

NDDOT Erosion & Sediment Control – Construction Course

Module 3: Temporary & Permanent Erosion & Sediment Control Measures



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Construction ESC

How do we define Erosion Control?

Temporary vs. Permanent

- What does temporary vs. permanent mean in the Special Provision?

What is temporary erosion control?

What is temporary sediment control?

Are the two mutually exclusive terms?



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Construction ESC

Key Considerations:

- Installation
(constructability*)
- Maintenance
- QA/QC
- Inspection
- Removal



Construction ESC

Site visits are needed to properly plan the project

- Critical areas
 - Does the ESC design match what is needed in the field?
- Think about progression through the project
- What should be one of the first things to do when you move on to a site?
 - What comes next?

Phasing

Construction phasing is a great ESCM

- Phasing the project
- Phasing the ESC plan

Plan construction activities to minimize the areas of disturbance and minimize impact

Complete grading activities and establish permanent controls as soon as possible



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Phasing



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Phasing



Perimeter Controls

Installing perimeter controls should be one of the first tasks before beginning earthwork operations

Options Available:

- Silt fence
- Fiber rolls
- Berms

Should consider location and type to maintain proper control

Silt Fence (Section 260)

Consists of partially buried fabric that is supported by posts used to control sediment from small disturbed areas

Only good for low-flow situations

Proper placement and installation are critical to their success



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Silt Fence

Construction Considerations:

- Drainage area: $\frac{1}{4}$ acre per 100 feet of fence ($\frac{1}{2}$ acre per 100 feet of fence when reinforced with wire backing)
- Longevity: approximately 6 months



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Silt Fence

Placement:

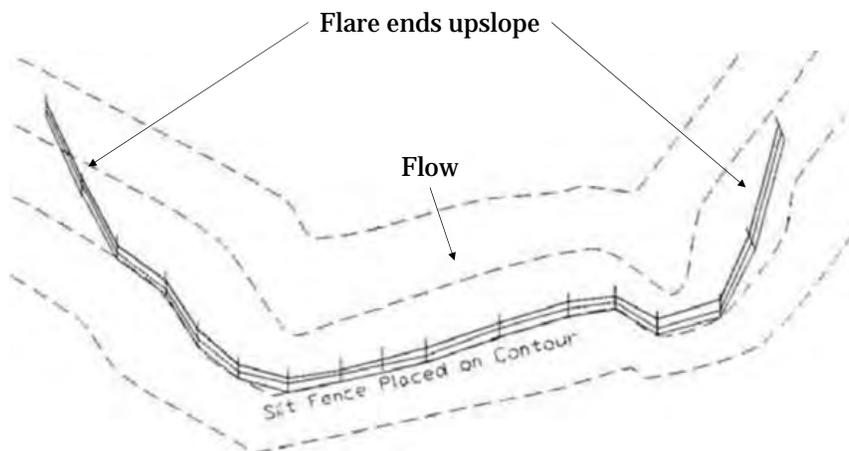
- Placed along elevation contours or as perimeter control

Slope (%)	Slope Length (ft)	Maximum Drainage Area (ft ²)
< 2	100	10,000
2 to 5	75	7,500
5 to 10	50	5,000
10 to 20	25	2,500
> 20	15	1,500



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Silt Fence

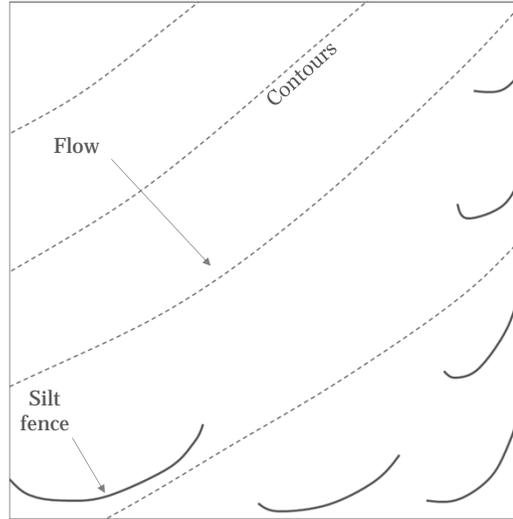


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Silt Fence

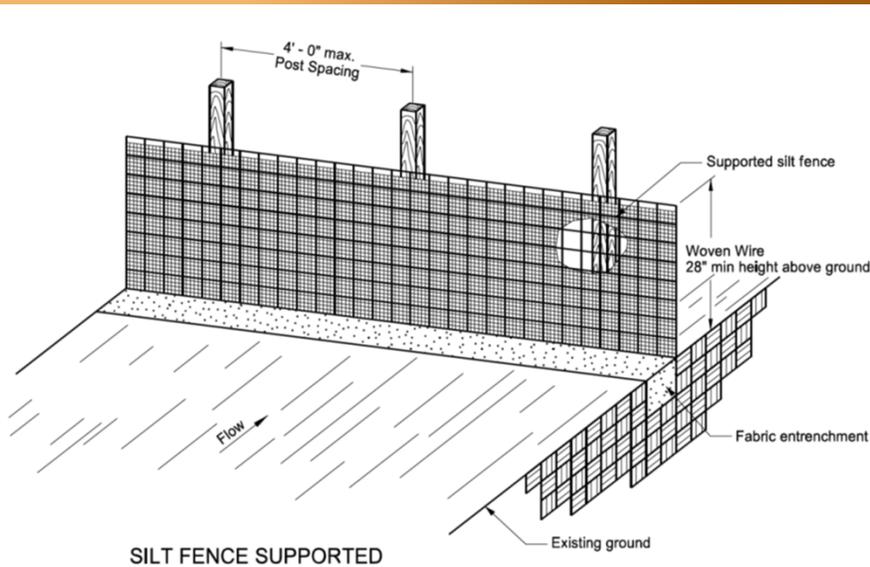
Placement:

- “J” hooks increase ponding and prevents flow along the silt fence perimeter



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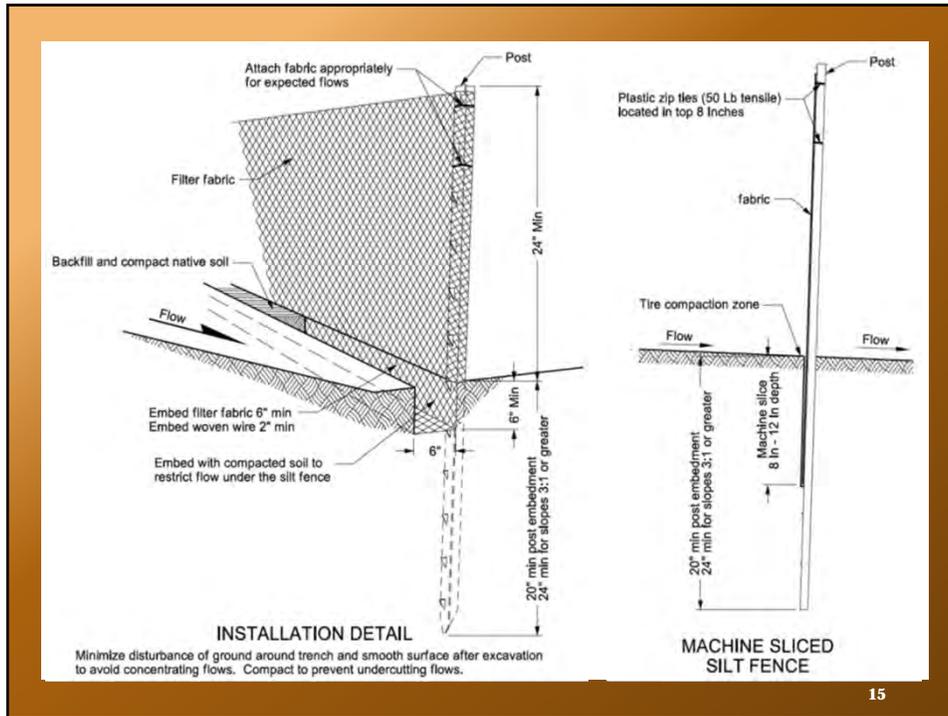


SILT FENCE SUPPORTED

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Standard Drawing D-260-1

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Silt Fence (Section 260.04 B. & C.)

Maintenance:

- Remove accumulated sediment when it reaches 1/3 of the exposed height of the silt fence
- Repair/replace damaged sections

Removal:

- Prep soil and seed and mulch removal area to match existing conditions

Fiber Rolls (Section 261.04 A. & B.)

Maintenance:

- Remove accumulated sediment when it reaches 1/3 of the exposed height of the fiber roll
- Repair/replace damaged sections

Removal:

- Prep soil and seed and mulch removal area to match existing conditions



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Berms

Slows sediment-laden water and filters sediment in low-flow areas

Common types:

- Topsoil
- Compost

May be used in conjunction with other sediment control measures



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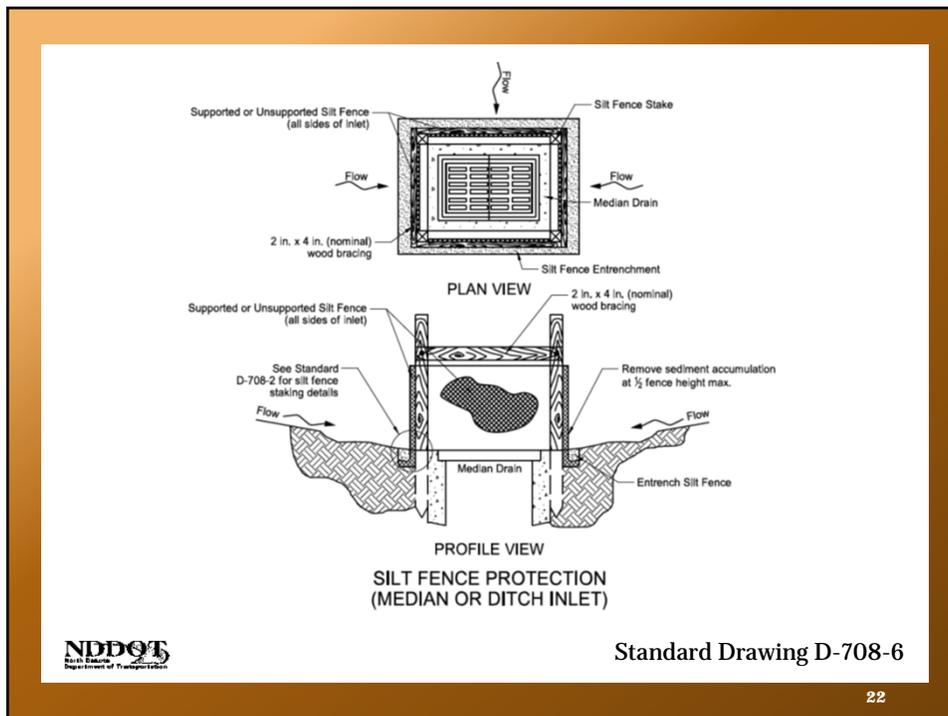
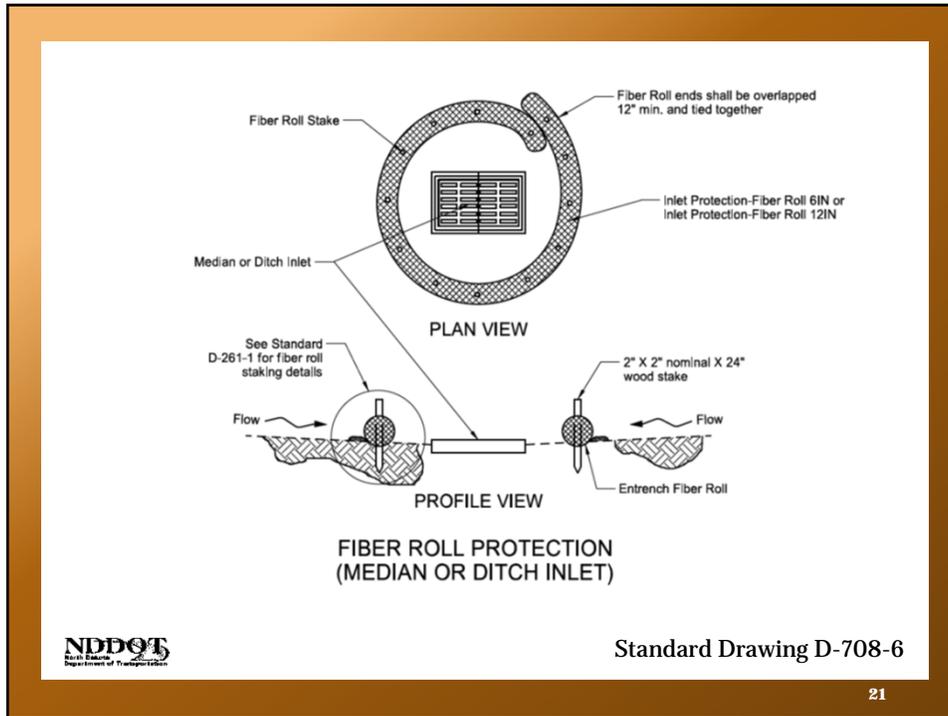


Inlet Protection

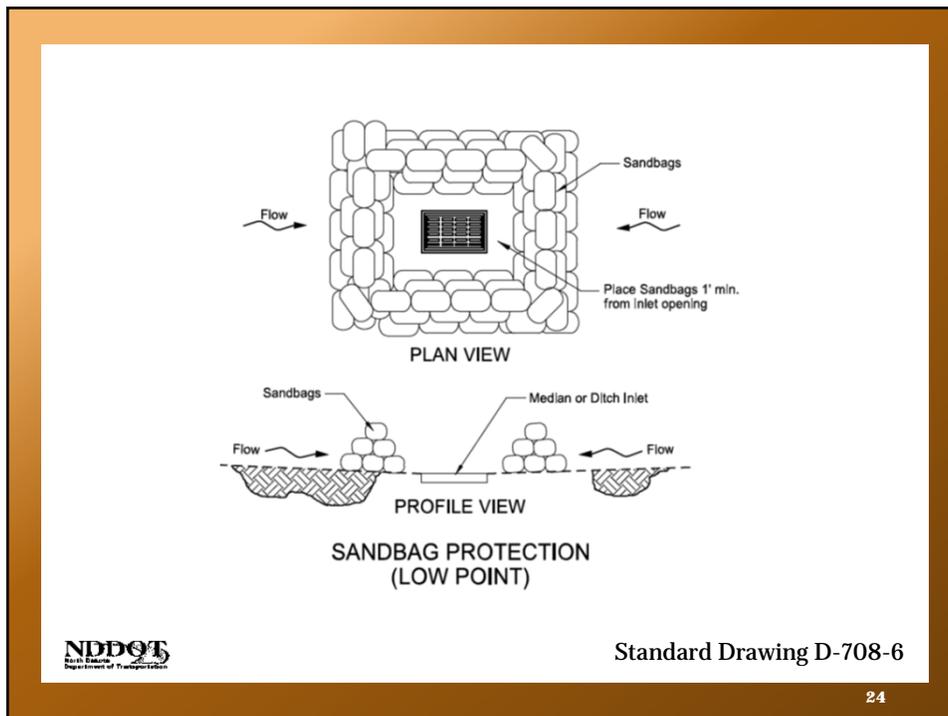
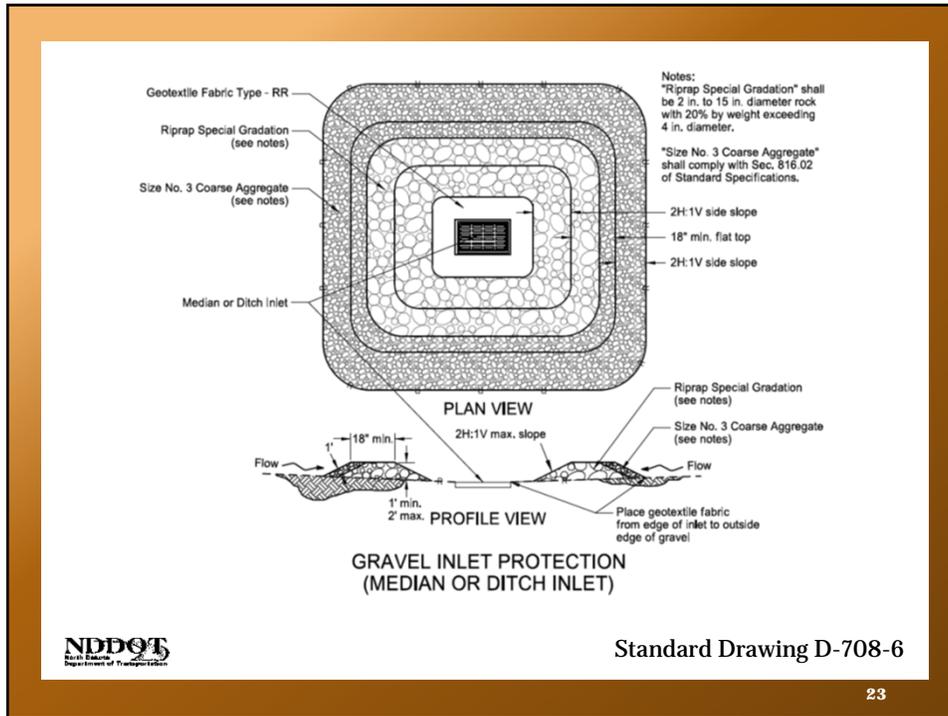
Multiple options available to prevent sediment from entering inlets

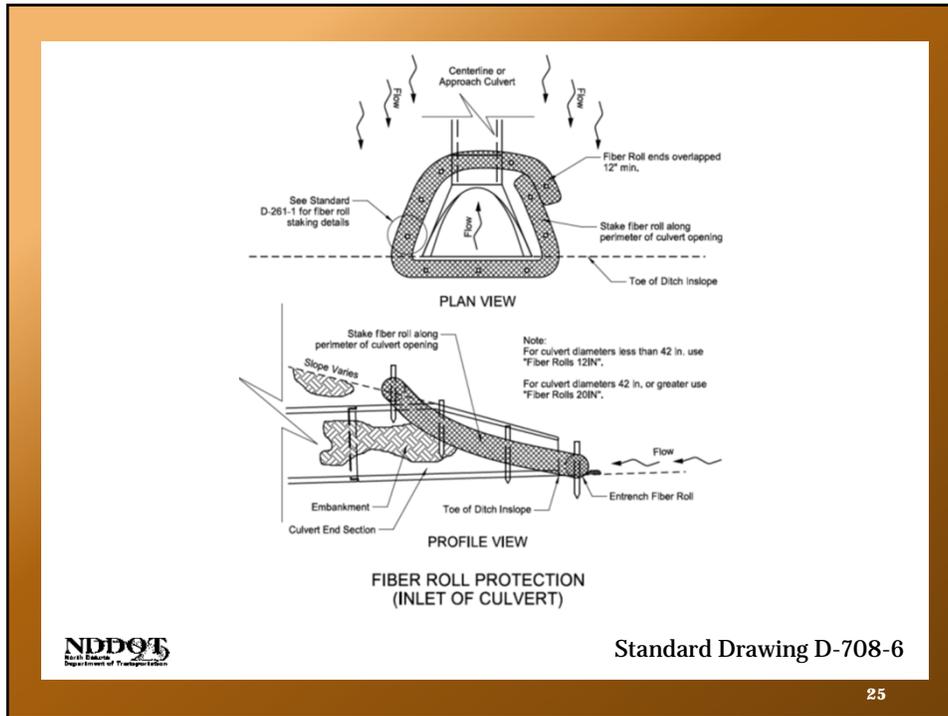
- Fabric
- Fiber rolls
- Gravel
- Manufactured (bags/domes/curb inlets)

**Module 3: Temporary & Permanent Erosion & Sediment Control Measures –
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Sediment Traps

