

ATTACHMENT F

CONVEYANCE CHANNEL



DESCRIPTION

A stormwater conveyance channel is a permanent, designed waterway, swale or ditch; sized and lined with vegetation, matting or riprap used to convey stormwater runoff without allowing channel erosion. In addition stormwater conveyance channels may be constructed to improve water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable where constructed channels are needed to improve drainage or convey stormwater such as roadside ditches or above steep-cut slopes.

This practice applies generally to small channels having flow only during storm events. Chapter 3, Stream Channel Construction and Restoration, should be referenced for larger channels having seasonal low or perennial flow. Conveyance channels should not be used if flow is greater than 100 cubic feet per second (cfs) from a 10-yr.-frequency storm.

PLANNING CONSIDERATIONS

Constructed Channels vs. Natural Drainageways--Discretion must be used when replacing natural channels with constructed stormwater conveyance channels. Natural drainage systems, even small intermittent and ephemeral drainageways, provide many hydraulic and environmental benefits not duplicated by constructed channels.

Permits--Permits for stream channel modifications may be required by local government. Additionally, the U.S. Army Corps of Engineers and the Ohio Environmental Protection Agency, through Sections 404 and 401, respectively, of the Clean Water Act, may require a permit for stream modifications. It is best to contact your local district office of the Corps to determine what both agencies' permit requirements are for your project.

Water Quality--Besides the primary design objective of providing a stable channel, water quality benefits may also be achieved. Runoff may be treated by stormwater conveyance channels which are designed to promote settling and infiltration. Although treatment efficiency is usually low, it may be maximized by creating grass-lined channels that are wide and have minimal slope.

Diverting Runoff from Steep Slopes--Channels may be used as permanent diversions at the top of steep slopes or at intervals across slopes to shorten the flow length on steep erodible slopes. The need for diversions shall be determined by considering outlet conditions, slope erodibility and water's influence on slip-prone slopes.

DESIGN CRITERIA

Runoff Calculations--Channels generally shall be designed so that the velocity of flow expected from a 10-yr. frequency storm does not exceed the permissible velocity for the type of lining used. NRCS's TR-55 or other suitable method shall be used for determining flow rate. Use Manning's Equation or other suitable method to determine velocity.

Capacity--Runoff computation will be based upon the most severe soil and cover conditions that will exist in the area draining into the waterway during the planned life of the structure.

Critical Areas--A channel's capacity shall be adequate to carry the peak rate of runoff from a 10-yr. frequency storm. Where high-hazard conditions exist, higher frequency storms should be chosen to provide protection compatible with conditions. Where fill is used to create the channel, such as when diverting runoff across or above a steep slope, the ridge height shall include a minimum of 0.3 ft. freeboard and a settlement factor of 10% in addition to the design flow depth.

Noncritical Areas--Where out-of-bank flow will not cause erosion, property damage or flood damage, no minimum size channel is required. These conditions will most often occur in areas with little slope and established woody vegetation.

Cross-Section Shape

- **Vee-shaped channels** generally are used where the quantity of water to be handled is relatively small, such as roadside ditches. Because vee-shaped channels are prone to create erosion problems they should not be used in channels with high-flow velocity or prolonged low-flow conditions.
- **Trapezoidal channels** often are used where the quantity of water to be carried is large and velocities high. Channels constructed to treat stormwater runoff should be trapezoidal in shape to promote settling and infiltration.
- **Parabolic channels** most closely approximate natural flow characteristics at low as well as high flows. Although generally preferred for esthetic reasons, design and construction procedures are more complex.

Design Velocity of Vegetative Lining:

Grass Lining Maximum Flow Velocity for a 10-Yr. Frequency Storm				
Soil		Maximum Velocity (fps)		
Texture	Type	Seed Lining	Seed & Matting	Sod
Sand, Silt, Sandy Loam, Silt Loam	Sand	1.5	3.0	3.5
Silty Clay Loam, Sandy Clay Loam	Firm Loam	2.0	4.0	4.0
Clay	Clay	2.5	4.0	5.0
N/A	Gravel	3.5	5.0	6.0
N/A	Weathering Shale	4.5	5.0	N/A

Note: Soil texture/type can be determined from the soil surveys. If the channel is on fill, the soil should be tested.

Establishing Vegetation--Stabilization should be done according to the appropriate Standards and Specifications for Vegetative Practices.

- **For design velocities of less than 3.5 fps**, seeding and mulching may be used for the establishment of the desired vegetation. It is recommended that when conditions permit, temporary diversion or other means be used to prevent water from entering the diversion during the establishment of vegetation.
- **For design velocities of more than 3.5 fps**, the diversion shall be stabilized with sod, with seeding protected by jute or excelsior matting, or with seeding and mulching including temporary diversion of water until the vegetation is established.

