CHAPTER 6

Sediment Controls

Sediment control is the compromise between protecting water resources and accomplishing work during grading and construction activities. Construction activities are often fully underway when Ohio's most intense storms happen, yielding significantly greater amounts of mud or sediment than other land disturbing activities such as agricultural crop production. Eventually disturbed soils will be stabilized with new vegetation, landscaping and buildings, but in the interim practices that are effective in capturing sediment are needed to prevent tons of soil from moving offsite and into wetlands, ponds, lakes, creeks and rivers.

Sediment controls are a compromise, because they don't capture all sediment. They capture the largest soil particles, (sands and large silts), but are not very effective with smaller silts and clay particles. Additionally, not all practices are equally effective. Settling ponds may be greater than 50 or 60 percent effective while the other practices (like inlet protection or silt fence) are frequently much less than 50 percent effective. Effectiveness also depends on the size of eroded particles entering the pond. For example, if suspended particles are fine silts and clays, then effectiveness of capture descreases. Conversely, if eroded particles are large silts and sands, then effectiveness will increase with the same pond design. Thus site designers must combine a strategy of phasing, construction, and rapid stabilization with the most effective sediment control practices that can be used on their site.

Sediment controls have limited effectiveness even when installed well and operating at their best. And this is often not the case. For this reason, the design, installation and maintenance of sediment control practices are critical for them to function properly.

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6.1 Sediment Basin

Description

A sediment basin is a temporary settling pond that releases runoff at a controlled rate. The basin is designed to slowly release runoff, detaining it long enough to allow most of the sediment to settle. Sediment basins typically consist of a dam or embankment, the pool area for water and sediment storage, principal and emergency spillways, and a controlled dewatering device or skimmer. Secondary benefits include runoff control and preserving the capacity of downstream reservoirs, ditches, canals, diversions, waterways and streams. The entire structure may be removed when construction is complete and the drainage area is stabilized or may be converted to a detention basin for post-construction storm water management.

Condition Where Practice Applies

Sediment basins under these guidelines are limited to sites where:

- Failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service from private utilities.
- The drainage area is 100 ac. or less.
- The height of the dam is 25 ft. or less, as measured from the natural streambed at the downstream toe of the dam to the top of the dam.
- The basin is to be removed within 36 months after its construction.

Sediment basins exceeding any of these limits shall conform to Ohio Dam Safety Laws, local requirements, or U.S.D.A Natural Resources Conservation Service Standards and Specifications No. 378 for ponds and No. 350 for sediment basins, whichever is most restrictive.

Ohio Dam Safety Laws may apply to basins larger than 15 ac.-ft. (24,000 cy) as measured to the top of the dam. Information is available from the Ohio Department of Natural Resources, Division of Water, 2045 Morse Road, Bldg. E-2, Columbus, Ohio 43229-6605; phone (614) 265-6731.

Planning Considerations

Sediment basins and sediment traps are generally accepted methods for treating sediment-laden runoff. Sediment basins and traps are usually placed near the perimeter of construction-sites to prevent off-site sedimentation. Construction activity should be phased to allow them to remain functional for as long as possible, ideally until the area contributing runoff is stabilized with dense permanent vegetation. Settling ponds, both traps and basins, are generally recommended as the principal sediment-control practices for construction-sites. The typical components of a settling basin are shown in Figure 6.1.2 on the following page.

Effectiveness – Sediment basins do not trap all the sediment that washes into them. Sediment basins are not as effective in controlling fine particles (i.e., silt, clay) as sand and other coarse particles. Therefore, sediment basins as with all sediment controls should be used in conjunction with erosion control practices such as temporary seeding to reduce the total amount of sediment washing into them. Soil analysis may be necessary to determine whether a sediment basin will be a feasible means of preventing off-site sedimentation.

Timing – Sediment basins, along with other sediment-control practices, must be constructed as a first step in any land disturbing activity and must be functional before upslope land disturbance takes place.

Construction Phases – Sediment basins should be placed so they function through all phases of the site’s development, both before and after new drainage systems are constructed.

Location – It is practical and economical to locate sediment basins where the largest storage capacity can be obtained with the least amount of earthwork, such as depressions and drainage ways (without a defined bed or bank). Do not place sediment basins in or immediately adjacent to wetlands or stream channels.

Diverting Runoff – Temporary diversions at the perimeter of construction sites are used to direct runoff to sediment basins.

Below Storm Drains – Sediment basins may be placed beyond the ends of proposed storm-drain systems. Postponing construction of the last sections of the storm drain may be necessary to provide adequate area for the sediment basin between the outlet and receiving watercourse.

Storm Drain Diversions – Storm drains may also be temporarily redirected through sediment basins during construction (Figure 6.1.1).

Utilities – Give special consideration to sediment basin location and potential interference with construction of proposed drainage ways, utilities and storm drains.

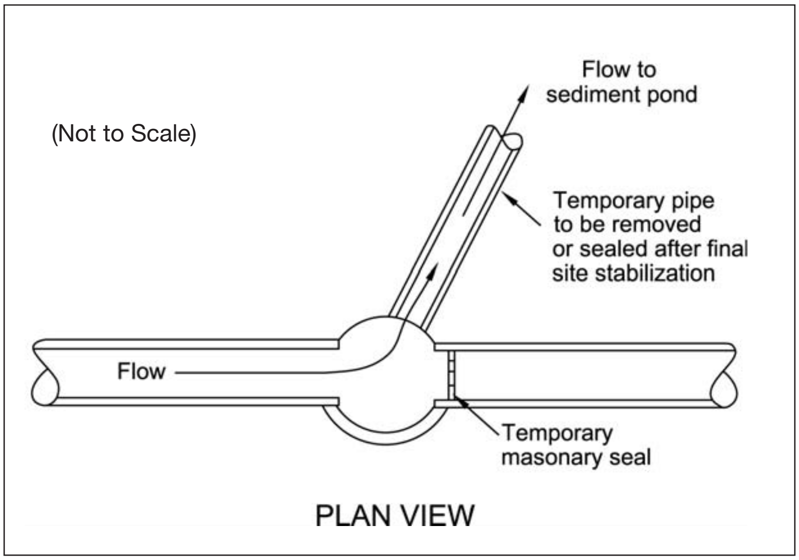


Figure 6.1.1 Temporary storm drain diversion

Design Criteria

For the purposes of this manual the design of a sediment basin is broken down into five parts which include:

1) Pool Design
2) Embankment Design
3) Dewatering Design
4) Principal Spillway Design
5) Emergency Spillway Design.

Generally accepted practices and procedures shall be followed to meet these design criteria. Sediment basins shall be designed by a registered professional engineer. Runoff computations shall be based upon the worst soil-cover conditions expected to occur in the contributing drainage area during the anticipated effective life of the structure. Runoff volumes must be computed by accepted engineering methods such as the NRCS curve number method.

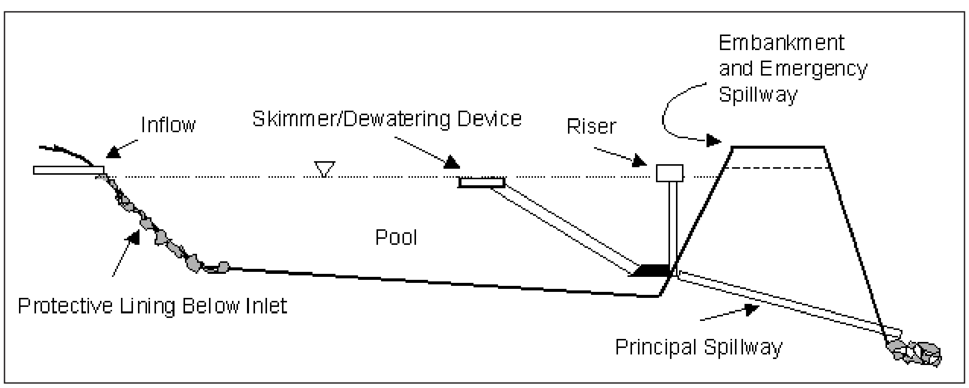


Figure 6.1.2 Typical components of a settling basin

1. POOL DESIGN:

Capacity – The minimum total design volume for the sediment basin shall consist of two components, the dewatering zone and the sediment storage zone. These zones are shown schematically in Figure 6.1.3. The volume of the dewatering zone shall be calculated for the entire drainage area by the method shown below. The drainage area includes the entire area contributing runoff to the sediment basin, offsite as well as on.

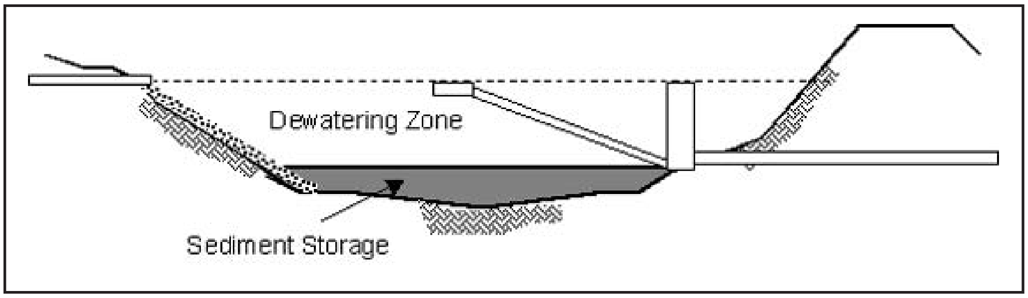


Figure 6.1.3 Pool showing dewatering area and additional sediment storage area

a) Dewatering Zone Volume -

The volume of the dewatering zone shall be a minimum of 1800 cubic feet per acre of drainage (67 yd^3/acre) or the minimum stated in the current NPDES construction general permit. Increasing this volume will increase the effectiveness of the basin, provided dewatering times are appropriately adjusted as well.

b) Sediment Storage Zone Volume -

The volume of the sediment storage zone shall be calculated by one of the following methods.

Method 1: The volume of the sediment storage zone shall be 1000 cubic feet (37 cubic yards) per disturbed acre within the watershed of the basin. OR

Method 2: The volume of the sediment storage zone shall be the volume necessary to store the sediment as calculated with RUSLE or a similar generally accepted erosion prediction model. While the sediment storage volume may extend to the expected time period of the construction project, the minimum estimated time between cleanouts shall be six months.

The total volume of the dewatering zone and the sediment storage zone shall be provided below the principal spillway elevation. The elevation at which the sediment storage zone reaches the design capacity should be designated by the top of stake located near the center of the basin. Accumulated sediment shall be removed from the basin whenever it reaches that elevation on the cleanout stake.

Depth – The pool shall be configured to maximize the optimum depth of 3 ft. Depths over 5 ft. should be avoided. The depth shall be measured to the invert of the principal spillway. These are optimum criteria and will not be feasible for all sediment basins.

Flow Length-to-Width Ratio – The length-to-width ratio shall be 4:1 or greater. If the flow length from the inlet of the basin to the principal spillway is not greater than or equal to the minimum length, either the inlet of the basin should be relocated farther away from the principal spillway, or one or more solid baffles should be used to increase the flow length within the basin. Flow length is to be measured at the elevation of the invert of the principal spillway. Where runoff from disturbed areas enters the basin from different directions, it is better to combine flows from the various areas into a single inlet into the basin rather than have multiple inlets into the basin. If multiple inlets to the basin exist, the flow length to width ratio from all inlets must be at least 4:1.

Use of Baffles in Sediment Basins – If individual situations require greater trapping efficiency or if optimum depth and length-to-width ratios are not feasible, baffles may be incorporated into the design. Baffles may be constructed of porous or solid materials depending upon their purpose. Solid baffles, as shown in Figures 6.1.4 and 6.1.5, may be used to increase the flow length within the basin.

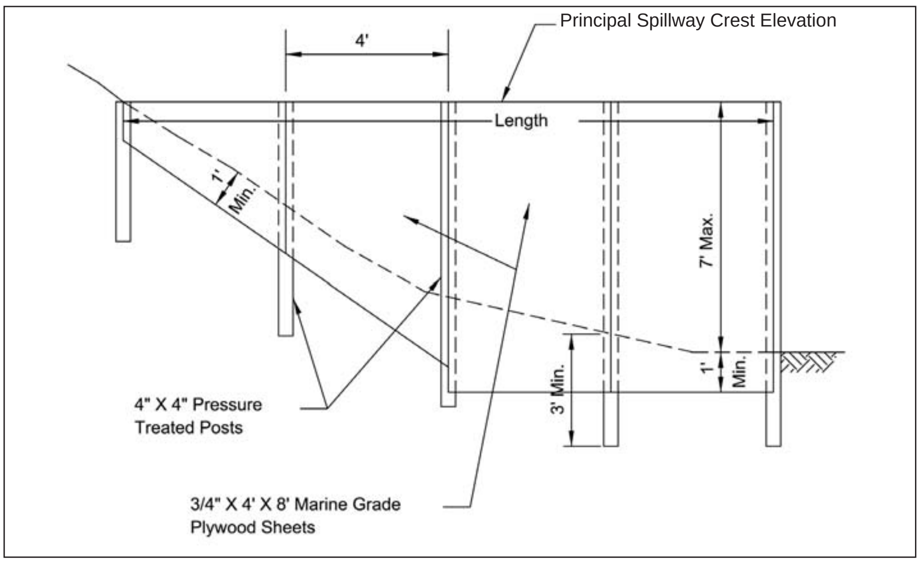


Figure 6.1.4 Typical construction of a solid baffle

Porous baffles, as shown in figure 6.1.5, are used to dampen turbulent currents and increase sedimentation. Porous baffles are typically constructed of jute matting, rock, plastic safety fence, or other material. Porous baffles typically partition the basin into two or three cells. Whether porous or solid baffles, the height shall extend to the crest elevation of the principal spillway.

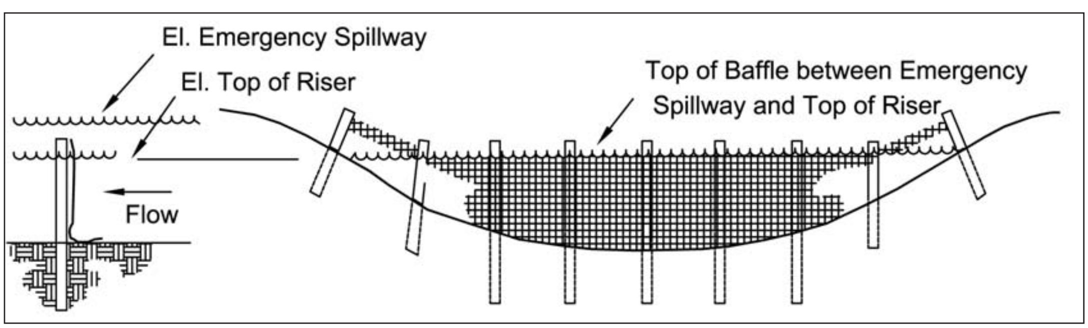


Figure 6.1.5 Porous baffle placed to increase pond efficiency (left shown in profile, right in cross-section)

Basin Inlet—A suitable protective lining for each collection channel or other device that discharges to the basin should be provided; the lining should extend to the bottom of the basin and at least 10' along the basin bottom for energy dissipation.