Small basins used for drainage areas that are 5 acres or less

Storage should provide for 3,600 cubic feet per acre of drainage area

– Should safely pass 2-yr, 24-hr design storm

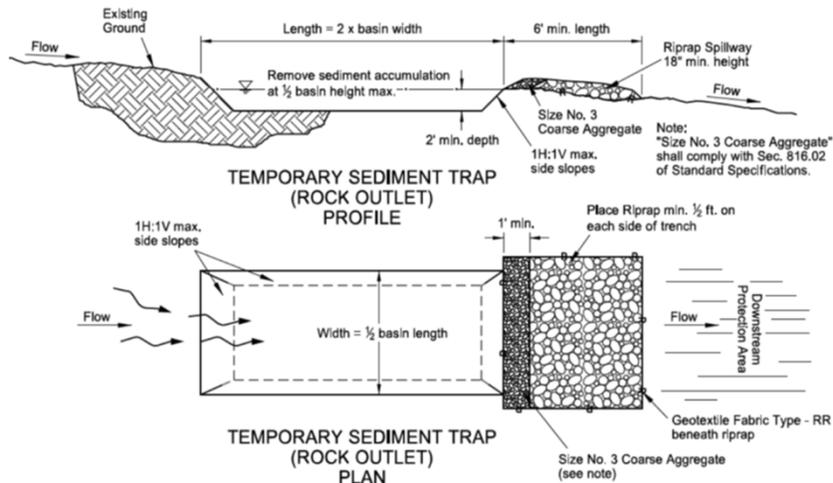


Sediment Traps

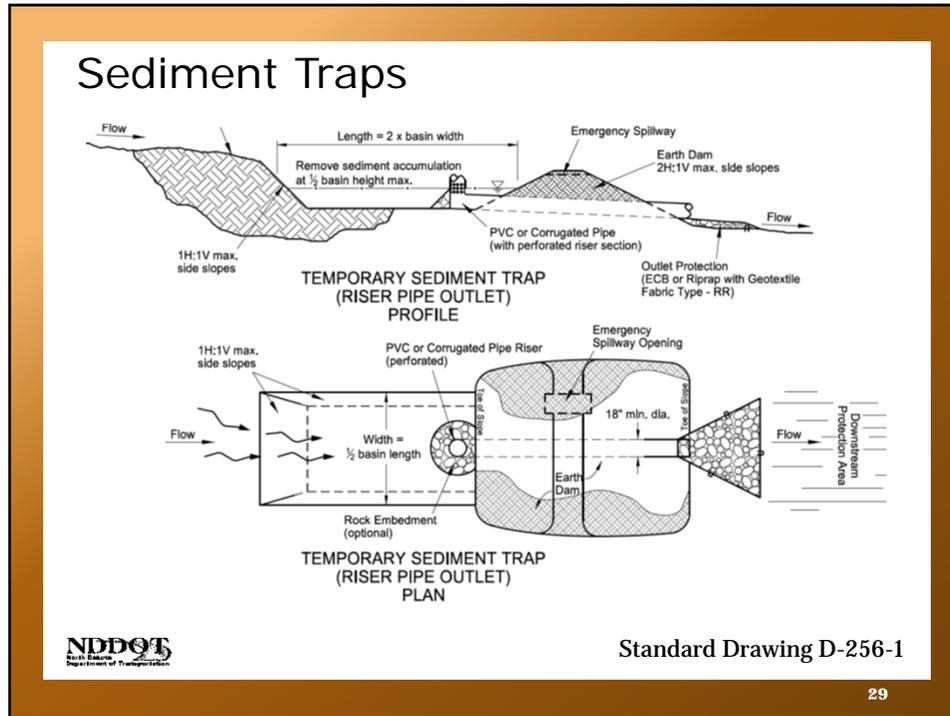
Sediment Trap Guidelines	
Dam height	Maximum of 5 ft.
Top width (embankment)	Minimum of 5 ft.
Fill slopes (embankment)	2.5:1 or flatter
Dam settlement	10% or less
Principal spillway	Rock-lined open channel or perforated riser
Bottom width	Minimum of 5 ft.
Freeboard	1.5 ft.



Sediment Traps



Standard Drawing D-256-1



Sediment Basins

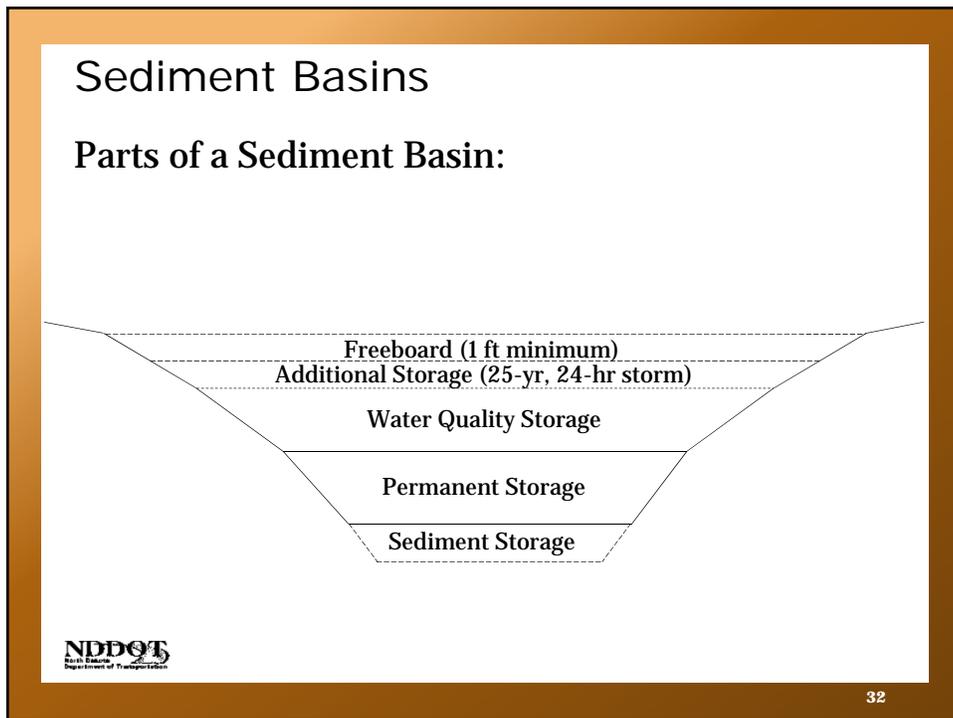
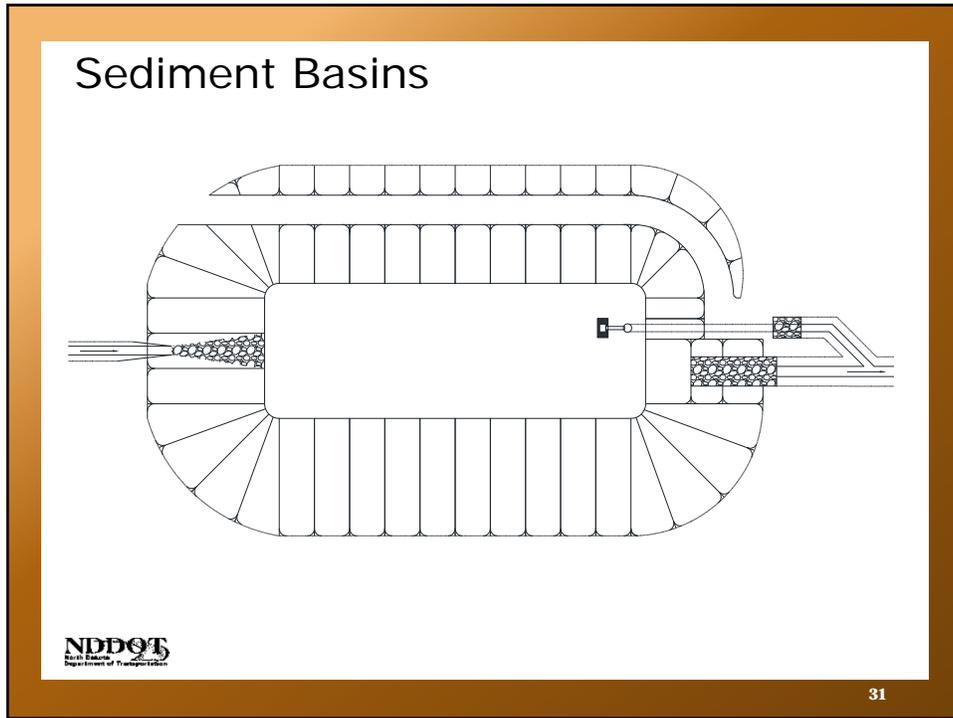
Structures that impound water and allow sedimentation of finer particles

Stormwater quality:

- Total suspended solids (TSS)
- Pollutants (heavy metals, nutrients, chemicals)

Stormwater quantity:

- Slow release of stormwater



Sediment Basins

Location of the Basin:

- Never locate in natural drainage ways (perennial streams, wetlands, etc.)
- Should be placed to receive the maximum amount of runoff from the site
- Divert run-on to avoid travel through the basin
- Discharge point



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Sediment Basins

Settled sediment should be removed to maintain capacity of basin

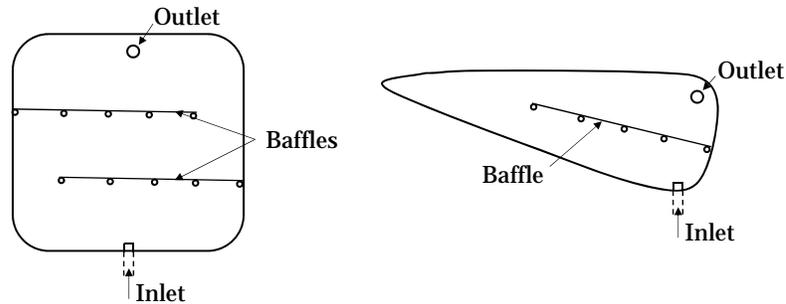
- May be necessary multiple times during the life of the project
- Should design sediment basin to allow access for cleanout



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Sediment Basins

Baffles increase the flow length and reduce velocity of flow through basin

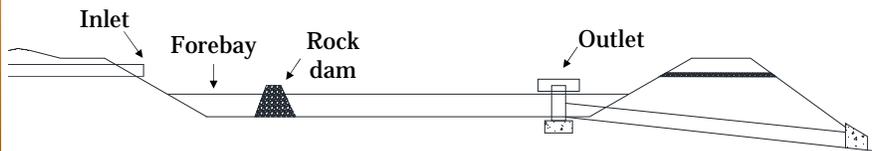


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Sediment Basins

Forebays create a small detention area before inflow reaches main part of basin



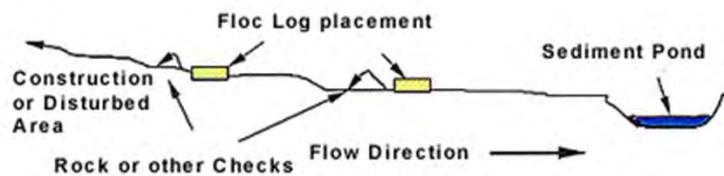
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Sediment Basins

Flocculants and coagulants can aid in sedimentation

– Passive vs. active applications



Stockpiles

Locate stockpiles as far away from bodies of water as possible

Protection of Stockpiles:

- Seeding (temporary or permanent)
- Plastic/geotextile
- Sediment barriers around piles



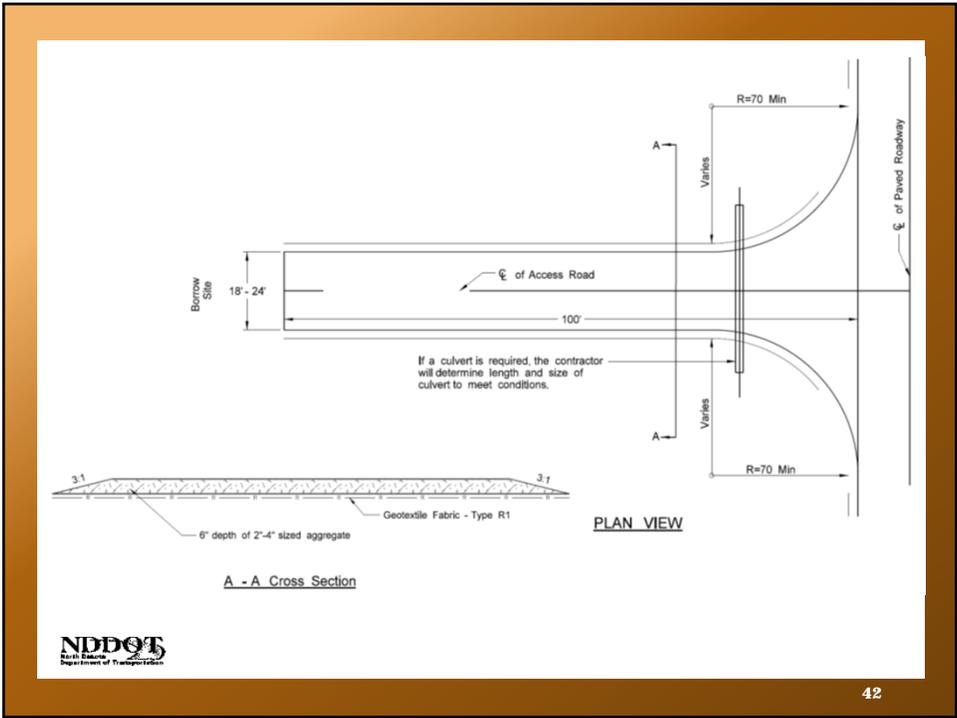
Track-out

Soil tracked out onto roadways by equipment causes numerous problems

Methods to prevent track-out:

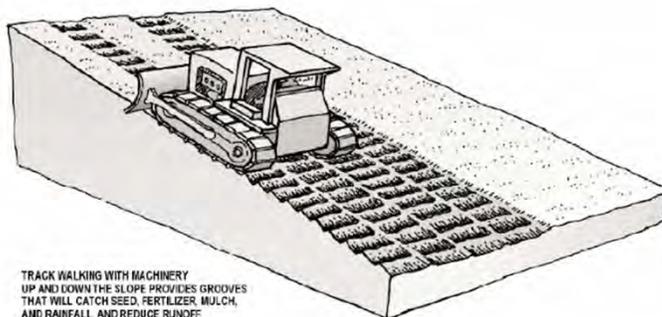
- Stabilized construction access (Section 265)
- Rumble plates
- Wheel wash stations

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Cat Tracking

Equipment tracking (or cat tracking) and roughening of the soil surface slows water flow over slopes



TRACK WALKING WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, FERTILIZER, MULCH, AND RAINFALL AND REDUCE RUNOFF

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Tillage (Section 251.04 B.)

During construction soils can become very compacted

Tillage introduces air into the soil and aids in the establishment and growth of vegetation

- Need approximately 3 inches of loosened soil for seedbed preparation



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Seed and Mulch Stabilization

Permanent stabilization as soon as possible is the most cost effective method

- May also be temporary

Should be considered during the planning stages of the project

- Phasing of the project
- When and where to seed and mulch



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Mulches (Section 253)

Benefits of Mulches:

- Protects soil by providing ground cover
- Healthy environment for seed and young plants
- Only resistant to raindrop impact and sheet flow
- Not for use in areas with concentrated flow



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Mulches

Construction Considerations:

- Preparation of site (soil, seed, fertilizer)
- Slope gradient and length
- Longevity
- Constructability
- Stability



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Hay or Straw Mulch (Section 253.04 C.)

Method of placement: Manually or with commercial blowers

Application rates: 2 tons per acre

Coverage: 90% minimum

Usage: Slopes < 2H:1V (see spec 253 D)

Longevity: Approximately 1 month



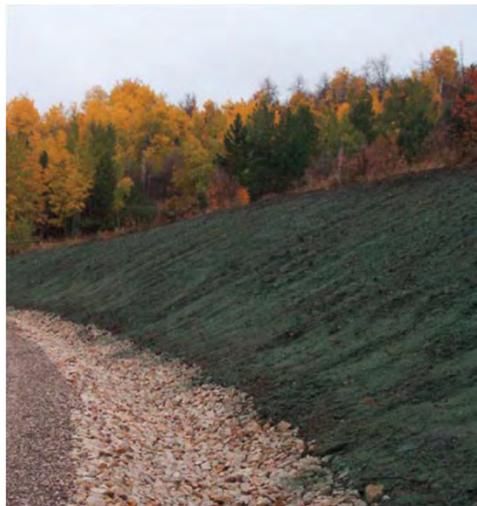
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Hydraulically applied erosion control products (HECP)

Matrix of fibers and additives

Requires specialized equipment to apply

Better protection and extended functional longevity compared to loose mulches



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Hydromulch (Section 253.04 B.)

Shredded wood and/or paper fibers

Application rates: 2,000 lbs/acre

Coverage: 95% of the seedbed

Usage: Slopes < 4H:1V

Longevity: Up to 3 months



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Bonded Fiber Matrix (BFM) (Section 253.04 D)

Wood fibers and tackifiers

Application rate: Manufacturer's recommended rate or 3,900 lbs/acre

Coverage: 100%

Usage: Slopes \leq 2H:1V

Longevity: 6 to 12 months



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Flexible Growth Medium (FGM)

Natural and crimped synthetic fibers

Application rate: 3,000 to 4,500 lbs/acre

Coverage: 100%

Usage: Slopes \leq 1H:1V

Longevity: Minimum of 12 months



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Polyacrylamide (PAM)

Flocculating agent used in erosion/sediment control

Anionic PAM should only be used

Must be tailored to soils on site

Most effective when used with in conjunction with mulches



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Rolled Erosion Control Products (RECP)

Range from simple nets to high performance products

Come in degradable or permanent forms

High performance RECPs can be used in areas with concentrated flow



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Rolled Erosion Control Products (RECP)

Construction considerations for RECPs:

- Application
- Soils
- Longevity
- Maintenance
- Constructability



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Rolled Erosion Control Products (RECP)

RECP Property	Common Test Method
Thickness	ASTM D6525
Density	ASTM D792
Tensile strength/elongation	ASTM D6818
Bench scale testing: <ul style="list-style-type: none">• Soil loss ratio• Shear resistance• Germination	ECTC Method 2 ECTC Method 3 ECTC Method 4
Large scale testing: <ul style="list-style-type: none">• Slope• Channel	ASTM D6459 ASTM D6460

Erosion Control Blankets (ECB) (Section 255 & 856)

Straw, coconut, excelsior, or combination used in matrix

Netting used on both sides, one side, or not at all

Slope and channel applications

Erosion Control Blankets (ECB)

Product Description	Slope Applications	Channel Applications
		Permissible Shear Stress (lbs/ft ²)
Netless	Up to 3H:1V	Up to 1
Single-net	Up to 2H:1V	Up to 1.5
Double-net	Up to 1H:1V	1.5 – 2.5

Category	Functional Longevity
Ultra short-term	Up to 3 months
Short-term	3 to 12 months
Extended-term	12 to 24 months
Long-term	24 to 36 months



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Erosion Control Blankets (ECB)

	ECB Type 1		ECB Type 2	
	Straw	Wood	Straw	Wood
Material	100% straw	100% excelsior fibers	100% straw	100% excelsior fibers
Min. Thickness (ASTM D 6525)	0.25 inch	0.25 inch	0.25 inch	0.25 inch
Max. Shear Stress at 0.5 inch soil loss (ASTM D 6460)	N/A	1.50 lbs/sf	1.50 lbs/sf	1.75 lbs/sf
Slope Gradient Application	≤ 3H:1V	< 3H:1V to 2H:1V	≤ 2H:1V	< 2H:1V to 1.5H:1V
Functional Longevity	≤ 3 months		≤ 12 months	



Section 856.01 Table 856-01

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Erosion Control Blankets (ECB)

	ECB Type 3		ECB Type 4	
	Straw/ Coconut	Wood	Coconut	Wood
Material	70% straw and 30% coconut fibers	100% excelsior fibers	100% coconut fibers	100% excelsior fibers
Min. Thickness (ASTM D 6525)	0.25 inch	0.25 inch	0.25 inch	0.50 inch
Max. Shear Stress at 0.5 inch soil loss (ASTM D 6460)	1.75 lbs/sf	2.00 lbs/sf	2.25 lbs/sf	2.25 lbs/sf
Slope Gradient Application	≤ 1.5H:1V	≤ 1.5H:1V	≤ 1H:1V	≤ 1H:1V
Functional Longevity	12 to 24 months		> 24 months	



Section 856.01 Table 856-02

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Turf Reinforcement Mats (TRM)

Turf reinforcement mats (TRM) are a type of permanent RECP with non-degradable, synthetic fibers and nettings

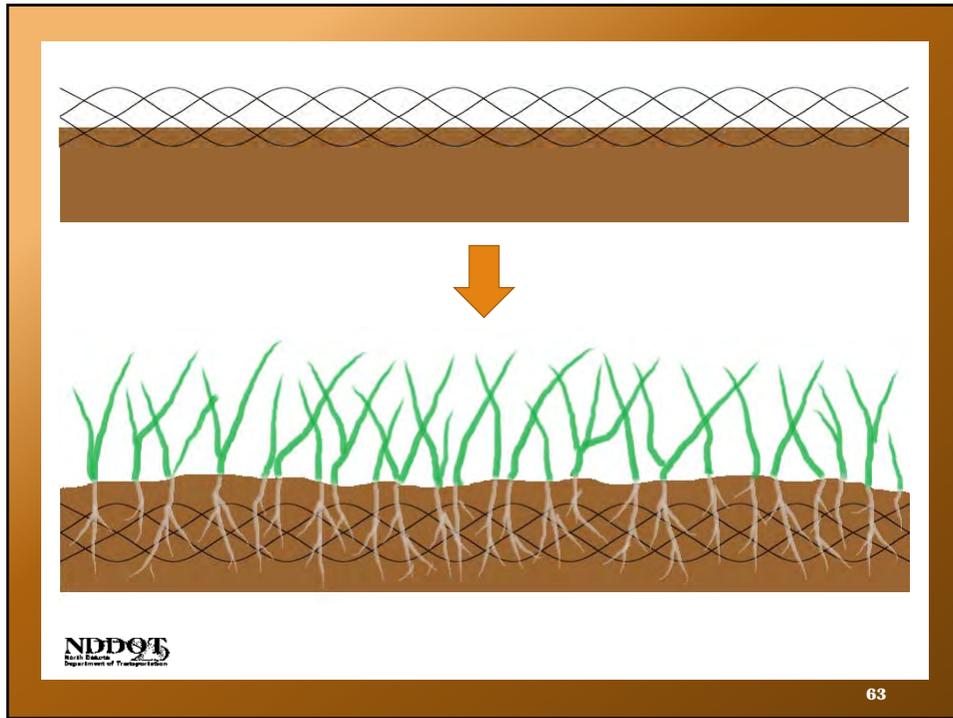
Provides reinforcement for the soil and vegetation

Usage Areas:

- High shear stress areas (concentrated flows)
- Very steep slopes
- Shorelines
- Pipe inlets and outlets



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Turf Reinforcement Mats (TRM)

	TRM Type 1	TRM Type 2
Matrix Fill Material	Wood excelsior, coconut or polymer fibers	100% stabilized polypropylene fibers
Min. Thickness (ASTM D 6525)	0.25 inch	0.50 inch
Min. Mass Unit Area (ASTM D 6475 for natural fibers)(ASTM D 6566 for synthetic fibers)	0.625 lbs/sy	0.625 lbs/sy
Max. Shear Stress at 0.5 inch soil loss (ASTM D 6460 under vegetated conditions)	6.0 lbs/sf	8.0 lbs/sf

