Section 4169. Erosion Control Materials

4169.01 DESCRIPTION.

All materials required to be furnished and described in this section.

4169.02 SEEDS.

A. Furnish seeds approved for use according to requirements of this section, including specified purity and germination, as shown in Tables 4169.02-1 and 4169.02-2.

Table 4169.02-1: Seeds (Common Names, Scientific Names, Purity, and Germination)

Common Name	Scientific Name	Purity (%)	Germination (%)
DOMESTIC GRASSES			
Bluegrass, Kentucky	Poa pratensis	85	80
Bluegrass, Ky. RAM-1	Poa pratensis-RAM-1	95	85
Bluegrass, Ky. PARK	Poa pratensis-PARK	95	85
Brome, smooth-LINCOLN	Bromus inermis	90	85
Fescue, tall, FAWN	Festuca arundinacea-FAWN	98	85
Fescue, chewings, red	Festuca rubra var. commutate	98	90
Fescue, creeping, red	Festuca rubra	98	85
Fescue, red-PENNLAWN	Festuca rubra PENNLAWN	98	85
Fescue, Tall, Olympic (Fineleaf)	Festuca arundinacea-Olympic	98	85
Fescue, Tall, Rebel (Fineleaf)	Festuca arundinacea	98	85
Fescue, Sheeps	Festuca ovina	98	85
Orchardgrass	Dactylis glomerata	90	90
Red top	Agrostis alba	92	85
Reed Canarygrass	Phalaris arundinacea	98	70
Wildrye, Canada	Elymus Canadensis	95	85
Wildrye, Russian	Elymus junceus	95	85
Ryegrass, Perennial	Lolium perenne	95	90
Timothy	Phleum pratense	99	85
LEGUMES			
Alfalfa, RANGER/VERNAL	Medicago sativa	99	90[(a)]
Alfalfa, Travois	Medicoa spp.	99	90[(a)]
Birdsfoot Trefoil EMPIRE	Lotus corniculatus	98	85[(a)]
Crownvetch, Emerald	Coronilla varia	98	70[(a)]
Hairy Vetch	Vicia villosa	96	85[(a)]
Lespedeza, Korean	Lespedeza stipulacea	98	80[(a)]
Red Clover, medium	Trifolium pretense	99	90[(a)]
Alsike Clover	Trifolium hybridum	99	90[(a)]
White Clover	Trifolium repens	98	90[(a)]
NURSE CROP OR STABILIZING CROP			
Oats	Avena sativa	97	90
Rye	Secale cereale	97	90
Sudangrass, PIPER	Sorghum vulgare var. sudanese	98	85

[(a)] Includes hard seed.

Table 4169.02-2: Seeds (Common Names, Scientific Names, and PLS)