Safety—Sediment basins are attractive to children and can be dangerous, particularly where 2:1 or steeper side slopes lead directly into water 3 ft. or deeper. Danger is also increased where side slopes are not vegetated. Fencing and warning signs shall be installed to minimize the danger associated with sediment basins.

2. EMBANKMENT DESIGN:

Embankment Slope—Embankment slopes must be sufficiently flat to ensure stability; however, in all cases the combined upstream and downstream side slopes of the settled embankment shall not be less than 5 horizontal to 1 vertical (5:1) with neither slope being steeper than 2:1.

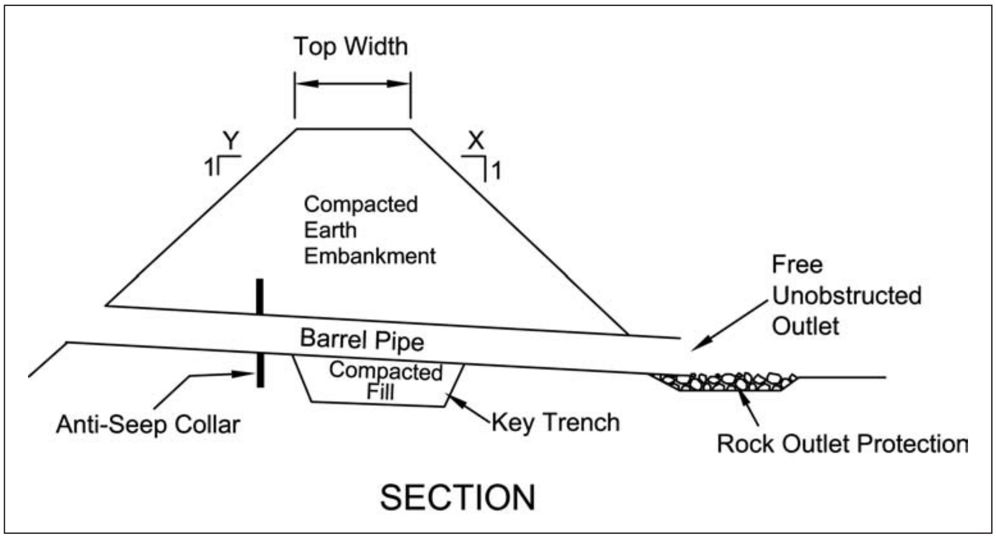


Figure 6.1.6 Embankment Design

Embankment Cutoff Trench—Use cutoff trenches to prevent seepage from flowing along the foundation of the embankment. Install cutoff trenches to a depth that extends into a relatively impervious layer. In all cases the minimum depth shall be 3 ft. and constructed of mechanically compacted material. A cutoff trench shall have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations. Side slopes shall be no steeper than 1:1.

Embankment Settlement—The embankment design height shall be increased by the amount needed to ensure that after all settlement has taken place the height of the dam will equal or exceed the design height. This increase shall not be less than 5%.

Embankment Top Width—The minimum top width of the embankment shall be as shown below.

Table 6.1.1 Embankment Top Width

Embankment Height at Centerline (ft.)	Minimum Top Width (ft.)
< 15	8
15 – 20	10
> 20	12

3. DEWATERING DEVICE DESIGN:

Dewatering should be part of all sediment basins. The minimum dewatering time for sediment basins is 48 hours. The maximum dewatering time should not exceed 7 days. The lower limit of dewatering is the top of the sediment storage zone, or the top of the permanent pool if a permanent pool is used. The upper limit is the crest of the principal spillway. Sediment basins shall be dewatered using a device that discharges water from the top of the dewatering zone.

Typical methods or devices for accomplishing this may include the following: skimmers, floating pumps, siphons or other acceptable methods that provide dewatering between 48 hours and 7 days. Where ice or other reasons make dewatering from the top of the water surface impractical, multiple orifices or a single orifice may be used to dewater down to the top of the sediment storage zone. Any dewatering of the sediment zone must be accomplished using protected dewatering methods (e.g. perforated riser with gravel cone or wire mesh and filter fabric covering perforations). All of these methods are appropriate for meeting the requirements of this standard, but only sizing procedures for skimmers are included below. Concern regarding ice may justify changing outlet types during months of hardest freezing or provide frequent monitoring and mainteance as a means of preventing freezing of the skimmer.

A schematic of a skimmer is shown in figure 6.1.7 or 6.1.8. Typically a single orifice plate is placed in the discharge pipe to control water outflow or discharge. It is recommended that the orifice be placed near the water surface or floating device to allow a constant head and a more consistent discharge. Note the dewatering device is not the same as the principal or emergency spillway. However, the dewatering device outlet may be connected to the principal spillway outlet.

Sediment basins are often permanent stormwater detention facilities (wet pond, dry pond, ...) modified for sediment control use during construction. Permanent stormwater ponds and sediment basins often have different volume and drawdown requirements. Thus, if the same facility (basin) is to be used both for sediment control during construction and for permanent stormwater control, the facility will require two different outlet designs - one to be used during construction, and the other to be installed upon completion of the development. Plans should explicitly show design calculations and outlet design details for both uses and configurations.

It is recommended that calculation summaries and design details for both outlets be included on the same plan page during submittal for ease of evaluation by the reviewing agency. Table 6.1.1.a highlights summary information that should be included.

In addition, the point at which the temporary sediment basin outlet is to be replaced with the permanent stormwater basin outlet should be clearly specified on the page(s) with outlet design details.

Table 6.1.1.a Summary information for Sediment Basin versus Permanent Stormwater Facility

	Sediment Basin				Permanent Stormwater Facility			
Contributing Drainage Area (ac.)	Dewatering Volume (yd^3) or (ac-ft)	Sediment Storage Volume (yd^3) or (ac-ft)	Detention Time Min 48 hr (hours)	Sediment Control Orifice Size (in) or (in^2)	Water Quality Volume-WQv (yd^3) or (ac-ft)	Permanent Pool Volume (yd^3) or (ac-ft)	Detention Time (hours)	WQv Orifice Size (in) or (in^2)

Sizing Procedures for Skimmers

Two types of skimmer are discussed here: the Faircloth Skimmer, a patented device manufactured and sold by William Faircloth of North Carolina; and the Delaware DOT skimmer incorporated into the State of Delaware Dept. of Transportation specifications. While similarly drawing water from near the surface, the devices differ in the location of the orifice control. The Faircloth Skimmer has its orifice control located near the water surface and will maintain the same head over the orifice during dewatering. The Delaware DOT skimmer has its orifice control located at the lowest portion of the device and therefore will not have a consistent head throughout the dewatering period. Thus two different design approaches must be used in sizing the orifices for each skimmer.

Delaware DOT skimmer discharge:

Discharge from the Delaware DOT skimmer can be calculated with the orifice flow equation shown below. The discharge from the Delaware DOT skimmer will vary since the head will change as the basin is dewatered.

Orifice Flow Equation: $Q=CA(2gH)^{0.5}$

Where: Q = discharge in cubic feet per second (cfs)

C = orifice coefficient, typically a value of 0.6 is used for C

A = cross-sectional area of the orifice plate in square feet

g = acceleration due to gravity, 32.2 ft/sec2

H = head above orifice in feet, from the orifice center to the water surface

As an alternative to utilizing the orifice flow equation, the following table can be utilized to determine discharge, Q, in cfs. The average head is used with the given range (e.g. for 0-2 feet, H = 0.5 feet)

Table 6.1.2 Discharge, Q, in cfs for different orifice sizes and head above orifice (ft).

Orifice size (in.)	0' to 1'	1' to 2'	2' to 3'	3' to 4'	4' to 5'
1"	0.019	0.032	0.042	0.049	0.056
1.5"	0.041	0.072	0.093	0.110	0.125
2"	0.074	0.129	0.166	0.196	0.223
2.5"	0.116	0.201	0.259	0.307	0.348
3"	0.167	0.289	0.373	0.442	0.501
3.5"	0.227	0.394	0.508	0.602	0.682
4"	0.297	0.514	0.664	0.786	0.891

The orifice shall be designed to remove the entire volume of the dewatering zone. The minimum dewatering time for the sediment basin is 48 hours. The maximum dewatering time should not exceed 7 days. The dewatering orifice shall be designed by the following procedure or other equivalent means.

Step 1 – Knowing the size and shape of your dewatering zone, calculate the volume of water (cubic feet) in each 1-foot increment from the bottom of the dewatering zone to the top of the dewatering zone (e.g., 0'-1', 1'-2', 2'-3', 3'-4', 4'-5').

Step 2 – Select a trial orifice size, and use the chart on page 9 to determine the discharge, Q, for each 1-foot increment of head.

Step 3 – Divide each volume calculated in step 1 by the corresponding Q (step 2) to get the total dewatering time.

Step 4 – Sum the dewatering times for the 1-foot increments to get the total dewatering time. Make sure to convert the units from seconds to days (86,400 seconds/day).

Step 5 – If the dewatering time is less than 2 days or greater than 7 days, select a different orifice size and repeat steps 2-5.

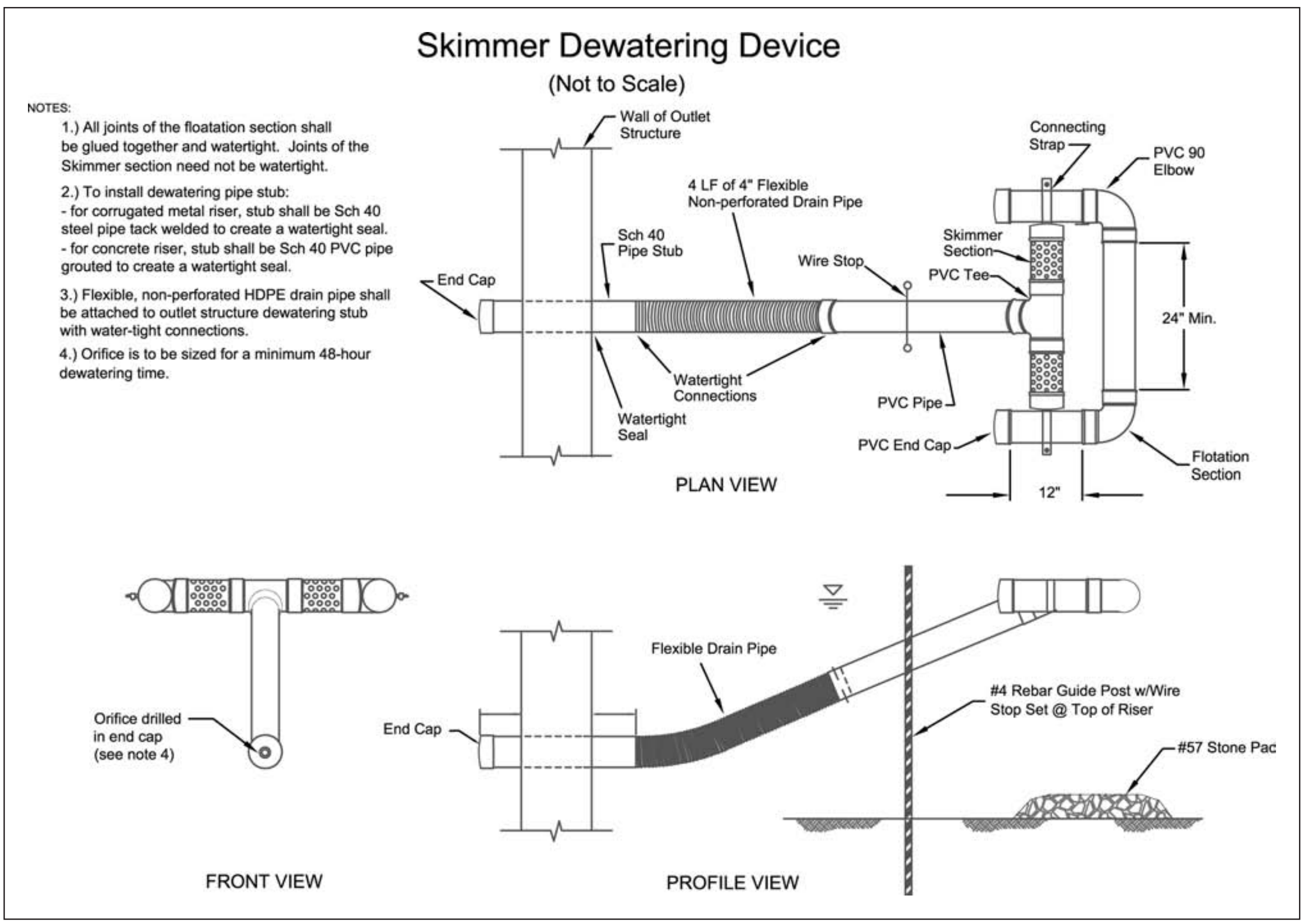


Figure 6.1.7 Delaware Dept. of Transportation Skimmer

Faircloth skimmer discharge:

The typical components of the Faircloth skimmer are shown in Figure 6.1.8. This skimmer consists of three primary parts: the arm assembly, the water entry unit and the “C” enclosure keep debris from water entrance. The “C” enclosure floats on the water surface and suspends the water entry unit just below the water surface. The arm assembly transports the water from the water entry unit to the basin’s principal spillway barrel. Water discharge rate is to be controlled by an orifice located at the connection between the water entry unit and the arm assembly.

Instructions for design, installation and maintenance of Faircloth skimmers is available from the J.W. Faircloth & Sons Company at www.fairclothskimmer.com.