Permanent RECPs

TRM Placement Types:

- Typically – directly applied over soil/seed
- Soil filled – typically requires sod or an ECB and seed over the TRM to hold soil in place
- Hydro injected – seed, place TRM, hydro-inject FGM (total coverage)



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RECP Construction

Should always consider the edges of RECPs

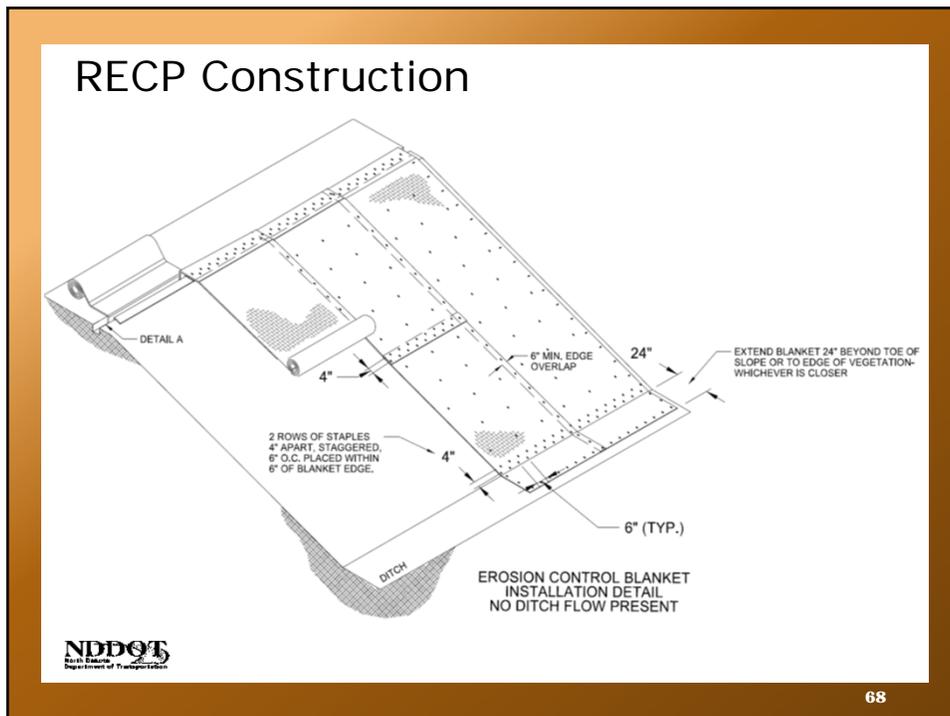
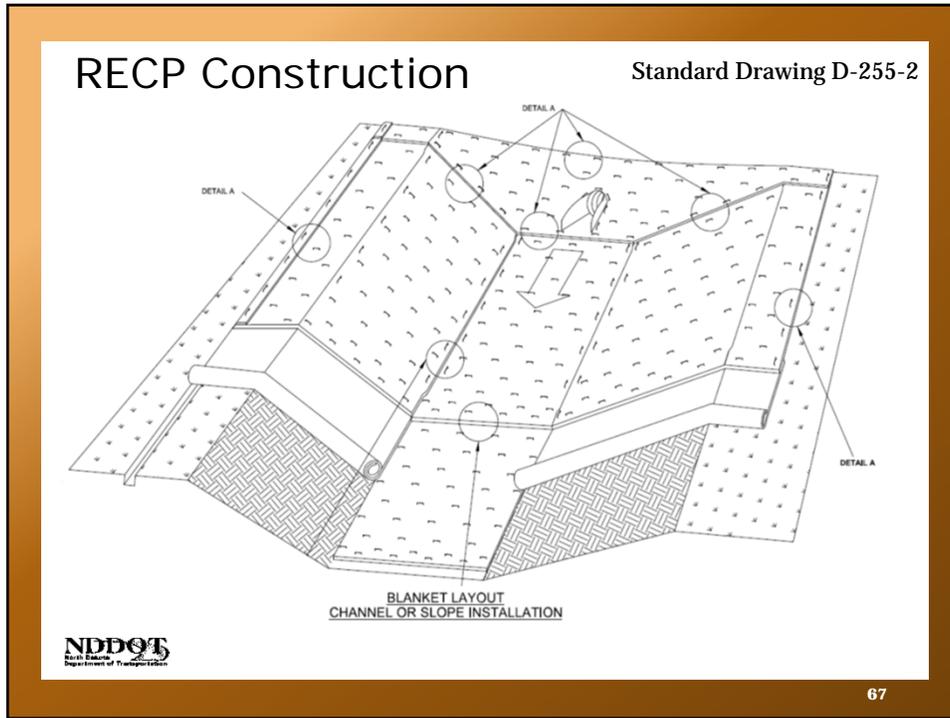
- Higher erosion potential

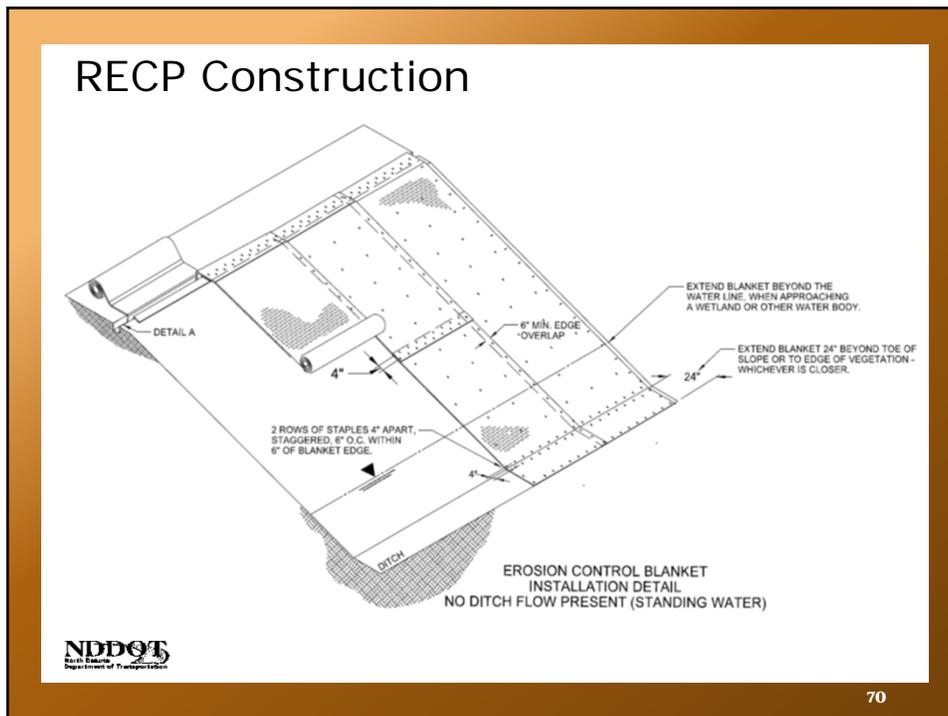
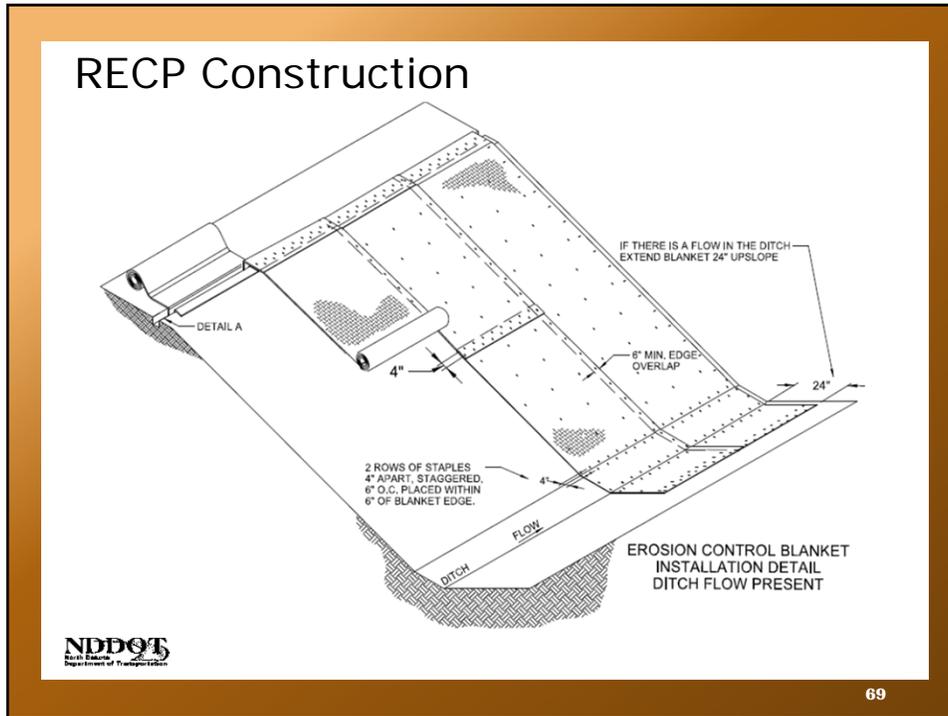
General RECP Installation Considerations:

- Site preparation (clods must be less than 1", bridging)
- Stapling
- Trenching in
- Overlapping

