



TYPICAL Best Management Practices FOR CONSTRUCTION SITES



JANUARY 2016

Westmoreland Conservation District

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TYPICAL Best Management Practices FOR CONSTRUCTION SITES

Hydroseeding at a Wet Pond with Forebay
North Huntingdon Township

**Typical Silt Sock along
a Stream**
Rostraver Township

Infiltration Trench Construction
Westmoreland County Community College
Youngwood, PA

Porous Concrete Pavement
Valley High School
New Kensington, PA

Typical Rock Energy Dissipater
Allegheny Township

Rain Garden
Westmoreland County Community College
Youngwood, PA

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Typical Best Management Practices

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Mission

The Westmoreland Conservation District promotes, educates, and implements conservation principles through examples and programs. We encourage best management practices and voluntary compliance of laws. Our Board of Directors, professionals, and volunteers are committed to the leadership and service required in pursuing a better environment. We use our skills and talents, and the cooperation of our partners to build a culture of responsible stewardship and sustainability.

Purpose

The purpose of this booklet is to give an overview of just some of the basic Erosion and Sediment and Stormwater controls, their proper installation, and areas of concern to inspectors. The Erosion and Sediment and Stormwater controls found in this booklet are representative of the many Best Management Practices (BMP's) available to site contractors.

Disclaimer

The information provided in this booklet is solely intended as guidance. The following examples should be constructed according to the approved engineered drawings which should be available on site. Nothing herein amends, alters, or changes any regulatory requirements. These guidelines are not to be considered either an adjudication or regulation.

Acknowledgements

This program booklet was created with input from District staff and a committee of long-time associates of our Erosion and Sediment Control and Stormwater Management Programs who brought a variety of knowledge, experience, and a valuable "user's perspective" while working with the District.

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This booklet was compiled by the Westmoreland Conservation District technical and education staff. The photos demonstrate good examples of construction site Best Management Practices that the Westmoreland Conservation District staff members have observed in Southwestern Pennsylvania. The drawings and photos were provided by Bove Engineering, Cahill Associates, Inc., ACF Environmental, Faircloth Skimmer™, North American Green, Pennsylvania's Department of Environmental Protection Erosion and Sediment Pollution Control Program Manual, the Pennsylvania Stormwater Best Management Practices Manual, and Westmoreland Conservation District.

Typical Best Management Practices for Construction Sites Production Team

Chris Droste, Kathy Hamilton, Mark Jackson, Jim Pillsbury, Tony Quadro, Christie Sebek, Jessica Thornton and Matt Zambelli

Definitions

- **Best Management Practice (BMP):** a structural or non-structural measure used to manage the volume, rate, velocity, and water quality of stormwater runoff.
- **Channel:** a natural or man-made water conveyance with defined bed and bank.
- **Chapter 93:** Water Quality Standards section of the Pa Code Title 25 Environmental Protection. Refer to www.pacode.com
- **Chapter 102:** Erosion and Sediment Control section of the Pa Code Title 25 Environmental Protection. Refer to www.pacode.com
- **Chapter 105:** Dam safety and Waterway Management section of the Pa Code Title 25 Environmental Protection. Refer to www.pacode.com
- **DEP or PADEP:** the Pennsylvania Department of Environmental Protection. Refer to www.depweb.state.pa.us
- **Disturbed area:** unstabilized ground where earth disturbance activity is occurring or has occurred. Erosion and sedimentation control plan is required for earth disturbance greater than 5,000 square feet and an NPDES permit is required for disturbance greater than 1 acre.
- **EPA:** the Federal Environmental Protection Agency. Refer to www.epa.gov
- **Erosion and sediment control plan:** a site specific plan identifying BMPs to minimize accelerated erosion and sedimentation.
- **Infiltration:** the entrance of surface water into the soil, usually at the soil/air interface.
- **NPDES:** National Pollutant Discharge Elimination System. An NPDES permit for construction sites is required when disturbance is greater than one acre. Refer to www.depweb.state.pa.us
- **PA One Call:** the agency to call (1-800-242-1776) before you dig for utility location information prior to excavation work. Refer to www.pa1call.org
- **Permeability:** the ability of rock, soil or other material to transmit gas or liquid.
- **Point source discharge:** a pollutant source regulated under the NPDES and defined as any discernable, confined and discrete conveyance from which pollutants are or may be discharged.
- **Pollutant:** any contaminant or other alteration of the physical, chemical, biological or radiological integrity of surface water that causes or has the potential to cause pollution as defined in Section 1 of the PA Clean Streams Law (35 P.S. § 691.1).
- **Precipitation:** a deposit on the earth of hail, mist, sleet, rain or snow.
- **Stormwater management:** a program developed to prevent pollution of stormwater, to control increase in stormwater volume and to prevent the acceleration of stormwater runoff.
- **Stormwater runoff:** water from precipitation that flows across the ground when it rains or when snow and ice melt.
- **Transpiration:** the transport of water vapor from the soil to the atmosphere through growing plants.
- **Waters of the Commonwealth:** any stream, lake, pond, spring, wetland, body of water or ground water within Pennsylvania borders.
- **Water quality standards:** the combination of water uses to be protected and the water quality criteria necessary to protect those uses.

When is a Permit Required?

Many earth disturbances and stream encroachments require permits. Earth disturbance greater than 5,000 square feet requires an erosion and sedimentation control plan*. Earth disturbances greater than 1 acre require a National Pollutant Discharge Elimination System (NPDES) permit. Water obstructions and encroachments, involving streams, wetlands and waterbodies with watersheds greater than 100 acres requires a General Permit (refer to pages 67-68). Water obstructions and encroachments with watersheds greater than 1 square mile require a Joint Permit. Check with your Conservation District if there are questions regarding permits or BMPs.

*Check with the Municipality in which the project is located for specific requirements on earth disturbance.

Typical Sequencing for Site Construction Activities:

It is required on permitted sites, prior to construction to have a **pre-construction site meeting** for all interested parties, including, but not limited to, the site construction foreman, municipal representative, Conservation District representative, site owner, etc. to discuss best management practices on the site.

The contractor must **provide notification** to the Conservation District and the Municipality at least **7 days prior to starting work**.

Sequencing of construction activities is a best management practice. The contractor must follow a designated sequence of BMP installation and removal in relation to the scheduling of earth disturbance activities prior to, during, and after earth disturbance activities. All sites should be evaluated by the site engineer prior to disturbance for the best sequencing of activities to limit site disturbance and the possibility of erosion events. The following is a list of typical sequencing items regarding site construction activities:

- Only limited disturbance will be permitted to provide access to BMP locations for grading and acquiring borrow to construct those BMPs.
- Erosion and sediment BMPs must be constructed, stabilized, and functional before site disturbance begins within the tributary areas of those BMPs.
- Stockpile heights must not exceed 35 feet and stockpile slopes must be 2:1 or flatter
- Until the site is stabilized, all erosion and sediment BMPs must be maintained properly. Maintenance must include inspections of all erosion and sediment BMPs after each runoff event and on a weekly basis.
- All preventative and remedial maintenance work on erosion and sediment control BMPs, including cleanout, repair, replacement, regrading, reseeding, mulching and renetting must be performed immediately.
- If erosion and sediment control BMPs fail to perform as expected, replacement BMPs or modifications of those installed will be required.
- Upon completion or temporary cessation of the earth disturbance activity, or any stage thereof, the project site shall be immediately stabilized.
- After final site stabilization has been achieved, temporary erosion and sediment BMPs must be removed. Areas disturbed during removal must be stabilized immediately.

Note: If the designed sequence cannot be followed, the contractor must stop work, consult with the owner and designer, and obtain a new Conservation District approved sequence before continuing work.

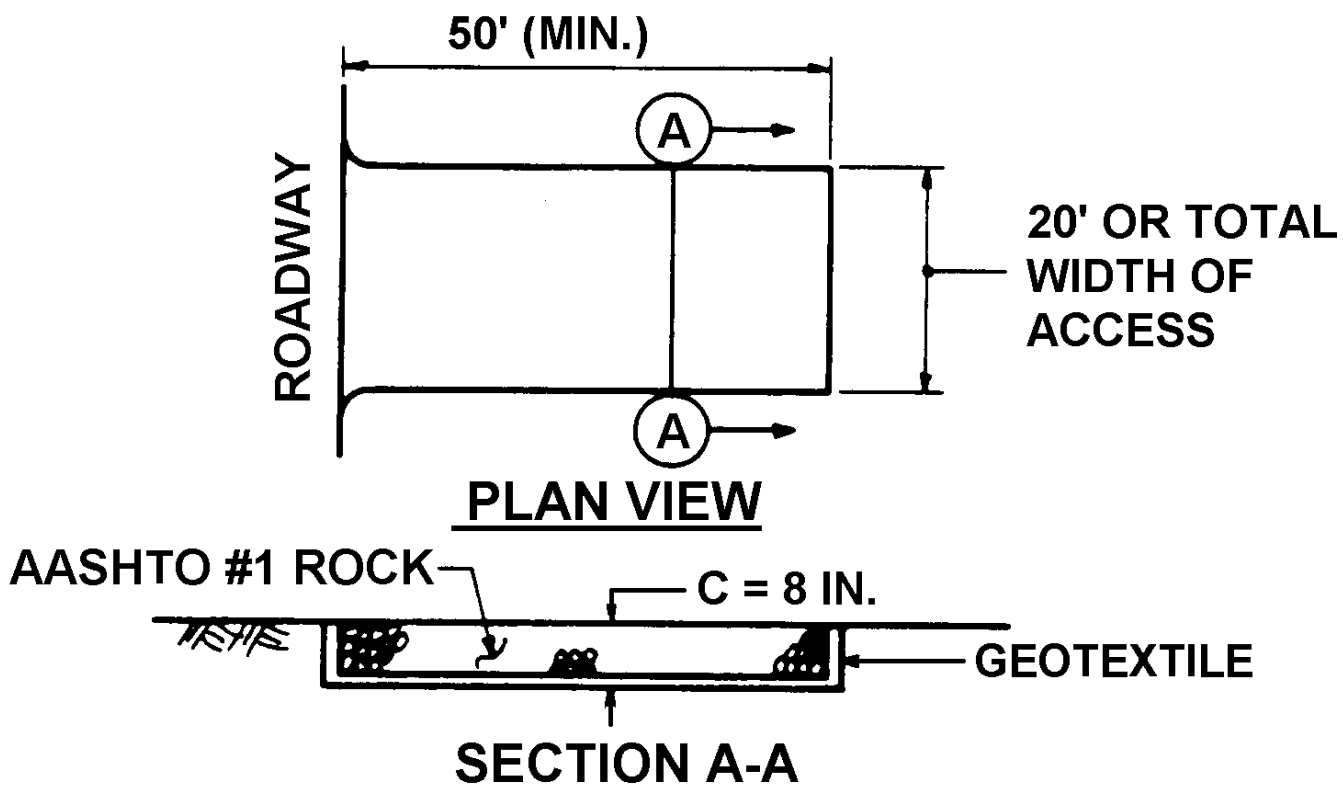


Rock Construction Entrance.
Photo courtesy of PaDEP

Typical Features:

- Minimum dimensions are 50' x 20'
- Rock size is AASHTO #1 or PennDOT Number 3 or 4 stone
- Geotextile is placed under rock to prevent rock from sinking into soft soil
- Used as a cleaning strip for trucks exiting site
- Required for all earthmoving sites

PA DEP STANDARD CONSTRUCTION DETAIL #16 Rock Construction Entrance



MAINTENANCE: Rock Construction Entrance thickness shall be constantly maintained to the specified dimensions by adding rock. A stockpile shall be maintained on site for this purpose. At the end of each construction day, all sediment deposited on paved roadways shall be removed and returned to the construction site.

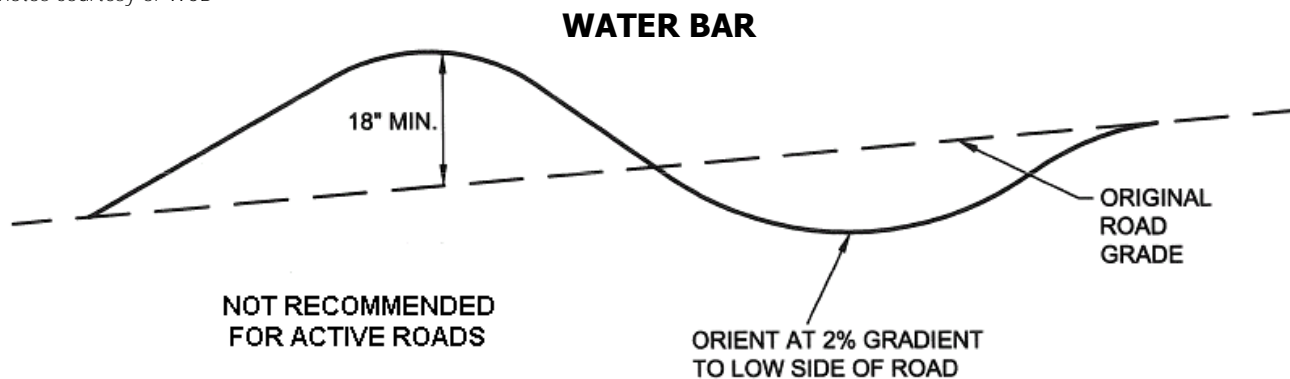


Typical Features:

- Used to direct runoff to a well-vegetated area or sediment removal facility
- Discharge to a stable area, on downslope side of access road or right of way
- 2% maximum gradient is recommended
- Waterbars should be vegetated
- Inspect weekly, after each rain event, or daily on active roads
- Restore to original condition within 24 hours of inspection
- Shall be left in place on right of ways or retired roads after permanent stabilization has been achieved

Water Bars on a utility corridor

Photos courtesy of WCD



MAXIMUM WATERBAR SPACING – adapted from USDA Forest Service

PERCENT SLOPE	SPACING (FT)
<5	250
5 - 15	150
15 - 30	100
> 30	50

Line drawing provided by PA DEP Erosion and Sediment Pollution Control Program Manual

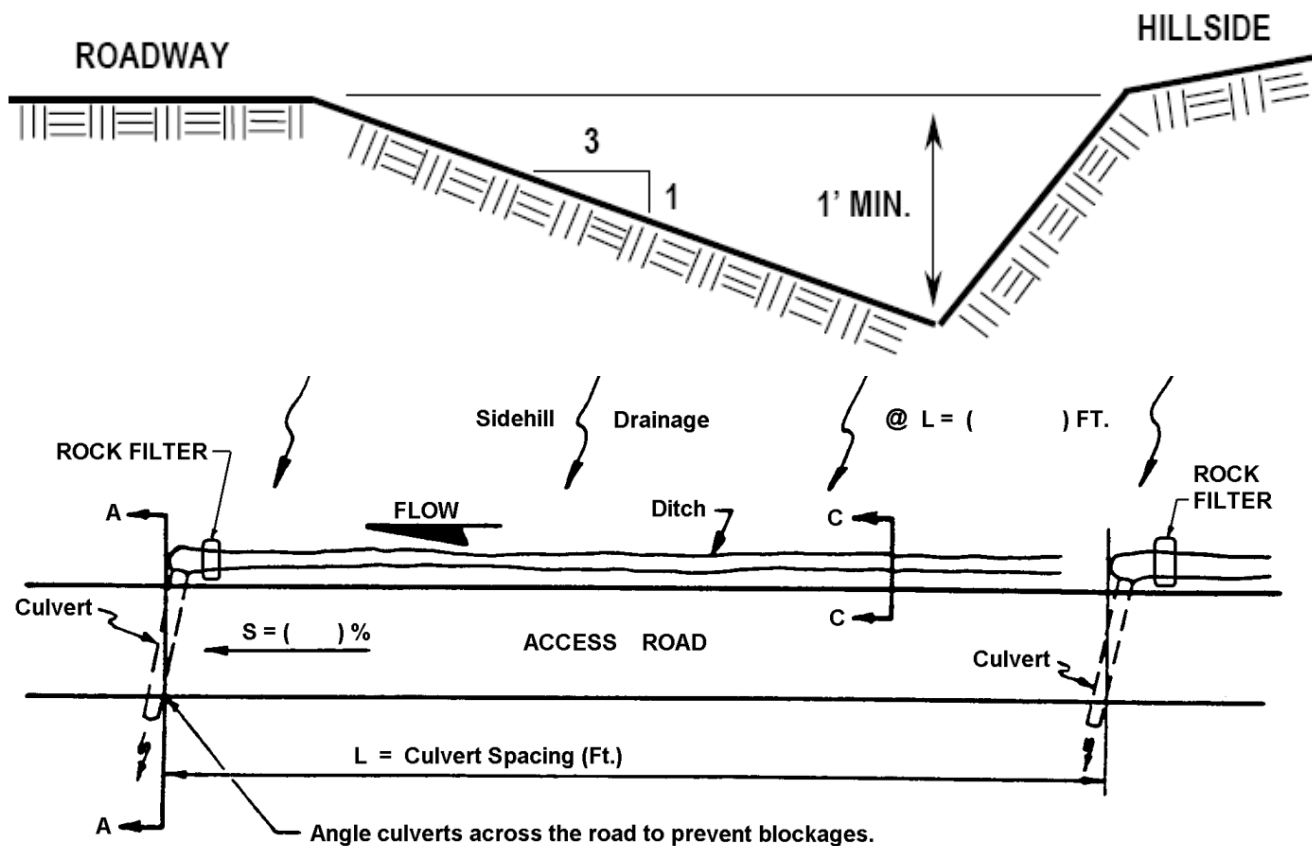


Roadside channel with pipe crossings
Photo courtesy of DEP

Typical Features:

- Protective lining is required when discharging to surface waters or to prevent erosion within the ditch
- Protect device from siltation during and after construction
- Dense vegetation for stabilization
- Sizing and spacing of ditch relief culverts should follow DEP recommendations, and should follow natural drainage courses.
 - Culverts should be 12" to 15" dependant on the slope and length of the upslope drainage.
 - Spacing should be 300' for 2% slope, 180' for 5% slope, 140' for 10% slope, etc. as listed in the DEP E&SPC Manual

ROADSIDE DITCH



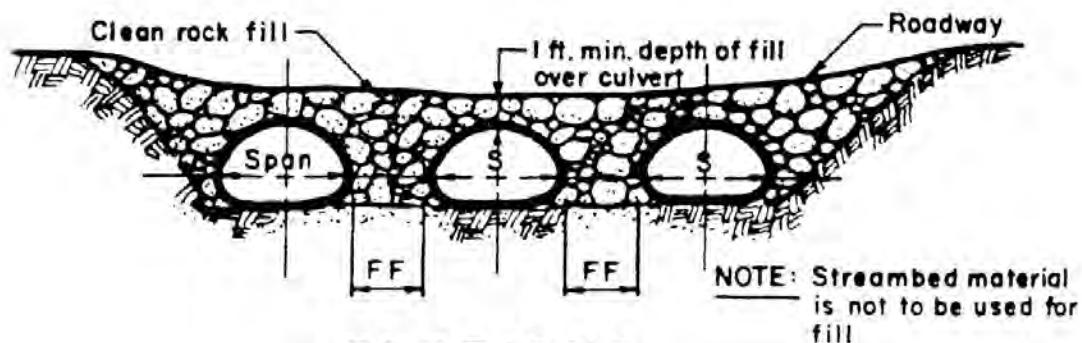
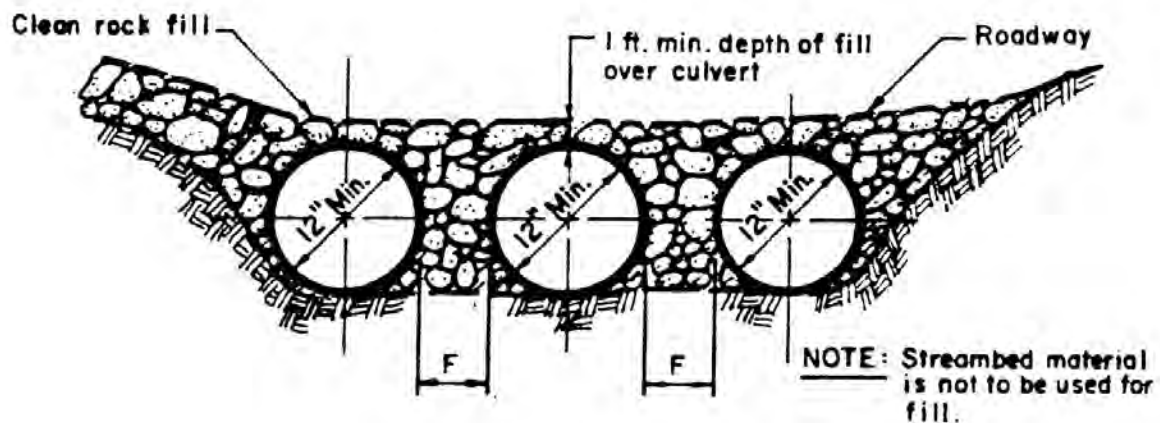


Typical Features:

- Clean rock fill should be used. Streambed material should NOT be used
- Roadway should be depressed over culvert to allow for overflow. Approaches should be stabilized
- Pipes should be depressed at least 6" below bed of stream
- Requires GP-8 permit

Temporary stream crossing

Photo courtesy of Westmoreland Conservation District



SECTIONS

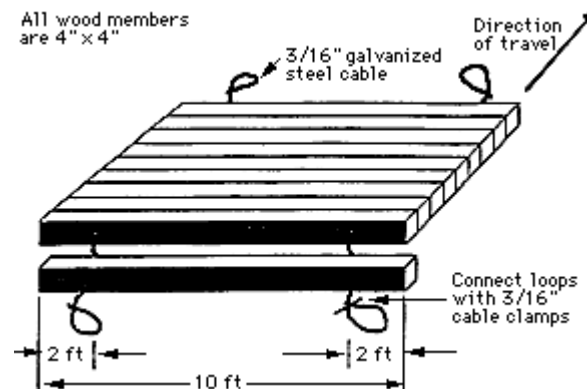


Timber mat wetland crossing
Photos courtesy of WCD

Typical Features:

- Avoid wetland crossing wherever possible
- Select crossing location to have least impact possible
- Shall conform to Chapter 105 permit requirements
- Prevents compaction of wetland soils
- Temporary crossings shall be constructed with minimum disturbance and with materials that can be completely removed
- Utilize geotextile underlayment