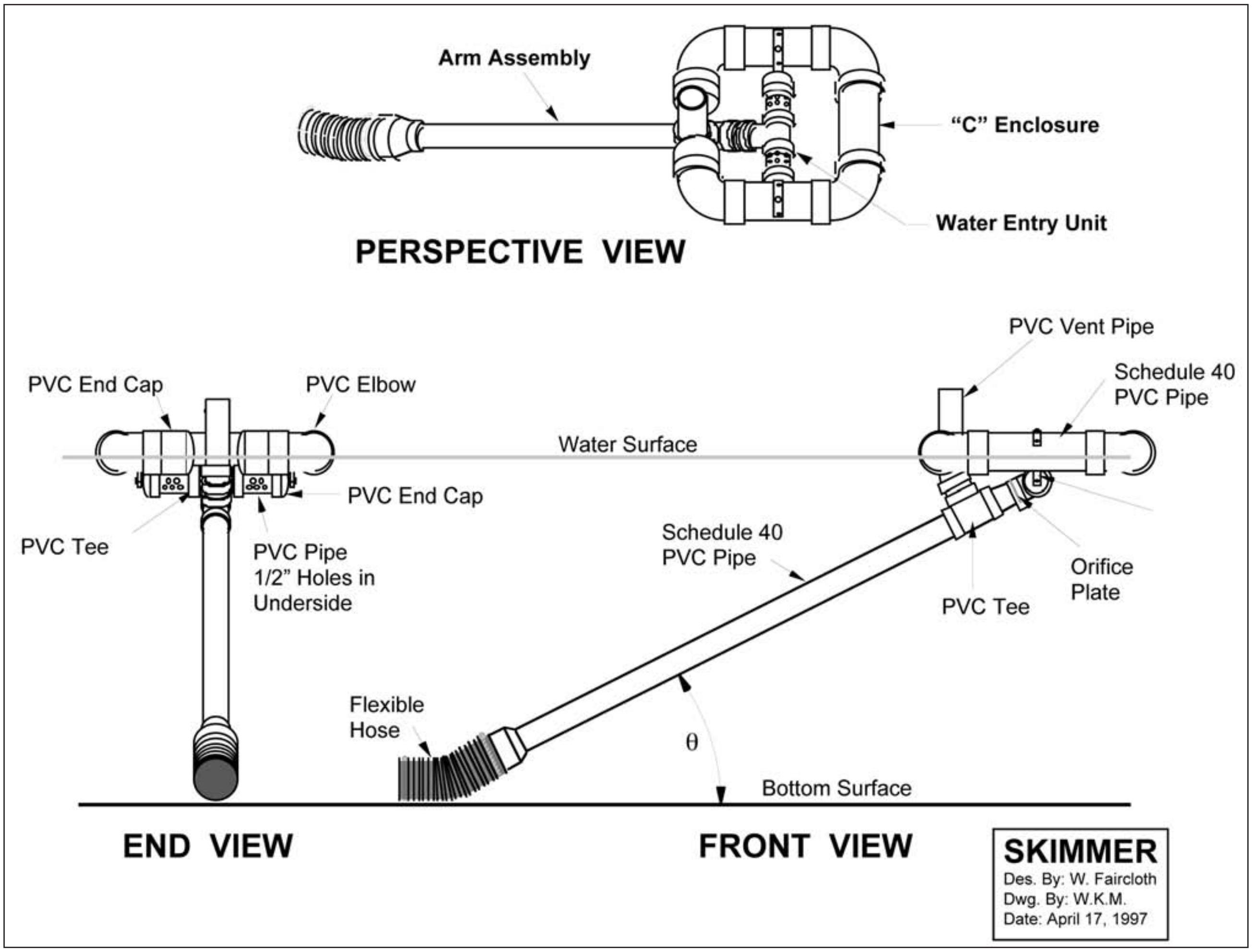


Figure 6.1.8 Faircloth Skimmer Schematic Developed by Warren Faircloth, North Carolina (Penn State Ag and Biol. Eng Fact Sheet F-252)

4) PRINCIPAL SPILLWAY DESIGN:

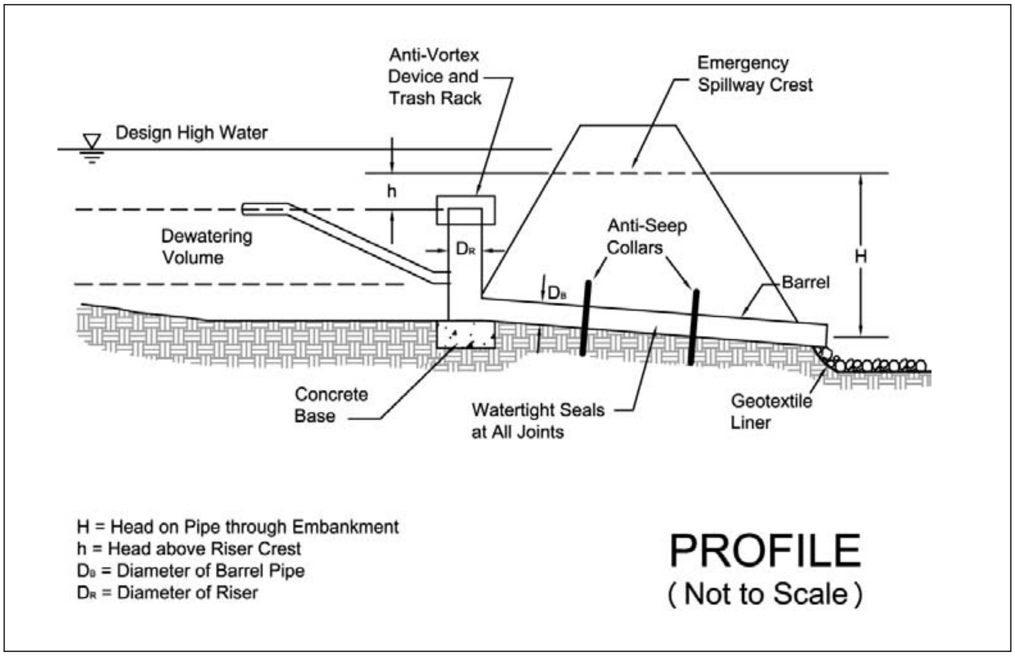


Figure 6.1.10 Principal Spillway Design

Capacity – The principal spillway must be designed to pass the discharge from a 10-year, 24-hour duration storm when the water surface is at the crest of the emergency spillway.

Materials – Principal spillway materials shall meet the NRCS standard and specification for ponds (NRCS Field Office Technical Guide standard 378).

Configuration – Configurations consisting of a riser and barrel (non-perforated) principal spillway with a skimmer dewatering device are encouraged although other configurations may be utilized provided the dewatering time is between 48 hours and 7days.

Staging Requirements – The principal spillway crest elevation must be a minimum of 1 ft. below the elevation of the emergency spillway crest. The minimum difference in elevation between the crest of the emergency spillway and settled top of dam shall be 2 ft., or 1 ft. above the water surface in the reservoir with the emergency spillway flowing at design depth, whichever is greater.

Sizing Procedures for Riser and Barrel – A principal spillway riser and barrel design procedure is shown below. The minimum riser diameter is 15", and the minimum barrel diameter is 12".

1. Determine Q from the design criteria. The principal spillway must be designed to pass the discharge from a 10-year, 24-hour duration storm when the water surface is at the crest of the emergency spillway.

2. Determine h as the difference in elevation between the crests of the principal spillway and the emergency spillway as shown in Figure 6.1.10.

3. Determine H as the difference in elevation between the barrel outlet and crest of the emergency spillway as shown in Figure 6.1.10.

4. Using Q and h, refer to the Riser Inflow Curves (Figure 6.1.11 for CMP), and find the riser size required. Different materials will require using alternative Riser Inflow (Inlet) Curves or equations.

5. Using Q and H, refer to the Barrel Size table (Table 6.1.3) to find the appropriate barrel size.

6. Compare barrel flow (Q_{pipe}), weir flow at the riser (Q_{weir}), orifice flow at the riser ($Q_{orifice\text{-}high}$), and flow at the entrance to the barrel ($Q_{orifice\text{-}low}$) in order to insure the lowest or controlling flow of the principal spillway meets the 10-year, 24-hour flow. Equations are shown below except those provided with figures.

$Q_{weir} = CLH^{1.5}$

where Q = Discharge across weir (cfs)
C = Weir coefficient
L = Length of weir (circumference of riser, ft)
H = Head above the orifice (ft)

$Q_{orifice\text{-}high} = CA(2gh)^{0.5}$

where Qorifice-high = Discharge due to orifice flow at the riser
C = Coefficient of discharge
A = Cross-sectional area of the riser (ft^2)
g = Acceleration due to gravity, (32.2 ft/sec^2)
h = Head above the riser, from the riser crest to the water surface (ft)

$Q_{orifice\text{-}low} = CA(2gh)^{0.5}$

where Qorifice-low = Pipe discharge at the barrel entrance
C = Coefficient of discharge
A = Cross-sectional area of the barrel conduit (ft^2)
g = Acceleration due to gravity (32.2 ft/sec^2)
h = Head above barrel entrance from orifice to water surface (ft)

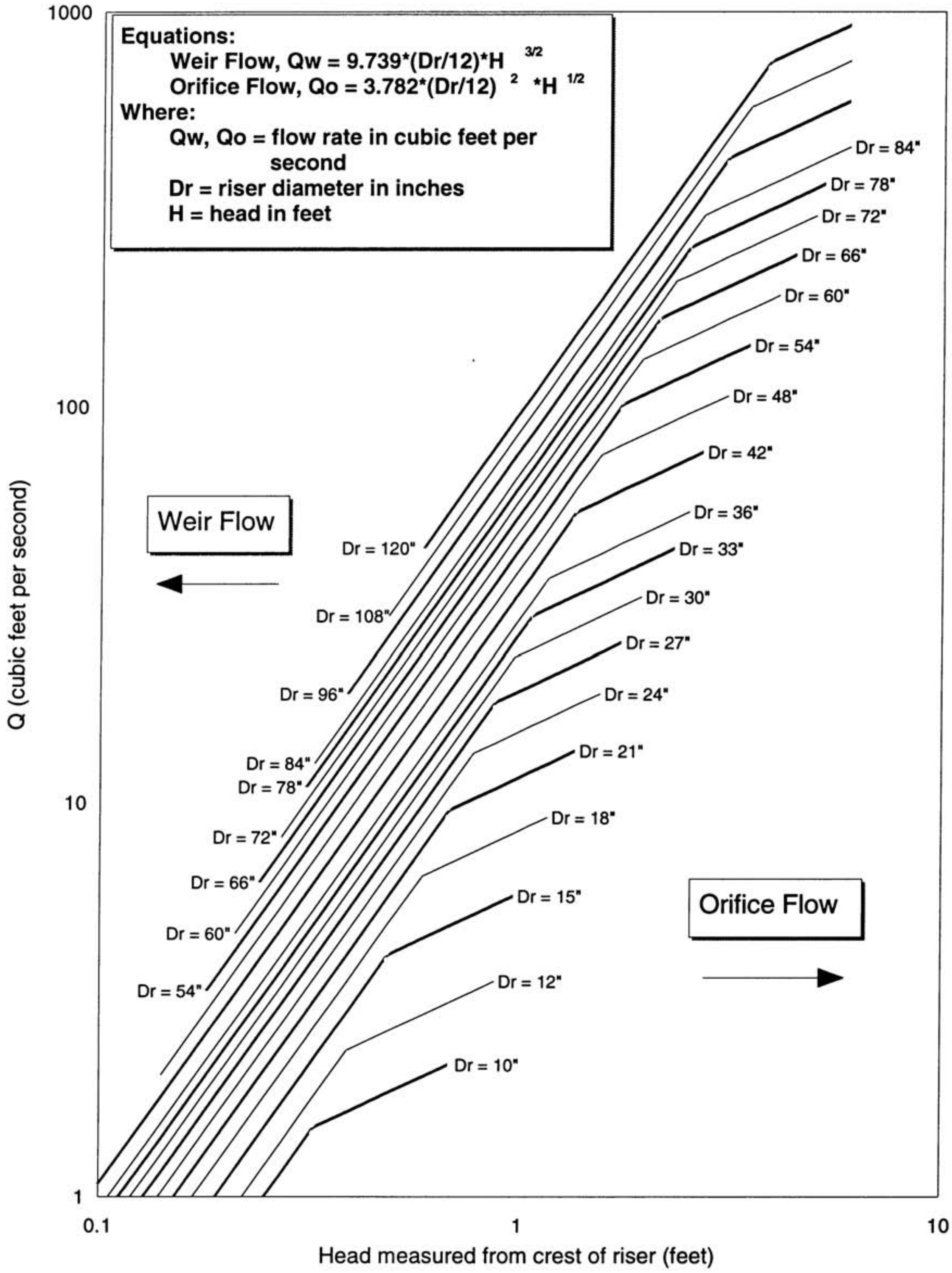


Figure 6.1.11 Riser Inflow Curves

Table 6.1.3 Barrel Size--For Corrugated Metal Pipe Principal Spillway Based on flow rate (Q) and head (H)

Head, H (ft.)	Barrel Diameter (in.)										
	12	15	18	21	24	30	36	42	48	54	60
	Flow Raate, Q (cfs)										
1	1.98	3.48	5.47	7.99	11.0	18.8	28.8	41.1	55.7	72.6	91.8
2	2.80	4.92	7.74	11.3	15.6	26.6	40.8	58.2	78.8	103	130
3	3.43	6.02	9.48	13.8	19.1	32.6	49.9	71.2	96.5	126	159
4	3.97	6.96	10.9	16.0	22.1	37.6	57.7	82.3	111	145	184
5	4.43	7.78	12.2	17.9	24.7	42.1	64.5	92.0	125	162	205
6	4.86	8.52	13.4	19.6	27.0	46.1	70.6	101	136	178	225
7	5.25	9.20	14.5	21.1	29.2	49.8	76.3	109	147	192	243
8	5.61	9.84	15.5	22.6	31.2	53.2	81.5	116	158	205	260
9	5.95	10.4	16.4	24.0	33.1	56.4	86.5	123	167	218	275
10	6.27	11.0	17.3	25.3	34.9	59.5	91.2	130	176	230	290
11	6.58	11.5	18.2	26.5	36.6	62.4	95.6	136	185	241	304
12	6.87	12.1	19.0	27.7	38.2	65.2	99.9	142	193	252	318
13	7.15	12.6	19.7	28.8	39.8	67.8	104	148	201	262	331
14	7.42	13.0	20.5	29.9	41.3	70.4	108	154	208	272	343
15	7.68	13.5	21.2	30.9	42.8	72.8	112	159	216	281	355
16	7.93	13.9	21.9	32.0	44.2	75.2	115	165	223	290	367
17	8.18	14.3	22.6	32.9	45.5	77.5	119	170	230	299	378
18	8.41	14.8	23.2	33.9	46.8	79.8	120	174	236	308	389
Length L (ft.)	Correction Factors for Pipe Lengths										
20	1.53	1.47	1.42	1.37	1.34	1.28	1.24	1.20	1.18	1.16	1.14
30	1.36	1.32	1.29	1.27	1.24	1.21	1.18	1.15	1.13	1.12	1.11
40	1.23	1.21	1.20	1.18	1.17	1.14	1.12	1.11	1.10	1.09	1.08
50	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05
60	1.06	1.06	1.05	1.05	1.05	1.04	1.04	1.03	1.03	1.03	1.02
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.95	.95	.95	.96	.96	.96	.97	.97	.97	.98	.98
90	.90	.91	.91	.92	.92	.93	.94	.94	.95	.95	.96
100	.86	.87	.88	.89	.89	.90	.91	.92	.93	.93	.94

Barrel Size Chart

Riser Base – The principal spillway must be weighted to prevent flotation. The minimum factor of safety against flotation shall be 1.1. If concrete is used for the weighted riser base, the formula shown below may be used in calculating the required volume of concrete.

$$V = 0.62\ HD_R^2 - \frac{HW_R}{87.6}$$

Where:
- H = Height of Riser (ft.)
- D_R = Diameter of Riser (ft.)
- W_R = Weight of Riser (lb./ft.)
- V = Volume of Concrete ($ft.^3$)

Trash Rack and Anti-Vortex Device—To prevent pipes from becoming clogged with straw or construction debris, a trash rack should be used. However, if conditions make clogging unlikely, a trash rack may not be necessary.