Check Dams--Check dams may be incorporated to enhance water quality benefits by maximizing the detention time within the swale or to increase channel stability by decreasing flow velocities. The structures should be of a more durable nature than those normally designed for temporary erosion control. Check dams should be used where they will not be considered a nuisance or create a high maintenance burden.

Rock Lining--Rock-lined channels shall be designed by accepted engineering methods such as the Federal Highway Administration Circular No. 15 or Figure 2-1. The chart will determine rock size using flow depth and velocity obtained from Manning's equation. Geotextile must be placed beneath all riprap to prevent the underlying soil from eroding and undermining the riprap.

Maximum Depth of Flow for Riprap Lined Channels

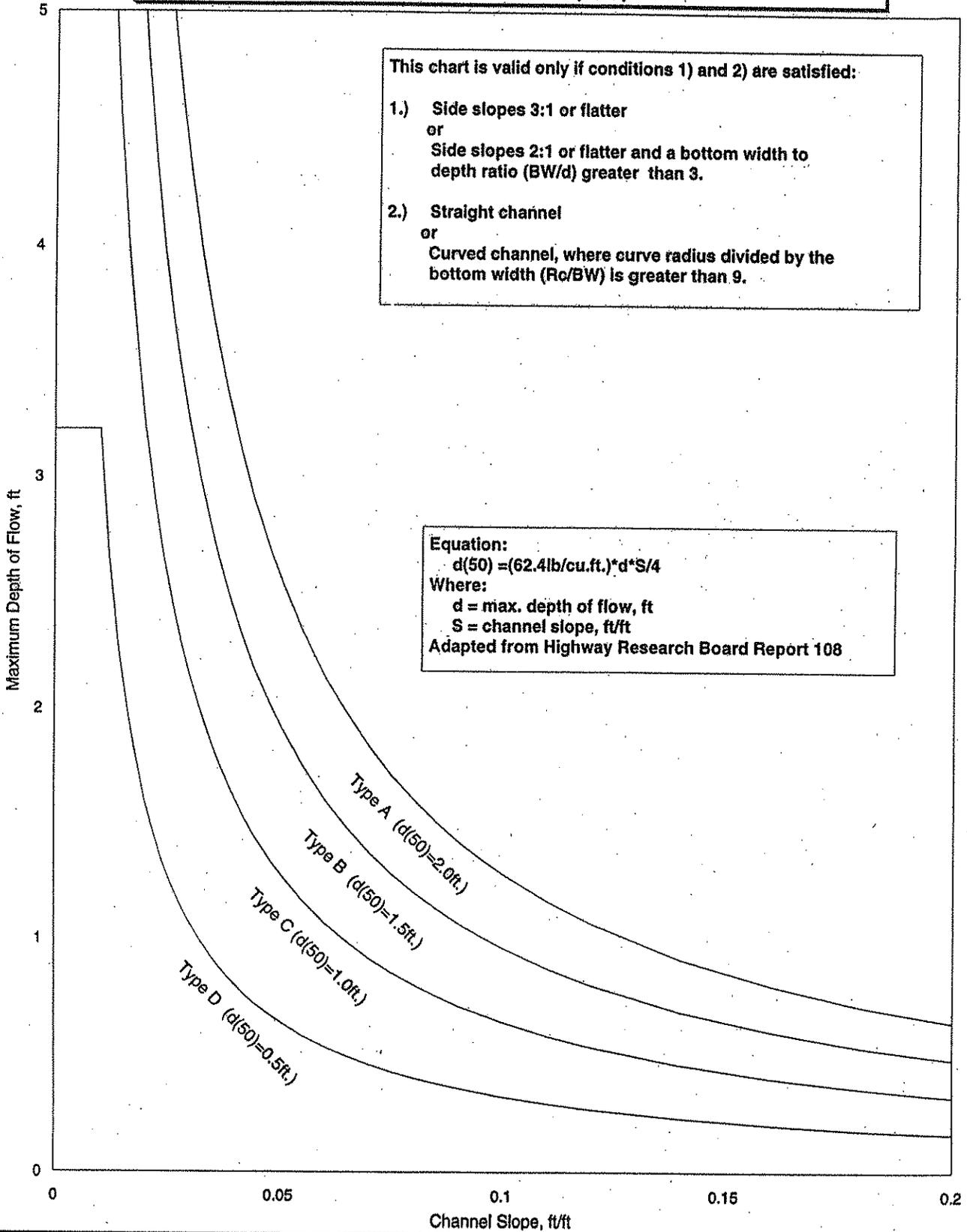


Figure 2-1 Rock size for rock-lined channels

Specifications
for
Grass Lined Channel

1. The channel shall be excavated and shaped to the proper grade and cross section.
2. Fill material used in the construction of the channel shall be well compacted to prevent unequal settlement.
3. Earth removed and not needed in construction shall be graded and sloped or disposed of so that it will not restrict flow to the channel or interfere with its functioning.
4. Stabilization shall be done according to the appropriate specifications for seeding, vegetative practices, sod and matting.
5. Construction shall be sequenced so that channels are stabilized prior to becoming operational or without delays after the channel becomes operational.
6. Gullies that may form in the channel or other erosion damage that occurs before the grass lining becomes established shall be repaired without delay.

Specifications
for
Rock Channel Protection

1. Subgrade for the filter and riprap shall be prepared to the required lines and grades as shown on the plan.
2. Riprap shall conform to the grading limits as shown on the plan.
3. No abrupt deviations from the design grade or horizontal alignment shall be permitted.
4. Geotextile shall be woven or nonwoven monofilament yarn and shall meet the following:
 - Thickness 20-60 mils
 - Grab Strength 90-120 lb.
 - ASTM D-1777 and ASTM D-1682
5. Geotextile shall be laid with the long dimension parallel to the direction of flow and shall be laid loosely, but without wrinkles and creases. Where joints are necessary, strips shall be placed to provide a 12-in. minimum overlap, with the upstream strip overlapping the downstream strip.
6. Riprap may be placed by equipment but shall be placed in a manner to prevent slippage or damage to the geotextile.