WETLAND CROSSING Typical Wood Mat



Utility Stream Crossing

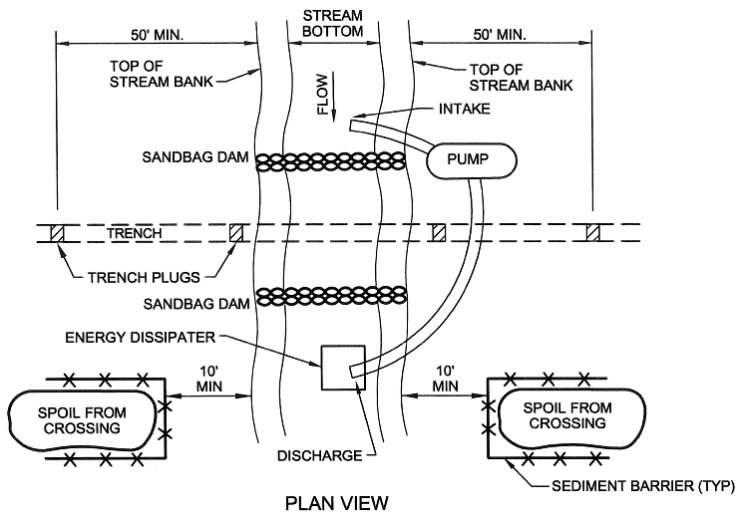
Erosion and Sediment Control BMP



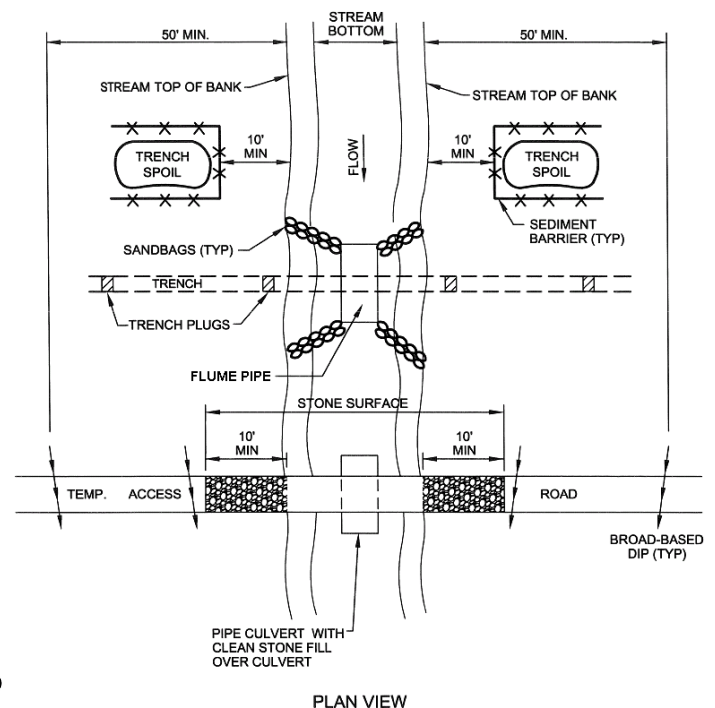
Flume (above) and pump bypass for stream crossing
Photos courtesy of WCD and DEP

Typical Features:

- Grubbing shall not take place within 50 ft of top of bank until all materials are on-site for project completion
- Trench plugs shall be installed within the trench on both sides of the stream
- Pumped water filter bag or sediment trap shall be used to remove any water accumulating in the work area
- All excess material shall be removed immediately from the crossing area
- Disturbed area, within 50 ft of top of bank, shall be stabilized within 24 hours



Pump Bypass



Flume

Line drawings provided by PA DEP Erosion and Sediment Control Program Manual

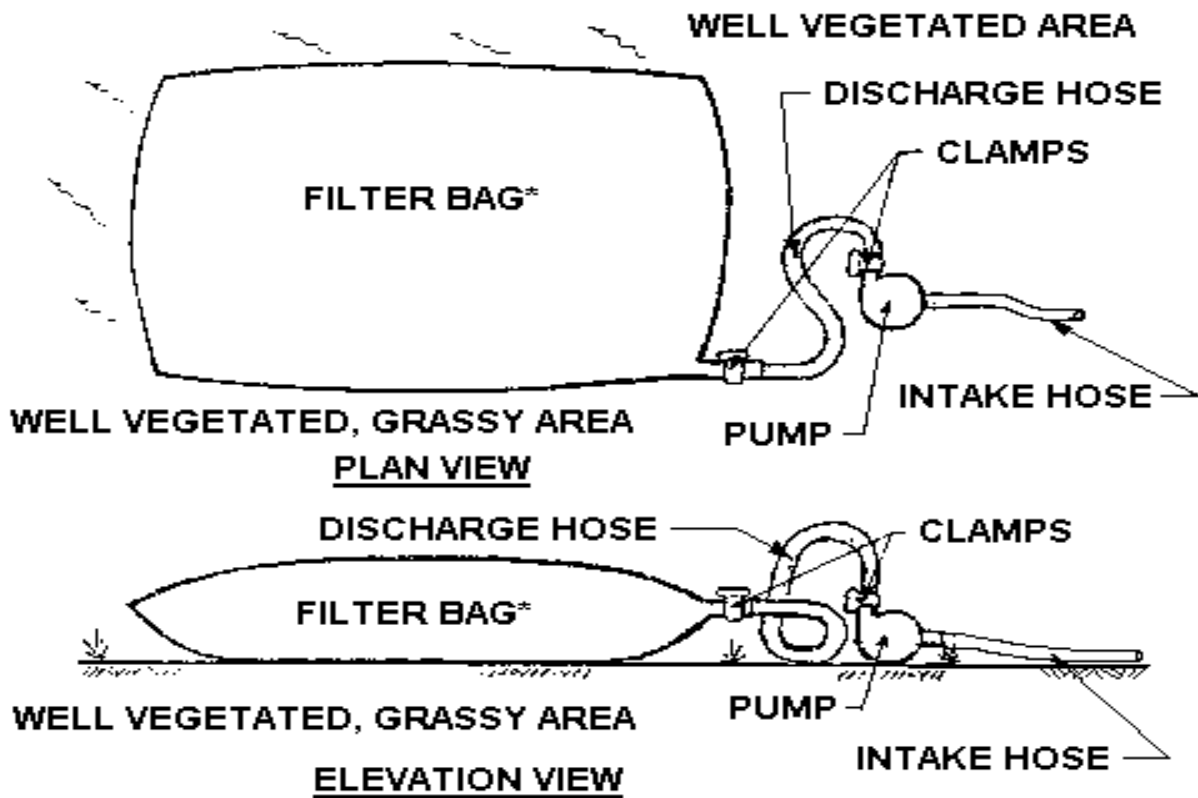


Filter bag
Photo courtesy of PaDEP

Typical Features:

- Placed in relatively flat, well vegetated areas or on a bed of #57 stone
- Hose should be inserted into the bag and securely clamped. Only one hose per bag
- Pumping rate should not exceed 750 gpm or $\frac{1}{2}$ the maximum rate specified by the manufacturer
- Bag should be properly disposed, not cut open and seeded

PA DEP STANDARD CONSTRUCTION DETAIL #26 Pumped Water Filter Bag



Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual

Trench Plug

Erosion and Sediment Control BMP

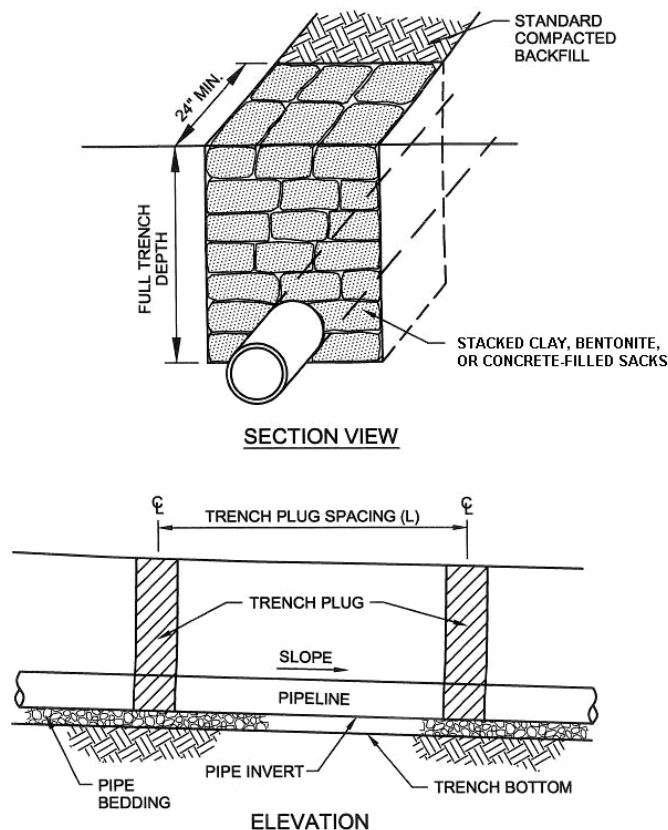


Foam trench plug (left) and sand bag trench plug
Photos courtesy of WCD and DEP

Typical Features:

- Trench plugs can be sand, clay or concrete filled sacks or synthetic foam. Topsoil may NOT be used.
- Impervious trench plugs are required for all stream or wetland crossings
- Spacing of trench plugs should be according to slope of trench
 - 1,000 ft for 5% slope or less
 - 500 ft for 5%-15% slope
 - 300 ft for 15%-25% slope
 - 200 ft for 25%-35% slope

TYPICAL TRENCH PLUG INSTALLATION



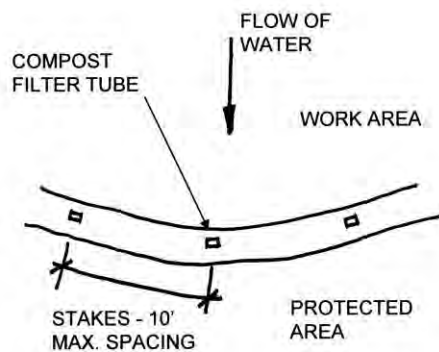
Line drawing provided by PA DEP Erosion and Sediment Control Program Manual



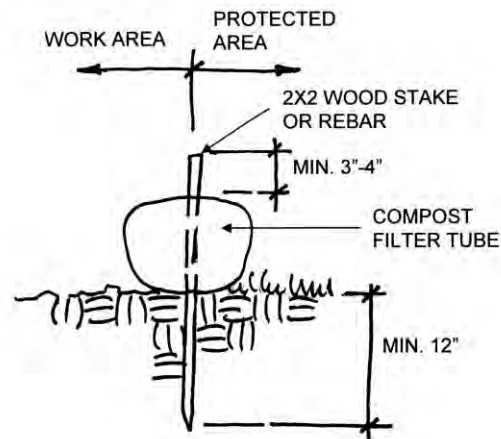
Compost Filter Tube
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Can be used in place of silt fence
- Should be laid on the contour
- Stakes should be driven through the tube at least 12" into the existing ground, with 3"- 4" exposed above the tube
- Remove sediment when it reaches 1/3 height of sock
- Once site is stabilized, tube may be cut open and seeded.



PLAN



SECTION

COMPOST FILTER TUBE SHOULD BE INSTALLED AS PER MANUFACTURERS RECOMMENDATIONS AND WHERE SHOWN ON THE PLAN

12" TUBE	COMPARABLE TO 18" SILT FENCE
18" TUBE	COMPARABLE TO 30" SILT FENCE
24" TUBE	COMPARABLE TO SUPER SILT FENCE

COMPOST FILTER TUBE

WCD 1/2008 N. T. S.

Line drawing provided by Westmoreland Conservation District

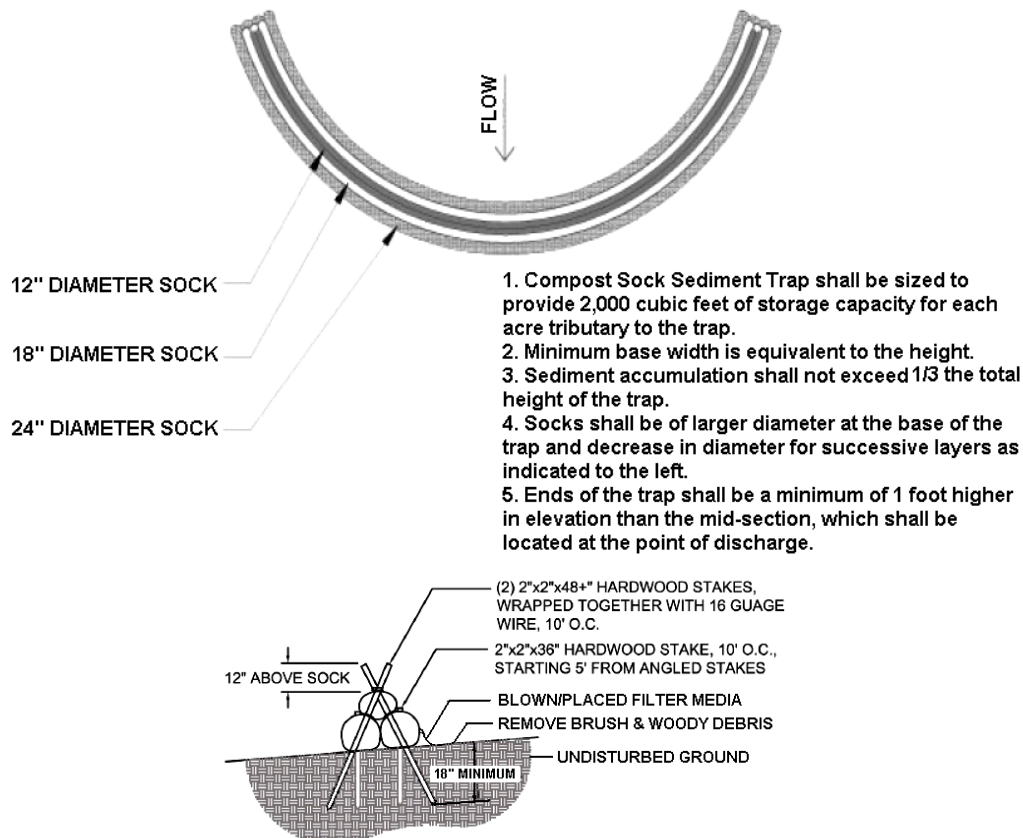


Compost Sock Sediment Trap
Photo provided by Filtrex™

Typical Features:

- Sock material and compost material shall meet industry standards
- Shall not exceed 3 socks in height, and shall be stacked in pyramidal form
- Maximum tributary area is 5 acres
- Shall be inspected weekly and after each runoff event
- Remove sediment when it reaches 1/3 height of socks

COMPOST SOCK SEDIMENT TRAP



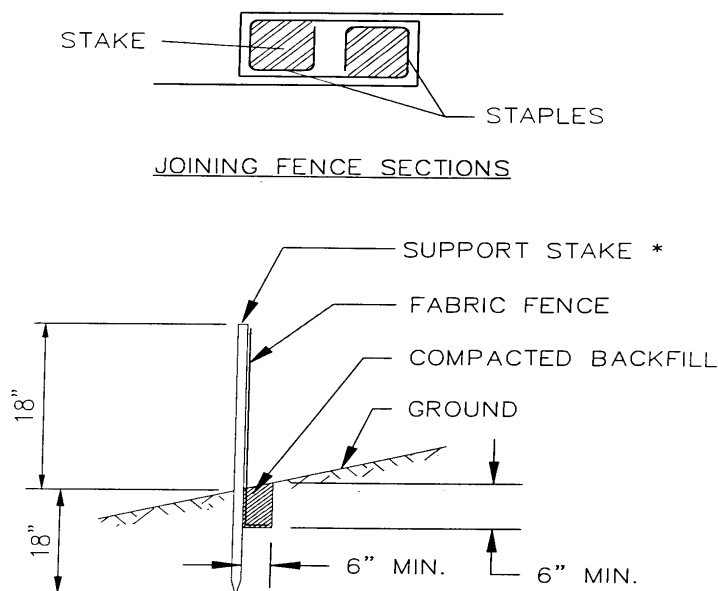


Standard Silt Fence
Photo courtesy of PaDEP

Typical Features:

- Designed to handle sheet flow, not concentrated flow
- 6" x 6" trench should be excavated
- The bottom 12" of the fabric should be placed in the trench in an "L" shape with a 6" horizontal flap and a 6" vertical rise
- Should not be able to lift the bottom of the fence off of the ground
- Multiple rows of silt fence may not be used on a continuous slope
- Should be at least 8' from toe of slope
- Should be installed at existing level grade
- Both ends of each section must be extended 8' upslope at 45 degrees
- Sediment must be removed when accumulations reach 1/2 of the above ground height of the fence
- Any section of fence which has been undermined or over-topped must immediately be replaced with a rock filter outlet

PA DEP STANDARD CONSTRUCTION DETAIL #19 Standard Filter Fabric Fence (18" High)



****Stakes spaced @ 8' maximum. Use 2"x 2" wood or equivalent steel stakes.***

Silt Fence - Standard Silt Fence with Straw Bales

Erosion and Sediment Control BMP



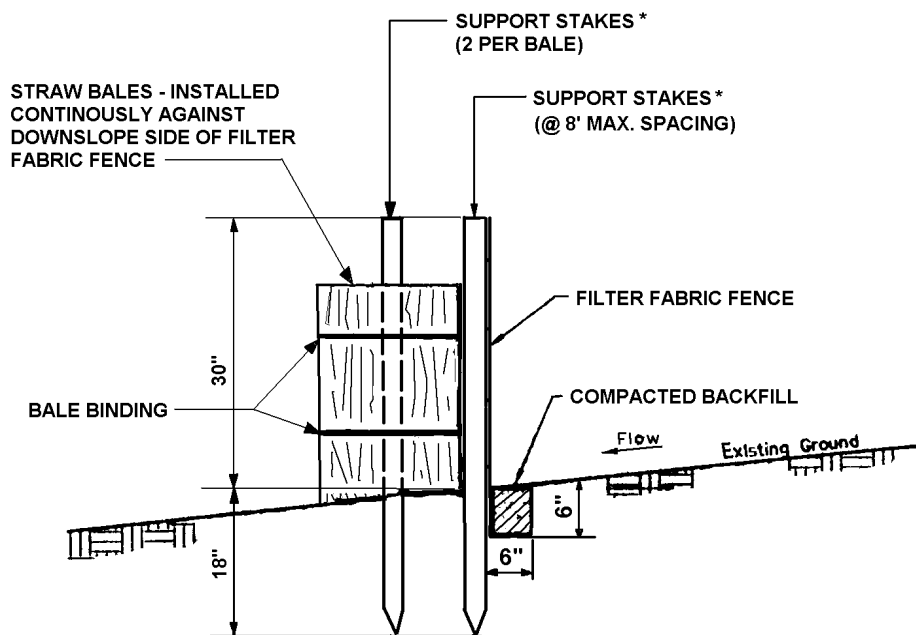
Silt fence with straw bales

Photo courtesy of PaDEP

Typical Features:

- Designed to handle sheet flow, not concentrated flow
- 6" x 6" trench should be excavated
- The bottom 12" of the fabric should be placed in the trench in an "L" shape with a 6" horizontal flap and a 6" vertical rise
- Should not be able to lift the bottom of the fence off of the ground
- Multiple rows of silt fence may not be used on a continuous slope
- Should be at least 8' from toe of slope
- Should be installed at existing level grade
- Both ends of each section must be extended 8' upslope at 45 degrees to main fence
- Sediment must be removed when accumulations reach $\frac{1}{2}$ of the above ground height of the fence
- Any section of fence which has been undermined or over-topped must immediately be replaced with a rock filter outlet

PA DEP STANDARD CONSTRUCTION DETAIL #21 Filter Fabric Fence (30" High) Reinforced by Staked Straw Bales



*USE 2" X 2" WOOD OR EQUIVALENT STEEL STAKES.

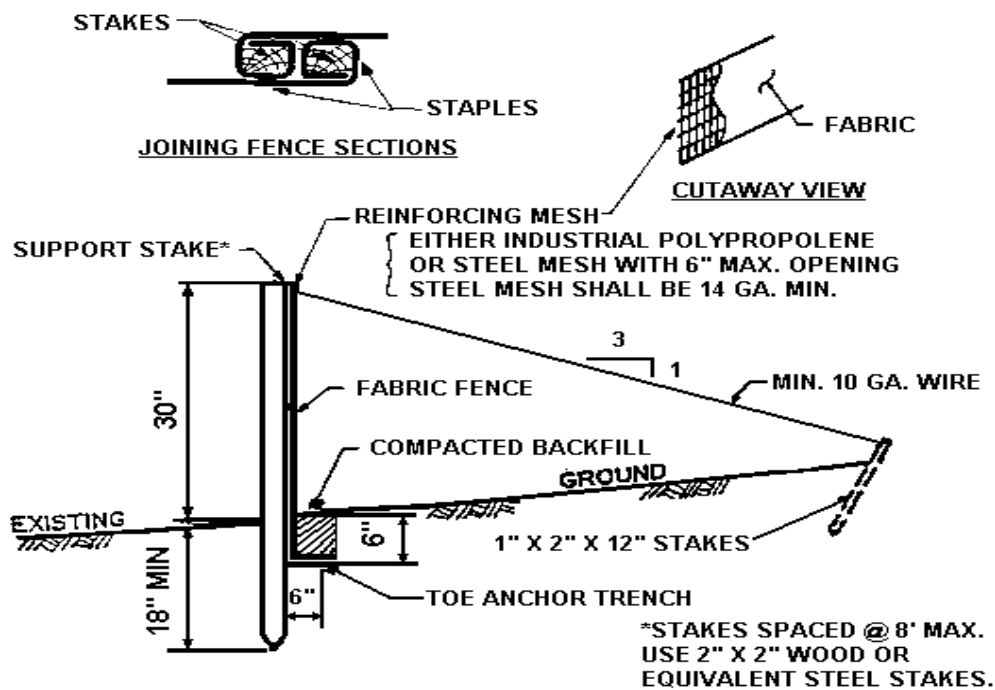


Standard reinforced silt fence
Photo courtesy of PaDEP

Typical Features:

- Designed to handle sheet flow, not concentrated flow
- 6" x 6" trench should be excavated
- The bottom 12" of the fabric should be placed in the trench in an "L" shape with a 6" horizontal flap and a 6" vertical rise
- Should not be able to lift the bottom of the fence off of the ground
- Multiple rows of silt fence may not be used on a continuous slope
- Should be at least 8' from toe of slope
- Should be installed at existing level grade
- Both ends of each section must be extended 8' upslope at 45 degrees
- Fence is reinforced with minimum 10 gauge wire
- Sediment must be removed when accumulations reach ½ of the above ground height of the fence
- Any section of fence which has been undermined or over-topped must be replaced immediately with rock filter outlet

PA DEP STANDARD CONSTRUCTION DETAIL # 20 Reinforced Filter Fabric Fence (30" High)





Super Silt Fence with Rock Filter Outlet
Photo courtesy of Westmoreland Conservation District

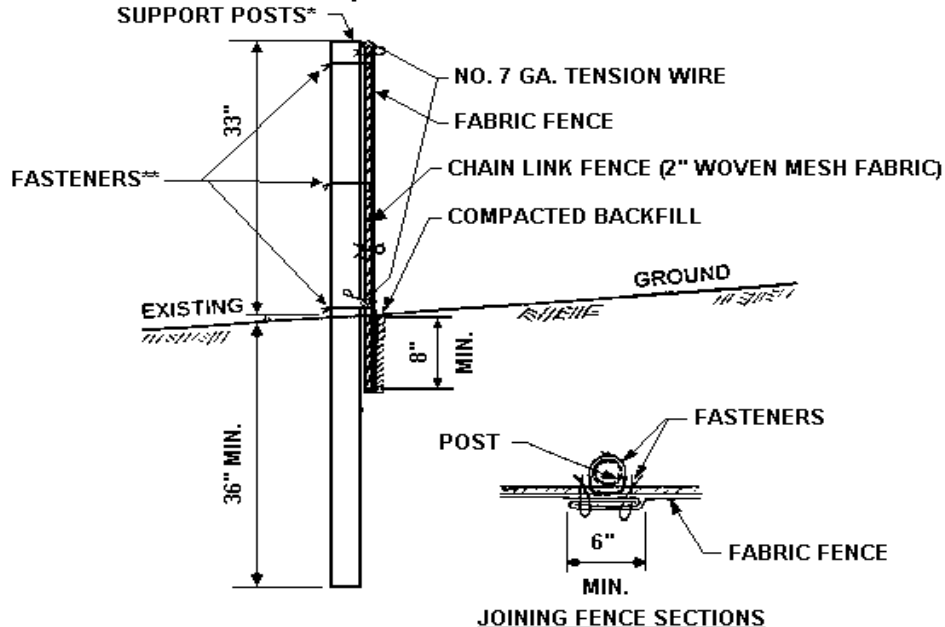
- Used in areas where the slope length exceeds the allowable limit for reinforced silt fence
- Important that the support posts, installed with post hole drill, are driven 36" into the ground. Posts should not be sticking up higher than the chain link fence

Typical Features:

- Designed to handle sheet flow, not concentrated flow
- An 8" deep trench should be excavated
- The bottom 8" of the fabric should be placed in the trench vertically
- Should not be able to lift the bottom of the fence off of the ground
- Multiple rows of silt fence may not be used on a continuous slope
- Should be at least 8' from toe of slope
- Should be installed at existing level grade
- Both ends of each section must be extended 8' upslope at 45 degrees to main fence
- Sediment must be removed when accumulations reach 1/2 of the above ground height of the fence
- Any section of fence which has been undermined or over-topped must immediately be replaced with a rock filter outlet

PA DEP STANDARD CONSTRUCTION DETAIL # 22

Super Filter Fabric Fence



* Posts spaced @ 10' max. Use 2 1/2" dia. galvanized or aluminum posts.