Common Names	Scientific Names	PLS (%)
*Furnish seed certified as Source Identified Class (Yellow Tag) Source G0-Iowa.		
NATIVE GRASSES		
Big Bluestem* ~~- Kaw, Pawnee, Roundtree or Champ~~	Andropogon gerardii	30
Little Bluestem* ~~- Blaze, Aldous or Camper~~	Andropogon scoparius	30
Switchgrass* ~~- Blackwell, Pathfinder, Cave-in-Rock or Nebr. 28~~	Panicum virgatum	63
Indiangrass* ~~- Neb. 54, Oto, Holt or Rumsey~~	Sorghastrum nutans	30
Sideoats Grama* ~~- Trailway, Butte or El Reno~~	Bouteloua curtipendula	30
Western Wheatgrass* ~~- Barton or Common~~	Agropyron smithii	56
Buffalograss* ~~- Texoka or Sharp's Improved~~	Buchloe dactyloides	60
Sand Bluestem* ~~- Champ or Goldstrike~~	Andropogon gerardii, var. paucipilus	30
Blue Grama	Bouteloua gracilis	30
Intermediate Wheatgrass	Agropyron intermedium	70
Slender Wheatgrass	Agropyron trachycaulum, var. unilaterale	70
Prairie Dropseed	Sporobolus heterolepis	65
Sand Dropseed	Sporobolus cryptandrus	65
Sand Lovegrass	Eragrostis trichodes	65
Weeping Lovegrass	Eragrostis curvula	65
Hairy Wood Chess	Bromus purgans	60
Blue-joint grass	Calamagrostis Canadensis	47
Bottlebrush sedge	Carex comosa	62
Tussock sedge	Carex stricta	78
Fox sedge	Carex vulpinoidea	64
Virginia wild-rye	Elymus virginicus	60
Reed manna grass	Glyceria grandis	50
Fowl manna grass	Glyceria striata	72
Common rush	Juncus effuses	80
Rice Cut Grass	Leesia oryzoides	62
Rye grass, annual	Lolium italicum	89
Fowl bluegrass	Poa palustris	72
Green bulrush	Scirpus atrovirens	45
Wool grass	Scirpus cyperinus	78
Soft-stem bulrush	Scirpus vallidus	78
Indian grass	Sorghastrum nutans	60
Spike Rush	Eleocharis palustris	71
FORBS		
Canada anemone	Anemone Canadensis	72
Marsh milkweed	Asclepias incarnate	25
New England aster	Aster novae-angliae	25
Swamp aster	Aster puniceus	25
Showy tic-trefoil	Desmodium canadense	25
Joe-pye weed	Eupatorium maculatum	66
Boneset	Eupatorium perfoliatum	41
Ox Eye sunflower	Heliopsis helianthoides	38
Blue-flag iris	Iris virginica-shrevii	19
Meadow blazingstar	Liatris ligulistylis	24
Tall blazingstar	Liatris pycnostachya	24
Great blue lobelia	Lobelia siphilitica	13
Reed manna grass	Glyceria grandis	50
Fowl manna grass	Glyceria striata	72
Common Rush	Juncus effuses	80
Rice Cut Grass	Leesia oryzoides	62

B. Furnish all seeds, including grass, legume, forbs, and cereal crop seeds, from an established seed dealer or certified seed grower. Ensure they meet requirements of the Iowa Department of Agriculture regulations (Iowa Seed Law) and are labeled accordingly. Ensure the test date to determine the percentage of germination requirement was completed within a 9 month period

exclusive of the calendar month in which the test was completed. Ensure the seed analysis on the label is mechanically printed.

C. Approval of all seed for use will be based on the accumulative total of PLS specified for each phase of the work, so that the PLS is not less than the accumulative total of the PLS specified. PLS is obtained by multiplying purity times germination.

~~**D.** If the purity and/or germination of native grasses exceeds the minimum required, the application rate may be adjusted, based on PLS.~~

E. If the seed does not comply with minimum requirements for purity and germination and such seed cannot be obtained, the Engineer may approve use of the seed on a basis of PLS or may authorize a suitable substitution for the seed specified.

F. The accumulative total of Pure Live Seed (PLS) is the product obtained by multiplying the pounds (kilograms) of each seed by the purity and germination percentages expressed as decimals. Calculations will be based on test results of samples taken by the Contracting Authority. If the seeds were not sampled or if these test results are not available, the PLS will be calculated from information shown on the label.

4169.03 FERTILIZER.

Furnish fertilizer of the grade, type, and form specified and that complies with Iowa Department of Agriculture rules and the following requirements:

A. Fertilizer grade will be identified according to the percent nitrogen (N), percent available phosphoric acid, (P_2O_5), and percent water soluble potassium, (K_2O), in that order. Approval will be based on that identification.

B. Furnish all fertilizer from an established fertilizer dealer. Ensure guaranteed analysis is provided either through mechanically printed commercial fertilizer bags or through a manufacturer's (not a distributor's) bill of lading.