7. Riprap shall be placed by a method that does not cause segregation of sizes. Extensive pushing with a dozer causes segregation and shall be avoided by delivering riprap near its final location within the channel.
8. Construction shall be sequenced so that riprap channel protection is placed and functional without delays when the channel becomes operational.

Type of Rock or Riprap	Size of Rock	
	50% by weight	85% by weight
Type D	> 6 in.	3 - 12 in.
Type C	> 12 in.	6 - 18 in.
Type B	> 18 in.	12 - 24 in.
Type A	> 24 in.	18 - 30 in.

Specifications
for
Permanent Diversion

1. Trees, brush, stumps, and materials that may become obstructions shall be removed and disposed of so as not to interfere with the proper functioning of the diversion channel.
2. The diversion channel shall be excavated or shaped to line, grade and cross section as required to meet the criteria herein, and be free of irregularities which will impede normal flow.
3. Fills shall be compacted with construction equipment in such a manner that the entire surface of the fill will be traversed by not less than one tread track of the equipment.
4. Fertilizing, seeding, and mulching shall conform to the recommendations in the applicable vegetative specification.

ATTACHMENT G

Specifications
for
Maintenance of Permanent Seeding

1. Permanent seeding shall not be considered established for at least 1 full yr. from the time of planting. Seeded areas shall be inspected for failure and vegetation reestablished as needed. Depending on-site conditions, it may be necessary to irrigate, fertilize, overseed, or reestablish plantings in order to provide permanent vegetation for adequate erosion control.
2. Maintenance fertilization rates shall be established by soil test recommendations or by using the rates shown in the following table.

Maintenance for Permanent Seedings Fertilization and Mowing					
Mixture	Formula	lb./ac.	lb./1,000 ft. ²	Time	Mowing
Creeping Red Fescue Ryegrass Kentucky Bluegrass	10-10-10	500	12	Fall, yearly or as needed.	Not closer than 3"
Tall Fescue	10-10-10	500	12		Not closer than 4"
Dwarf Fescue	10-10-10	500	12		Not closer than 2"
Crown Vetch Fescue	0-20-20	400	10	Spring, yearly following establish- ment and every 4-7 yr. thereafter	Do not mow
Flat Pea Fescue	0-20-20	400	10		Do not mow

Note: Following soil test recommendations is preferred to fertilizer rates shown above.

SODDING



DESCRIPTION

Sod is used to provide immediate soil stabilization in erosive areas such as drainageways and on steep slopes.

CONDITIONS WHERE PRACTICE APPLIES

Sod may be used where immediate cover is required or preferred and where vegetation will be adequate stabilization such as minor swales, around drop inlets, and lawns.