** Chain Link To Post Fasteners spaced @ 14" max. Use No. 6 Ga. aluminum wire or No. 9 galvanized steel pre-formed clips. Chain Link To Tension Wire Fasteners spaced @ 60" max. Use No. 10 Ga. galvanized steel wire. Fabric To Chain Fasteners spaced @ 24" max. C to C.

Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual



Rock filter

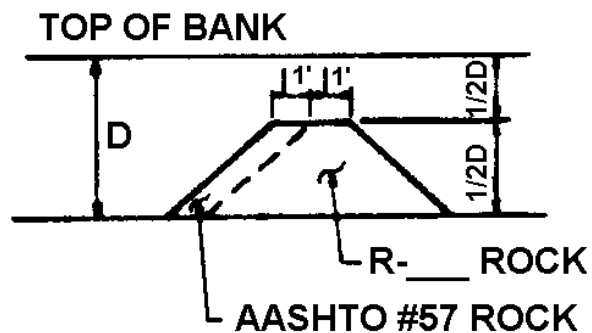
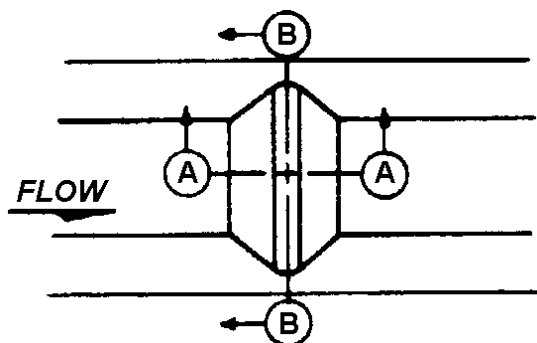
Photo courtesy of Westmoreland Conservation District

Typical Features:

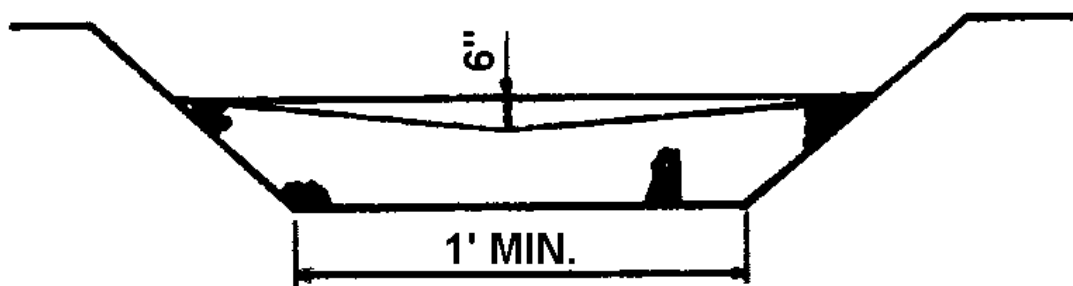
- Constructed of R-3, R-4 or R-5 rock faced with 2B (AASHTO #57) stone
- Used to filter sediment laden water from concentrated areas but not used in place of sediment traps or basins
- May not be used in lieu of channel liner

PA DEP STANDARD CONSTRUCTION DETAIL # 23

Rock Filters



SECTION A-A



SECTION B-B

FOR $3' \leq D$ USE R-4
 FOR $2' \leq D < 3'$ USE R-3
 FOR $1' \leq D < 2'$ USE R-2

Vegetative Filter Strip

Erosion and Sediment Control BMP

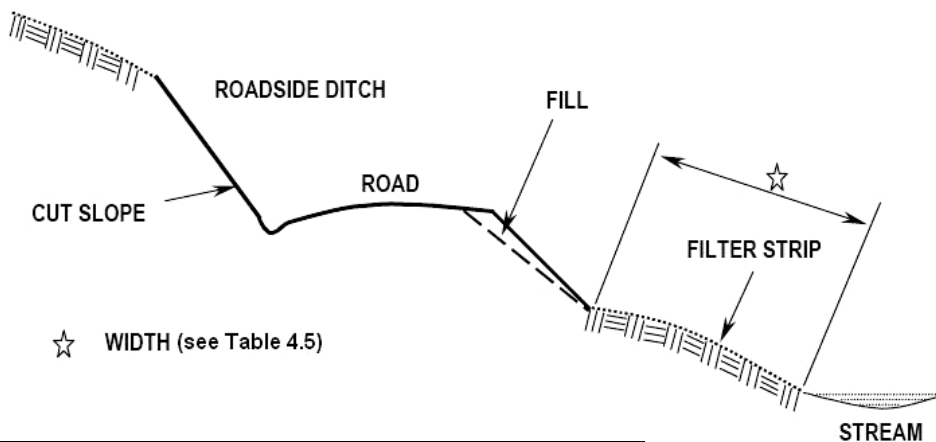


Vegetated Filter Strip
Photo courtesy of WCD

Typical Features:

- Suitability of natural vegetation should be field verified
- Should be well-established perennial grass at a minimum or other dense, meadow vegetation
- Width should be minimum 50 feet in width
- Protect area from compaction
- Protect device from siltation during and after construction
- Woody or brushy vegetation is NOT acceptable
- Runoff should be in the form of sheet flow

VEGETATED FILTER STRIP



Land Slope (%)*	Minimum Filter Strip Width (ft)
<= 10	50
20	65
30	85
40	105
50	125
60	145
70	165

*Land slope is at location of filter strip

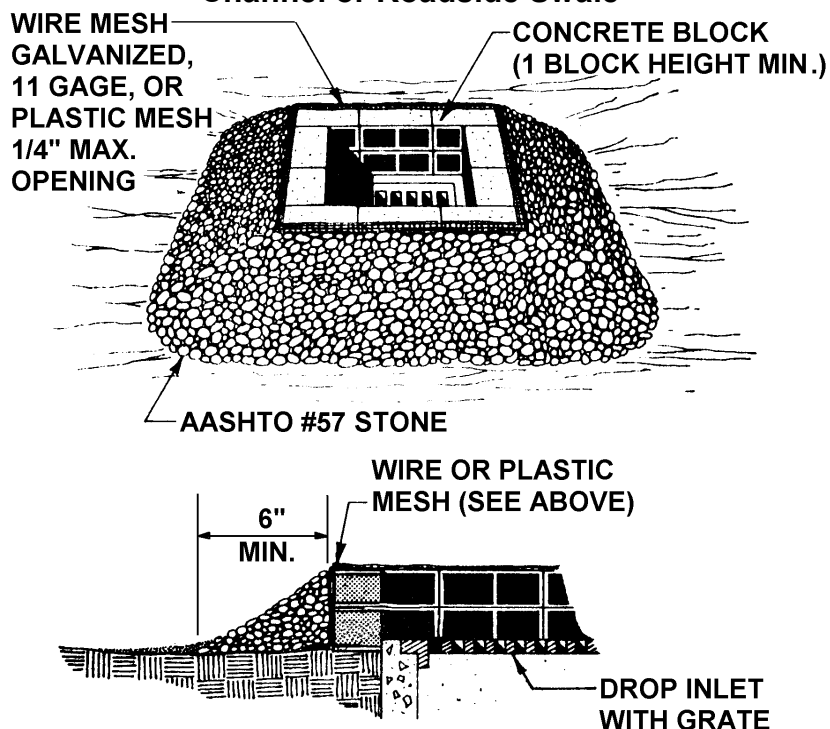


Concrete Block Inlet Protection
Photo courtesy of PaDEP

Typical Features:

- Concrete block with openings facing the side
- 11 gauge wire mesh covers block openings
- 2B stone surrounds the mesh covered block
- Use 1 course or 2 courses of concrete block stacked

PA DEP STANDARD CONSTRUCTION DETAIL #29 Stone & Concrete Block Inlet Protection Channel or Roadside Swale



Maximum Drainage Area =1 acre.

Inlet protection is not required for inlet tributary to sediment basin or trap. Berms required for all installations.

Earthen berm in roadway shall be maintained until roadway is stoned. Road subbase berm on roadway shall be maintained until roadway is paved. Earthen berm in channel shall be maintained until permanent stabilization is completed or to remain permanently.

DO NOT USE ON MAJOR PAVED ROADWAYS WHERE PONDING MAY CAUSE TRAFFIC HAZARDS

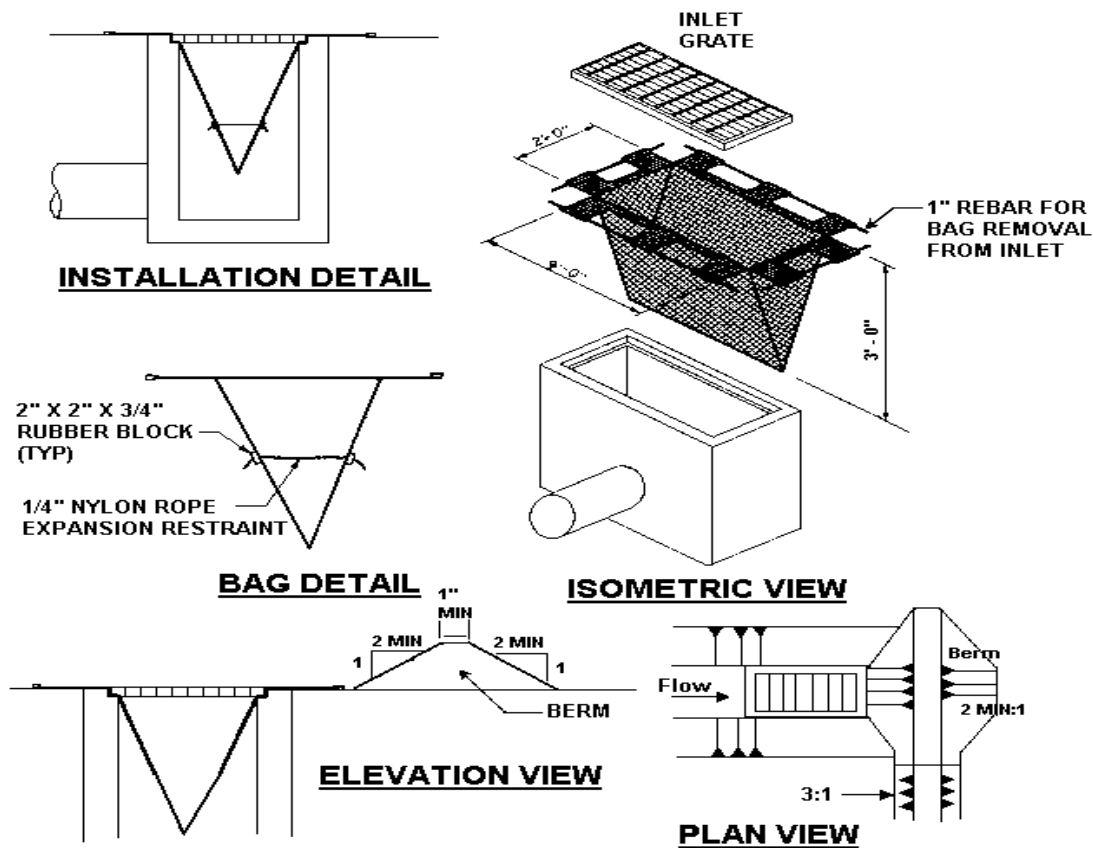


Filter bag inlet protection.
Photo courtesy of ACF Environmental.

Typical Features:

- Should be used in inlets which do not discharge into a sediment basin
- Should be cleaned or replaced when the bag is $\frac{1}{2}$ full or flow capacity has been reduced
- Should not be used on major roadways where ponding may cause traffic hazards
- 1" rebar must be installed to properly remove the filter bag

PA DEP STANDARD CONSTRUCTION DETAIL #28a Filter Bag Inlet Protection Channel or Roadside Swale



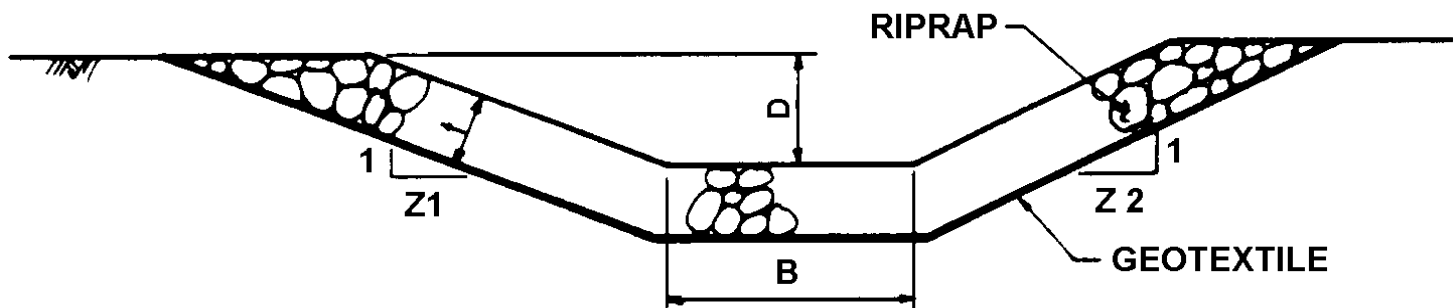


Riprap Channel
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Should be over-excavated to accommodate the riprap
- Geotextile material should be placed in the channel beneath the rock
- Rock sized for velocity of flow
- Install the appropriate size of rock according to the plan
- Can be used to divert water around a disturbed area, collect water and direct it to a sediment removal facility, or convey discharges from sediment removal facility to waters of the Commonwealth

PA DEP STANDARD CONSTRUCTION DETAIL #2 RIPRAP CHANNELS



Riprap Gradation

NSA No.	Graded Rock Size (inches)			Placement Thickness
	Max.	D(50) *	Min.	
R-4	12	6	3	15
R-5	18	9	5	24
R-6	24	12	7	30
R-7	30	15	12	36

* d(50) stone size is the size exceeded by 50% of the total weight of the tonnage shipped

- Rock shall be limestone or durable sandstone, no shale
- Rock shall be placed on slopes LESS than 1.5:1

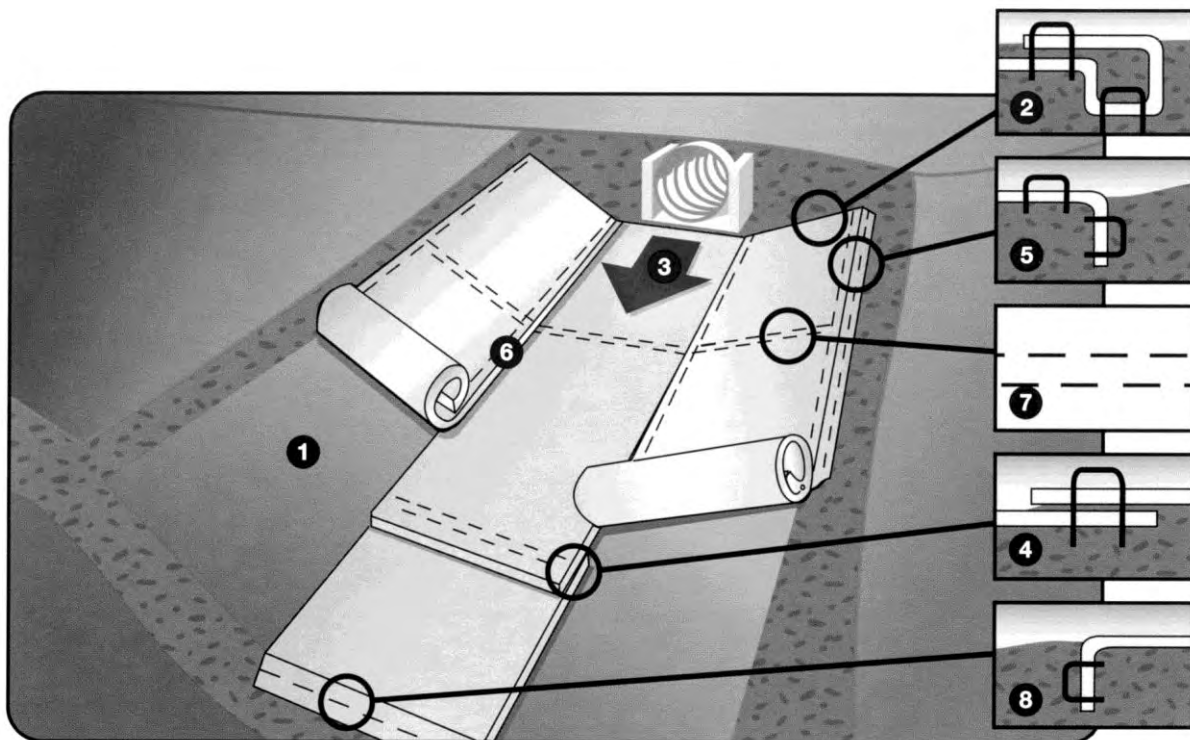
Channel Stabilization with Turf Reinforcement Mat (TRM) Erosion and Sediment Control BMP



Turf reinforcement mat in a channel
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Used to stabilize slopes and channels to prevent severe erosion
- Allows seed to germinate easier and grow faster
- Must be stapled to the ground according to manufacturer suggestion
- Sections are overlapped and pinned to surface
- Soil contact is very important for TRM to do its job, or soil will erode under TRM
- Does not prevent slumping of soil due to saturation



Turf reinforcement mat installation in a channel

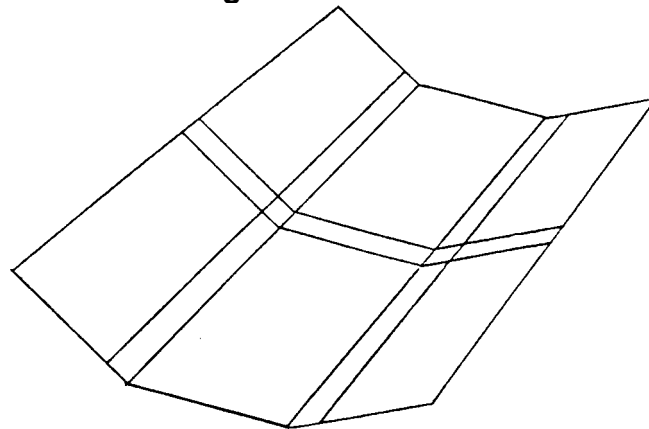


Vegetated Channel
Photo courtesy of Westmoreland Conservation District

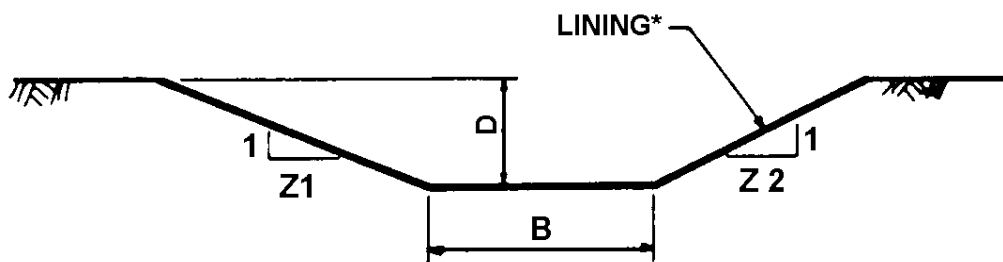
Typical Features:

- Collect water from disturbed areas and convey to a sediment trap or basin
- Can be used to divert runoff from upslope un-disturbed areas
- Shear stress becomes excessive in channels with $>10\%$ slope and a slope pipe should be considered instead
- Avoid sharp 90 degree turns
- Avoid $< 1\%$ bedslope
- Vegetative channels should be lined with a suitable Turf Reinforcement Mat (TRM)

PA DEP STANDARD CONSTRUCTION DETAIL #1 Vegetated Channels



LINING INSTALLATION



CHANNEL CROSS-SECTION

Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual

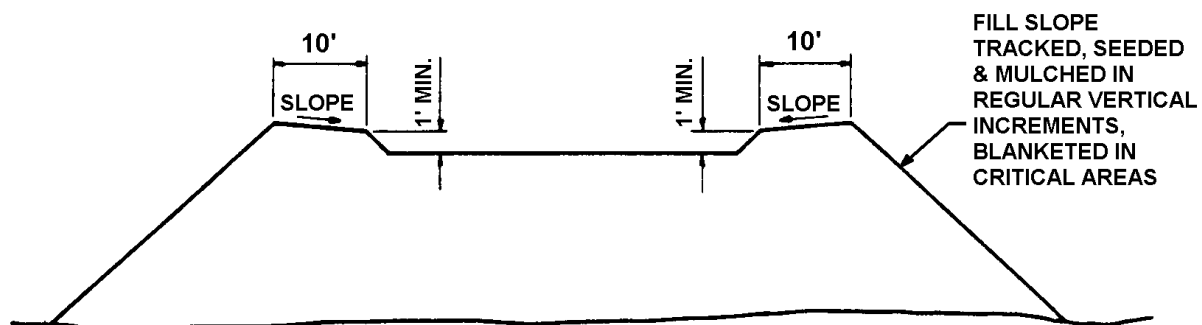


Top of Slope Berm
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Earth berms that control water on top of the slope
- Prevent concentrated water from washing out slope
- Reduce erosion and provide stability to the slope to prevent saturation

PA DEP STANDARD CONSTRUCTION DETAIL #27A Top-Of-Slope Berms



TEMPORARY BERMS TO BE PLACED, MAINTAINED, AND ADJUSTED CONTINUOUSLY UNTIL 90% VEGETATIVE GROWTH IS ESTABLISHED ON THE EXTERIOR SLOPES WITH PERMANENT STORM DRAINAGE FACILITIES FUNCTIONING.