C. Fertilizer inspection and acceptance will be according to Materials I.M. 469.03.

D. Furnish fertilizer of a type that can be uniformly distributed by the application equipment. Fertilizer may be chemically combined or may be furnished as separate ingredients. If supplying chemically combined fertilizer, have each unit of fertilizer chemically combined. Ensure the manufacturer’s guarantee indicates compliance with this agreement. If supplying fertilizer as separate ingredients, comply with the following:

- Each of the separate ingredients of uniform size,
- Analysis guaranteed by the manufacturer.
- Mixed using a drum mixer, grinder mixer, or other mechanical mixers.
- Mixed only by the fertilizer dealer.

E. When 6-24-24 chemically combined commercial fertilizer has been specified, a combination of ammoniated phosphate (either monoammonium phosphate (11-52-0) or diammonium phosphate (18-46-0)), muriate of potash (granular form), and urea (granular form) may be used.

F. When 13-13-13 chemically combined commercial fertilizer has been specified, a combination of ammoniated phosphate (either monoammonium phosphate (11-52-0) or diammonium phosphate (18-46-0)), muriate of potash (granular form), and urea (granular form) may be used.

G. Fertilizer may be furnished in a dry or liquid form.

H. Furnish a list of the number of containers and a corresponding scale ticket from an approved scale for the fertilizer to be used in the work.

I. Official samples taken by the Contracting Authority may be tested. A tolerance of minus 1.0 percentage point from the guaranteed analysis for each nutrient will be considered substantial compliance.

J. Ground limestone is to be of the type known as No. 1 fine (70% passing No. 200 (75 µm) sieve) with an analysis of elemental calcium of no less than 37% or no more than 40%.

4169.04 INOCULANT FOR LEGUMES.
An inoculant is a culture of bacteria specifically formulated for legume seeds (alfalfa, clovers, lespedeza, birdsfoot trefoil, hairy vetch, and crownvetch). Ensure the manufacturer's container indicates the specific legume seed to be inoculated and the expiration date. Use inoculant that meets the requirements of the Iowa Seed Law. Follow the safety precautions specified on the product label.

4169.05 STICKING AGENT.
A sticking agent is a commercial material recommended by the manufacturer to improve adhesion of inoculant to the seed. For quantities less than 50 pounds (25 kg), the sticking agent need not be a commercial agent; however, the Engineer's approval is required. Apply separately prior to application of inoculant. Follow safety precautions specified on the product label. A sticking agent is not required if a liquid formulation of inoculant is used.

4169.06 SOD.

A. Use sod consisting of approximately 1 inch (25 mm) of well established turf consisting of live Kentucky bluegrass, unless otherwise specified. Ensure sod is free from roots of trees or brush, stones, and other objectionable materials. Ensure sod is free from all noxious weeds and reasonably free of all other weeds.

B. Ensure sod is cut in strips of uniform width and thickness with ends square. The Engineer may order the thickness adjusted to meet the sod conditions. Cut sod to the length specified for the use intended. If not specified, cut to a minimum length of 3 feet (1 m). Mow sod areas to a height of approximately 1 1/2 inches (40 mm) to 2 inches (50 mm) prior to cutting.

C. Ensure sod was regularly maintained prior to cutting. Apply pre-emergence weed control chemicals and weed control chemicals for broadleaf weeds.

D. Roll or stack sod within 1 hour after being cut. The Engineer may approve other methods of handling sod. Take precautions to prevent drying or heating. Do not use sod damaged by heat or dry conditions, or sod cut more than 18 hours before being incorporated into the work.

E. Sod will be subject to inspection by the Engineer at the job site, and approval of the work constitutes approval of the material.

4169.07 MULCH.

A. Straw Mulch.
Material used as mulch may consist of dry cereal straw or native grass straw. Use ~~material free from noxious weeds~~ Certified Noxious Weed Seed Free Mulch certified by the Iowa Crop Improvement Association or other state's Crop Improvement Associations.

B. Hydraulic Mulches.

1. Wood Cellulose Fiber.
- **a.** Natural or cooked cellulose fiber processed from whole wood chips, or a combination of (50%-50%) cellulose fiber produced from whole wood chips and recycled fiber from sawdust, recycled paper, chipboard, or corrugated cardboard.
- **b.** Contains a colloidal polysaccharide tackifier adhered to the fiber to prevent separation during shipment and avoid chemical coagglomeration during mixing.
- **c.** Forms a homogeneous slurry of fibers, tackifier, and water that can be applied with standard hydraulic mulching equipment and be dyed green to facilitate visual metering during application.
- **d.** Contains no growth or germination inhibiting factors, and has a minimum pH of 4.8.