Specifications
for
Sodding

MATERIALS

1. Sod shall be harvested, delivered and installed within a period of 48 hr. Sod not transplanted within this period shall be inspected and approved prior to installation.
2. The sod shall be kept moist and covered during hauling and preparation for placement on the sod bed.
3. Sod shall be machine cut at a uniform soil thickness of 0.75 in., plus or minus 0.25 in., at the time of cutting. Measurements for thickness shall exclude top growth and thatch.

SITE PREPARATION

1. A subsoiler, plow or other implement shall be used to reduce soil compaction and allow maximum infiltration. (Maximizing infiltration will help control both runoff rate and water quality.) Subsoiling shall not be done on slip-prone areas where soil preparation should be limited to what is necessary for establishing vegetation.
2. The area shall be graded and resoiling shall be done where needed.
3. Soil Amendments:
 - Lime--Agricultural ground limestone shall be applied to acid soil as recommended by a soil test. In lieu of a soil test, lime shall be applied at the rate of 100 lb./1,000 sq. ft. or 2 tons/ac.
 - Fertilizer--Fertilizer shall be applied as recommended by a soil test. In lieu of a soil test fertilizer shall be applied at a rate of 12 lb./1,000 sq. ft. or 500 lb./ac. of 10-10-10 or 12-12-12 analysis.
 - The lime and fertilizer shall be worked into the soil with a disk harrow, spring-tooth harrow, or other suitable field implement to a depth of 3 in.
4. Before laying sod, the surface shall be uniformly graded and cleared of all debris, stones and clods larger than 3-in. diameter.

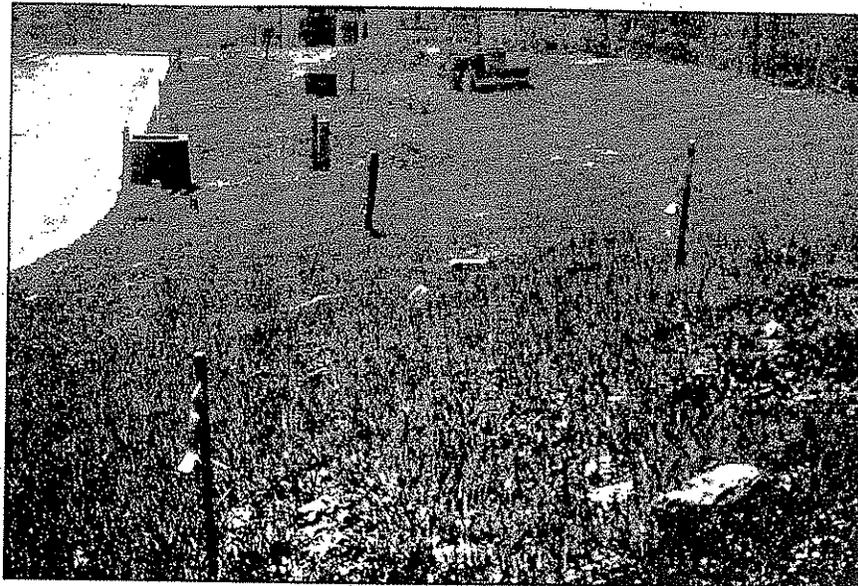
SOD INSTALLATION

1. During periods of excessively high temperatures, the soil shall be lightly irrigated immediately prior to laying the sod.
2. Sod shall not be placed on frozen soil.
3. The first row of sod shall be laid in a straight line with subsequent rows placed parallel to and tightly wedged against each other. Lateral joints shall be staggered in a brick-like pattern. Ensure that sod is not stretched or overlapped and that all joints are butted tight in order to prevent voids which would dry the roots.
4. On sloping areas where erosion may be a problem, sod shall be laid with the long edge parallel to the contour and with staggered joints. The sod shall be secured with pegs or staples.
5. As sodding is completed in any one section, the entire area shall be rolled or tamped to ensure solid contact of roots with the soil surface. Sod shall be watered immediately after rolling or tamping until the sod and soil surface below the sod are thoroughly wet. The operations of laying, tamping and irrigating for any piece of sod shall be completed within 8 hr.

SOD MAINTENANCE

1. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantities to maintain moist soil to a depth of 4 in.
2. After the first week, sod shall be watered as necessary to maintain adequate moisture and ensure establishment.
3. The first mowing shall not be attempted until sod is firmly rooted.

TEMPORARY SEEDING



DESCRIPTION

Temporary seeding provides erosion control on areas in between construction operations. Grasses which are quick growing are seeded and usually mulched to provide prompt, temporary soil stabilization. It effectively minimizes the area of a construction-site prone to erosion and should be used everywhere the sequence of construction operations allows vegetation to be established.