BERMS MUST OUTLET TO TEMPORARY SLOPE PIPES, PERMANENT SLOPE PIPES, TEMPORARY CHANNELS, OR PERMANENT CHANNELS.

Sediment Trap (Embankment Type)

Erosion and Sediment Control BMP

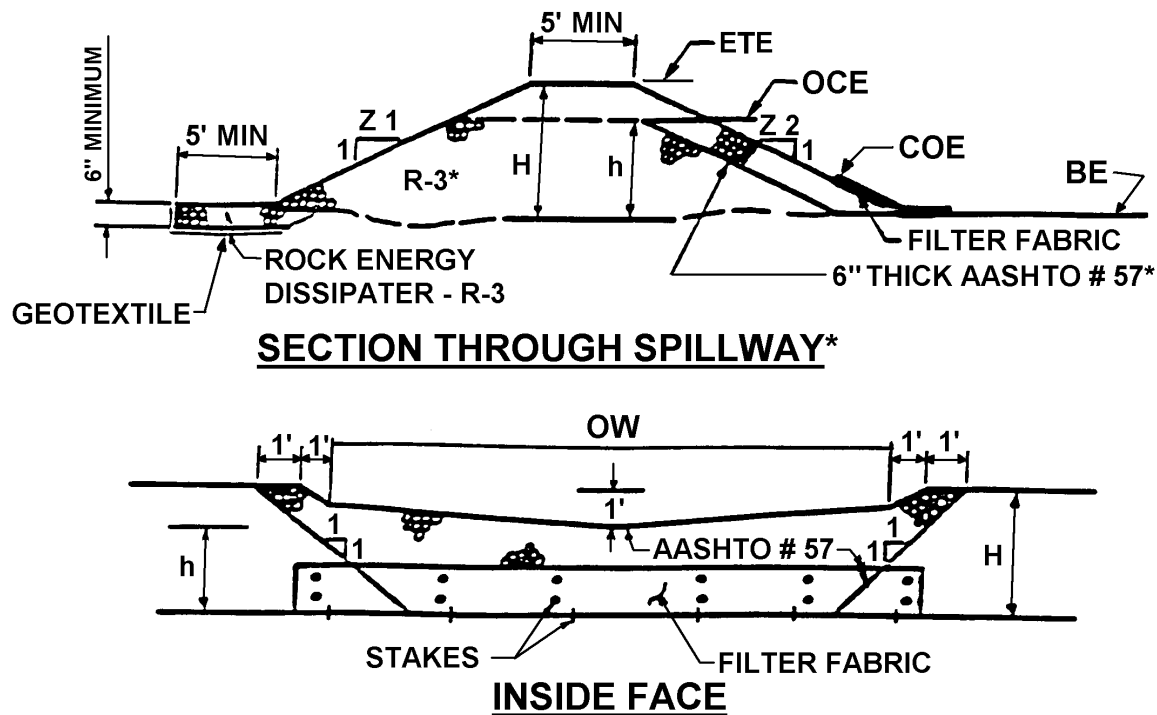


Typical Features:

- Should be located below disturbed areas
- Embankment spillway width should be installed according to the plan
- Inside face of spillway constructed with Geotextile material and #57 stone

Embankment type sediment trap
Photo courtesy of Westmoreland Conservation District

PA DEP STANDARD CONSTRUCTION DETAIL #11 Embankment Sediment Traps



* R-3 is minimum, AASHTO #57 is maximum size

Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual

Sediment Trap (Riser Spillway)

Erosion and Sediment Control BMP

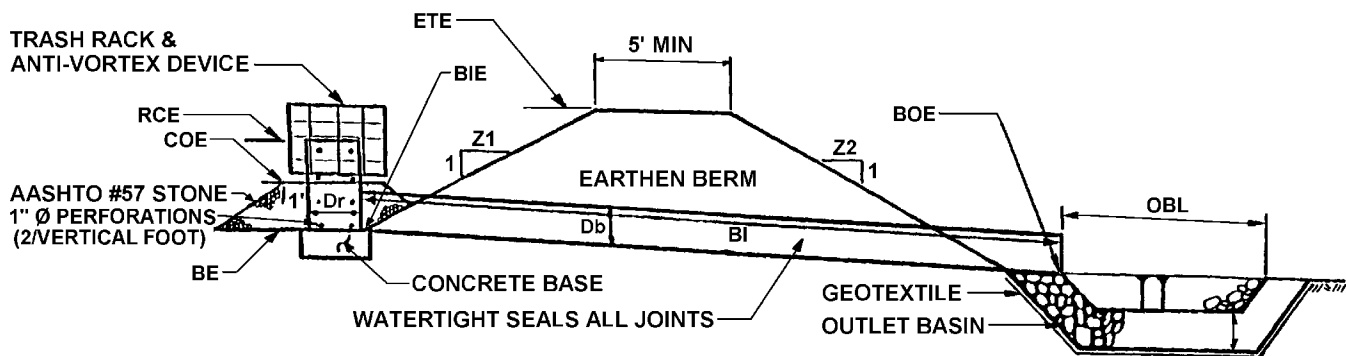


Riser spillway sediment trap
Photo courtesy of Westmoreland Conservation District

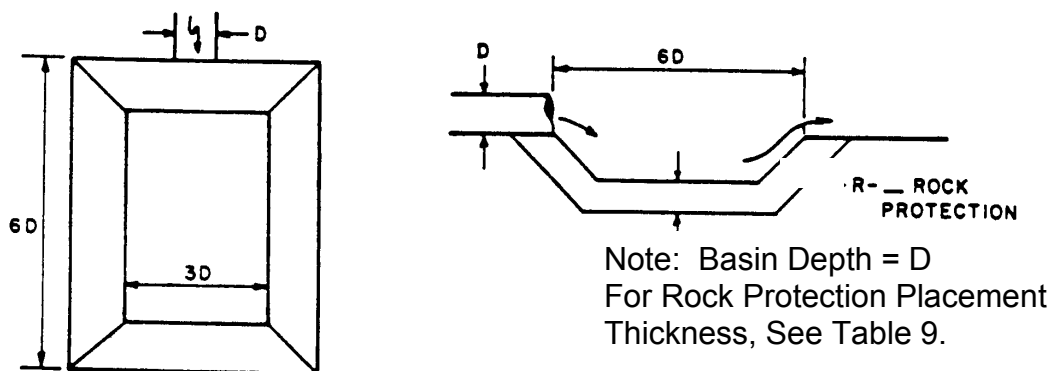
Typical Features:

- Maximum drainage area to any one trap is 5 acres
- A watertight seal should be installed between all connections of temporary and permanent risers
- A clean out stake should be installed near the center of the trap. Accumulated sediment shall be removed once it reaches the clean out mark on the stake. Replace stake after cleaning as necessary

PA DEP STANDARD CONSTRUCTION DETAIL #13 Dry Barrel / Riser Sediment Traps



PA DEP FIGURE 15 Sediment Trap Outlet Basin Details



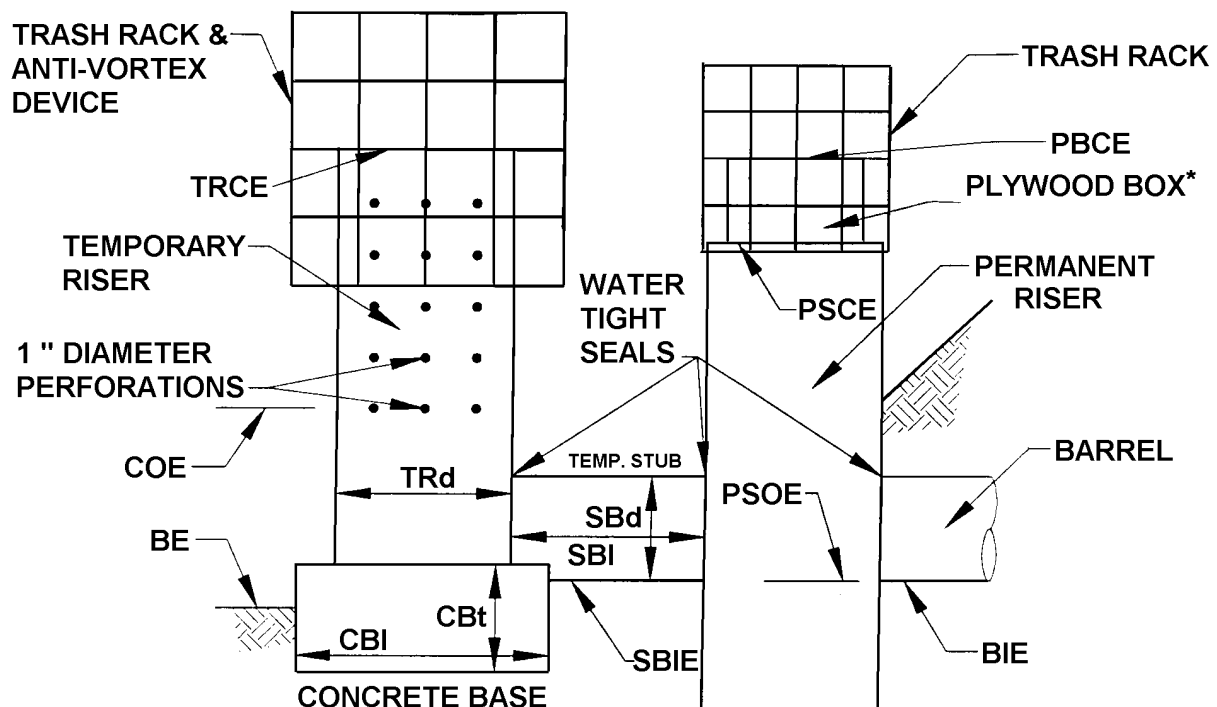


Temporary riser before installation
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Used in sediment traps and sediment basins to hold and slowly decant water
- Constructed of metal or plastic
- 1" holes are drilled as per drawing details in plans to dewater pond
- Risers are set in concrete base and connections should be leak-proof
- Trash rack and anti-vortex plate is welded to the top

PA DEP STANDARD CONSTRUCTION DETAIL #6 Sediment Basin Temporary Riser & Permanent Structure



Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual, see page 52

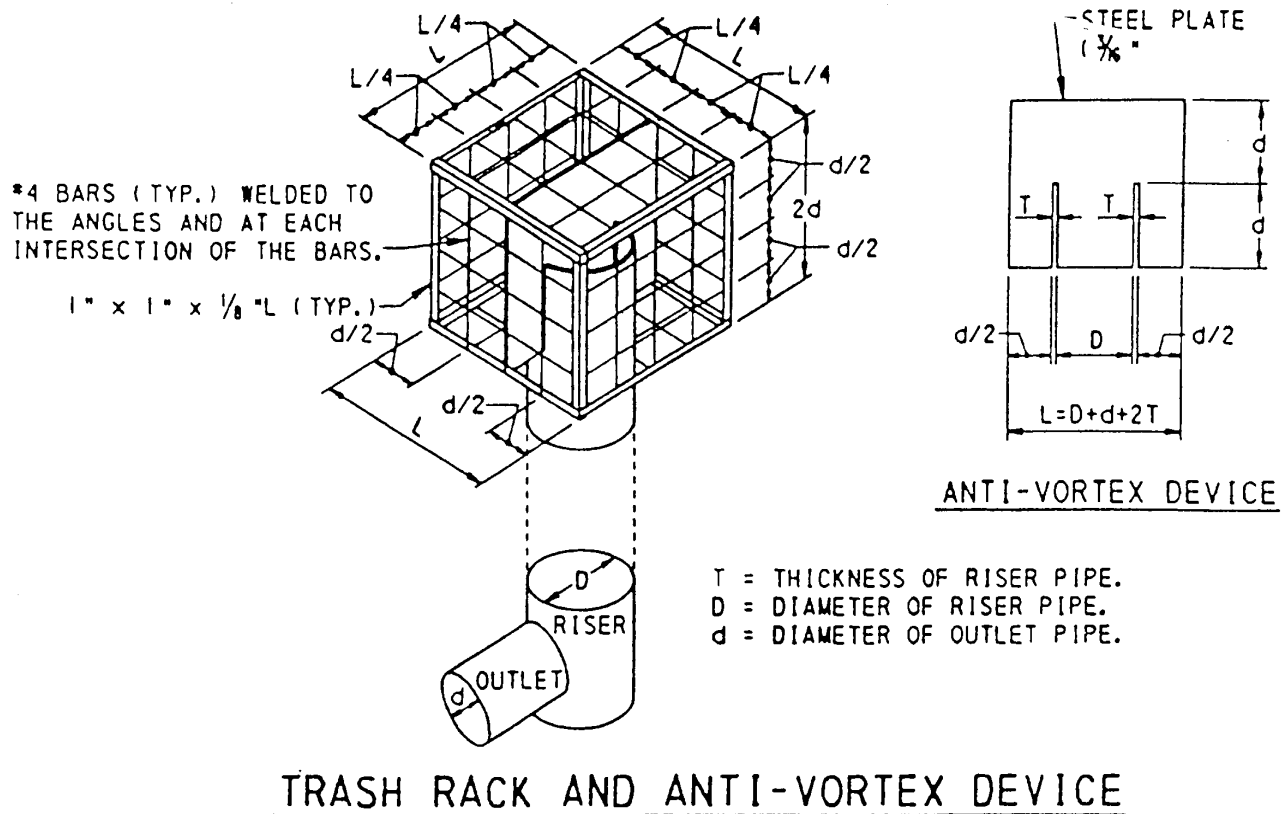


Trash rack and anti-vortex mounted on temporary riser
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Trash rack constructed of rebar or angle iron
- Anti-vortex steel plate welded to rebar box
- Device securely fastened to standpipe riser plumb
- Keeps debris from blocking overflow spillway pipe
- Align anti-vortex device with outlet barrel
- Trash rack must be such that debris is caught before reaching top of riser

FIGURE 9
Typical Trash Rack and Anti-vortex Device



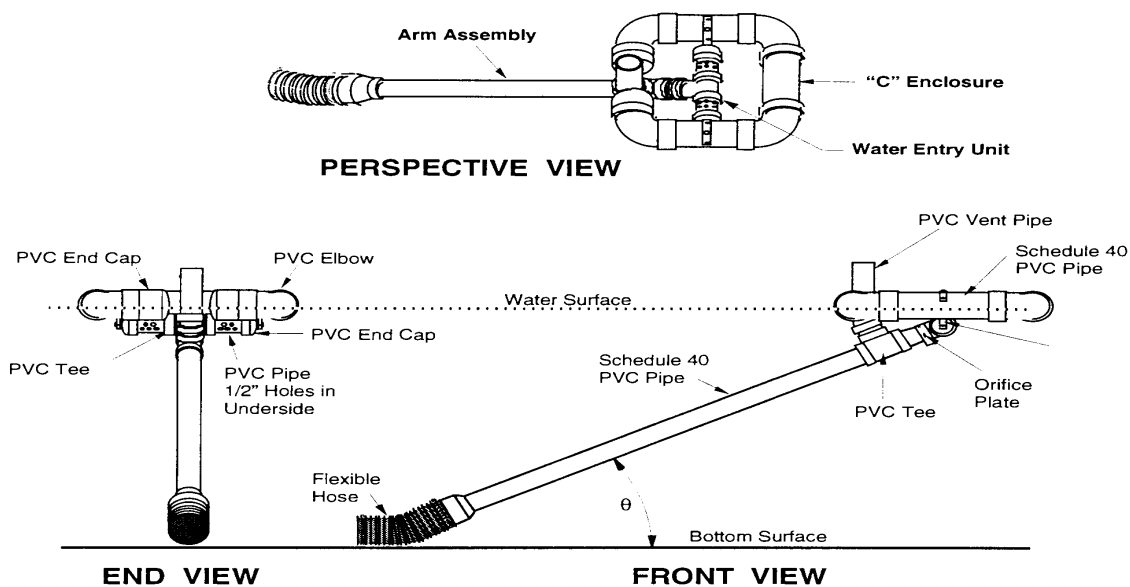


Faircloth skimmer™ US Patent number 5,820,751

Typical Features:

- Constructed of PVC tubing
- Device floats on top of water
- Discharges water from the top of the dewatering zone to minimize sediment discharge
- Dewateres through a single orifice plate in down-tube
- Skimmer should be connected securely to outlet riser
- Flexible hose and dewatering tube length as per plan specification
- A concrete block seat should be placed at the bottom of the pond for skimmer to “rest” on when water levels are low

**PA DEP FIGURE 6
Skimmer**



θ should be 45° or less when the water surface is at the maximum pool elevation - the elevation of the 2 cfs/acre discharge.

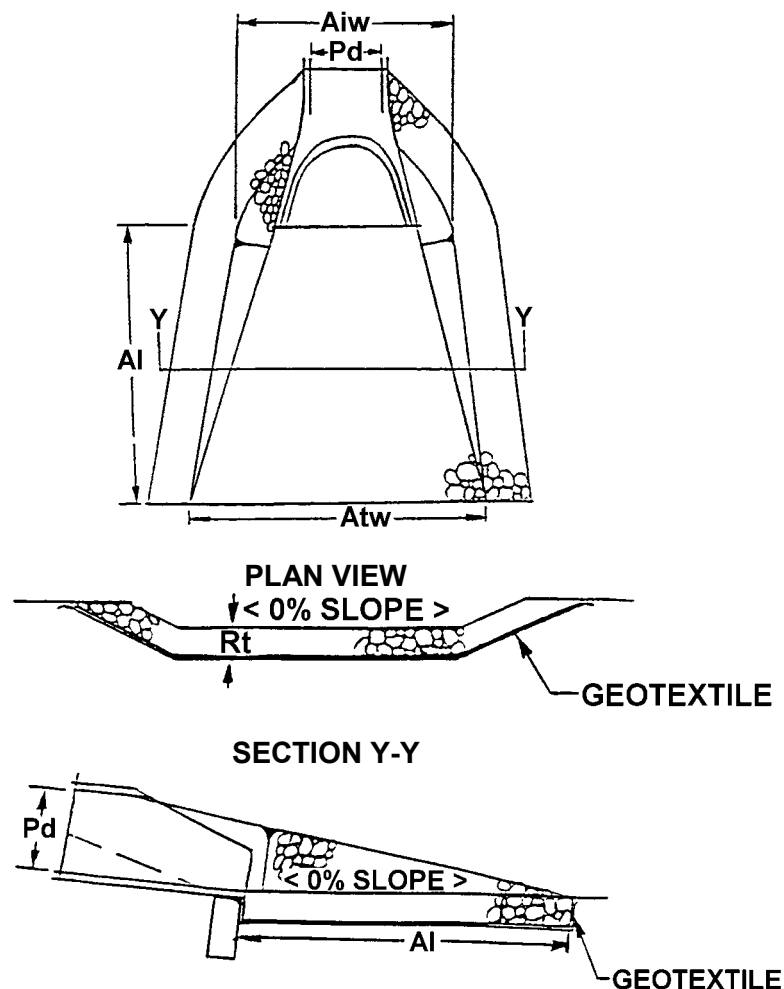


Rock energy dissipater
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Rock rip-rap sized to dissipate energy from high velocity water discharges from pipes
- Geotextile fabric is placed under the rock to prevent scour of the earth beneath
- Apron dimensions designed for slope and volume (velocity)
- Stabilized surface should extend to natural flow channel
- Sediment deposit indicates serious problem

PA DEP STANDARD CONSTRUCTION DETAIL #33 Riprap Aprons at Pipe Outlets with Flared End Sections



Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual

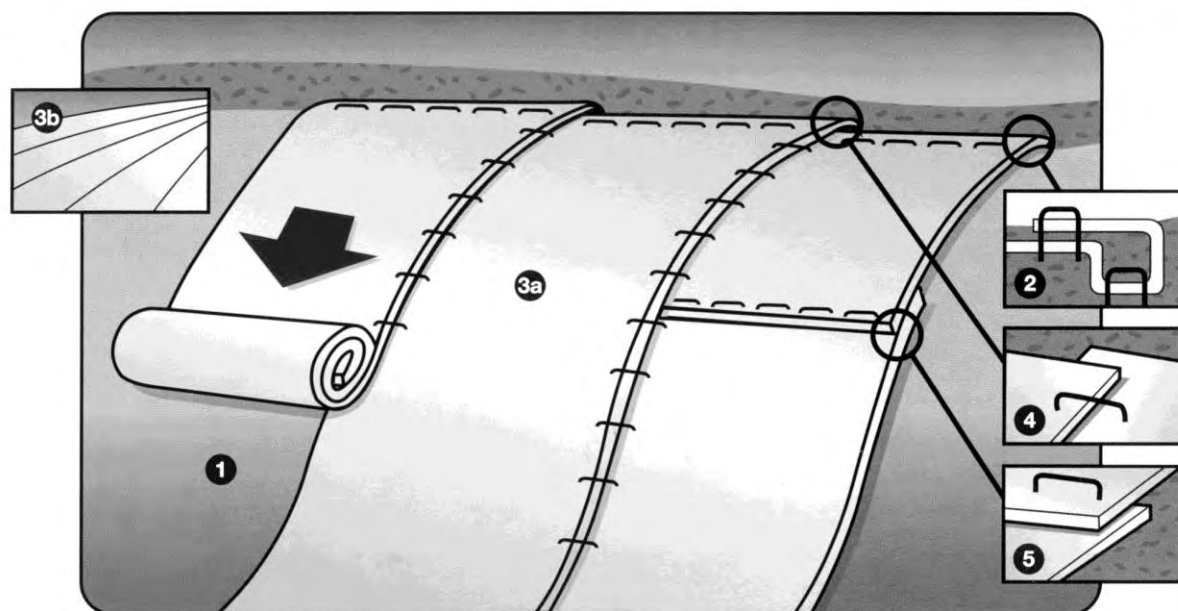


Turf reinforced mat being laid on a slope
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Turf reinforcement mat used to stabilize slopes to prevent severe erosion
- Allows seed to germinate easier and grow faster
- Must be installed in the direction of water flow
- Must be stapled to the ground according to manufacturer recommendations
- Colored dots are typically provided on the TRM for installation guidance
- Sections are overlapped and pinned to surface
- Soil contact is very important for TRM to do its job, or soil will erode under TRM
- Does not prevent slumping of soil due to saturation