2. Bonded Fiber Matrix.
- **a.** Long-strand wood fibers held together by organic tackifiers and bonding agents that, when dry, become insoluble and non-dispersible.

b. Upon curing (24 to 48 hours) forms a continuous, 100% coverage, flexible, absorbent, erosion-resistant blanket that encourages seed germination.
c. Manufactured to be applied with standard hydraulic mulching equipment and dyed green to facilitate visual metering during application.
d. Contains no growth or germination inhibiting factors.
e. Physical Properties:
1) Fibers: Virgin wood, greater than 88% by volume.
2) Organic Material: Greater than 96% by volume.
3) Tackifier: 8 to 10%.
4) pH: 4.8 minimum.
5) Moisture Content: 12% ±3%.
6) Minimum Water Holding Capacity: 1.2 gallons per pound (10 L/kg).

3. Mechanically-Bonded Fiber Matrix.
a. Long-strand wood fibers and crimped, interlocking synthetic fibers.
b. Upon curing (2 hours) forms a continuous, 100% coverage, flexible, absorbent, porous, erosion-resistant blanket that encourages seed germination.
c. Manufactured to be applied with standard hydraulic mulching equipment and dyed green to facilitate visual metering during application.
d. Contains no growth or germination inhibiting factors.
e. Physical Properties:
1) Virgin Wood Fibers: 73% minimum.
2) Crimped, Interlocking Synthetic Fibers: 5% ±1%.
3) Tackifier: 10% ±1%.
4) Moisture Content: 12% ±3%.
5) Minimum Water-Holding Capacity: 1.2 gallons per pound (10 L/kg).
6) pH: 4.8 minimum.

4169.08. COMPOST.

A. Use an organic substance produced by the biological and biochemical decomposition of source-separated compostable materials separated at the point of waste generation. Organic substances may include, but are not limited to:
- Leaf and yard trimmings,
- Food scraps,
- Food processing residues,
- Manure and/or other agricultural residuals,
- Forest residues and bark, and
- Soiled and/or unrecyclable paper and biosolids.

B. Compost is to contain no visible admixture of refuse or other physical contaminants nor any material toxic to plant growth. Compost is to meet the additional requirements below. All physical requirements are to comply with the United States Composting Council, “Testing Methods for the Examination of Composting and Compost” (TMECC).

1. Minimum organic material: 30% (dry weight (mass) basis) as determined by loss on ignition.

2. Moisture content: 30% to 60%. Organic material shall be loose and friable and not dusty.

3. Soluble salts: less than 5.0 ds/m.

4. Stability: Carbon dioxide evolution rate less than 8 according to TMECC 5.08-B. Growth screening: Emergence a minimum of 80% for all compost to be vegetated.

5. pH: 6.0 - 8.0.

6. Fecal Coliform: comply with TMECC 07.01-B.

7. Heavy Metals: comply with TMECC 04.06 and TMECC 04.13-B.

8. Comply with the following for particle size:
- **Pneumatic Seeding (Urban):** 100% passing the 1/2 inch (12.5 mm) screen.

- **Pneumatic or Mechanical Seeding (Rural):** 100% passing the 1 inch (25 mm) screen, 80% to 90% passing the 3/4 inch (19 mm) screen, and 70% to 80% passing the 1/2 inch (12.5 mm) screen.
- **Filter Sock, Filter Berm, and Filter Blanket:** 100% passing the 2 inch (50 mm) screen, 70% to 90% passing the 1 inch (25 mm) screen, and 50% to 70% passing the 1/2 inch (12.5 mm) screen.

4169.09 STAKES FOR HOLDING SOD.

Use either wood or metal wire stakes for holding sod. Use wood stakes in sandy soils or when the Engineer requires.