CONDITIONS WHERE PRACTICE APPLIES

Temporary seeding should be applied on exposed soil where additional work (grading, etc.) is not scheduled for more than 45 days. Permanent seeding should be applied if the areas will be idle for more than a year.

PLANNING CONSIDERATIONS

This practice has the potential to drastically reduce the amount of sediment eroded from a construction-site. Control efficiencies greater than 90% will be achieved with proper applications of temporary seeding. Because practices used to trap sediment are usually much less effective, temporary seeding is to be used even on areas where runoff is treated by sediment trapping practices. Because temporary seeding is highly effective and practical on construction-sites, its liberal use is highly recommended.

Specifications
for
Temporary Seeding

Temporary Seeding Species Selection			
Seeding Dates	Species	Lb./1,000 ft. ²	Per Ac.
March 1 to August 15	Oats	3	4 bushel
	Tall Fescue	1	40 lb.
	Annual Ryegrass	1	40 lb.
	Perennial Ryegrass	1	40 lb.
	Tall Fescue	1	40 lb.
	Annual Ryegrass	1	40 lb.
August 16 to November 1	Rye	3	2 bushel
	Tall Fescue	1	40 lb.
	Annual Ryegrass	1	40 lb.
	Wheat	3	2 bushel
	Tall Fescue	1	40 lb.
	Annual Ryegrass	1	40 lb.
	Perennial Ryegrass	1	40 lb.
	Tall Fescue	1	40 lb.
	Annual Ryegrass	1	40 lb.
November 1 to Spring Seeding	Use mulch only, sodding practices or dormant seeding.		

Note: Other approved seed species may be substituted.

1. Structural erosion- and sediment-control practices such as diversions and sediment traps shall be installed and stabilized with temporary seeding prior to grading the rest of the construction-site.
2. Temporary seed shall be applied between construction operations on soil that will not be graded or reworked for 45 days or more. These idle areas should be seeded as soon as possible after grading or shall be seeded within 7 days. Several applications of temporary seeding are necessary on typical construction projects.
3. The seedbed should be pulverized and loose to ensure the success of establishing vegetation. However, temporary seeding shall not be postponed if ideal seedbed preparation is not possible.
4. Soil Amendments--Applications of temporary vegetation shall establish adequate stands of vegetation which may require the use of soil amendments. Soil tests should be taken on the site to predict the need for lime and fertilizer.
5. Seeding Method--Seed shall be applied uniformly with a cyclone seeder, drill, cultipacker seeder, or hydroseeder. When feasible, seed that has been broadcast shall be covered by raking or dragging and then lightly tamped into place using a roller or cultipacker. If hydroseeding is used, the seed and fertilizer will be mixed on-site and the seeding shall be done immediately and without interruption.

MULCHING TEMPORARY SEEDING

1. Applications of temporary seeding shall include mulch which shall be applied during or immediately after seeding. Seedings made during optimum seeding dates and with favorable soil conditions and on very flat areas may not need mulch to achieve adequate stabilization.

2. Materials:

- Straw--If straw is used, it shall be unrotted small-grain straw applied at the rate of 2 tons/ac. or 90 lb./1,000 sq. ft. (two to three bales). The mulch shall be spread uniformly by hand or mechanically so the soil surface is covered. For uniform distribution of hand-spread mulch, divide area into approximately 1,000-sq.-ft. sections and spread two 45-lb. bales of straw in each section.
- Hydroseeders--If wood cellulose fiber is used, it shall be used at 2,000 lb./ac. or 46 lb./1,000 sq. ft.
- Other--Other acceptable mulches include mulch mattings applied according to manufacturer's recommendations or wood chips applied at 6 tons/ac.

3. Straw mulch shall be anchored immediately to minimize loss by wind or water. Anchoring Methods:

- Mechanical--A disk, crimper, or similar type tool shall be set straight to punch or anchor the mulch material into the soil. Straw mechanically anchored shall not be finely chopped but, generally, be left longer than 6 in.
- Mulch Nettings--Nettings shall be used according to the manufacturer's recommendations. Netting may be necessary to hold mulch in place in areas of concentration runoff and on critical slopes.
- Asphalt Emulsion--Asphalt shall be applied as recommended by the manufacturer or at the rate of 160 gal./ac.
- Synthetic Binders--Synthetic binders such as Acrylic DLR (Agri-Tac), DCA-70, Petroset, Terra Tack or equal may be used at rates recommended by the manufacturer.
- Wood-Cellulose Fiber--Wood-cellulose fiber binder shall be applied at a net dry weight of 750 lb./ac. The wood-cellulose fiber shall be mixed with water and the mixture shall contain a maximum of 50 lb./100 gal.