Seepage Control Along Principal Spillway—Seepage along the principal spillway conduit extending through the embankment shall be controlled by use of a filter and drainage diaphragms, or anti-seep collars. The placement and design of these controls shall meet requirements as set forth in the NRCS standard and specification for Ponds (378).

Outlet Protection—The discharge from a sediment basin shall be designed, to prevent accelerated erosion or sedimentation. Typical alternatives include riprap or concrete structures, storm sewers, and similar means that dissipate the energy without causing erosion to the downstream channel or stilling basin.

5) EMERGENCY SPILLWAY DESIGN:

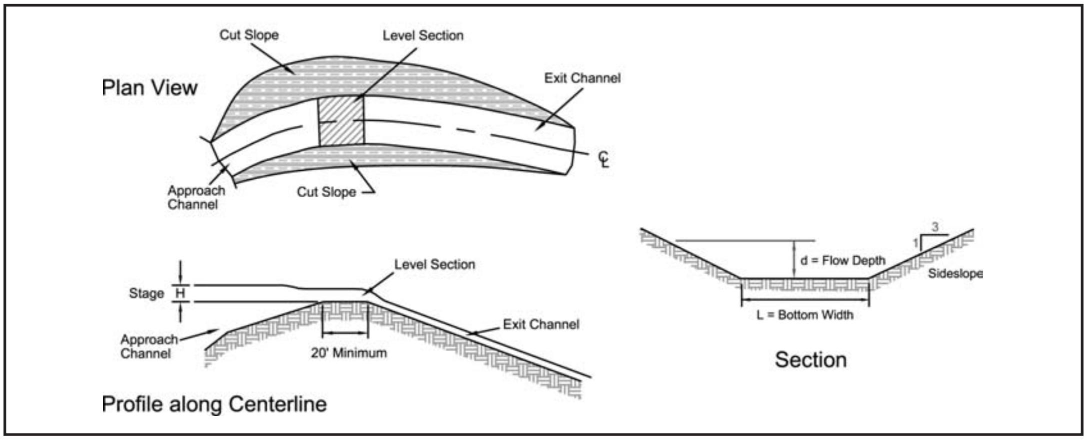


Figure 6.1.12 Emergency Spillway Design

Location and Shape—Constructed earth spillways shall be trapezoidal and located in undisturbed ground. It must not be constructed over the embankment. Spillways should have an approach channel, a flat control section, and an exit channel. Side slopes of the trapezoidal spillway are typically 3:1 or flatter. The exit channel shall be lined with grasses or riprap as appropriate, based on channel velocities.

Capacity—The capacity of the emergency spillway shall be that required to pass the peak flow from a 25-year, 24-hour storm less any reduction creditable to pipe conduit discharge detention storage and routing.

Emergency Spillway Sizing Procedure—Three methods for sizing the emergency spillway are shown below.

1) Utilize tables provided in Chapter 11 of the NRCS' Engineering Field Handbook for determining emergency spillway capacity.
2) Utilize the weir equation with the level being equal to 20 or 25 feet:

$$Q=CLH^{1.5}$$

Where this procedure is used, the maximum value of "C" should be 2.8. "L" is the bottom width of the spillway at the crest, and "H" is the height of water in the pond-above the spillway crest.

3) Having determined the design discharge "Q", find the spillway width and stage required in the Capacity of Earth Spillways table below. The stage is the difference between the pond surface and the crest of the emergency spillway.

Staging Requirements—The principal spillway invert elevation must be a minimum of 1 ft. below the elevation of the emergency spillway crest. The minimum difference in elevation between the crest of the emergency spillway and settled top of dam shall be 2 ft., or 1 ft. above the water surface in the reservoir with the emergency spillway flowing at design depth, whichever is greater.

Exit Channel Outlet Protection—The discharge from an emergency spillway shall be designed to prevent accelerated erosion or sedimentation. Typical alternatives include vegetation, riprap, concrete structures, and similar means that dissipate energy without causing erosion.

Table 6.1.4 Capacity of Earth Spillways

Stage (ft.)	Bottom Width (ft.)																
	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
	Flow Rate Q (cfs)																
0.5	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28
0.6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	35	37	39
0.7	11	13	16	18	20	23	25	28	30	33	35	38	41	43	44	46	48
0.8	13	16	19	22	26	29	32	35	38	42	45	46	48	51	54	57	60
0.9	17	20	24	28	32	35	39	43	47	51	53	57	60	64	68	71	75
1.0	20	24	29	33	38	42	47	51	56	61	63	68	72	77	81	86	90
1.1	23	28	34	39	44	49	54	60	65	70	74	79	84	89	95	100	105
1.2	28	33	40	45	51	58	64	69	76	80	86	92	98	104	110	116	122
1.3	32	38	46	53	58	65	73	80	86	91	99	106	112	119	125	133	140
1.4	37	44	51	59	66	74	82	90	96	103	111	119	127	134	142	150	158
1.5	41	50	58	66	75	85	92	101	108	116	125	133	142	150	160	169	178
1.6	46	56	65	75	84	94	104	112	122	132	142	149	158	168	178	187	197
1.7	52	62	72	83	94	105	115	126	135	145	156	167	175	187	196	206	217
1.8	58	69	81	93	104	116	127	138	150	160	171	182	194	204	214	226	233
1.9	64	76	88	102	114	127	140	152	164	175	188	201	213	225	235	248	260
2.0	71	83	97	111	125	138	153	164	178	193	204	218	232	245	256	269	283
2.1	77	91	107	122	135	149	162	177	192	207	220	234	250	267	276	291	305
2.2	84	100	116	131	146	163	177	194	210	224	238	253	269	288	301	314	330
2.3	90	108	124	140	158	175	193	208	226	243	258	275	292	306	323	341	354
2.4	99	116	136	152	170	189	206	224	241	260	275	294	312	327	346	364	378

A maintenance program shall be established to maintain the capacity and function of the sediment basin.

Note: The side slopes cut for the emergency spillway must be no steeper than 2:1.

Operation and Maintenance:

Sediment basins shall be inspected on a weekly basis and after each runoff event. Necessary activities are shown as follows:

1. Establish vegetative cover and fertilize as necessary to maintain a vigorous cover in and around the sediment basin.
2. Remove undesirable vegetation periodically to prevent growth of trees and shrubs on the embankment and spillway areas.
3. Promptly repair eroded areas. Reestablish vegetative cover immediately where scour erosion has removed established seeding.
4. Promptly remove any burrowing rodents that may invade areas of the embankment.
5. Remove trash and debris that may block spillways and accumulate in the pond.
6. Remove sediment from basin when it fills the design depth of the sediment storage zone. This elevation shall be marked on a cleanout stake near the center of the basin.
7. Check spillway outlets and points of inflow to ensure drainage is not causing erosion and that outlets are not clogged. Replace displaced riprap immediately.
8. After the entire construction project is completed, temporary sediment basins should be dewatered and regraded to conform to the contours of the area. All temporary structures should be removed and the area seeded, mulched and stabilized as necessary.

References:

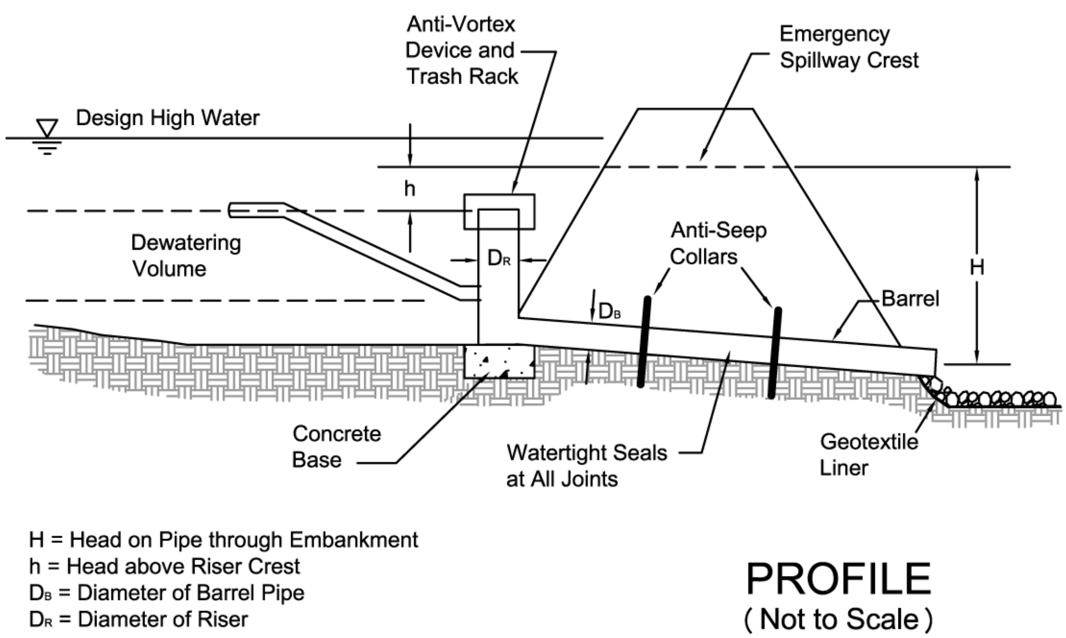
Barfield, B.J., R.C. Warner, and C.T. Haan. 1985. Applied Hydrology and Sedimentology for Disturbed Areas. Oklahoma Technical Press (Stillwater, OK).

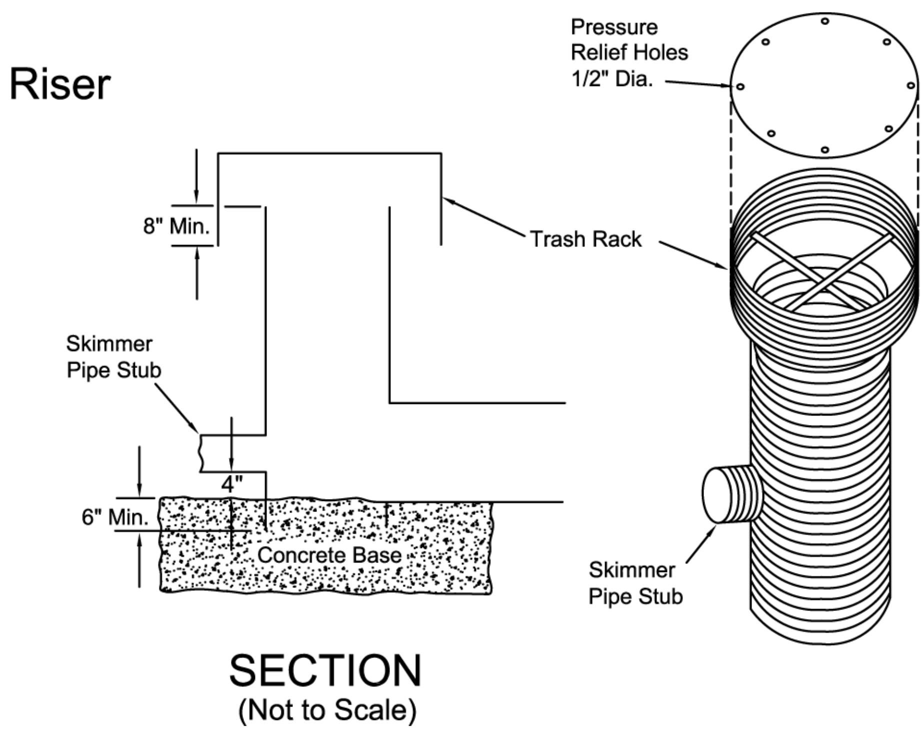
U.S. Department of Agriculture, Natural Resource Conservation Service, 2003. Pond Standard 378. Section IV, Ohio Field Office Technical Guide. U.S. Department of Natural Resources, Natural Resource Conservation Service, Ohio State Office, Columbus, Ohio. http://www.nrcs.usda.gov/technical/efotg/

Ohio Department of Natural Resources, 1994. Dam Safety: Construction Permits for Dams. Factsheet 94-34. Ohio Department of Natural Resources, Division of Water. Columbus, Ohio. http://www.ohiodnr.com/water/pubs/pdfs/fctsht34.pdf

Specifications
for

Sediment Basins





Specifications
for
Sediment Basins

1. Sediment basins shall be constructed and operational before upslope land disturbance begins.
2. Site Preparation -The area under the embankment shall be cleared, grubbed, and stripped of any vegetation and root mat. The pool area shall be cleared as needed to facilitate sediment cleanout. Gullies and sharp breaks shall be sloped to no steeper than 1:1. The surface of the foundation area will be thoroughly scarified before placement of the embankment material.
3. Cut-Off Trench -The cutoff trench shall be excavated along the centerline of the embankment. The minimum depth shall be 3 ft. unless specified deeper on the plans or as a result of site conditions. The minimum bottom width shall be 4 ft., but wide enough to permit operation of compaction equipment. The trench shall be kept free of standing water during backfill operations.
4. Embankment -The fill material shall be free of all sod, roots, frozen soil, stones over 6 in. in diameter, and other objectionable material. The placing and spreading of the fill material shall be started at the lowest point of the foundation and the fill shall be brought up in approximately 6 in. horizontal layers or of such thickness that the required compaction can be obtained with the equipment used. Construction equipment shall be operated over each layer in a way that will result in the required compaction. Special equipment shall be used when the required compaction cannot be obtained without it. The moisture content of fill material shall be such that the required degree of compaction can be obtained with the equipment used.
5. Pipe Spillway -The pipe conduit barrel shall be placed on a firm foundation to the lines and grades shown on the plans. Connections between the riser and barrel, the anti-seep collars and barrel and all pipe joints shall be watertight. Selected backfill material shall be placed around the conduit in layers and each layer shall be compacted to at least the same density as the adjacent embankment. All compaction within 2 ft. of the pipe spillway will be accomplished with hand-operated tamping equipment.
6. Riser Pipe Base -The riser pipe shall be set a minimum of 6 in. in the concrete base.
7. Trash Racks -The top of the riser shall be fitted with trash racks firmly fastened to the riser pipe.
8. Emergency Spillway - The emergency spillway shall be cut in undisturbed ground. Accurate construction of the spillway elevation and width is critical and shall be within a tolerance of 0.2 ft.
9. Seed and Mulch -The sediment basin shall be stabilized immediately following its construction. In no case shall the embankment or emergency spillway remain bare for more than 7 days.
10. Sediment Cleanout -Sediment shall be removed and the sediment basin restored to its original dimensions when the sediment has filled one-half the pond's original depth or as indicated on the plans. Sediment removed from the basin shall be placed so that it will not erode.
11. Final removal - Sediment basins shall be removed after the upstream drainage area is stabilized or as indicated in the plans. Dewatering and removal shall NOT cause sediment to be discharged. The sediment basin site and sediment removed from the basin shall be stabilized.