SLOPES



Turf reinforcement mat installation on slopes

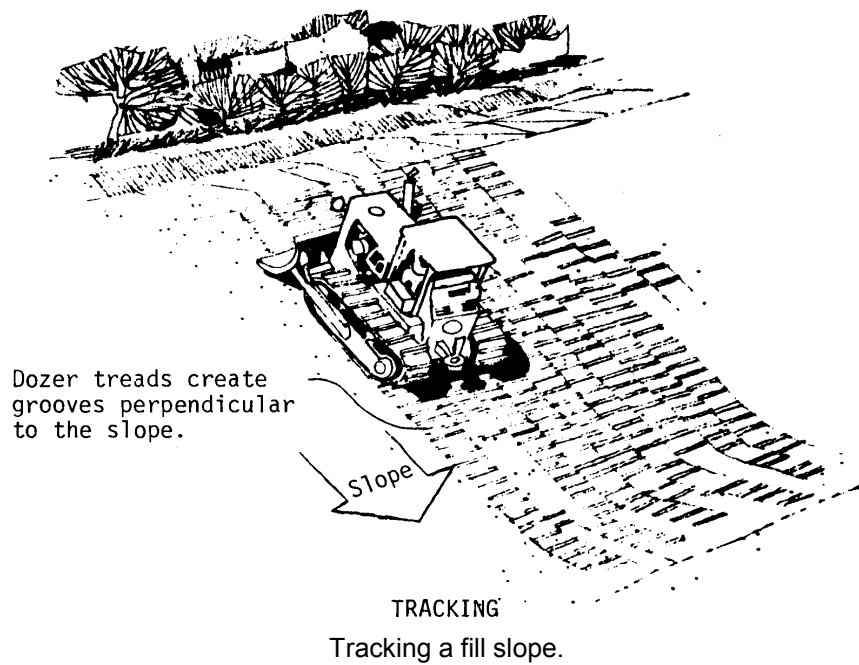


Slope tracking
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Machinery should be run up and down slopes
- Tread marks parallel to the contour
- Care should be exercised on soils which have a high clay content to avoid over-compaction

PA DEP FIGURE 18





Straw Mulch
Photo courtesy of DEP

Typical Features:

- Mulch should be applied at recommended rates
- Mulch should be anchored or tackified immediately to prevent being windblown
- Mulch on slopes >8% should be held in place by netting

MULCH APPLICATION RATES

Mulch Type	Per Acre	Application Rate (Min.)		Notes
		Per 1,000 sq.ft.	Per 1,000 sq.yd.	
Straw	3 tons	140 lb.	1,240 lb.	Either wheat or oat straw, free of weeds, not chopped or finely broken
Hay	3 tons	140 lb.	1,240 lb.	Timothy, mixed clover and timothy or other native forage grasses
Wood Chips	4 - 6 tons	185 - 275 lb.	1,650 - 2,500 lb.	May prevent germination of grasses and legumes
Hydromulch	1 ton	47 lb.	415	See limitations above



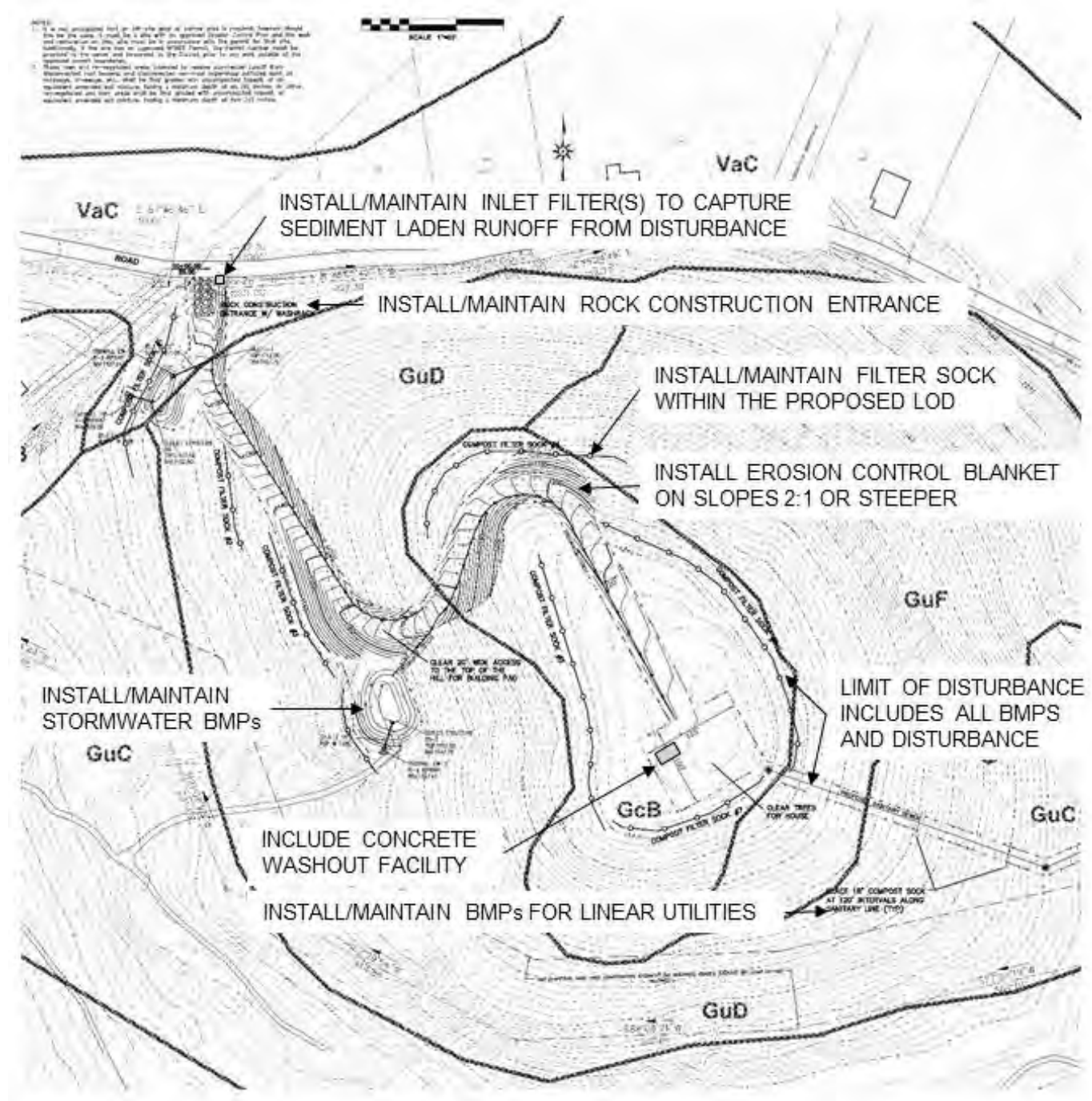
Typical Features:

- E & S controls must remain in place and function properly until a **70% UNIFORM** vegetative cover is established throughout the entire site
- Site should be stabilized immediately once final grade is achieved



Typical Large Homesite* Erosion & Sediment Control Plan Erosion and Sediment Control BMP

*May require an NPDES permit application, contact the municipality in which the project is located to determine earth disturbance requirements

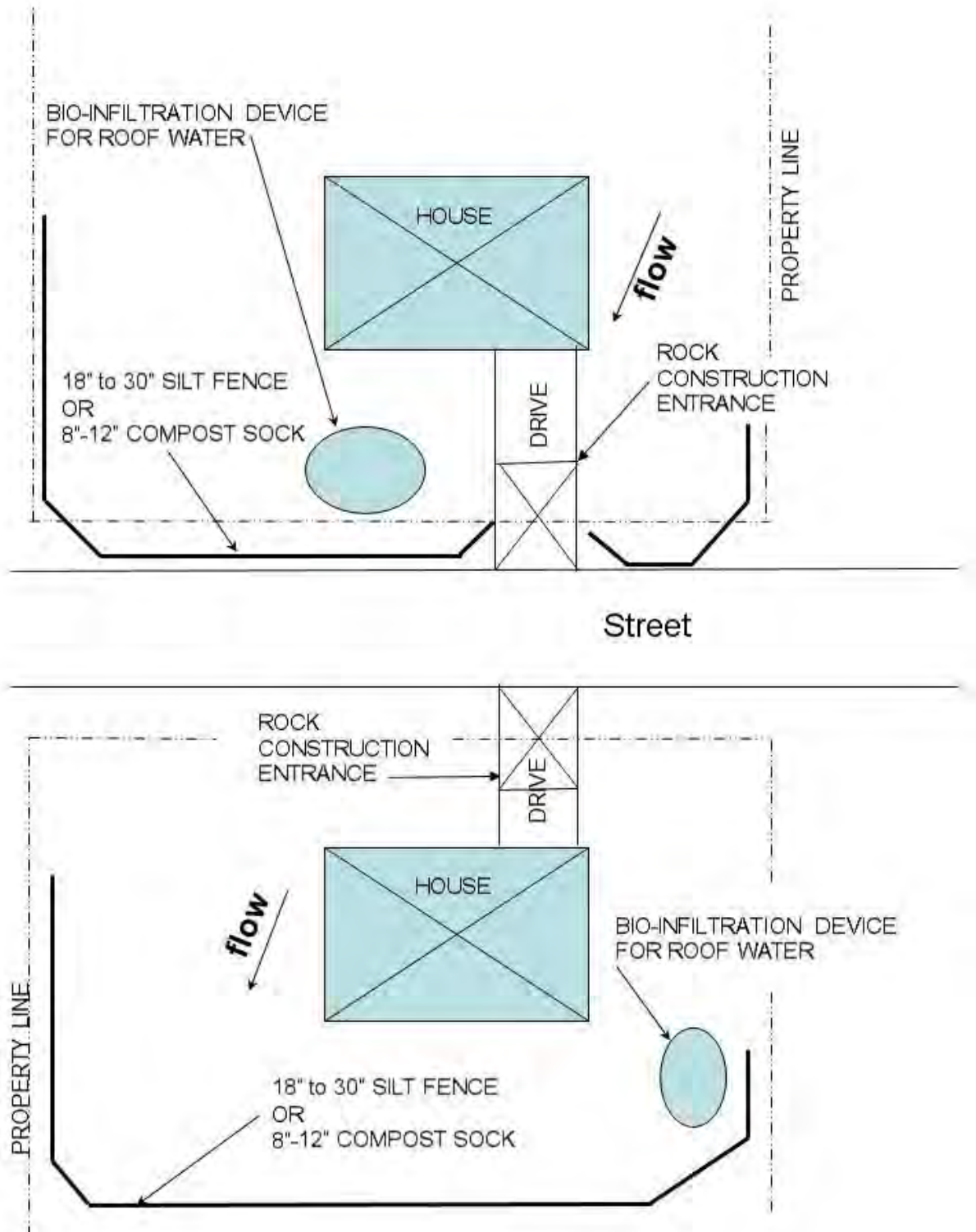


Line drawing provided by R.F. Mitall & Associates, Inc.

Typical

Small Homesite* Erosion & Sedimentation Control Plan Erosion and Sediment Control BMP

*For sites less than 1 acre of disturbance, contact the municipality in which the project is located to determine earth disturbance requirements

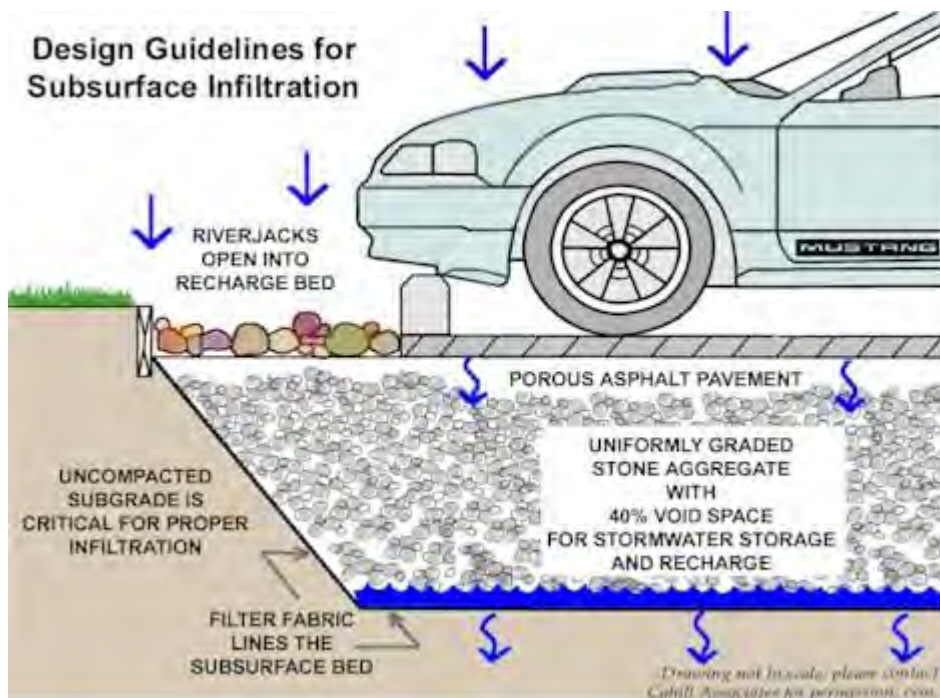




Turfstone™ paving block installation over porous base
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Protect area from compaction
- Protect from siltation during and after installation
- Level or gently sloping subgrade
- Layer of geotextile fabric beneath porous base
- Porous base, 8" to 12" clean crushed stone
- Paving material meets permeability standards
- Subdrain if needed



Line drawing provided by Cahill Associates, Inc., DEP PA Stormwater BMP Manual

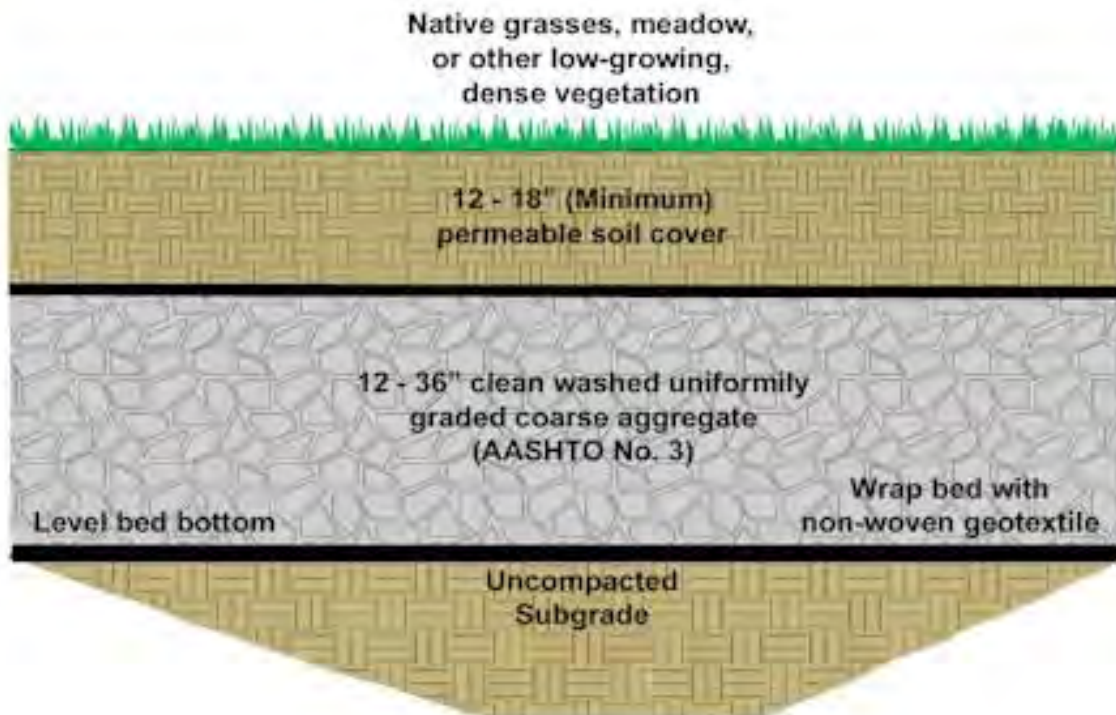


Playing field over an infiltration bed in Philadelphia PA
Photo courtesy of Pa DEP Stormwater Best Management Practices Manual

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Drainage layer of clean, washed, uniform grade aggregate wrapped in geotextile fabric
- Engineered soil media
- Dense vegetation for stabilization

INFILTRATION BED



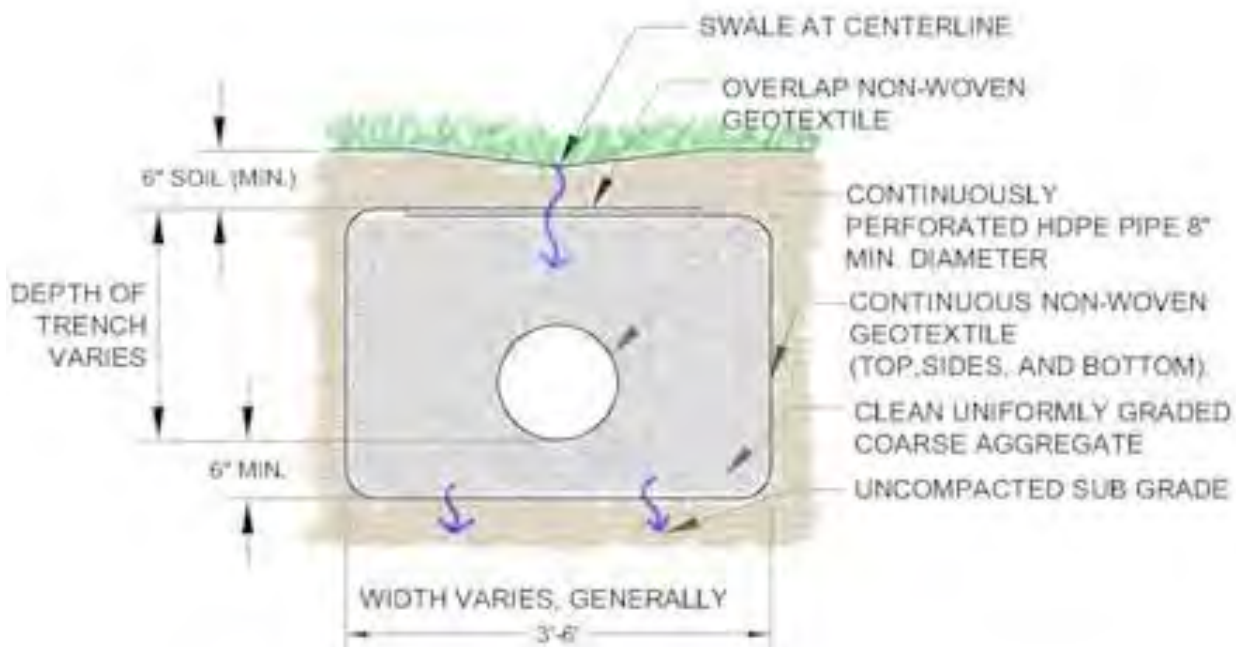


Infiltration trench during and after installation.
Photos courtesy of Pa DEP Stormwater Best Management Practices Manual

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Continuous perforated pipe at minimum slope
- Drainage layer of clean, washed, uniform grade aggregate wrapped in geotextile fabric
- Engineered soil media
- Dense vegetation for stabilization

INFILTRATION TRENCH

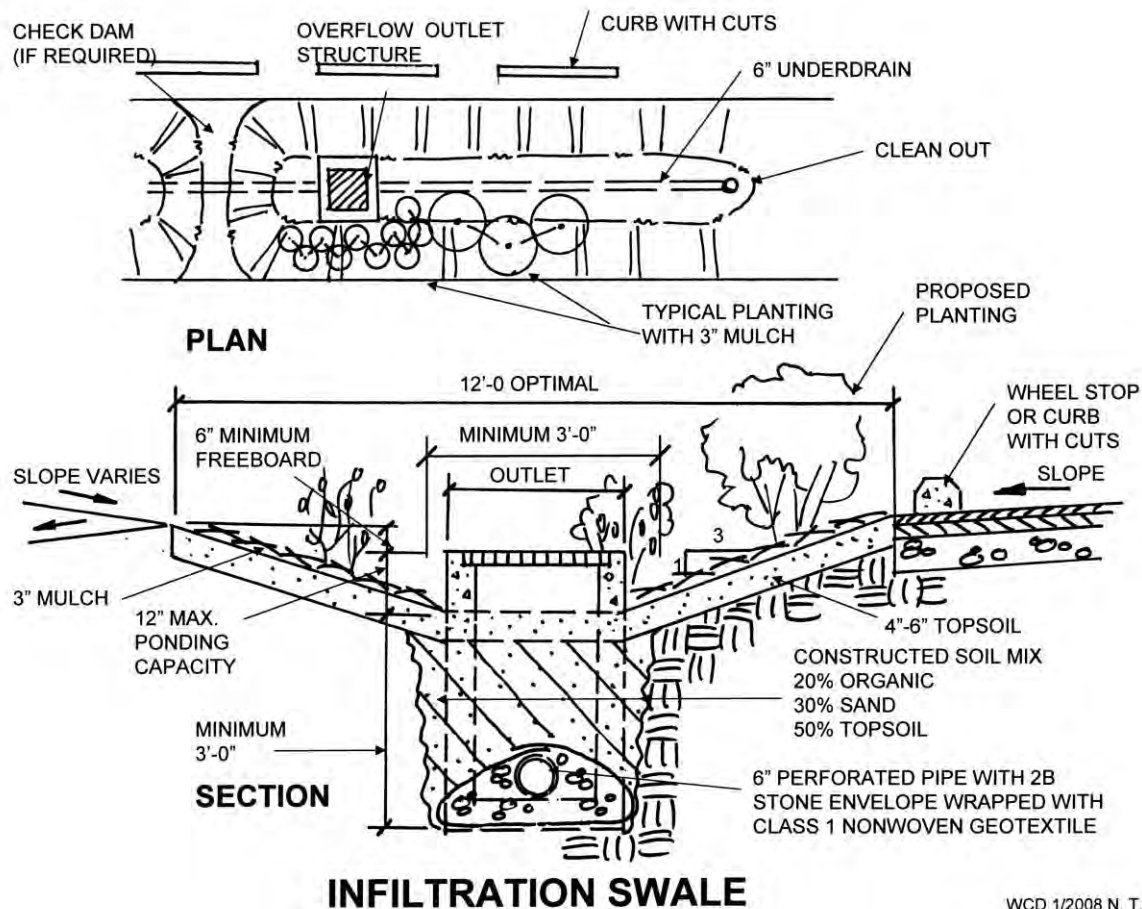




Example of bio-infiltration swale
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Provide underdrain in clean crushed stone and fabric envelope
- Engineered soil mix
- 6" to 12" ponding capacity
- Overflow outlet
- 6" to 12" freeboard
- 3:1 or less side slopes
- Stabilized surface
- Landscaping



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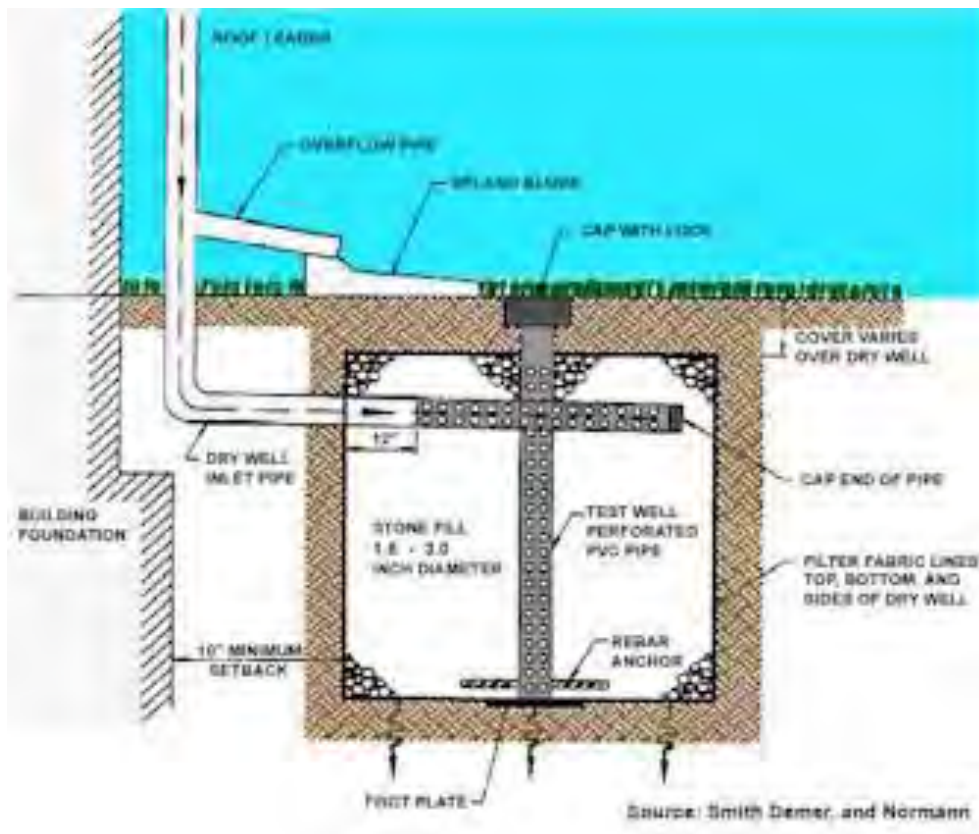


Underground chamber system being installed as a dry well.
Photo courtesy of Bove Engineering Inc.