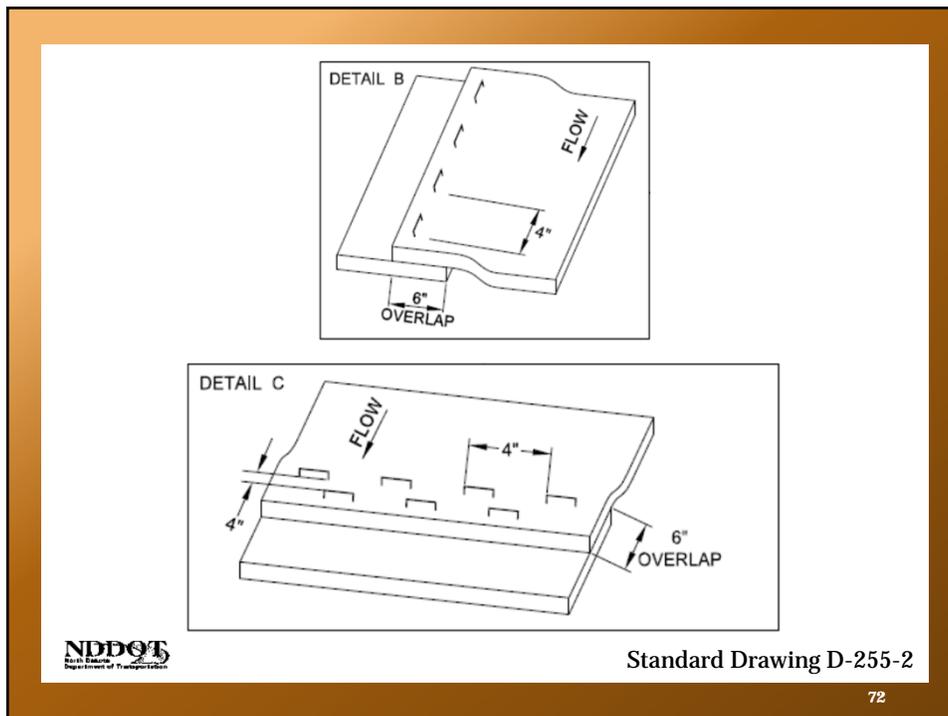
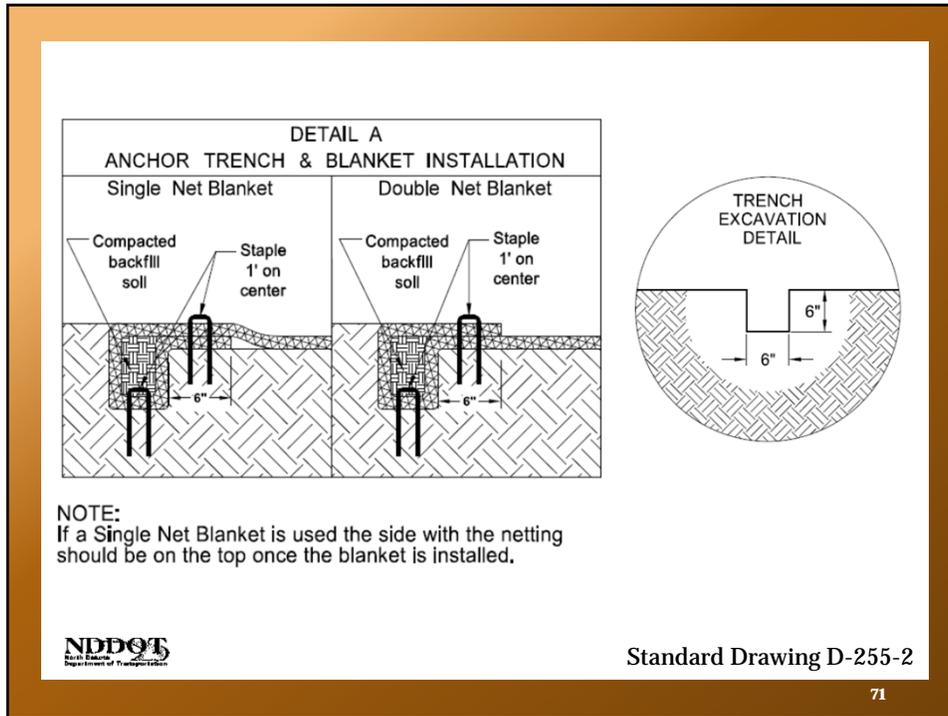


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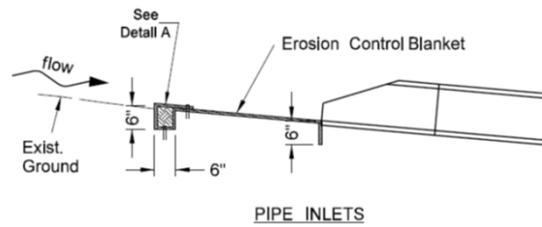
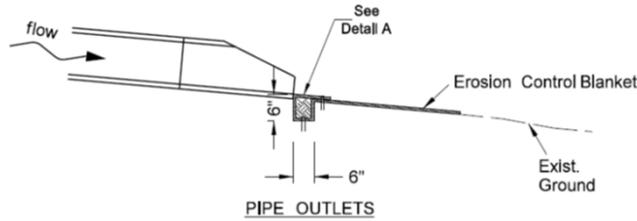




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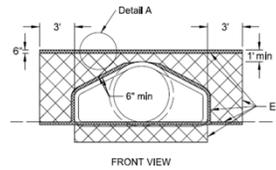
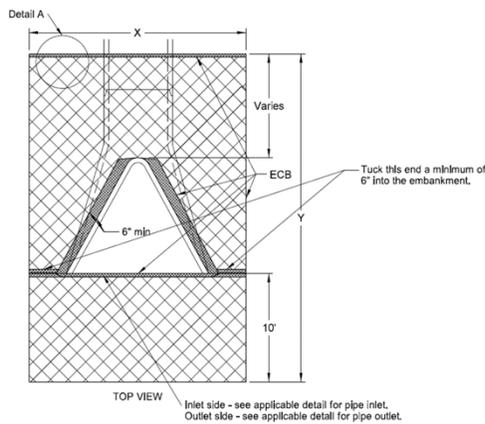
RECP Construction



Standard Drawing D-255-2

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RECP Construction



APPROACH CULVERTS				
DIA	X	Y	Surface area to be protected	ECB
In	Ft	Ft	SF	SY
15	9.0	20.0	176.0	20
18	9.5	20.7	190.7	22
21	9.5	21.0	190.9	22
24	10.5	21.6	214.1	24
27	11.0	22.0	226.3	25
30	11.6	22.5	241.5	27
36	12.7	23.3	268.8	30
42	13.3	23.3	279.7	31
48	13.8	24.0	293.2	33
54	14.5	23.4	300.6	34
60	15.0	23.0	307.5	35
66	15.6	24.0	325.6	37
72	16.2	24.5	340.6	38

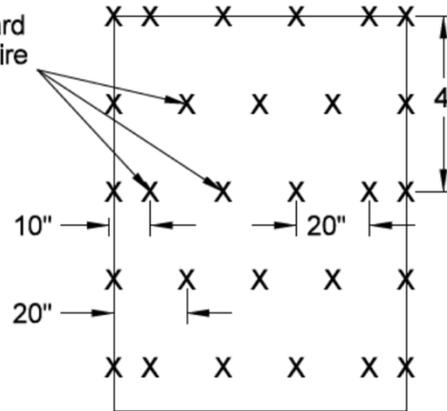
Note: Quantities based on 8:1 slope.



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RECP Construction

3.8 staples per square yard
using 8-inch 11 gauge wire
"u" staples.



STAPLE PATTERN

Interceptor Ditches

Interceptor ditches are used to divert run-on
safely around the active construction areas

- May be temporary or permanent structures
- Channels and swales may be unlined or use linings depending on length of use

Slope Diversions

Berms can be used to prevent run-on onto the site or down slopes

- Direct flow to a stable channel
- Short-term usage until more permanent conveyance systems are in place



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Slope Diversions

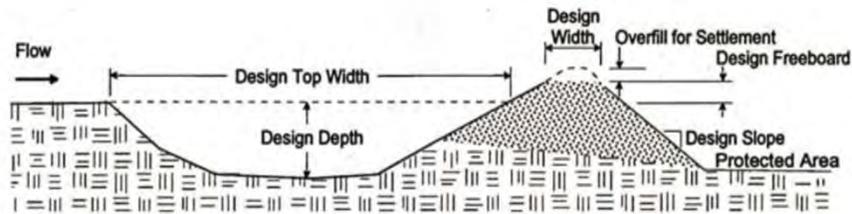
Ridge Design	
Side slopes	2:1 or flatter (3:1 or flatter where vehicles must cross)
Top width	2.0 ft.
Freeboard	0.3 ft.
Settlement	10% of fill height

Channel Design	
Side slopes	2:1 or flatter (3:1 or flatter where vehicles must cross)
Grade	Stable, positive grade towards outlet (should not exceed 2%)



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Slope Diversions



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Slope Diversions

Temporary slope drains are used to safely convey runoff down the slope

Slope drain considerations:

- Drainage area
- Type and size of drains
- Drain location
- Inlet type
- Outlet protection

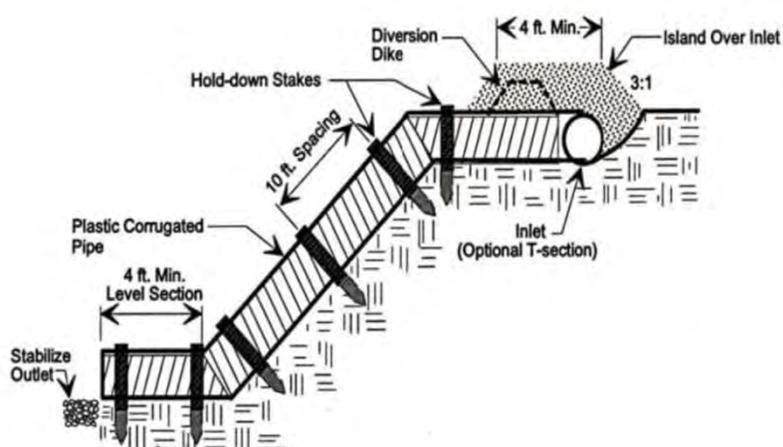


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Slope Diversions



Temporary Seeding

Short-term establishment of vegetation to protect exposed areas

Site considerations:

- Time of planting
- Soils

Oats, rye, and winter wheat application rate is 64 lbs. of pure live seed per acre (Section 251.03 E.)



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Dust Control (Sections 107.07 E. and 216)

Phasing and physical controls are the best way to prevent wind erosion

- Vegetation
- Mulches/blankets

Other methods:

- Water
- Barriers
- Chemical applications (emulsions, tackifiers)



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Slope Breaks

Fiber rolls used to shorten a slope and prevent rill erosion

– Slows sediment-laden water and filters sediment in low-flow areas

May be used with or without RECPs



Slope Breaks

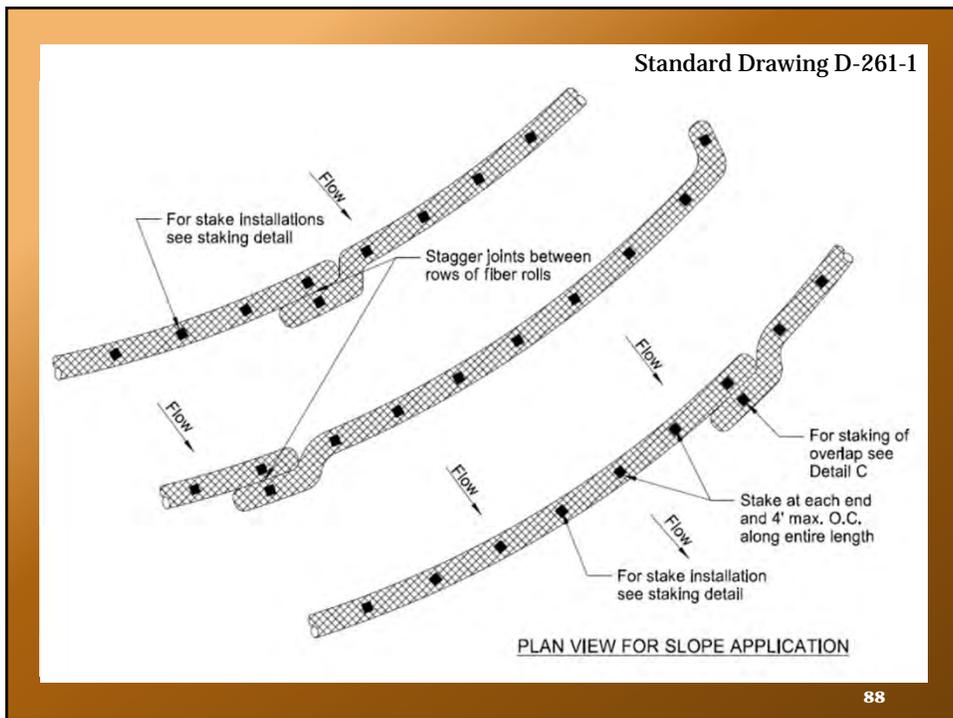
Recommended spacing of fiber rolls on slopes (ft):