6.2 Sediment Trap

Description

A sediment trap is a temporary settling pond formed by construction of an embankment and/or excavated basin and having a simple outlet structure that is typically stabilized with geotextile and rip-rap. Sediment traps are constructed to detain sediment-laden runoff from small, disturbed areas for a sufficient period of time to allow the majority of the sediment to settle out. They are established early in the construction process using natural drainage patterns and favorable topography where possible to minimize grading.

Conditions Where Practice Applies

Sediment traps are used:

1. At the outlets of diversions, channels, slope drains, or other runoff conveyances that discharge sediment–laden water.
2. Below disturbed areas where the total contributing drainage area is **5 acres or less**. If the contributing drainage area is greater than 5 acres, the use of a Sediment Basin is recommended.
3. Where access can be maintained for removal and proper disposal of sediment.
4. In drainage swales or areas, where sediment control is needed upstream of a drainage pattern leading to a storm drain inlet.
5. Where the required life of the structure will be 18 months or less.

6. Where failure of the structure will not result in loss of life; or cause damage to buildings, roads, utilities, or other properties.

Note: Sediment traps, that have the entire capacity achieved through excavation, may have larger drainage areas without compromising the stability of the sediment trap.

Planning Considerations

Timing – Sediment traps shall be constructed as a first step in any land-disturbing activity, and shall be made functional before upslope land disturbance takes place. Sediment traps are temporary measures with a typical design life of 6 months to 18 months. One or more traps are often built early in the construction process to capture sediment, prior to construction of a larger structure (e.g., sediment basin or modified detention basin) is constructed. Sediment traps are to be functional during the entire construction process, both before and after new drainage systems are constructed.

Location – Sediment traps usually are placed near the edges of construction sites so to be out of the way of major construction activities.

Diverting Runoff – Temporary diversions at the perimeter of sites are used to direct runoff to sediment traps (see Temporary Diversion Specifications).

Storm-Sewer Diversions – Storm drains may be temporarily redirected through sediment traps during construction. After construction, the temporary pipes are removed and runoff is allowed to flow through the permanent storm drain as originally intended.

Utilities – Give special consideration to sediment trap location and possible interference with construction of proposed drainage ways, utilities and storm drains.

Trapping Efficiency – Improved sediment trapping efficiencies can be achieved by including both a “wet” storage volume and a drawdown or “dry” storage volume that enhances settling and prevents excessive sediment losses during large storm events. In order to maintain effectiveness, sediment must be periodically removed from the trap to maintain the required design volume. Frequent inspection and appropriate maintenance should be provided until the construction site is permanently protected against erosion.

Design Criteria

Capacity - The minimum total design volume for the sediment trap shall consist of two components, the dewatering zone and the sediment storage zone. These zones are shown schematically in Figure 6.2.1. The volume of the dewatering zone shall be calculated for the entire drainage area by the method shown below. The drainage area includes the entire area contributing runoff to the sediment basin, offsite as well as on. The sediment storage volume may be in the form of a permanent pool or wet storage to provide a stable-settling medium, while the dewatered volume shall be in the form of a draw down or dry storage of at least 67 cubic yards per acre which will provide extended settling time during less frequent, larger storm events.

a) Dewatering Zone Volume –

The volume of the dewatering zone shall be a minimum of 1800 cubic feet per acre of drainage (67 yd3/acre) or the minimum stated in the current NPDES construction general permit. The total volume of the dewatering zone shall be measured from the base of the stone outlet structure to the crest of the stone outlet structure.

b) Sediment Storage Zone Volume –

The volume of the sediment storage zone shall be calculated by one of the following methods. The sediment storage zone shall be measured below the elevation of the base of the stone outlet structure.

Method 1: The volume of the sediment storage zone shall be 1000 cu. ft. per disturbed acre within the watershed of the basin; OR

Method 2: The volume of the sediment storage zone shall be the volume necessary to store the sediment yield as calculated with RUSLE or a similar generally accepted erosion prediction model. While the sediment storage volume may extend to the expected time period of the construction project, the minimum estimated time between cleanouts shall be six months.

Sediment shall be removed when it has accumulated to the top of the sediment storage or wet storage zone. This elevation shall be signified by the top of a stake near the center of the trap.

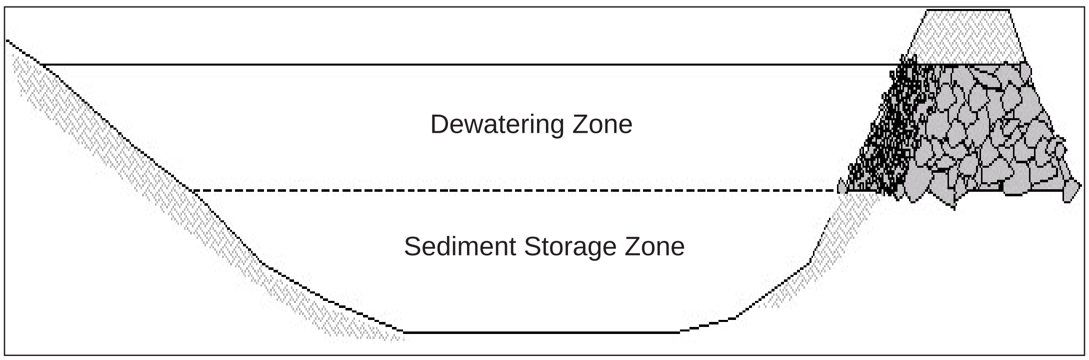


Figure 6.2.1 Capacity of a sediment trap is distributed between dewatering and sediment storage zones.

Embankment – Ensure that embankments for temporary sediment traps do not exceed 5 feet in height measured at the centerline from the original ground surface to the top of the embankment. Construct embankments with a minimum 4 foot top width and 2:1 (H:V) or flatter side slopes.

The design height of the embankment shall be increased by 5% to allow for settlement of the finished embankment. The original ground under the embankment shall be stripped of vegetation and scarified to a depth of 6 inches or more before placement of the fill material. Fill material should be made of clay, free of roots, large rocks, and organic material. Place fill in layers 6 inches thick and then compact using appropriate equipment. Fill material shall not be placed on frozen ground.

The completed embankment shall be seeded in accordance with temporary or permanent vegetation as found in this manual (Temporary Seeding or Permanent Seeding).

Excavation – Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 (H: V) or flatter for safety. The maximum depth of excavation within the wet storage area (sediment storage zone) should be 4 feet to facilitate clean out and for site safety considerations.

Outlet Section – Construct the sediment trap outlet using a stone section of embankment located at the low point in the basin. The stone section serves two purposes: 1) the top section serves as a non-erosive spillway outlet for flood flow, and 2) the bottom section provides a means to de-watering the basin between runoff events. A combination of coarse aggregate and riprap shall be used to provide for filtering/detention as well as outlet stability.

Construct the outlet using well-graded stones with a d50 size larger than 6 inches (ODOT Type D). A 1 foot layer of AASHTO # 57 aggregate should be placed on the inside face to reduce drainage flow rate. Geotextile that meets the minimum requirements of ODOT Construction and Material Specification 712.09, Geotextile Fabric Type B, shall be placed at the stone-soil interface to act as a separation and to prevent piping. The geotextile shall be buried or keyed in at the upstream end a minimum of 6 inches. The crest of the stone outlet must be at least 1.5 feet below the top of the embankment to ensure that the flow will travel over the stone and not the embankment. The outlet shall be configured as noted in figure 2.

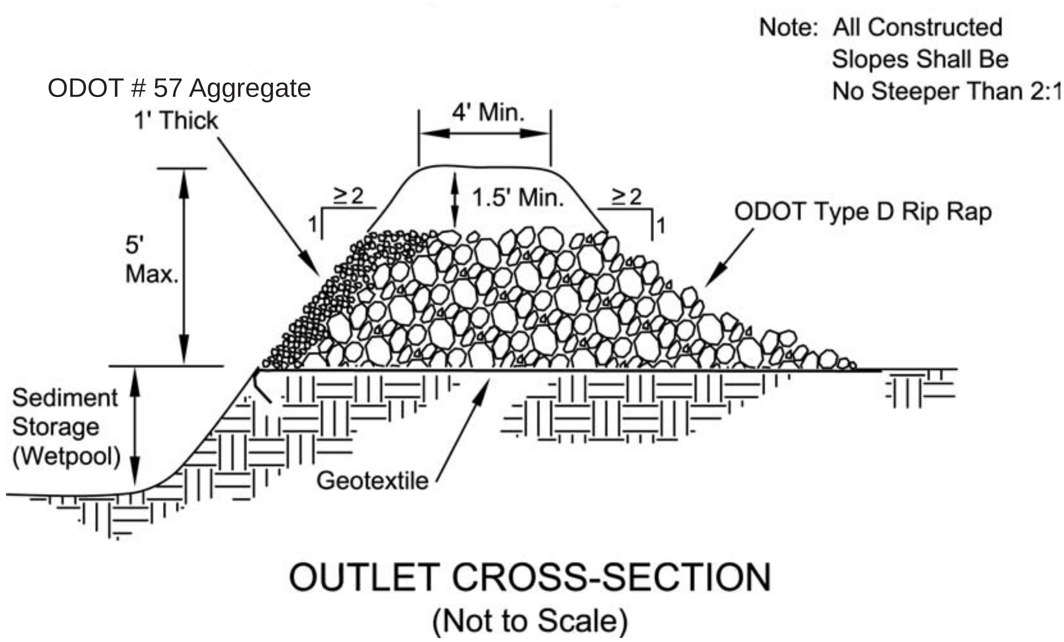


Figure 6.2.2 Outlet configuration

The spillway weir shall be at least 4 feet long and sized to pass the peak discharge of the 10-year, 24-hour storm without failure, overtopping of the basin or significant erosion. A maximum flow depth of 1 foot, a minimum freeboard of 0.5 foot, and maximum side slopes of 2:1 are required. See Table 6.2.1 for weir length associated with drainage area.

Table 6.2.1 Sediment Trap weir length.

Drainage Area (acres)	Weir Length (feet)
1	4.0
2	6.0
3	8.0
4	10.0
5	12.0

Note: alternatively use $Q_{weir} = CLH^{3/2}$
Where C = Weir coefficient
L = Weir Length (feet)
H = Head of 1 foot

Direct spillway discharges to natural, stable areas. Locate outlets so that flow will not damage the embankment. Discharges must be conveyed to a natural waterway via a channel of adequate capacity and stability. Where the channel enters a natural waterway, the discharge shall be less than 1 ½ feet per second or otherwise less than the velocity that will initiate erosion or scour within the receiving waterway. When traps discharge to storm water facilities, the facility must have adequate capacity to receive the discharge from the sediment trap.

Where an emergency spillway is utilized, the primary rock spillway crest should be at least 1.5 feet below the settled top of the embankment with the emergency spillway crest being 0.5 foot below the top of the embankment.

The plans and specifications should show the following requirements:

1. Location of the sediment traps.
2. Size of sediment trap including width, length and depth.
3. Minimum cross section of embankment.
4. Typical cross section through the spillway with geotextile fabric details and rock placement.
5. Location of emergency spillway, if used.
6. Gradation and quality of rock.
7. Plans shall detail how excavated sediment is to be disposed of, such as placement on areas where it will be stabilized or removal to an approved off-site location.

All plans should include the installation and maintenance schedules with the responsible party identified.

Install warning signs, barricades, perimeter fence and other measures around sediment traps as necessary to protect workers, children, equipment, etc.

Operation and Maintenance

1. The capacity and function of the sediment trap shall be maintained by inspecting on a weekly basis and after each runoff event, and by performing the necessary activities shown below.
2. Establish vegetative cover and fertilize as necessary to maintain a vigorous cover around the sediment trap.
3. Inspect the pool area, embankment and spillway area for burrowing rodents, slope failure, seepage, excess settlement, and displaced stone. The area should be inspected for structural soundness and repaired as needed.
4. Regularly inspect water discharged from trap for excess suspended sediments. Identify and perform necessary repairs to improve water quality. Excessive suspended sediments may require design modifications or treatment with flocculants.
5. Remove woody vegetated growth on the embankment and spillway areas.
6. Remove trash and debris that accumulate in the pond and have potential to block spillways.
7. Dewatering outlets shall be regularly checked to ensure that performance is maintained. Filter stone choked with sediment shall be removed and replaced to restore its flow capacity.
8. Remove sediment and restore the sediment trap to its original dimensions when sediment has accumulated to the top of the sediment storage or wet storage zone. This elevation shall be signified by the top of a stake near the center of the trap. Removing sediment by hand may be necessary adjacent to the outlet section of the embankment to prevent equipment damage. Place the removed sediment and stabilize with vegetation in a designated area where it will not easily erode again. Restore trap to its original dimensions and replace stone as needed on the outlet.
9. After the entire construction project is completed, temporary sediment traps should be dewatered and regraded so as to conform to the contours of the area. All temporary structures should be removed and the area seeded, mulched and stabilized as necessary.

