	Late Summer	Dormant	Frost	
Grasses Only	≥1	≥60			X	NR	NR	NR	Limit Canada Wildrye, Virginia Wildrye, and Sideoats Grama to 20% of the total grasses.
Mixtures	≥1	≥40	≥1	≥20	X	NR	NR	NR	- Mix must be at least 60 seeds per square foot total. - Grasses must be at least 50% of the mix (can have up to 20% Canada and Virginia Wildrye and Sideoats Grama).

Standard 512 - Forage and Biomass Planting									
Mix Type	Grasses		Forbs		Seeding Periods				Notes
	No.	Seeds/Ft^2	No.	Seeds/Ft^2	Spring	Late Summer	Dormant[a]	Frost[a]	
Pasture/Hayland	1	See Notes			X	NR	X	X	- Big Bluestem: 42 seeds per square foot. - Indiangrass: 44 seeds per square foot. - Switchgrass: 63 seeds per square foot.
Biomass Seeding	1	≥60			X	NR	X	X	Only Switchgrass is approved.

(a) Increase rate 15% for frost and dormant seedings.