A. Wood Stakes.

- 1 inch (25 mm) to 1 1/2 inches (40 mm) wide, 1/4 inch (6 mm) to 1/2 inch (13 mm) thick, and 12 inches (300 mm) long.
- Where this length of stake does not provide firm bearing, the Engineer may require stakes of sufficient length to secure firm bearing.

B. Wire Stakes.

- Staples made from No. 11 (3.06 mm diameter) wire or heavier and with a minimum 2 inch (50 mm) flat spread on the top of the sod.
- Legs at least 6 inches (150 mm) long. The Engineer may require wire legs longer than 6 inches (150 mm).

4169.10 SPECIAL DITCH CONTROL, TURF REINFORCED MAT, AND SLOPE PROTECTION.

For plastic netting, wood excelsior mat, coconut fiber mat, straw-coconut mat, straw mat, and wire staples, comply with the following and meet the requirements of Materials I.M. 469.10.

A. Wire Staples.

Meet the following requirements for wire staples for holding special ditch control wood excelsior mat and special ditch control jute mesh over sod:

1. U-shaped wire staples.

2. Each leg a minimum of 6 inches (150 mm) long. In sandy soil conditions the Engineer may require the length of each leg to be a minimum of 12 inches (300 mm).

3. No. 11 (3.06 mm) diameter wire.

4. Staples of sufficient hardness to facilitate installation without bending.

B. Special Ditch Control.

1. Wood Excelsior Mat.

A mat of interlocking wood fibers. Meet the following requirements:

- Plastic netting applied to both sides for holding the excelsior in place.
- Nontoxic to growth of plants and germination of seeds.
- Minimum dry weight (mass) of 0.68 pounds per square yard (334 g/m2) according to ASTM D 6475.
- Furnished in rolls with a uniform width of 48 inches (1.2 m), with a tolerance of minus 1 inch (25 mm) and a minimum length of 80 feet (24 m).
- Furnished in plastic bags or otherwise protected to prevent damage from weather and handling.

2. Coconut Fiber Mat.

At the Contractor's option, coconut fiber mat may be substituted for wood excelsior mat for special ditch control. Meet the following requirements:

- Uniform thickness with the coconut fiber evenly distributed over the entire area of the mat.
- Both sides of the mat covered with polypropylene netting attached with cotton thread.
- Minimum dry weight (mass) of 0.40 pounds per square yard (182 g/m^2) according to ASTM D 6475.
- Furnished in rolls with a uniform width of 48 inches (1.2 m) with a tolerance of minus 1 inch (25 mm) and a minimum length of 80 feet (24 m).

- Furnished in plastic bags or otherwise protected to prevent damage from weather and handling.

C. Slope Protection.

Wood excelsior mat, coconut fiber mat, straw mat, or straw coconut mat may be used for slope protection.

1. Wood Excelsior Mats.

A mat of interlocking wood fibers meeting the requirements of Article 4169.10, B, 1. with the following exceptions:

- Plastic netting applied to one or both sides for holding the excelsior in place. Mats without netting where the excelsior is mechanically stitched together to hold it in place may be allowed.
- Minimum dry weight (mass) of 0.50 pounds per square yard (246 g/m2) according to ASTM D 6475.

2. Straw Mat, Straw-Coconut Fiber Mat, or Coconut Fiber Mat.

At the Contractor's option straw mat, straw-coconut fiber mat, or coconut fiber mat may be substituted for wood excelsior mat for slope protection. Meet the following requirements:

- Consistent thickness with the straw, straw-coconut fiber, or coconut fiber evenly distributed over the entire area of the mat.
- The top side of the mat covered with polypropylene netting attached with cotton thread.
- Minimum dry weight (mass) of 0.40 pounds per square yard (182 g/m^2) according to ASTM D 6475.
- Furnished in rolls with a uniform width of 48 inches (1.2 m), with a tolerance of minus 1 inch (25 mm) and a minimum length of 80 feet (24 m).
- Furnished in plastic bags or otherwise protected to prevent damage from weather or handling.