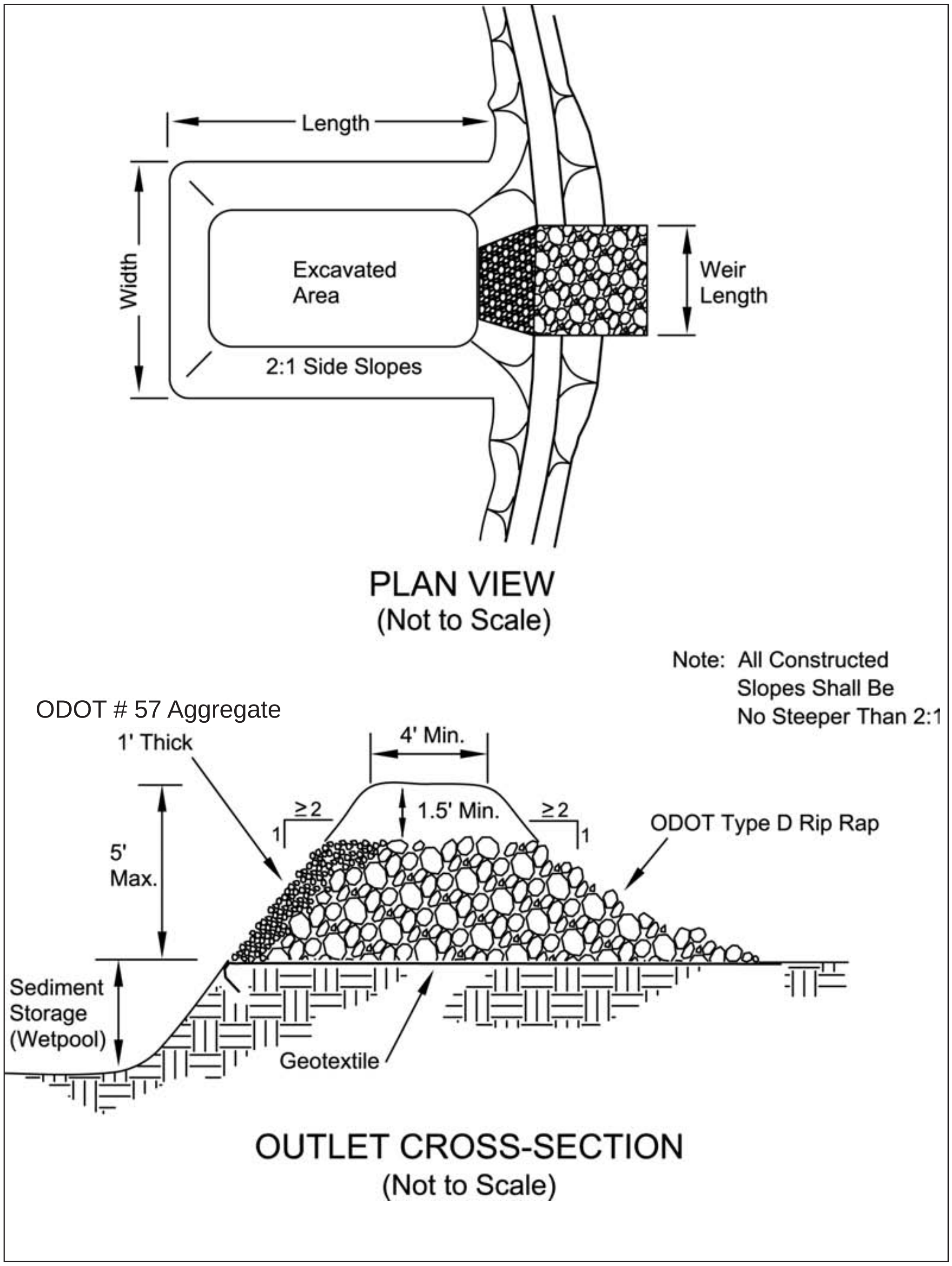
Common Problems/Concerns

Utilizing sediment traps on large drainage areas (greater than 5 acres) where Sediment Basins (see page 2 of this chapter) are appropriate will increase sediment discharged during construction.

Failure to removed trapped sediment will reduce the effectiveness of this practice in capturing sediment.

Specifications
for

Sediment Trap



Specifications
for

Sediment Traps

1. Work shall consist of the installation, maintenance and removal of all sediment traps at the locations designated on the drawings.
2. Sediment traps shall be constructed to the dimensions specified on the drawings and operational prior to upslope land disturbance.
3. The area beneath the embankment shall be cleared, grubbed and stripped of vegetation to a minimum depth of six (6) inches. The pool shall be cleared as needed to facilitate sediment cleanout.
4. Fill used for the embankment shall be evaluated to assure its suitability and it must be free of roots or other woody vegetation, large rocks, organics or other objectionable materials. Fill material shall be placed in six (6) inch lifts and shall be compacted by traversing with a sheepsfoot or other approved compaction equipment. Fill height shall be increased five (5) percent to allow for structure/foundation settlement. Construction shall not be permitted if either the earthfill or compaction surface is frozen.
5. The maximum height of embankment shall be five (5) feet. All cut and fill slopes shall be 2:1 (H:V) or flatter.
6. A minimum storage volume below the crest of the outlet of 67 yd^3. for every acre of contributing drainage area shall be achieved at each location noted on the drawings with additional sediment storage volume provided below this elevation.
7. Temporary seeding shall be established and maintained over the useful life of the practice.
8. The outlet for the sediment trap structure shall be constructed to the dimensions shown on the drawings.
9. The outlet shall be constructed using the materials specified on the drawings. Where geotextile is used, all overlaps shall be a minimum of two (2) feet or as specified by the manufacturer, whichever is greater. All overlaps shall be made with the upper most layer placed last. Geotextile shall be keyed in at least 6" on the upstream side of the outlet.
10. Warning signs and safety fence shall be placed around the traps and maintained over the life of the practice.
11. After all sediment-producing areas have been permanently stabilized, the structure and all associated sediment shall be removed. Stabile earth materials shall be placed in the sediment trap area and compacted. The area shall be graded to blend in with adjoining land surfaces and have positive drainage. The area shall be immediately seeded.

6.3 Silt Fence

Description

Silt fence is a sediment-trapping practice utilizing a geotextile fence, topography and sometimes vegetation to cause sediment deposition. Silt fence reduces runoff's ability to transport sediment by ponding runoff and dissipating small rills of concentrated flow into uniform sheet flow. Silt fence is used to prevent sediment-laden sheet runoff from entering into downstream creeks and sewer systems.

Conditions Where Practice applies

Silt fence is used where runoff occurs as sheet flow or where flow through small rills can be converted to sheet flow. Major factors in its use are slope, slope length, and the amount of drainage area from which the fence will capture runoff. Silt fence cannot effectively treat flows in gullies, ditches or channels. For concentrated flow conditions see specifications for temporary diversions, sediment traps and sediment basins.

Planning Considerations

Alternatives: Silt Fence vs. Temporary Diversions and Settling Ponds. While silt fence requires less space and disturbs less area than other control measures there are significant disadvantages to its use. Silt fence is not as effective controlling sediment as routing runoff through a system of diversions and settling ponds. Settling ponds and earth diversions are more durable, easier to construct correctly and significantly more effective at removing sediments from runoff. Additionally earth diversions and settling ponds are less apt to fail during construction and typically require less repair and maintenance.

Proper installation is critical. Experience from ODNR and other field testing has shown that nearly 75 percent of silt fence does not function properly due to poor installation. Proper installation consists of it being installed: (1) on the contour; (2) with sufficient geotextile material buried; (3) with the fence pulled taut and supported on the downstream side by strong posts: (4) and with the fence backfilled and compacted.

Two general methods are used to install silt fence: (1) utilizing traditional method of digging the trench, installation of the fence materials, then backfilling and compaction; or (2) a method using an implement to static slice or narrow plow while installing the geotextile in the slot opening, followed by compaction and installation of posts. The latter methods generally installs silt fence more effectively and efficiently.

Silt fence is most applicable for relatively small areas with flat topography. Silt fence should be used below areas where erosion will occur in the form of sheet and rill erosion. For moderately steep areas, the area draining to the silt fence should be no larger that one quarter acre per 100 feet of fence length, the slope length no longer than 100 feet, and the maximum drainage gradient no steeper than 50 percent (2:1). This practice should be sited so that the entire fence ponds runoff and facilitates settling of suspended solids.

Design Criteria

Proper installation of silt fence requires utilizing the site topography. This is critical because the sediment removal process relies on ponding runoff behind the fence. As a ponding occurs behind the fence, coarser materials are allowed to settle out. Leaving a long, flat slope behind the silt fence maximizes areas for ponding (sediment deposition), and for water to disperse and flow over a much larger surface area of the silt fence. For silt fence to work effectively, runoff must be allowed to maintain sheet flow, to pond and to be released slowly. However, if silt fence is used without regard to a site's topography, it will typically concentrate runoff, increasing the likelihood of blocking and overtopping of the fence, thus reducing or eliminating its effectiveness.

Level Contour – For silt fence to promote deposition, it must be placed on the level contour of the land, so that flows are dissipated into uniform sheet flow that has less energy for transporting sediment. Silt fence should never concentrate runoff, which will result if it is placed up and down slopes rather than on the level contour.

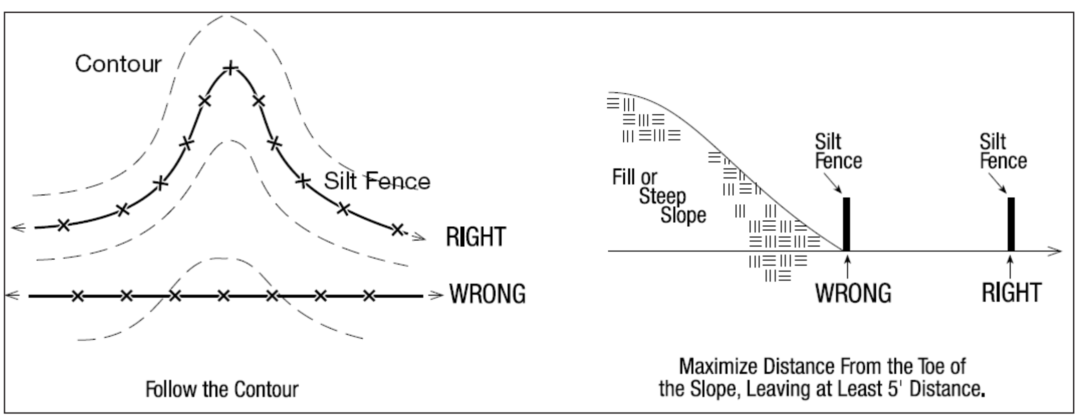


Figure 6.3.1 Silt fence layout

Flat Slopes – Slope has the greatest influence on runoff's ability to transport sediment, therefore silt fence should be placed several feet away from the toe of a slope if at all possible, to encourage deposition. Silt fence generally should be placed on the flattest area available to increase the shallow ponding of runoff and maximize space available for deposited sediment.

Flow Around Ends – To prevent water ponded by the silt fence from flowing around the ends, each end must be constructed upslope so that the ends are at a higher elevation.

Vegetation – Dense vegetation also has the effect of dissipating flow energies and causing sediment deposition. Sediment-trapping efficiency will be enhanced where a dense stand of vegetation occurs for several feet both behind and in front of a silt fence.

Table 6.3.1 Maximum area contributing area using slope length

Maximum Slope Length Above Silt Fence		
Slope		Slope Length (ft.)
0% - 2%	Flatter than 50:1	250
2% - 10%	50:1 - 10:1	125
10% - 20%	10:1 - 5:1	100
20% - 33%	5:1 - 3:1	75
33% - 50%	3:1 - 2:1	50
> 50%	> 2:1	25

Note: For larger drainage areas, see standards for temporary diversions, sediment traps and sediment basins.

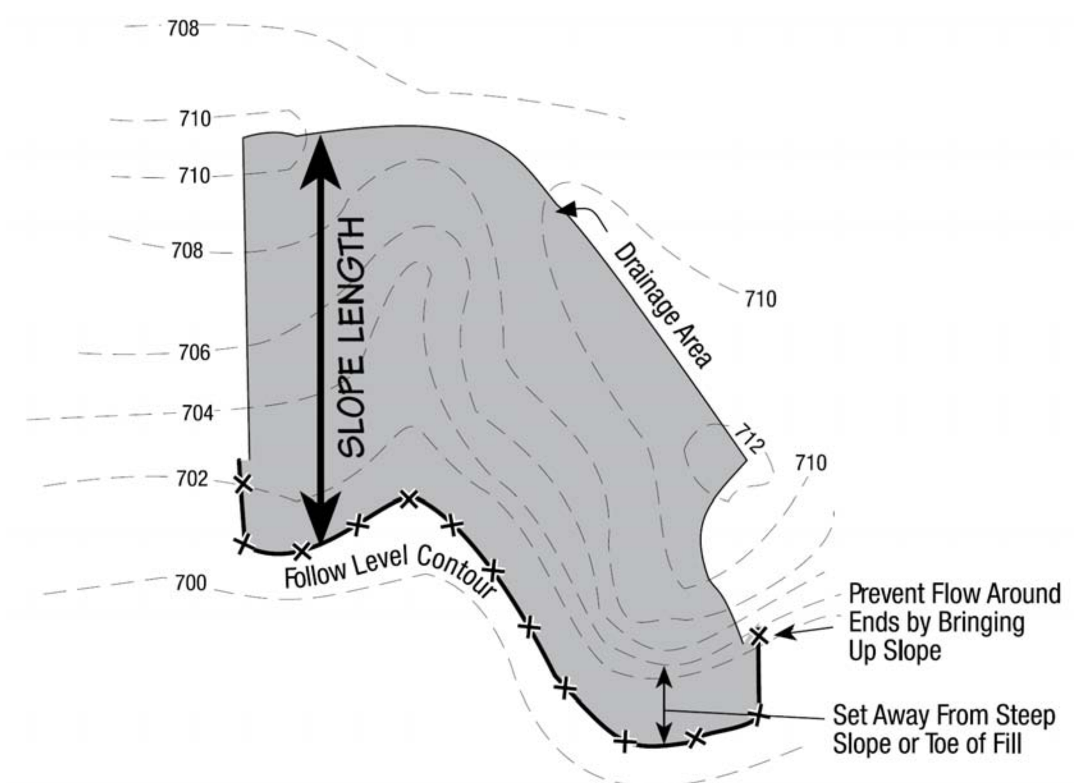


Figure 6.3.2 Silt fence and allowable drainage area

Dispersing Flow – Proper applications of silt fence allow all the intercepted runoff to pass as diffused flow through the geotextile. Runoff should never overtop silt fence, flow around the ends, or in any other way flow as concentrated flow from the practice. If any of these failures occurs, an alternative silt fence layout, or other practices are needed.