		Fiber Roll Nominal Diameter			
		6"	9"	12"	20"
Slope Gradient	≤4H:1V	20	40	60	80
	3H:1V	15	30	45	60
	2H:1V	10	20	30	40
	1H:1V	5	10	15	20

Source: Sediment retention fiber roll (SRFR) general usage and installation guidelines, Erosion Control Technology Council (ECTC), 2011



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Flotation Silt Curtain (Section 262)

Geotextiles with floats and an anchorage system to prevent significant sediment from reaching watercourse

Available in different lengths and depths to match conditions

Should avoid placing completely across high flow channels or ditches



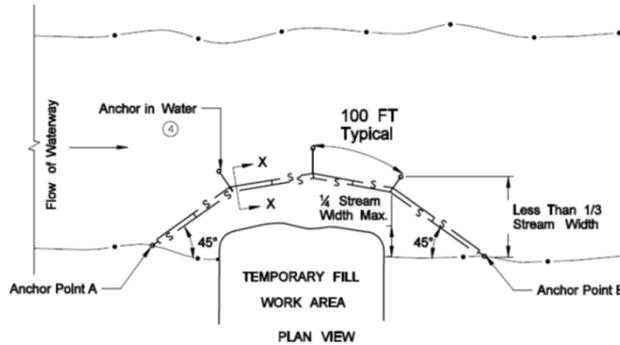
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Flotation Silt Curtain (Section 262)



FLotation SILT CURTAIN - TYPE WORK AREA

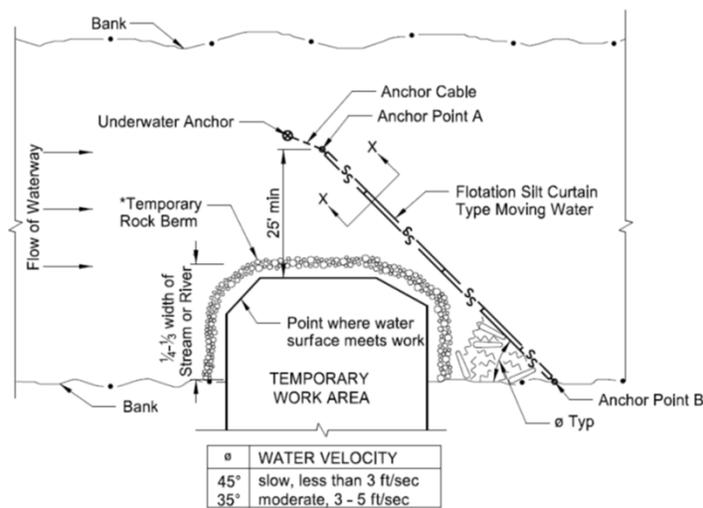
FOR CONTAINING OVERFLOWS FROM WEIRS, STANDPIPES, SETTLING PONDS

DESIGN GUIDELINES:
 WHEN TEMPORARY FILL ENEROACHES LESS
 THAN 1/4 OF THE WIDTH OF STREAM.
 MAXIMUM WATER VELOCITY: 5 FT./SEC.
 MAXIMUM WATER DEPTH: 11 FT.



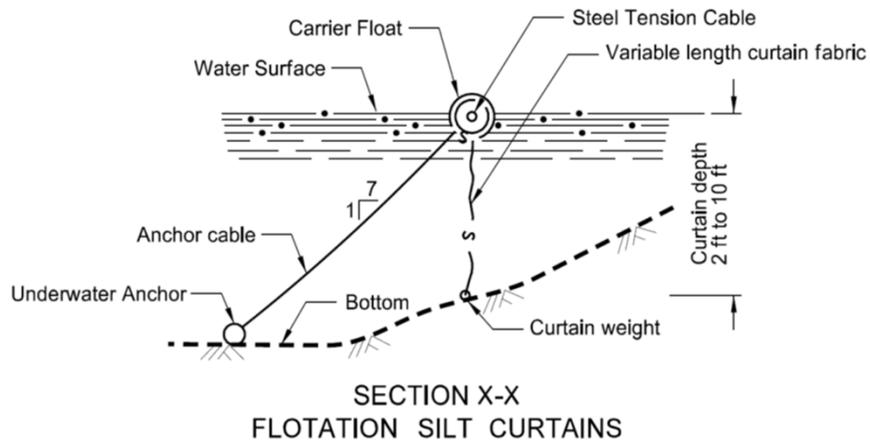
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Flotation Silt Curtain (Section 262)



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Flotation Silt Curtain (Section 262)



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Checks

Barriers built to dam water across concentrated flow

– Provides both erosion and sediment control

Can be made of rock or tubes filled with straw, excelsior, or other materials

Should consider drainage area, depth of flow, and water velocity

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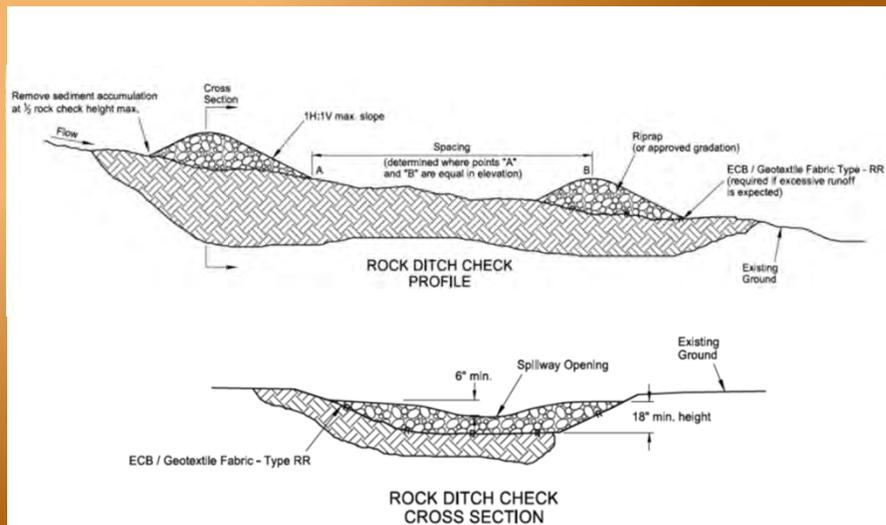
Rock Ditch Checks

Construction considerations:

- Spacing between checks
- Minimum 18 inches in height
- Center of rock ditch check should be lower than the ends (spillway)
- Back end of check should be protected to prevent erosion
- Remove sediment when it has reached $\frac{1}{2}$ the height of the check



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Standard Drawing D-256-1

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Fiber Roll Ditch Checks (Section 261)

May be filled with straw or wood excelsior

Available in multiple tube diameters

– 6 inch to 20 inch

Placed on ECBs or bare soil

– Must be trenched in on bare soil (2 to 3 inches)

Stake spacing should not exceed 4 feet



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Fiber Roll Ditch Checks

Spacing of fiber rolls in a channel:

$$Spacing = \frac{D_{FR} - TD}{S_{Channel}}$$

Where:

D_{FR} = nominal diameter of fiber roll (ft)

TD = trench depth (ft)

$S_{Channel}$ = slope of channel (ft/ft)



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Fiber Roll Ditch Checks

Spacing of fiber rolls in a channel (Example):

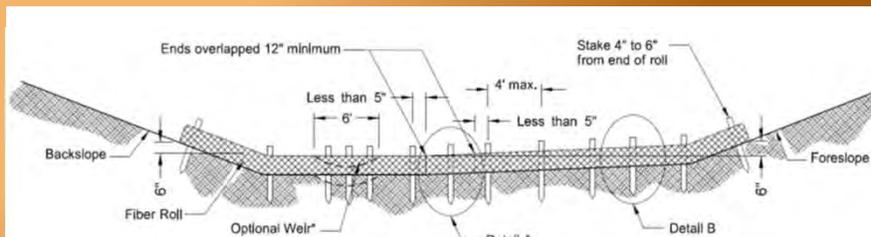
20" roll trenched in 3" in a 4% (0.04 ft/ft) slope

$$\text{Spacing} = \frac{20/12 - 3/12}{0.04}$$

Spacing \cong 35 ft between rolls

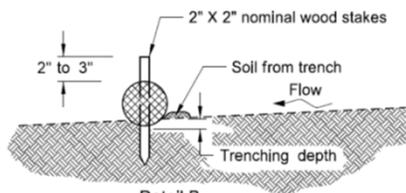


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*Optional Weir. Use in flat areas, such as the Red River Valley, where there is potential for water to back up on adjacent property. Lower fiber roll enough to prevent water from backing up on adjacent property. Do not use 20-inch fiber rolls in flat areas where there is potential for water to back up on adjacent property.

12 OR 20 INCH FIBER ROLL - DITCH BOTTOM



Detail B
 Fiber Roll Staking Detail



Standard Drawing D-261-1

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Ditch Checks

Inspect checks after significant rainfall events

Should watch for erosion at the ends of the check, downstream toe, and undercutting



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Good Housekeeping

Waste management

Sanitary waste management
(portable toilets)

Petroleum/chemical/
hazardous waste management

Concrete washout



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**Module 3: Temporary & Permanent Erosion & Sediment Control Measures –
NDDOT Erosion & Sediment Control – Construction Course**



Dewatering/Pumping

Dewatering on a construction site is a common practice

- Remove water from excavated areas
- Provide storage room in a sediment trap or basin before a rain event

For projects that require dewatering or pumping, sediment laden water cannot be pumped directly into surface waters



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Dewatering/Pumping

Water treatment options:

- Sediment basins and traps
- Filtration
- Flocculants
- Weir tanks



Dewatering/Pumping

General Guidance:

- Draw water from top of water column for improved efficiency
- Know pump rates and filtration rates
- Knowledge of particle size within sediment laden water
- Stabilization of discharge

Vegetation (Seeding) (Section 251)

Permanent vegetation provides excellent erosion and sediment control benefits

– Should aim to establish permanent vegetation as quickly as possible

Temporary cover crop may be used to help perennial vegetation growth



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Vegetation

Seed Class Mix Requirements		
Grass Species	Variety	Pounds Pure Live Seed per Acre
Class I		
Kentucky bluegrass	Park	4.0
Perennial Rye grass	--	5.4
Blue Gamma	Bad River	2.4
Sideoats Grama ¹	Killdeer, Pierre, Butte	7.2
TOTAL		19.0
¹ Substitute Thickspike or Stream bank Wheatgrass of the Critana, Banstock, Sodar, AC Polar, or Elbee variety if Sideoats Grama is unavailable.		