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Drainage layer of clean, washed, uniform grade aggregate wrapped in geotextile fabric
- Perforated pipe distribution system with cleanouts and overflow
- Minimum 10 feet from building foundation

DRY WELL / SEEPAGE PIT

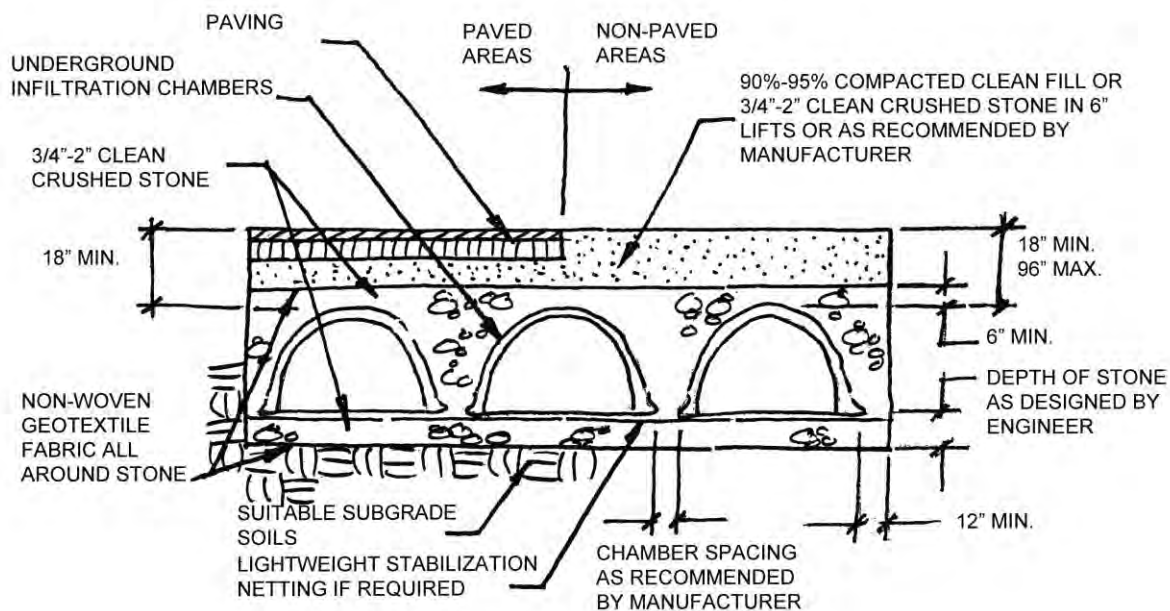




Underground infiltration chamber installation showing cleanouts
Photo courtesy of Bove Engineering Inc

Typical Features:

- Protect area from compaction
- Protect system from siltation during and after construction
- Use geotextile fabric envelope
- Clean crushed stone base and fill
- Clean out access
- Pipe system installed as per plan
- Outlet as designed by engineer



SECTION

UNDERGROUND INFILTRATION CHAMBERS

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Line drawing provided by Westmoreland Conservation District

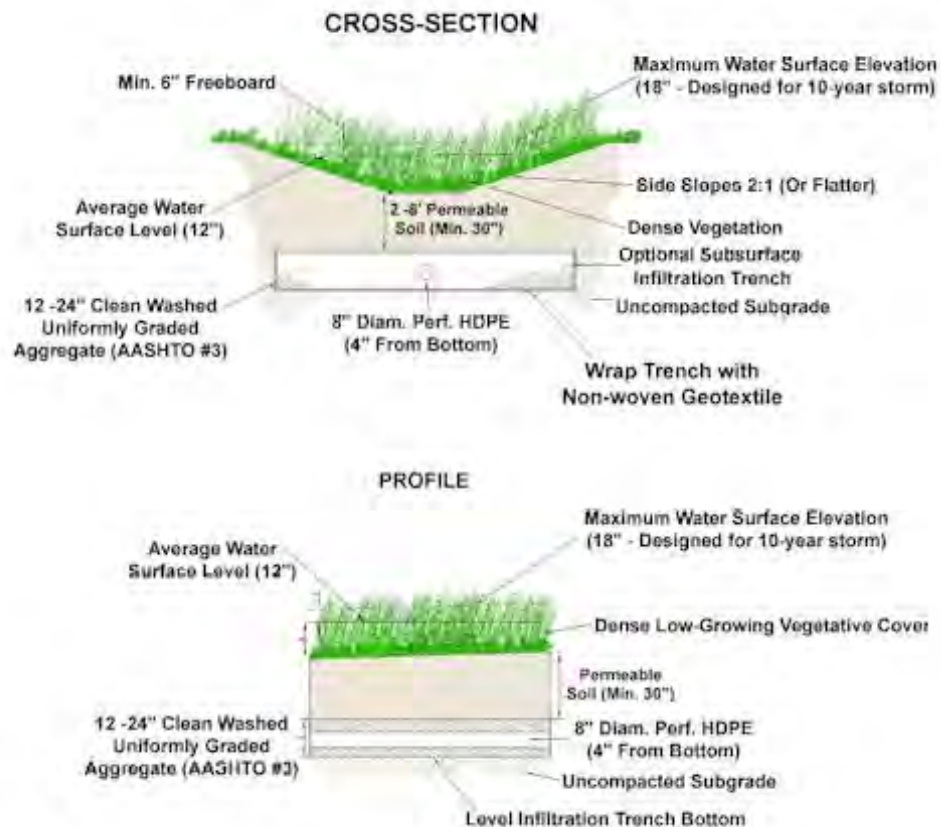


Vegetated swale at the Hawthorn Ridge subdivision, Foster.
Photo courtesy of Pa DEP Stormwater Best Management Practices Manual

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Planted with dense, low-growing native vegetation tolerant to excessive water drought and salt
- Longitudinal slopes 1% to 6% with 3:1 or gentler side slopes and trapezoidal channel
- Check dams maximize infiltration

VEGETATED SWALE



Line drawing provided by PA DEP Stormwater Best management Practices Manual

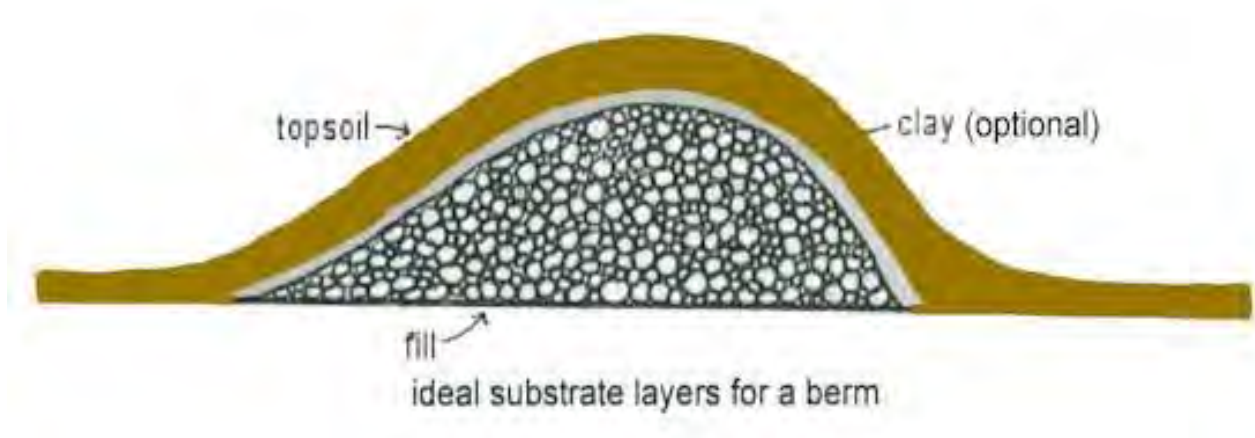


Photo courtesy of PA DEP Stormwater Best management Practices Manual

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Berms should be lopsided with 4:1 side slopes or gentler and no higher than 24 inches
- Planted with turf grass at a minimum or other dense, meadow vegetation, shrubs and trees

INFILTRATION BERM



Line drawing provided by PA DEP Stormwater Best management Practices Manual

Vegetated Roof

Stormwater Management BMP



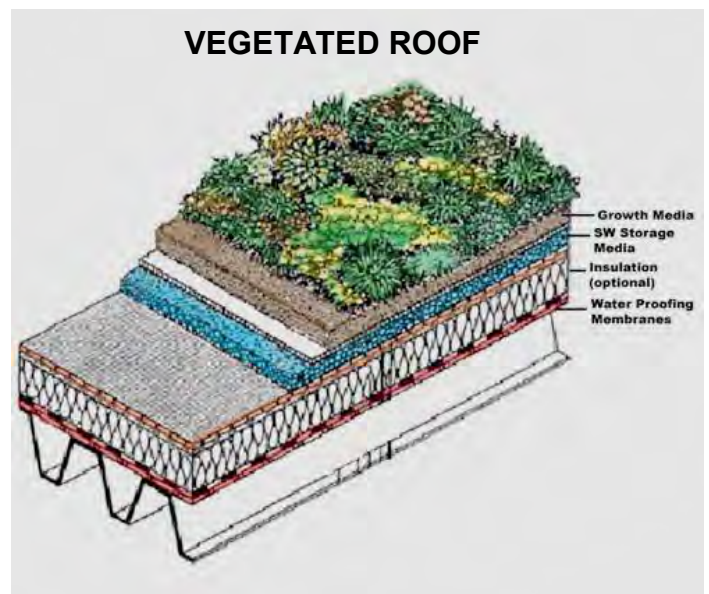
GreenForge extensive green roof, Greensburg, PA
Photo courtesy of Westmoreland Conservation District



Maintenance of the GreenForge green roof, Greensburg, PA
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Investigate load bearing capacity of existing roof structures. Extensive greenroofs (generally less than 6" of growing medium) can add 10 to 20 lbs/sf
- Professional designs should include drainage, and roof protection layers
- An extensive green roof will capture 1" or more of each rainfall event
- A variety of vegetation ensures coverage in changing climates
- Maintenance is required to maintain healthy vegetated cover for managing stormwater (ie. weeding, fertilizing)



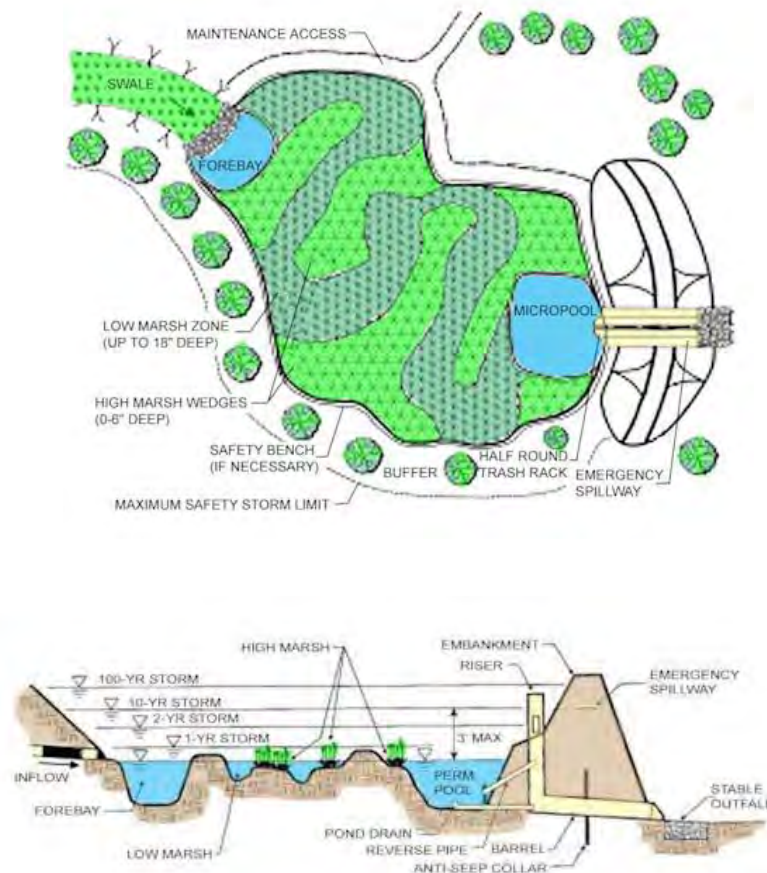


Constructed pocket wetlands, Mt Pleasant, PA
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Should have adequate drainage area (5 to 10 acres)
- Maintain a permanent water surface with adjustable permanent pool and dewatering device
- Multiple vegetated growth zones with varying depth
- Robust and diverse native vegetation
- Sediment collection and removal system

POCKET WETLAND

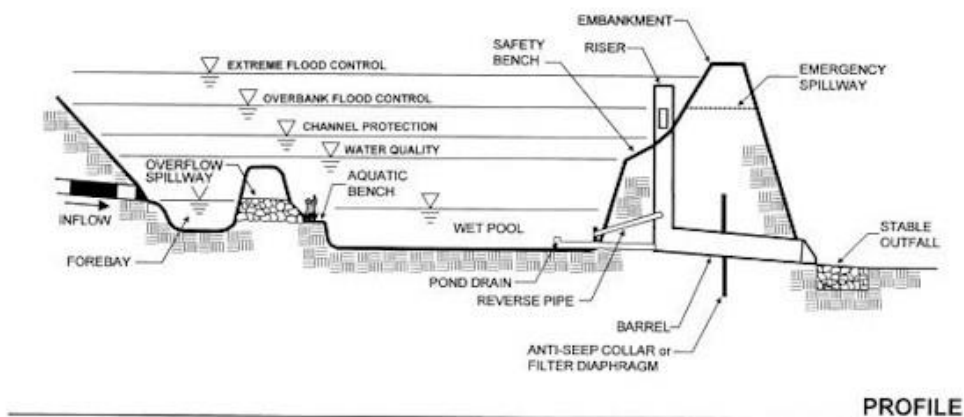
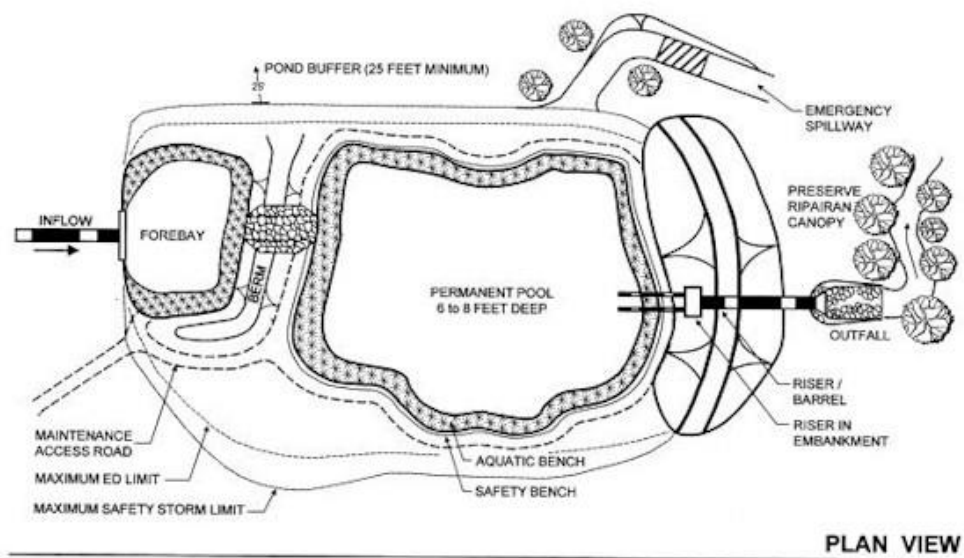




Wet pond with vegetated edge
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Forebay
- As-built dimensions meet design standards
- Side slopes 3:1 or less
- Safety bench
- Aquatic bench
- Landscaping
- Outlet structure
- Energy dissipaters
- Emergency spillway
- Maintenance access



Line drawing provided by DEP PA Stormwater BMP Manual



Concrete Anti-Seep Collar

Photo courtesy of Westmoreland Conservation District



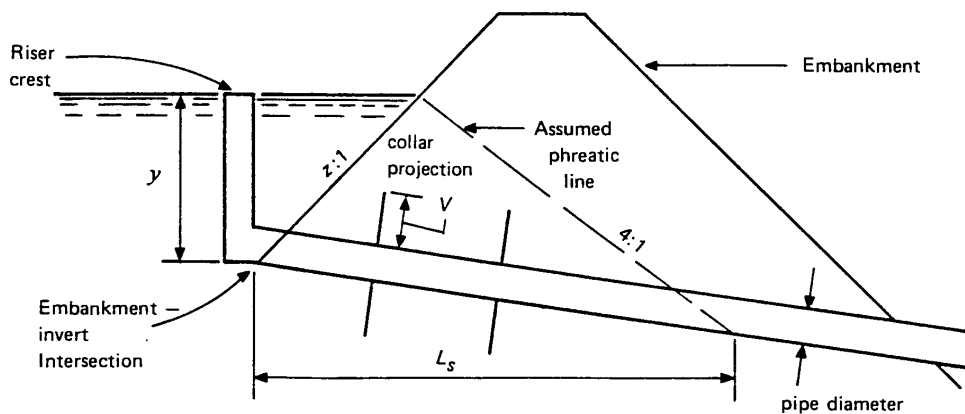
Galvanized Anti-Seep Collar

Photo courtesy of Westmoreland Conservation District

Typical Features:

- Plate must be watertight to outfall (barrel)
- Should not be closer than 2 feet from a joint
- Must be sufficient distance between collars for hauling and compacting equipment
- Can be made of concrete, metal or plastic
- Installed to dimensions shown on plan
- Barrel should be compacted and sealed with clay material
- Stone should NOT be placed around outfall barrel (pipe)

**PA DEP FIGURE 12
Anti-seep Collar Design**



** L_s is length of pipe in saturated zone*

Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual



Plywood baffle being used with skimmer dewatering device. Note: Baffle is extended into side of basin
Photo courtesy of Westmoreland Conservation District

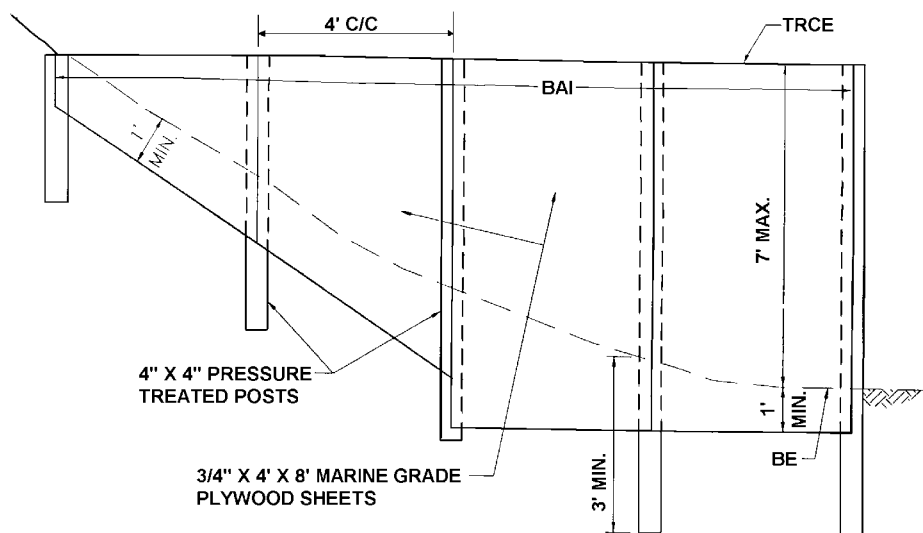


Jersey barrier baffles being used
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Can be constructed with marine grade plywood supported by 4x4 posts, Jersey barriers, or super silt fence
- End of baffle must be extended into side of basin.
- Used to increase flow length from incoming runoff water to the outfall structure riser
- Assists in increasing sediment drop out rate

PA DEP STANDARD CONSTRUCTION DETAIL #9 Baffles



In pools with depths exceeding 7', the top of the plywood baffle does not need to extend to the temporary riser crest.