D. Netting.

1. Comply with the following mesh netting sizes. A tolerance of plus or minus 0.10 inch (2.5 mm) applies to netting size.

- Netting applied on wood excelsior mats: no more than 1 inch by 2 inches (25 mm by 50 mm).
- Netting applied on coconut fiber only mats for channel and slope: no more than 3/4 inch by 3/4 inch (19 mm by 19 mm).
- Netting applied on the top side of straw and straw-coconut fiber mats for slopes only: no more than 1/2 inch by 1/2 inch (13 mm by 13 mm).

2. A minimum weight of 9 pounds per 1000 square yards (44 g/m^2) is required for netting for special ditch control or slope protection.

E. Turf Reinforcement Mat (TRM).

1. Type 1 TRM: constructed of a web of mechanically or melt-bonded polymernetting, or monofilaments fibers entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of synthetic fibers between two high-strength, biaxially-oriented nets, mechanically bound by parallel stitching with polyolefin thread. Products may contain a degradable component.

2. Type 2 and 3 TRM: constructed of a web of mechanically or melt-bonded polymer netting, or monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Non-woven bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between two high-strength, biaxially oriented nets, mechanically bound by parallel stitching with polyolefin thread. Components are to be 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

3. Type 4 TRM: a high performance/survivability TRM composed of monofilament yarns woven into a resilient uniform configuration. Use mats consisting of a matrix exhibiting very high interlock and reinforcement capacities with both soil and root systems and demonstrating a high tensile modulus. TRMs manufactured from discontinuous or loosely held together by

stitched or glued, netting, or composites will not be allowed in this category. Components are to be 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Use this category when field conditions exist with high loading and/or high survivability requirements.

4. Comply with Table 4169.10-1 for minimum material property and performance requirements:

Table 4169.10-1: Minimum Material Property and Performance Requirements

Property	Property	Test Method	Type 1	Type 2	Type 3	Type 4
Material	Thickness	ASTM D 6525	0.25 in (6.25 mm)	0.25 in (6.25 mm)	0.25 in (6.25 mm)	0.25 in (6.25 mm)
Material	Tensile Strength[a, b]	ASTM D 6818	125 lb/ft (186 kg/m)	240 lb/ft (357 kg/m)	750 lb/ft (1116 kg/m)	3000 lb/ft (4465 kg/m)
Material	UV Resistance	ASTM D 4355	80% @ 500 hrs	80% @ 1000 hrs	80% @ 1000 hrs	90% @ 3000 hrs
Performance	Maximum Shear Stress (Channel Applications)[c]	ASTM D 6460	7-9 lb/ft^2 (1.4-1.8 kg/m^2)	10-11 lb/ft^2 (2.0-2.3 kg/m^2)	12-14 lb/ft^2 (2.5-2.9 kg/m^2)	15-16 lb/ft^2 (3.1-3.3 kg/m^2)
Performance	Maximum Slope Gradient (Slope Applications)	N/A	1:1 (H:V) or flatter	1:1 (H:V) or flatter	1:1 (H:V) or greater	1:1 (H:V) or greater

a. Minimum Average Roll Values, machine direction only.
b. Tensile Strength of structural components retained after exposure.
c. Maximum shear stress that fully-vegetated TRM can sustain without physical damage or excess erosion (1/2 inch (12.5 mm) soil loss) during a 30 minute flow event in large scale testing. Acceptable large scale testing protocol includes ASTM D 6460 or independent testing conducted by the Texas Transportation Institute, Colorado State University, Utah State University, or other approved testing facility. Bench scale testing is not acceptable.

4169.11 FILTER FABRIC.

Furnish nonwoven polypropylene, UV stabilized filter fabric complying with Table 4169.11-1.

Table 4169.11-1: Filter Fabric Properties

Property	Typical	Minimum
Tensile Strength, lbs (metric)	130 (metric)	115 (metric)
Grab Elongation, %	70	50
Trapezoidal Tear Strength, lbs (metric)	60 (metric)	50 (metric)