Section 251.03 D. Table 251-01

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**Module 3: Temporary & Permanent Erosion & Sediment Control Measures –
NDDOT Erosion & Sediment Control – Construction Course**

Seed Class Mix Requirements		
Grass Species	Variety	Pounds Pure Live Seed per Acre
Class II – Early Season		
Western Wheatgrass	Rodan, Rosana, Walsh, Flintlock, W. R. Poole, Recovery	9.6
Switchgrass	Dacotah, Forestburg, or Sunburst, Summer	3.2
Green Needlegrass	Lodorm, AC Mallard, Fowler	2.4
Sideoats Grama ¹	Killdeer, Pierre, Butte	3.6
Slender Wheatgrass	Revenue, Primar, Adanac, Pryor, Firststrike	5.0
TOTAL		23.8
Class II – Late Season		
Western Wheatgrass	Rodan, Rosana, Walsh, Flintlock, W. R. Poole, Recovery	9.6
Switchgrass	Dacotah, Forestburg, or Sunburst, Summer	1.6
Green Needlegrass	Lodorm, AC Mallard, Fowler	3.6
Canada Wild-rye	Mandan	5.2
Slender Wheatgrass	Revenue, Primar, Adanac, Pryor, Firststrike	5.0
TOTAL		25.0
¹ Substitute Thickspike or Stream bank Wheatgrass of the Critana, Banstock, Sodar, AC Polar, or Elbee variety if Sideoats Grama is unavailable.		

Section 251.03 D. Table 251-01

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Vegetation

Wetland Seed Mix			
Grass		Pounds Pure Live Seed per Acre	
Common Name	Variety	East of HWY 83	West of HWY 83
Prairie Cord Grass	Red River	1.1	1.1
American Slough Grass	Common	0.2	0.2
Fowl Blue Grass	Common	0.2	0.2
Fox Sedge	Common	0.2	0.2
American Manna Grass ¹	Common	0.2	0.2
Fowl Manna Grass ¹	Common	0.1	0.1
Bluejoint Grass ²	Common	0.1	0.1
Virginia Wild-rye	Omaha	2.0	---
Canada Wild-rye	Mandan	---	1.3
TOTAL		4.1	3.4

¹American, Fowl, or may be used. If only one is used the seeding rate of other species does not need to be increased.
²Seed may not be available and can be removed without increasing the seeding rate of other species.

Section 251.03 F. Table 251-02

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Vegetation

Seeding Type	Seeding Dates			
	Before April 20	April 20 to July 15	July 16 to August 9	August 10 to ground freeze
Class I	X	X	X	X
Class II – Early Season mixture		X		
Class II – Late Season mixture				X
Temporary cover crop	X		X	

Vegetation

Sodding provides immediate erosion control

Must select grass variety for region and intended use and maintenance

Must consider irrigation while sod is establishing

Outlet Protection

Riprap aprons and hard armor are common methods of reducing the impact of water exiting an outlet

Other Options:

- Energy dissipators
- Transition mats





Outlet Protection



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Outlet Protection



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Outlet Protection



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Vegetative Buffer Strips

Vegetative buffer strips are used to slow down runoff and intercept sediment

Must have a minimum width of 1 foot for every 5 feet of disturbed area which drains to the buffer

Buffer strip should be uniform and have a slope less than 5%

Area draining to the buffer should have a slope of 6% or less

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Stabilization Measures

Banks of streams and channels may need remediation or extra protection against increased flows

– Soil bioengineering techniques are becoming increasingly popular for their effectiveness and aesthetics



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Stabilization Measures

Structural stabilization:

- Riprap
- Gabions
- Precast elements

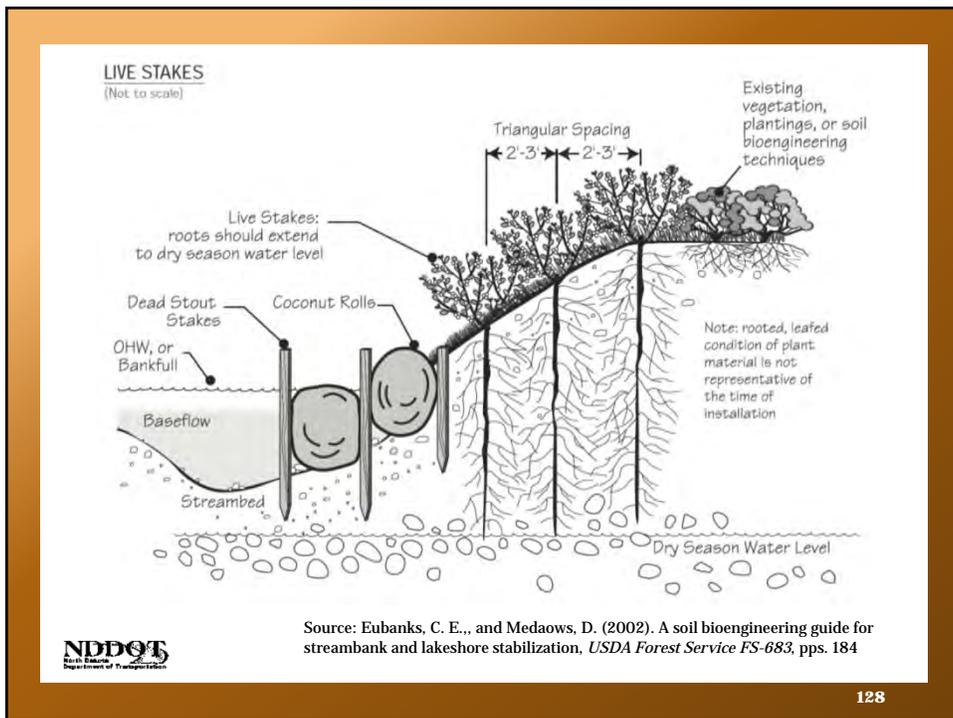
Geotextiles:

- TRM
- Geogrids
- Cellular confinement systems

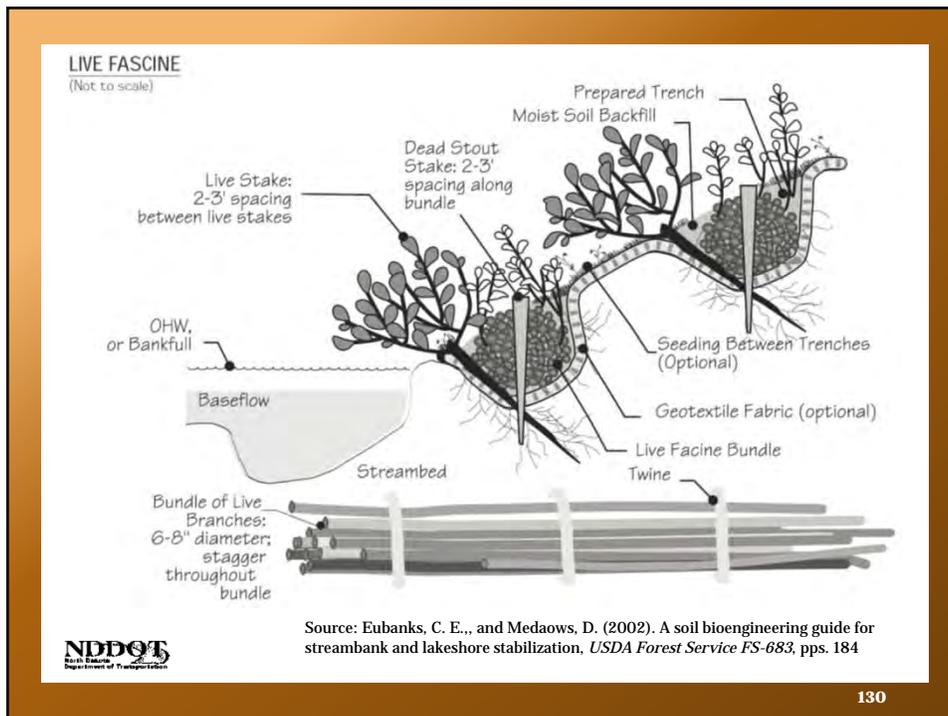
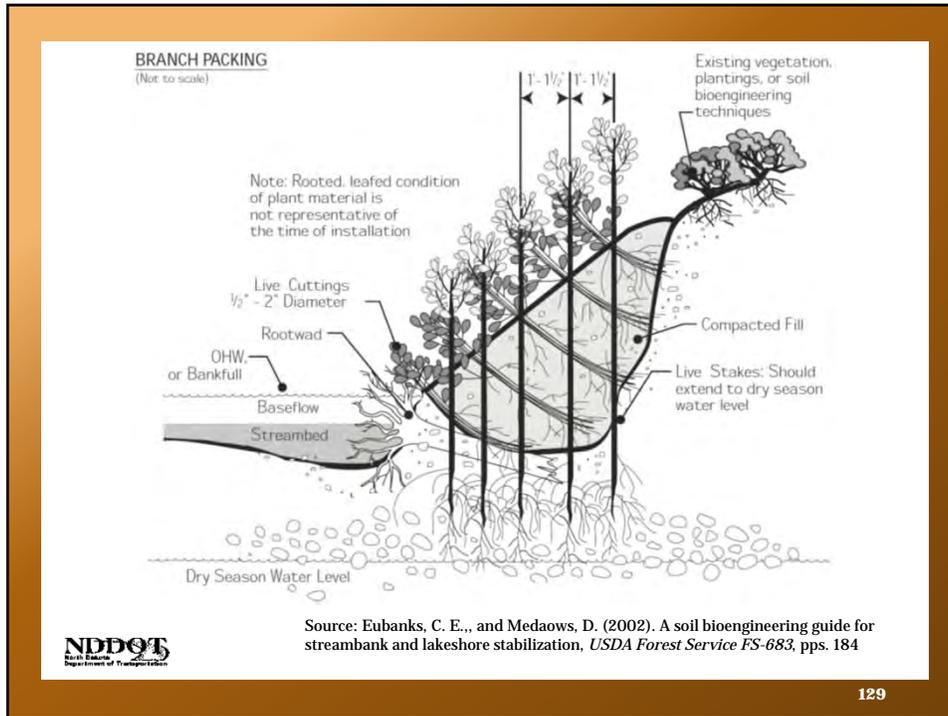


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**Module 3: Temporary & Permanent Erosion & Sediment Control Measures –
NDDOT Erosion & Sediment Control – Construction Course**



**Module 3: Temporary & Permanent Erosion & Sediment Control Measures –
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Stormwater Management

Bioswales/bioretenion

Underground storage

Infiltration basins

Grit chambers

Questions?