In cases where additional support of the fabric is needed, either wire or geogrid fencing may be used as a backing on the fabric. In these instances, the reinforcing material should be attached/erected first, then the fabric installed.

Materials

Fence posts shall be a minimum length of 32 inches long, composed of nominal dimensioned 2-by-2-inch hardwood of sound quality. They shall be free of knots, splits and other visible imperfections which would weaken the posts. Steel posts may be utilized in place of wood provide the geotextile can be adequately secured to the post.

Silt fence geotextile must meet the minimum criteria shown in the table below.

Table 6.3.2

Minimum criteria for Silt Fence Fabric (ODOT, 2002)		
Minimum Tensile Strength	120 lbs. (535 N)	ASTM D 4632
Maximum Elongation at 60 lbs	50%	ASTM D 4632
Minimum Puncture Strength	50 lbs (220 N)	ASTM D 4833
Minimum Tear Strength	40 lbs (180 N)	ASTM D 4533
Apparent Opening Size	≤ 0.84 mm	ASTM D 4751
Minimum Permittivity	$1X10^{-2}$ $sec.^{-1}$	ASTM D 4491
UV Exposure Strength Retention	70%	ASTM G 4355

Maintenance

Silt Fence requires regular inspection and maintenance to insure its effectiveness. Silt fences must be inspected after each rainfall and at least daily during prolonged rainfall. Silt fence found damaged or improperly installed shall be replaced or repaired immediately.

Sediment deposits shall be routinely removed when they reach approximately one-half the height of the silt fence.

Common Problems/Concerns

The predominant problems with silt fence regard inadequate installation or location that allows runoff to concentrate, overtop the fence, flow under the fabric or around the fence ends. If this occurs one of the following shall be performed, as appropriate:

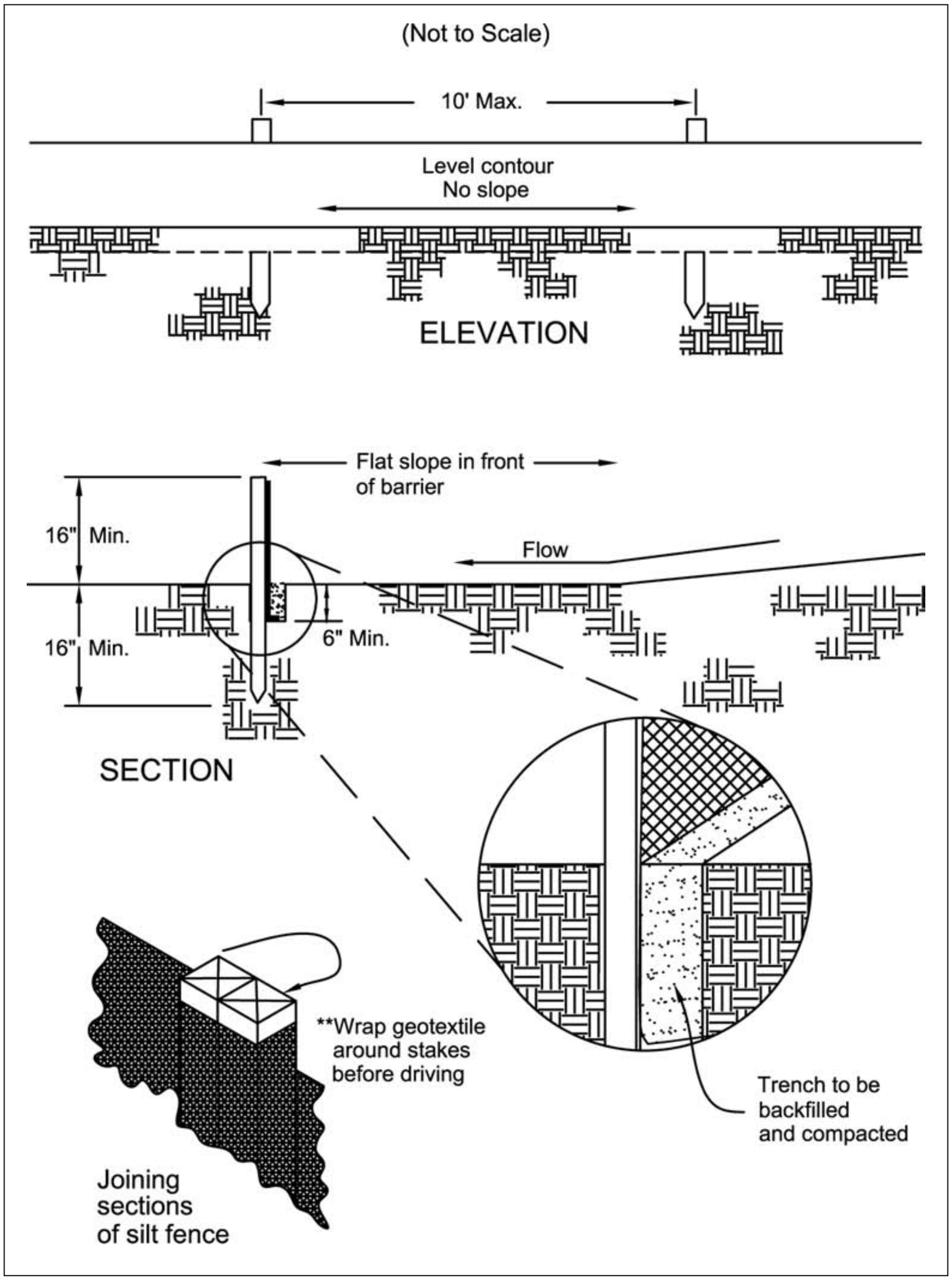
- The location and layout of the silt fence shall be changed to conform to the level contour
- The silt fence shall be reinstalled with proper burial, backfill and compaction and support
- Accumulated sediment shall be removed
- Alternative practices shall be installed.

References

Construction and Material Specifications, January 1, 2002. State of Ohio Department of Transportation, P.O. Box 899, Columbus, Ohio 43216-0899, http://www.dot.state.oh.us/construction/OCA/Specs/2002CMS/Specbook2002/Specbook2002.htm

Specifications
for

Silt Fence



Specifications
for
Silt Fence

1. Silt fence shall be constructed before upslope land disturbance begins.
2. All silt fence shall be placed as close to the contour as possible so that water will not concentrate at low points in the fence and so that small swales or depressions that may carry small concentrated flows to the silt fence are dissipated along its length.
3. Ends of the silt fences shall be brought upslope slightly so that water ponded by the silt fence will be prevented from flowing around the ends.
4. Silt fence shall be placed on the flattest area available.
5. Where possible, vegetation shall be preserved for 5 feet (or as much as possible) upslope from the silt fence. If vegetation is removed, it shall be reestablished within 7 days from the installation of the silt fence.
6. The height of the silt fence shall be a minimum of 16 inches above the original ground surface.
7. The silt fence shall be placed in an excavated or sliced trench cut a minimum of 6 inches deep. The trench shall be made with a trencher, cable laying machine, slicing machine, or other suitable device that will ensure an adequately uniform trench depth.
8. The silt fence shall be placed with the stakes on the downslope side of the geotextile. A minimum of 8 inches of geotextile must be below the ground surface. Excess material shall lay on the bottom of the 6-inch deep trench. The trench shall be backfilled and compacted on both sides of the fabric.
9. Seams between sections of silt fence shall be spliced together only at a support post with a minimum 6-in. overlap prior to driving into the ground, (see details).
10. Maintenance—Silt fence shall allow runoff to pass only as diffuse flow through the geotextile. If runoff overtops the silt fence, flows under the fabric or around the fence ends, or in any other way allows a concentrated flow discharge, one of the following shall be performed, as appropriate: 1) the layout of the silt fence shall be changed, 2) accumulated sediment shall be removed, or 3) other practices shall be installed.

    Sediment deposits shall be routinely removed when the deposit reaches approximately one-half of the height of the silt fence.

    Silt fences shall be inspected after each rainfall and at least daily during a prolonged rainfall. The location of existing silt fence shall be reviewed daily to ensure its proper location and effectiveness. If damaged, the silt fence shall be repaired immediately.

Criteria for silt fence materials

1. Fence post – The length shall be a minimum of 32 inches. Wood posts will be 2-by-2-in. nominal dimensioned hardwood of sound quality. They shall be free of knots, splits and other visible imperfections, that will weaken the posts. The maximum spacing between posts shall be 10 ft. Posts shall be driven a minimum 16 inches into the ground, where possible. If not possible, the posts shall be adequately secured to prevent overturning of the fence due to sediment/water loading.
2. Silt fence fabric – See chart below.

Table 6.3.2 **Minimum criteria for Silt Fence Fabric (ODOT, 2002)**

FABRIC PROPERTIES	VALUES	TEST METHOD
Minimum Tensile Strength	120 lbs. (535 N)	ASTM D 4632
Maximum Elongation at 60 lbs	50%	ASTM D 4632
Minimum Puncture Strength	50 lbs (220 N)	ASTM D 4833
Minimum Tear Strength	40 lbs (180 N)	ASTM D 4533
Apparent Opening Size	≤ 0.84 mm	ASTM D 4751
Minimum Permittivity	1X10-2 sec.-1	ASTM D 4491
UV Exposure Strength Retention	70%	ASTM G 4355

6.4 Storm Drain Inlet Protection

Description

Storm drain inlet protection devices remove sediment from storm water before it enters storm sewers and downstream areas. Inlet protection devices are sediment barriers that may be constructed of washed gravel or crushed stone, geotextile fabrics and other materials that are supported around or across storm drain inlets.

Inlet protection is installed to capture some sediment and reduce the maintenance of storm sewers and other underground piping systems prior to the site being stabilized. Due to their poorer effectiveness, inlet protection is considered a secondary sediment control to be used in conjunction with other more effective controls.

Condition Where Practice Applies

Storm drain inlet protection is applicable anywhere construction site runoff may enter closed conveyance systems through storm sewer inlets. Generally inlet protection is limited to areas draining less than 1 acre.

This practice is generally not recommended as a primary means of sediment control. Storm drain inlet protection has limited capacity to control silts and clays, and is most effective in capturing larger sand-sized particles. It should only be a primary means if it is not possible to divert the storm drainage to a sediment trap or sediment basin, or if it is to be used only for a short period of time during the construction process.

Planning Considerations

Inlet protection in effect blocks storm drain inlets. Therefore consider the effect of ponding muddy water on streets and nearby areas and plan accordingly. Although ponding is beneficial in the sediment removal process, this may pose hazardous conditions for street travel. Additional ponding capacity with related increase in effectiveness can be provided for some drop inlets by excavating around the inlet.

Utilizing inlet protection on long sloping streets may cause runoff to bypass inlets on the slope and cause extra water to accumulate in low areas. In order for the inlet protection to work ponding must be maintained at the practice.

The recommended geotextiles are suitable for retaining/trapping large particle size materials, such as sand while maintaining some flow. Only specialized geotextile materials are suitable for retaining clay, silt and other fine soils. These materials, however, are subject to clogging.

Apply storm drain inlet protection as soon as the surface inlet is capable of receiving storm water. Geotextiles utilized in inlet protection are manufactured to control the rate of storm water flow, to retain certain sizes of soil particles. The controlled flow and ponding assists in sediment deposition. Geotextile fabrics come in a variety of materials with permeability, strength and durability ratings. In all cases, follow the manufacturer's recommendations for the specific product application, as well as installation and maintenance requirements.

All inlet protection practices require frequent maintenance and cleaning to maintain sufficient flow rates and to prevent accumulation of mud on streets and other areas.

The following types of storm drain inlet protection are listed according to type of flows and situations where they will perform best. Note that straw bales are not suitable as storm drain inlet protection, since they are often cease to allow flow through once saturated and often leak where bales join. Different types of storm drain inlet protection available are as follows:

A. Excavated Drop Inlet Sediment Trap. Where the storm sewer can be left below the final grade, a depression in the ground adjacent to the inlet can be an effective way of reducing sediment going to the storm sewer. Runoff is directed to the depression and a sediment barrier is maintained between the depression and the storm sewer.

B. Geotextile Inlet Protection. This method consists of placing filter fence around the perimeter of the drop inlet and backfilling. Apply this method where the inlet drains overload flow or sheet flow from gentle slopes and sheet or overland flow.

C. Geotextile-Stone Protection. These are used both on drop inlets and in street curbs and gutters where the ponding of water will not cause damage or inconvience. This filter is simply constructed of geotextile materials over the inlet, with stone on top. Note: this practices does not have an opening for overflow and should not be placed where clogging and subsequent flooding would cause safety concerns or property damage.

D. Geotextile-Stone Curb Inlet Protection. This method is used only on curb and gutter inlets and utilizes wire mesh, geotextile and stone over a wood frame. This practice should be used to prevent larger volumes of water from ponding in the street. If the overflow provided is insufficient, it may be modified according to this specification to accommodate greater flows.

E. Block and Gravel Drop Inlet Protection. This practice utilizes a wall of cement blocks overlain with wire mesh and gravel around the perimeter to slow runoff before entering a storm drain. It is not recommended anywhere vehicle traffic will be operating.

F. Manufactured Inlet Protection Devices. Any manufactured products utilized for inlet protection must be constructed of materials equally durable and effective as those provided in this practice. They must be able to be secured such that construction site runoff is intercepted, ponded and filtered prior to entering the storm drain except during extreme flows. Devices must allow the removal of captured material without falling into the catch basin.