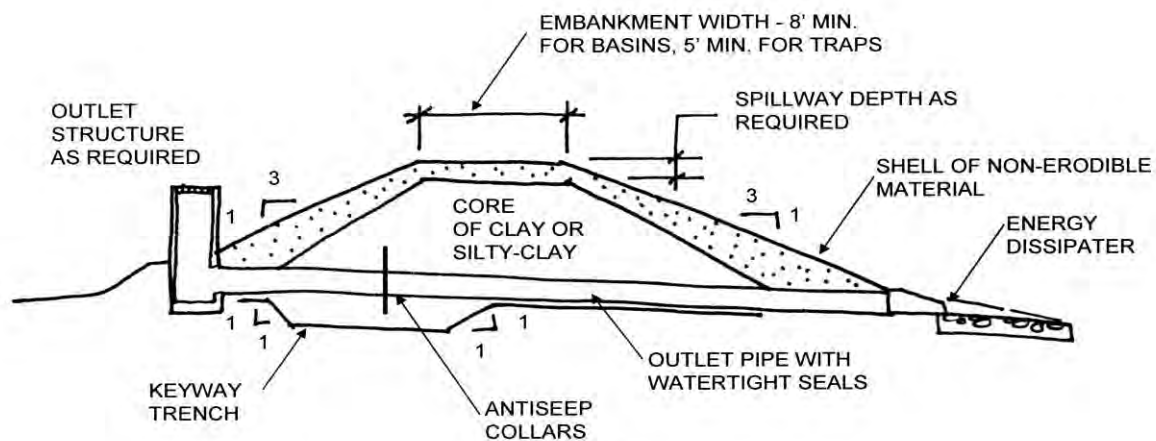
Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual



Sheepsfoot roller compacting an embankment
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Topsoil should be stripped prior to construction
- Keyway and anti-seep collars should be used
- Fill should be laid in 6" to 9" lifts and compacted
- Top width should be minimum 5" for traps and 8" for basins
- Side slopes should be 3:1 or flatter



SECTION

- TOPSOIL SHOULD BE STRIPPED IN AREA OF EMBANKMENT
- EMBANKMENT SHALL BE CONSTRUCTED IN 6" TO 9" LIFTS AND COMPACTED
- EMBANKMENT SHALL BE STABILIZED WITH VEGETATION

EMBANKMENT

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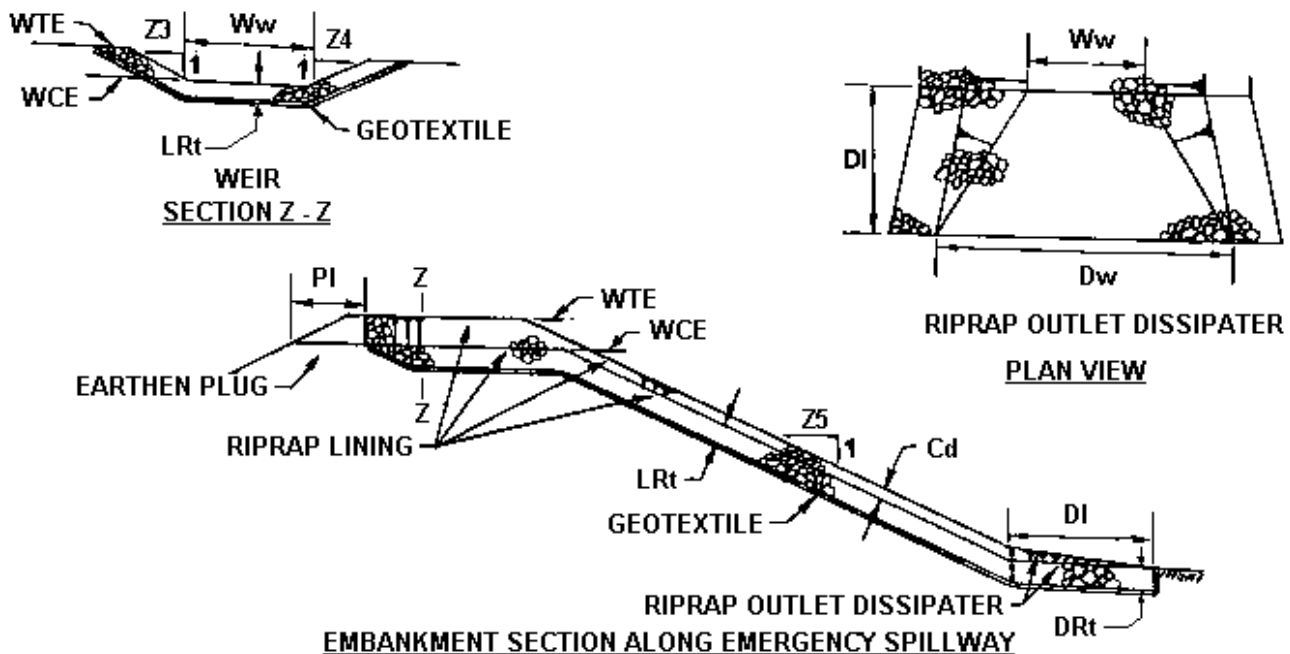


Rock spillway
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Provides emergency discharge for water in case riser clogs or discharge exceeds 100 year storm
- Geotextile must be installed under riprap lining
- Rock should be shaped to proper dimension in plans
- Over-excavation for rock is required to allow for passage of water over rock
- Other liners, besides rock, can be used

PA DEP STANDARD CONSTRUCTION DETAIL #8 Sediment Basin Emergency Spillways



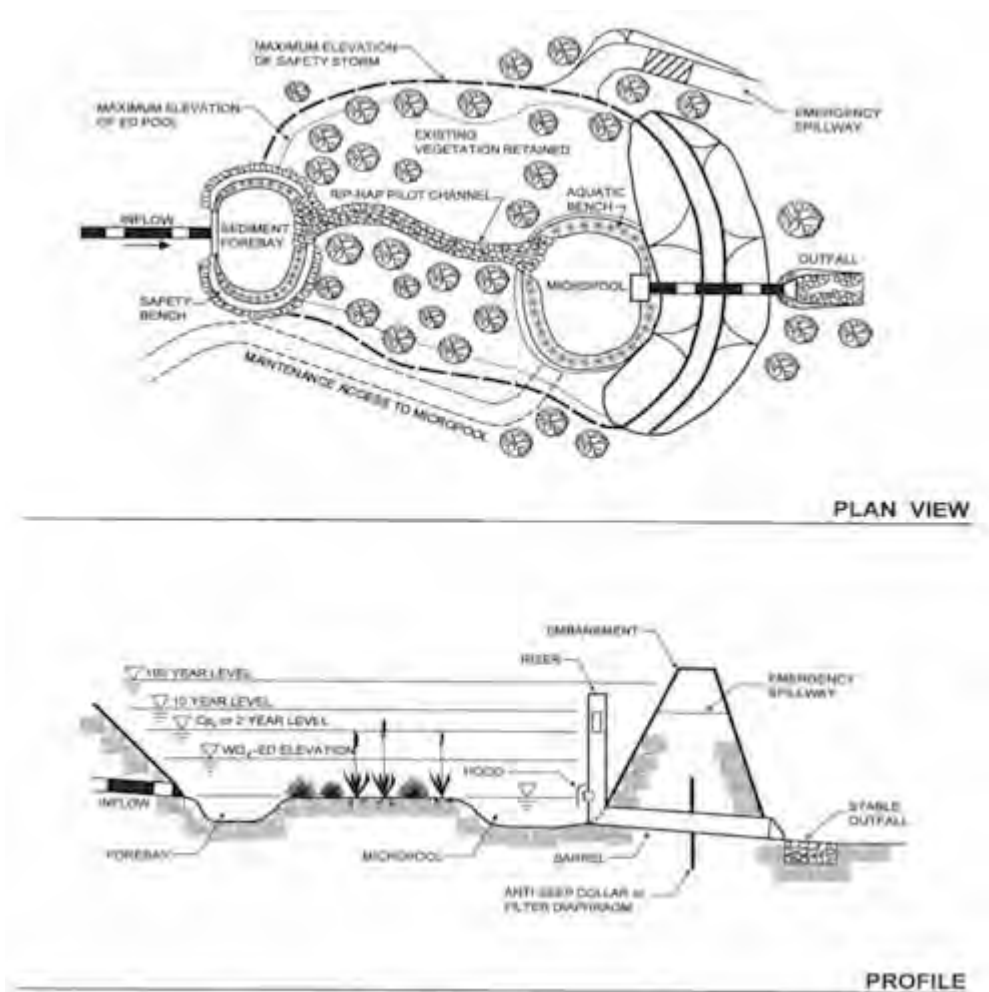
Line drawing provided by PA DEP Erosion and Sedimentation Pollution Control Program Manual



Water quality forebay for a detention pond
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Locate at major inlets to detention ponds
- Sized for water quality volume
- Maintenance access for cleanout
- Non-erosive velocities at inlet/outlet



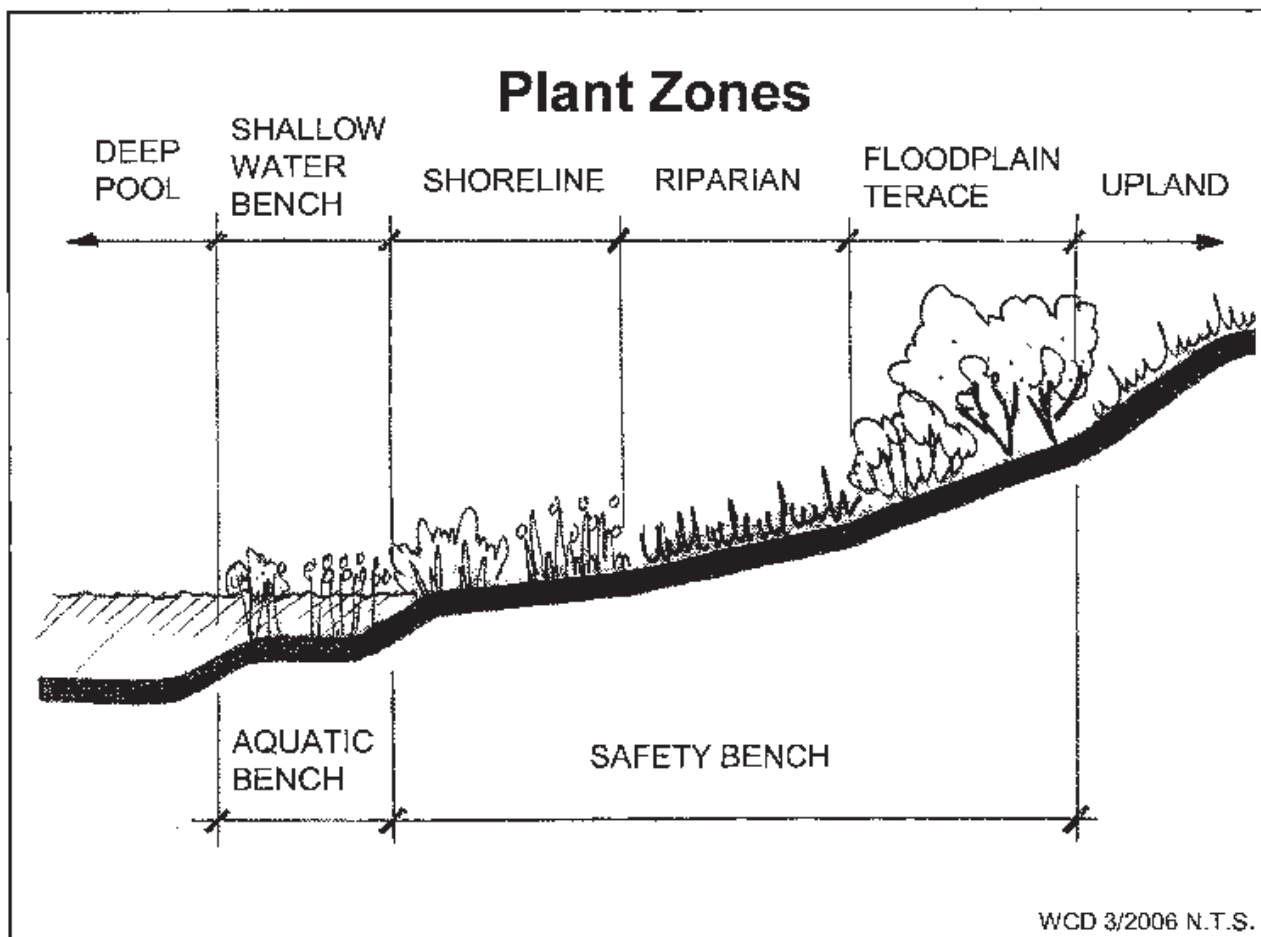
Line drawing provided by DEP PA Stormwater BMP Manual



Wet pond with safety bench
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Safety Bench - Level or gently sloping area extending from shoreline, 5ft minimum width, 5% maximum slope
- Aquatic Bench - Level or gently sloping area extending into pond from shoreline, 5ft minimum width, 18in maximum depth
- Vegetation of benches



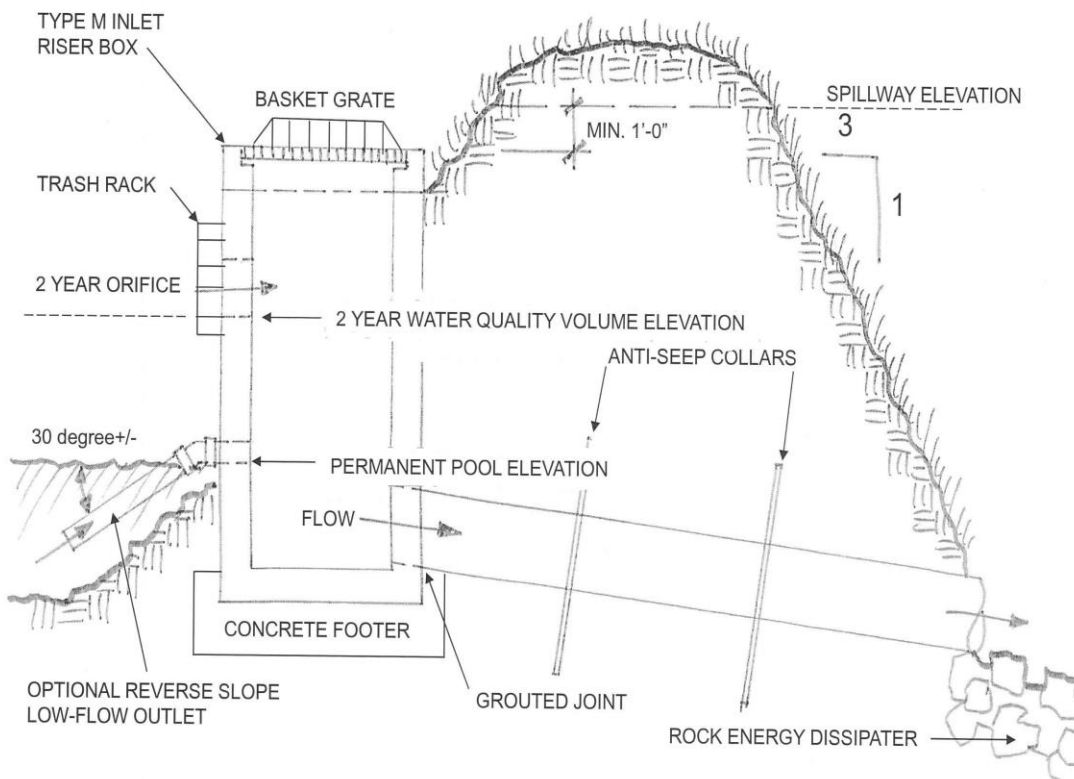
Line drawing provided by Westmoreland Conservation District



Type M inlet box permanent riser
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Permanent structure – concrete inlet box or corrugated metal pipe with concrete footing
- Basket grate or trash rack
- Low flow/dewatering orifice
- Sealed connections to outlet pipe
- Elevations of top, invert, and orifices meet plan specifications



PERMANENT OUTLET RISER FOR BASINS

WCD 3/2006 N.T.S.

Trash Rack for Type M Inlet Riser Outlet

Stormwater Management BMP



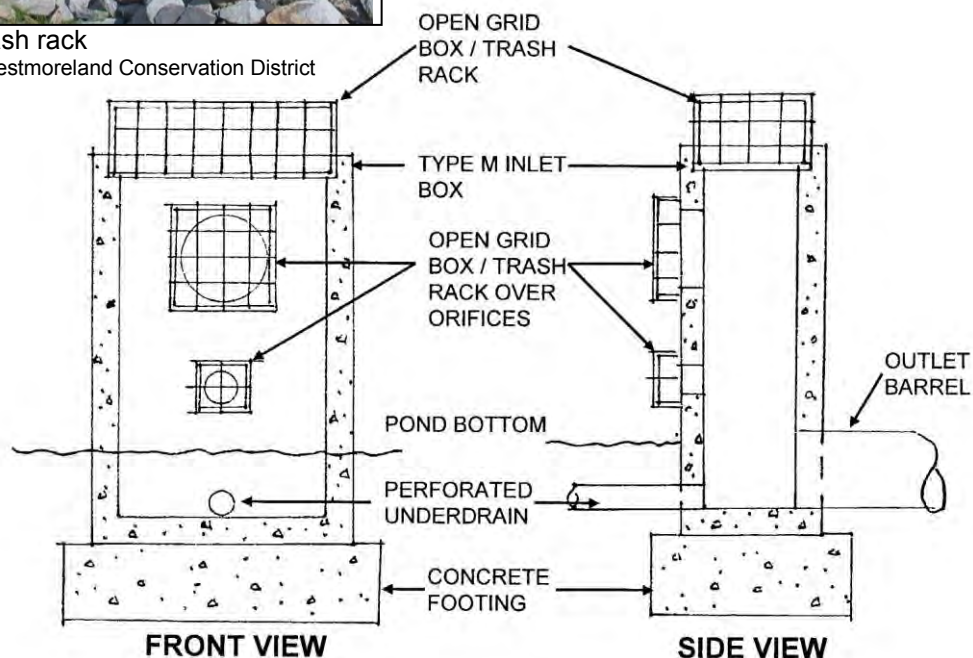
Angle iron and rebar trash rack
Photo courtesy of Westmoreland Conservation District



Painted rebar trash rack
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Trash racks should be fabricated from #4 rebar and/or angle iron, preferably box-shaped to prevent blockage
- Steel should be protected by galvanizing, epoxy or paint
- Openings in rack should be approximately 4" to allow leaf litter to pass but nothing larger
- Racks should be attached securely to concrete riser with stainless steel or galvanized bolts or anchors to cover all openings in the riser



TRASH RACK FOR TYPE M INLET BASIN RISER

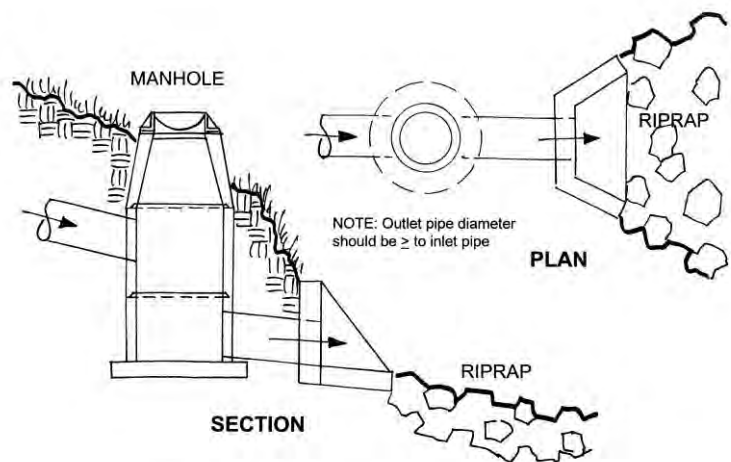
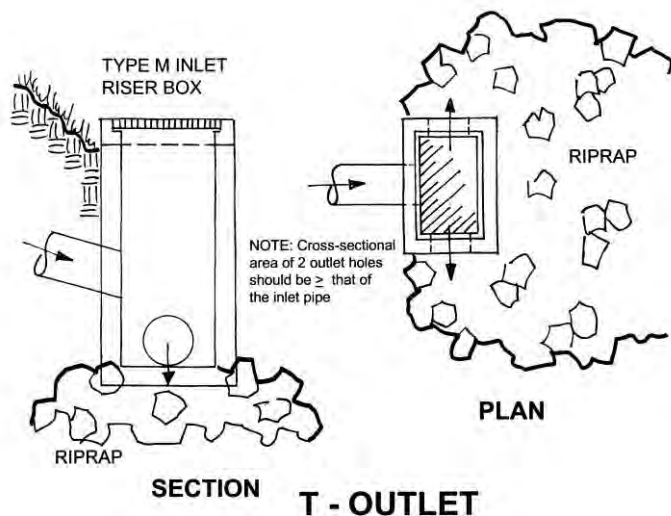
Line drawing provided by Westmoreland Conservation District



T-Outlet energy dissipater using Type M inlet
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Structural element to stop, turn, or reduce velocity of flow
- Examples: drop manhole, offset or T inlet box
- Built according to the plan
- Stabilization of outlet by rock, TRM (turf reinforcement mat) or other to reduce scour or erosion hazard



Line drawing provided by Westmoreland Conservation District



Poorly designed level spreader – constructed level with a stabilized downslope berm, but there is no alternative to drain the system

Typical Features:

- A structure designed to uniformly distribute concentrated flow over a large area essentially converting concentrated flow to sheet flow when no alternative exists to convey flow to a surface water or storm sewer
- Should be designed by a professional and included on an approved plan
- Should not exceed a drainage area of 5 acres
- Should be constructed and maintained LEVEL along an existing contour
- Downslope edge should be properly stabilized with TRM or by using a formed concrete curb



Well-designed level spreader – constructed with t-outlet and stable downslope berm, using concrete curb

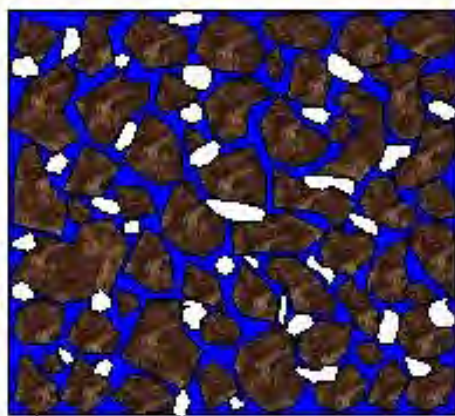


Soil ripping.
Photo courtesy of google™ images

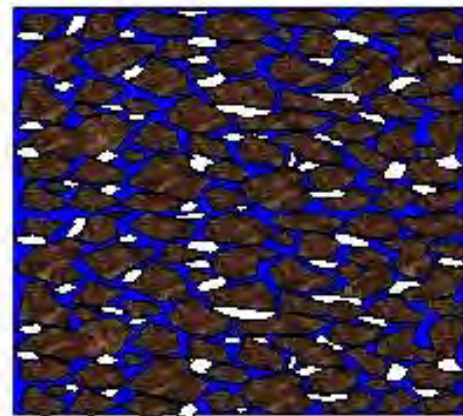
Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Existing soil conditions should be evaluated before forming a restoration plan
- Physical loosening of the soil by subsoiling or tilling can treat compaction
- Compost amendments increase water retention
- Combination of subsoiling and soil amendments is often the most effective

SOIL COMPACTION



good physical condition



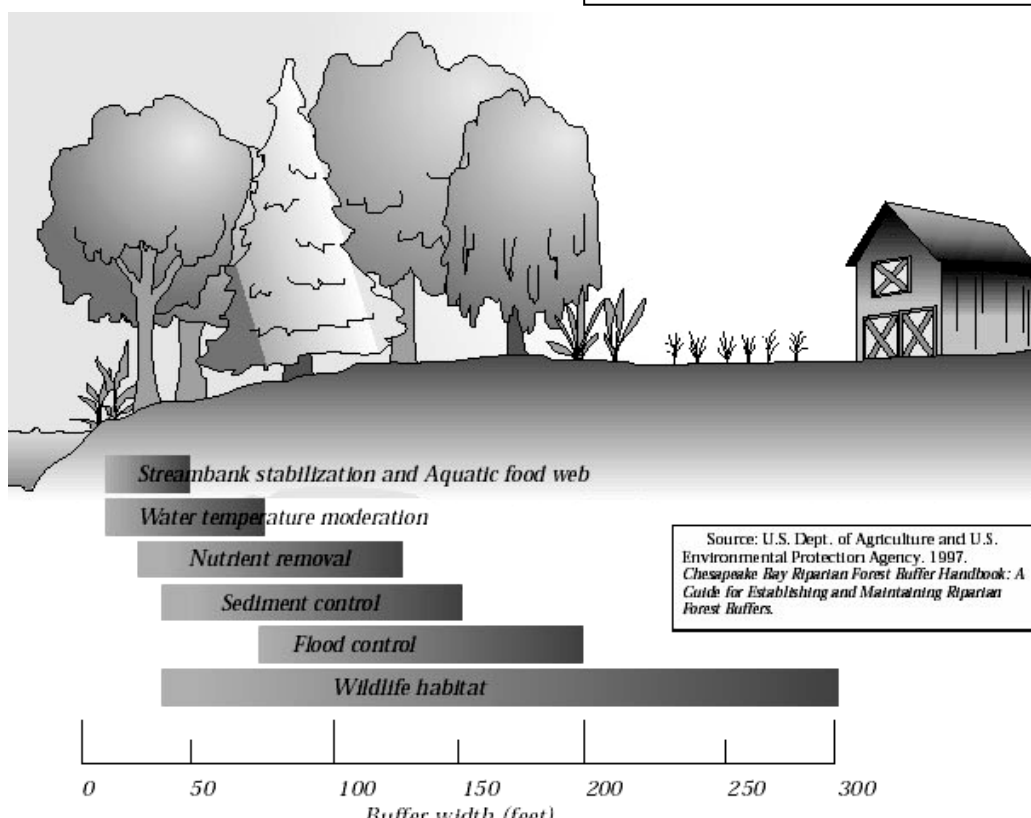
poor physical condition (compacted)



Establishing a riparian buffer along one side of an impacted stream channel, Youngwood PA
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Establish riparian buffers along perennial, intermittent and ephemeral streams
- Protect area from compaction
- Protect stream channel from siltation during and after construction
- Minimize traditional turf lawn areas and mowing
- Maximize plantings with a diversity of native trees and shrubs (a mature forest is the target)
- Width of buffer is dependant on preferred function (streambank stabilization, control of thermal pollution/nutrient loads/sediment, flood control, wildlife habitat)
- Create a short-term and long-term maintenance program



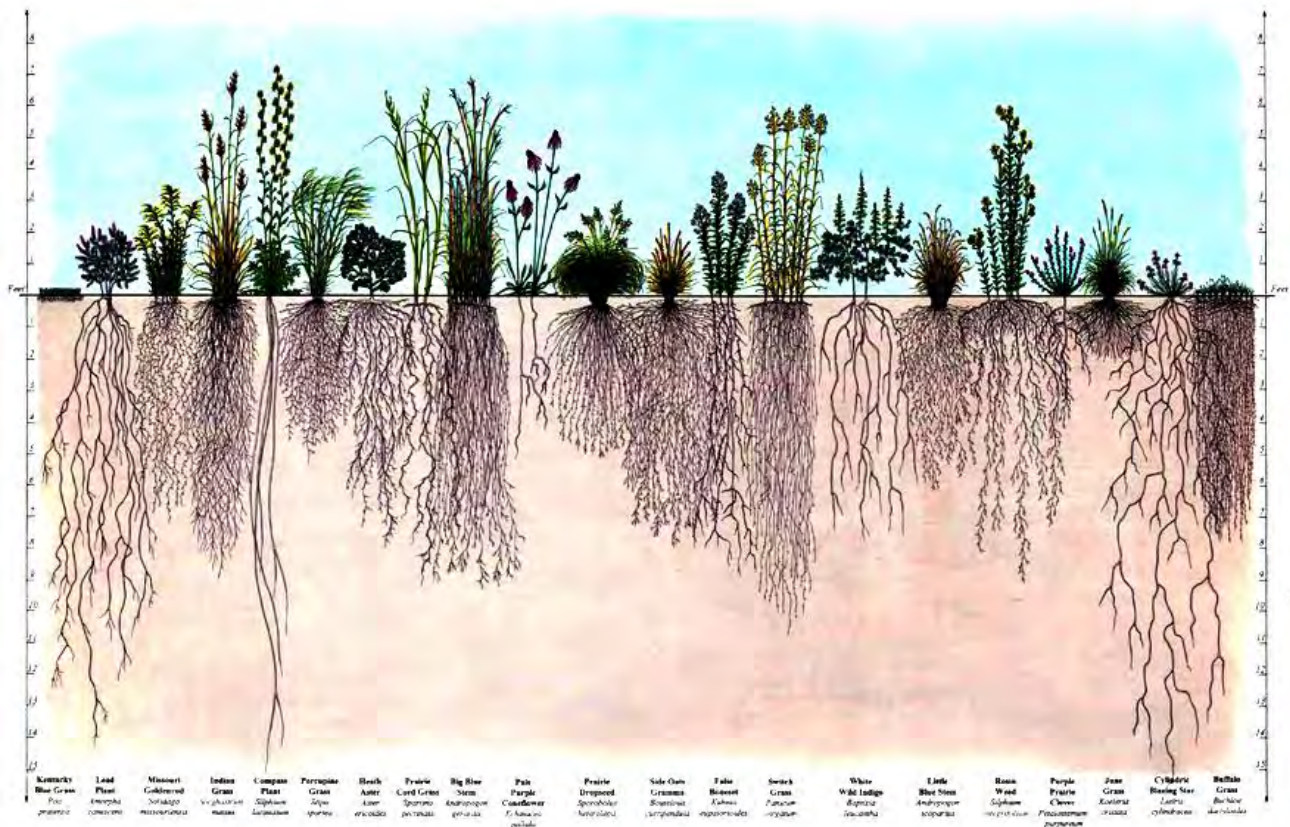


Naturalized meadow planting at Westmoreland Conservation District office, Greensburg PA
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Protect area from compaction
- Protect device from siltation during and after construction
- Minimize traditional turf lawn areas
- Maximize plantings with native vegetation
- Minimize fertilizer and chemical based pest control programs
- Minimize mowing

COMPARISON BETWEEN TURF GRASS (far left) AND NATIVE MEADOW PLANTS



Root Systems of Prairie Plants

Conservation Research Institute
© 1993



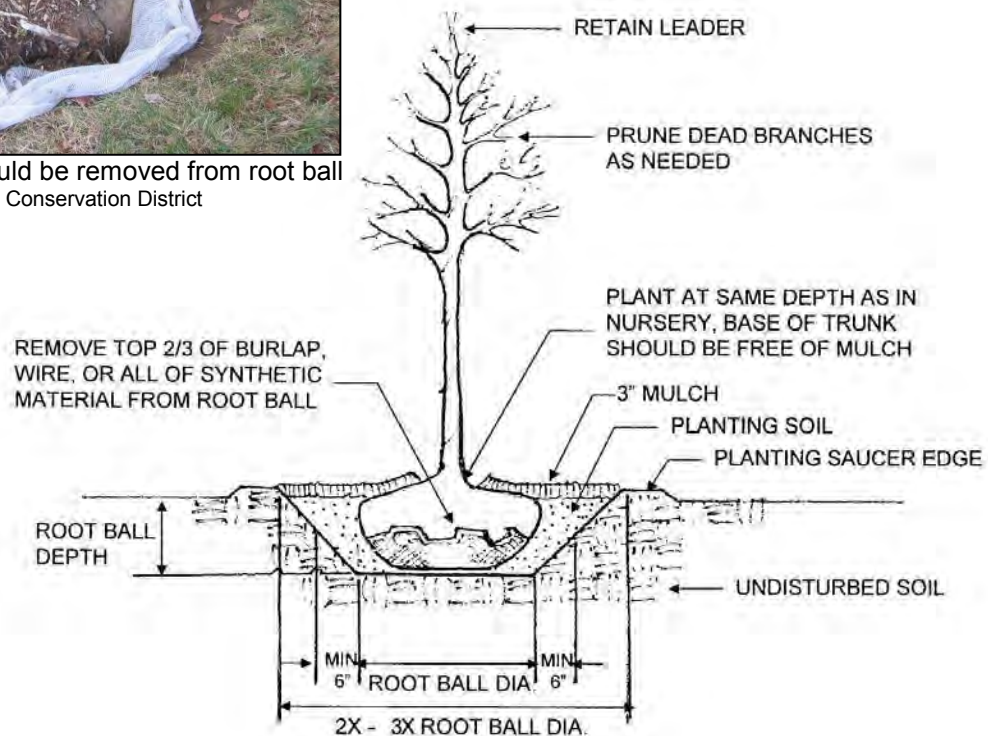
1. Hole should be 2 to 3 times wider than root ball
Photo courtesy of Westmoreland Conservation District



2. Protective covering should be removed from root ball
Photo courtesy of Westmoreland Conservation District

Typical Features:

- Hole should be minimum twice the width of the root ball (1).
- Edges of the hole should be roughed up for better root growth
- Remove all string, wire and burlap from top 2/3 of root ball. Completely remove all synthetic material (2).
- Topsoil backfill should be mixed with compost.
- Tree should be planted so base of trunk is level or no greater than 2" above existing grade.
- Create saucer edge to retain water and water thoroughly.
- Tree spacing should be minimum 12' on center.



TREE PLANTING

Line drawing provided by Westmoreland Conservation District



1. Plant stem should be at the same relationship to the ground as in the nursery.

Photo courtesy of Westmoreland Conservation District

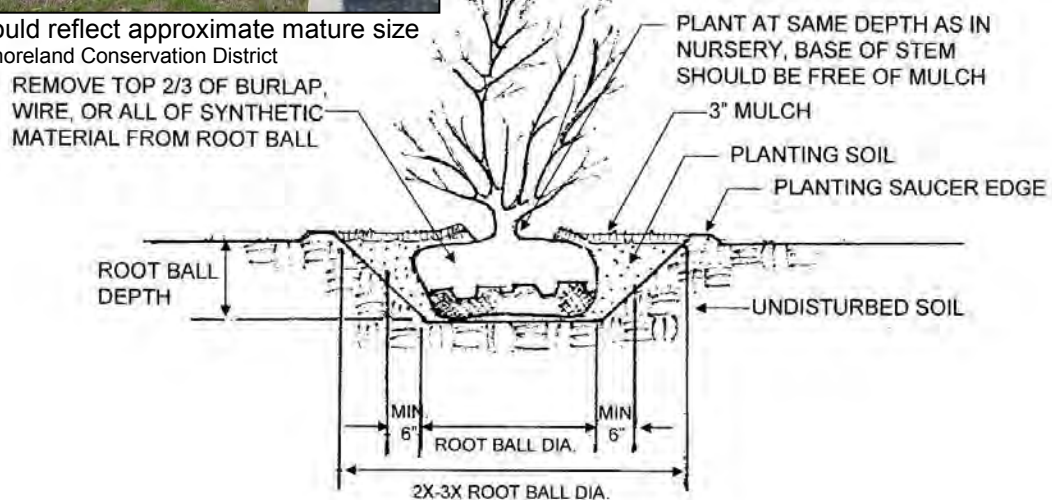


2. Plant spacing should reflect approximate mature size

Photo courtesy of Westmoreland Conservation District

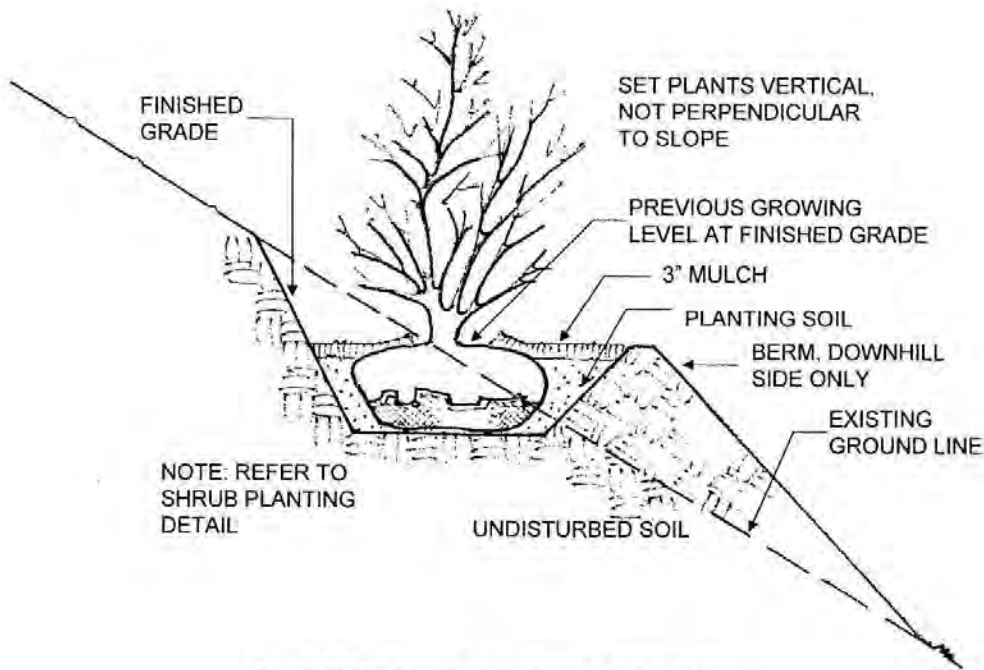
Typical Features:

- Hole should be 2 to 3 times the width of the root ball.
- Edges of the hole should be roughed up for better root growth.
- Remove all string, wire and burlap from top 2/3 of root ball. Completely remove all synthetic material.
- Topsoil backfill should be mixed with compost.
- Shrub should be planted so base of stem is level or no greater than 2" above existing grade (1).
- Create saucer edge to retain water and water thoroughly.
- Spacing should be appropriate for mature size of plant (2).

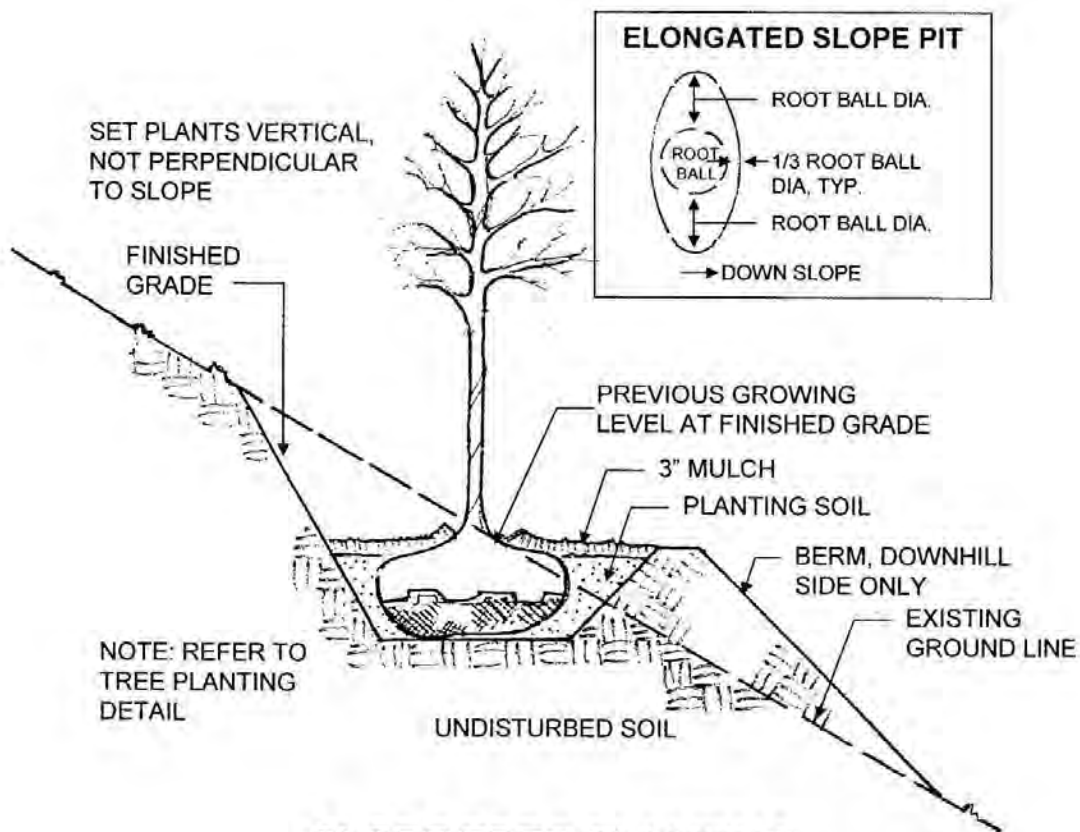


SHRUB PLANTING

Line drawing provided by Westmoreland Conservation District



SLOPE SHRUB PLANTING



SLOPE TREE PLANTING

WATER OBSTRUCTION AND ENCROACHMENT PERMITS

The following types of permits or approvals are available under Title 25, Chapter 105, Dam Safety and Waterway Management, for various water obstructions and encroachments. Before you begin a project, please determine if you need a permit or an approval and which type of permit or approval you need.

1. Joint (Water Obstruction and Encroachment) Permit
2. Small Projects Permit
3. General Permits
 - A. GP-1 Fish Enhancement Structures
 - B. GP-2 Private Recreational Docks
 - C. GP-3 Bank Rehabilitation and Protection; Gravel Bar Removal
 - D. GP-4 Intake and Outfall Structures
 - E. GP-5 Utility Line Stream Crossings
 - F. GP-6 Agricultural Crossings and Ramps
 - G. GP-7 Minor Road Crossings
 - H. GP-8 Temporary Road Crossings
 - I. GP-9 Agricultural Activities
 - J. GP-10 Mine Reclamation
 - K. GP-11 Maintenance, Repair, Rehab or Replacement of Water Obstructions and Encroachments.
 - L. GP-15 Residential Construction in Wetlands
4. Waiver of Permit Requirements
5. Emergency Permit.

FOR MORE INFORMATION ABOUT PERMITS PLEASE CONTACT:

PA Department of Environmental Protection (DEP)
Bureau of Watershed Management
500 Waterfront Drive
Pittsburgh, PA 15222
(412) 442-4315
www.depweb.state.pa.us

Westmoreland Conservation District
218 Donohoe Road
Greensburg, PA 15601
(724) 837-5271
www.wcdpa.com

PA Fish and Boat Commission
Southwest Regional Office
236 Lake Road
Somerset, PA 15501
(814) 445-8974
www.fish.state.pa.us

U.S. Army Corps of Engineers
Pittsburgh District
1000 Liberty Avenue
Pittsburgh, PA 15222
(412) 395-7155
www.usace.army.mil

WATER OBSTRUCTION AND ENCROACHMENT PERMIT INFORMATION

All activities that change the *course, current, cross section, or quality* of Waters of the Commonwealth (streams, lakes, rivers, ponds, wetlands, etc.) require a permit or approval of some type from DEP. Many activities *near* Waters of the Commonwealth also require a permit or approval.

WAIVER

Certain activities in Waters of the Commonwealth may have the requirement for a permit waived. These include but are not limited to 1) obstructions in a stream with drainage of less than 100 acres; 2) dams less than 3 **feet high and 50 feet long used 'for fish and fishing purposes';** 3) **dams less than 15 feet high, with less than 100** acres of tributary drainage, and less than 50 acre-feet of storage; 4) certain maintenance activities. Waivers usually do not apply to work in Wetlands. Some waivers are automatic; other situations may require a written waiver from DEP.

GENERAL PERMIT

General Permits are for projects which fit pre-determined parameters established by DEP. Limitations **include project size and the drainage area of affected bodies of water.** GP's are issued by the DEP SWRO, or by the Westmoreland Conservation District in Westmoreland County.

SMALL PROJECTS PERMIT

The Small Projects Permit is used for work which does not qualify for a General Permit, and which also **does not impact Wetlands. It is for projects which "will have an insignificant impact on safety and protection of** life, health, property, and **the environment."**

Three categories of Small Projects are Minor Bridge and Culvert Projects, Minor Work in Stream Channels, and Small Structures and Limited Activities in Floodways. Examples of such permitted activities include golf cart bridges, storage sheds, and restoration of stream channels blocked by sediment. Small Projects Permits are issued by DEP.

JOINT PERMIT (WATER OBSTRUCTION AND ENCROACHMENT PERMIT)

This permit is required for all projects which do not qualify for a Waiver, a General Permit, or a Small Projects Permit. Most work which affects Wetlands requires a Joint Permit. The Joint Permit is issued jointly by PA DEP and the US Army Corps of Engineers. Joint Permits require extensive environmental, hydraulic, hydrologic, and other documentation.

EMERGENCY PERMIT

This permit is issued for situations posing an immediate threat to property, safety, or the environment. Contact PA DEP for authorization.

CORPS OF ENGINEERS

Some stream or drainage channel fills and other activities which might be either waived or not regulated by DEP, require Corps approval. Contact their Pittsburgh office for more information.

WETLANDS INFORMATION

Wetlands are a unique ecosystem characterized by the presence of any of three indicators—soil, water, and plants. Wetlands have Hydric soil, which is wet, gray or black, mucky, or clayey. Wetlands also are saturated with water in the plant root zone and to the surface of the ground during the growing season. Wetland plants include cattails, rushes, sedges, willows, skunk cabbage, marsh marigolds, and others. Usually if two of the three wetland indicators are present, wetlands are found. The rule for working with wetlands is, first, *avoid* impacting them; second, *minimize* the impact; and third, if you must impact a wetland the damage must be *mitigated*, that is, the wetland must be replaced somewhere else. All wetland impacts are potentially regulated by DEP, regardless of size.

Revised and updated 02-12, WCD