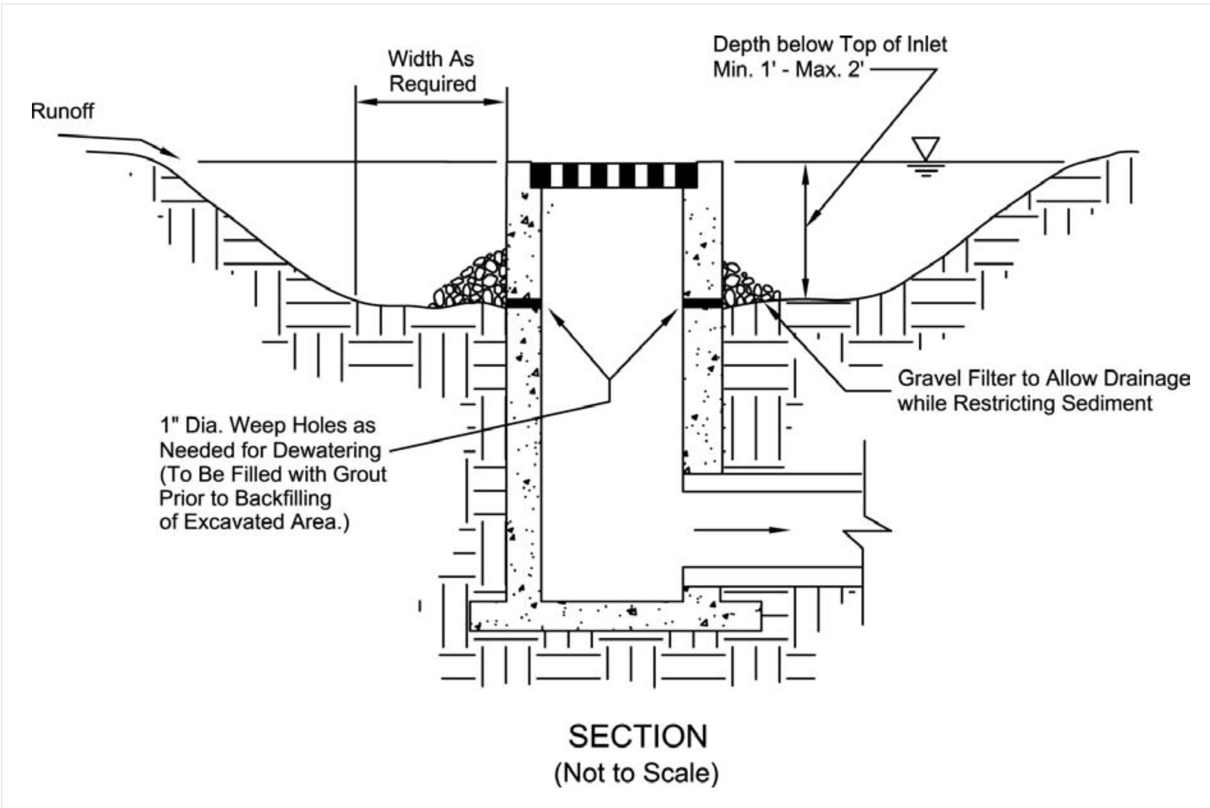
Maintenance

Effective storm drain inlet protection collects sediment and therefore must be cleaned regularly to prevent clogging and subsequent flooding conditions, piping, or overtopping of the control structures. Sediment barriers that sag, fall over, or are not properly secured, must be promptly repaired or replaced.

Inlet protection shall be inspected weekly and after each rainfall event. Areas where there is active traffic shall be inspected daily. Repairs shall be made as needed to assure the practice is performing as intended. Sediment shall be removed when accumulation is one-half the height of the trap. Sediment shall not be washed into the inlet. Sediment shall be removed and placed in a location where it is stable and not subject to erosion.

Once the contributing drainage area has been properly stabilized, all filter material and collected sediment shall be removed and properly disposed.

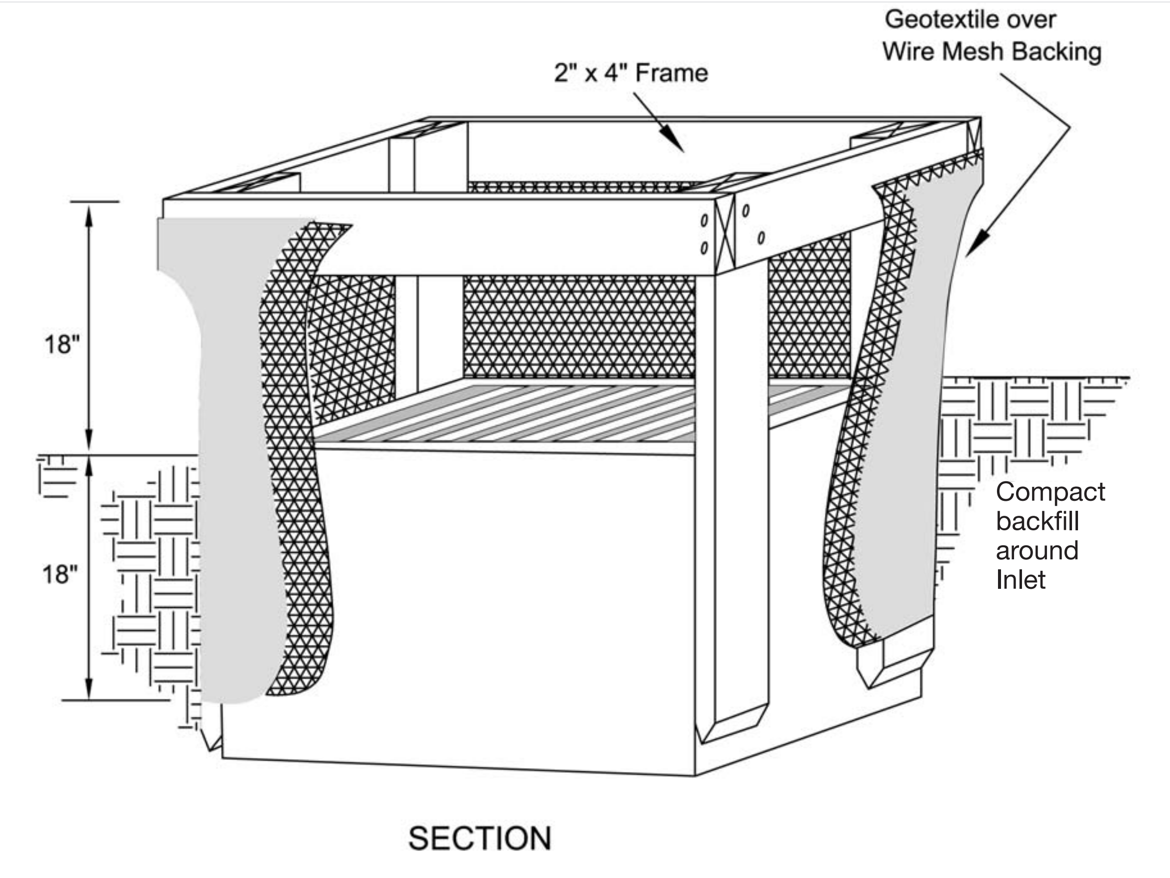
Specifications
for
Excavated Drop Inlet Sediment Protection



1. The excavated trap should be sized to provide a minimum storage capacity calculated at the rate of 135 cubic yards for one (1) acre of drainage area. A trap should be no less than one (1) foot, nor more than two (2) feet deep measured from the top of the inlet structure. Side slopes should not be steeper than 2:1.
2. The slopes of the trap may vary to fit the drainage area and terrain.
3. Where the area receives concentrated flows, such as in a highway median, provide the trap with a shape having a 2:1 ratio of length to width, with the length oriented in the direction of the flow.
4. Sediment should be removed and the trap restored to the original depth when the sediment has accumulated to 40% the design depth of the trap. Removed sediment should be spread in a suitable area and stabilized so it will not erode.
5. During final grading, the inlet should be protected with geotextile-stone inlet protection. Once final grading is achieved, sod or a suitable temporary erosion control material shall be implemented to protect the area until permanent vegetation is established.

Specifications
for

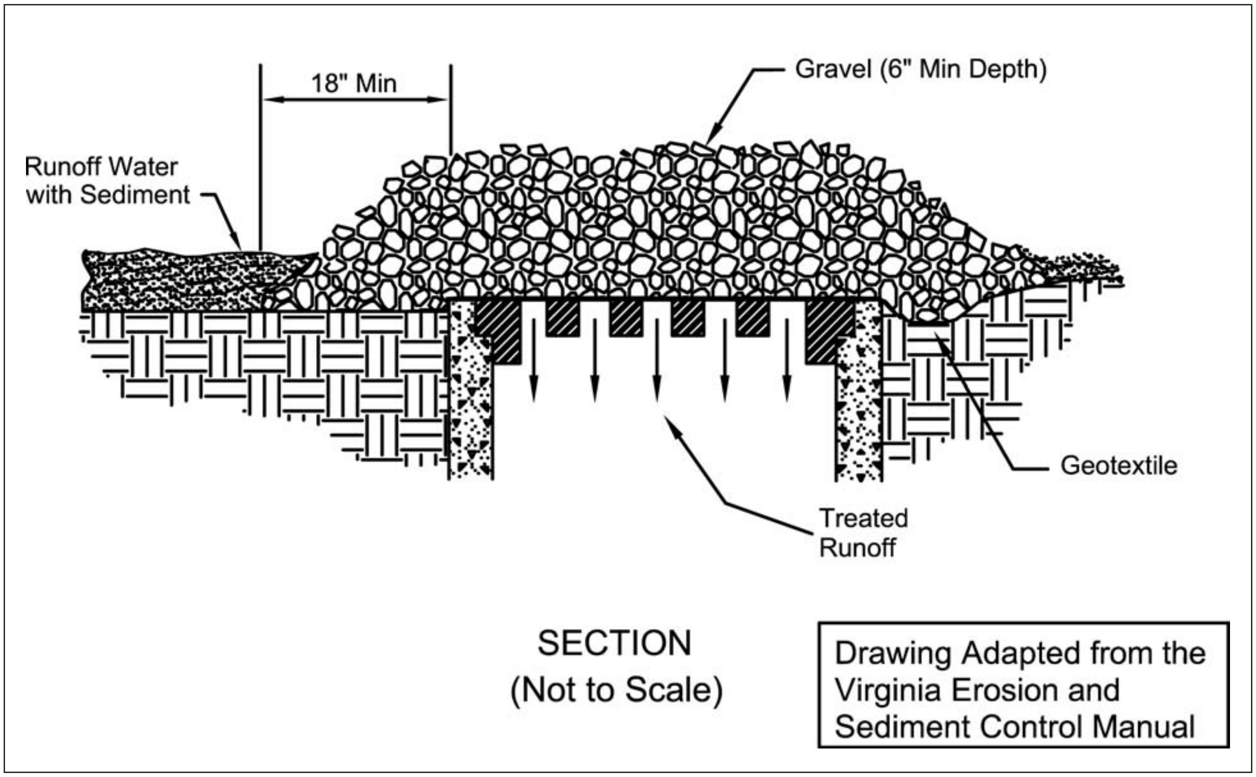
Geotextile Inlet Protection



1. Inlet protection shall be constructed either before upslope land disturbance begins or before the inlet becomes functional.
2. The earth around the inlet shall be excavated completely to a depth at least 18 inches.
3. The wooden frame shall be constructed of 2-inch by 4-inch construction grade lumber. The 2-inch by 4-inch posts shall be driven one (1) ft. into the ground at four corners of the inlet and the top portion of 2-inch by 4-inch frame assembled using the overlap joint shown. The top of the frame shall be at least 6 inches below adjacent roads if ponded water will pose a safety hazard to traffic.
4. Wire mesh shall be of sufficient strength to support fabric with water fully impounded against it. It shall be stretched tightly around the frame and fastened securely to the frame.
5. Geotextile material shall have an equivalent opening size of 20-40 sieve and be resistant to sunlight. It shall be stretched tightly around the frame and fastened securely. It shall extend from the top of the frame to 18 inches below the inlet notch elevation. The geotextile shall overlap across one side of the inlet so the ends of the cloth are not fastened to the same post.
6. Backfill shall be placed around the inlet in compacted 6-inch layers until the earth is even with notch elevation on ends and top elevation on sides.
7. A compacted earth dike or check dam shall be constructed in the ditch line below the inlet if the inlet is not in a depression. The top of the dike shall be at least 6 inches higher than the top of the frame.

Specifications
for

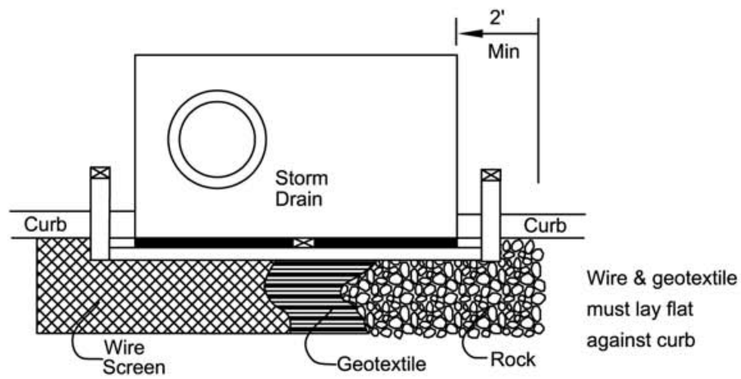
Geotextile-Stone Inlet Protection



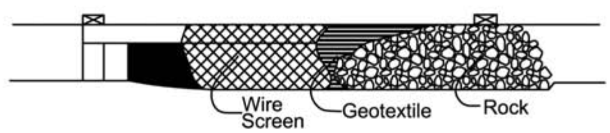
1. Inlet protecion shall be constructed either before upslope land disturbance begins or before the inlet becomes functional.
2. Geotextile and/or wire material shall be placed over the top of the storm sewer and approximately six (6) inches of 2-inch or smaller clean aggregate placed on top. Extra support for geotextile is provided by placing hardware cloth or wire mesh across the inlet cover. The wire should be no larger than ½" mesh and should extend an extra 12 inches across the top and sides of the inlet cover.
3. Maintenance must be performed regularly, especially after storm events. When clogging of the stone or geotextile occurs, the material must be removed and replaced.

Specifications
for

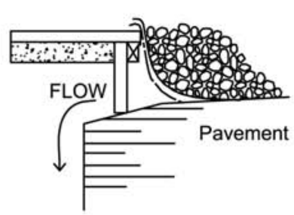
Geotextile - Stone Inlet Protection for Curb Inlets



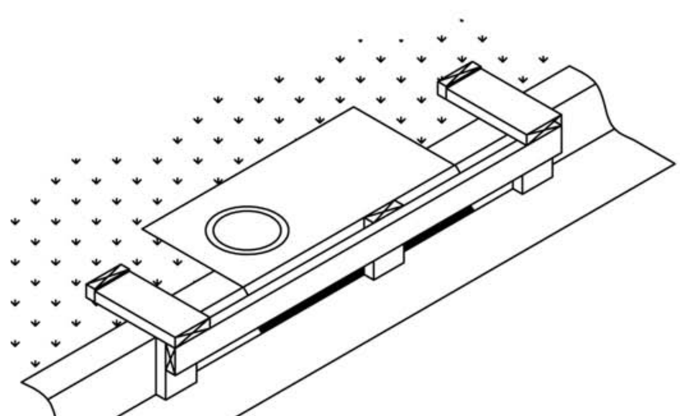
PLAN VIEW



ELEVATION



CROSS SECTION



ISOMETRIC

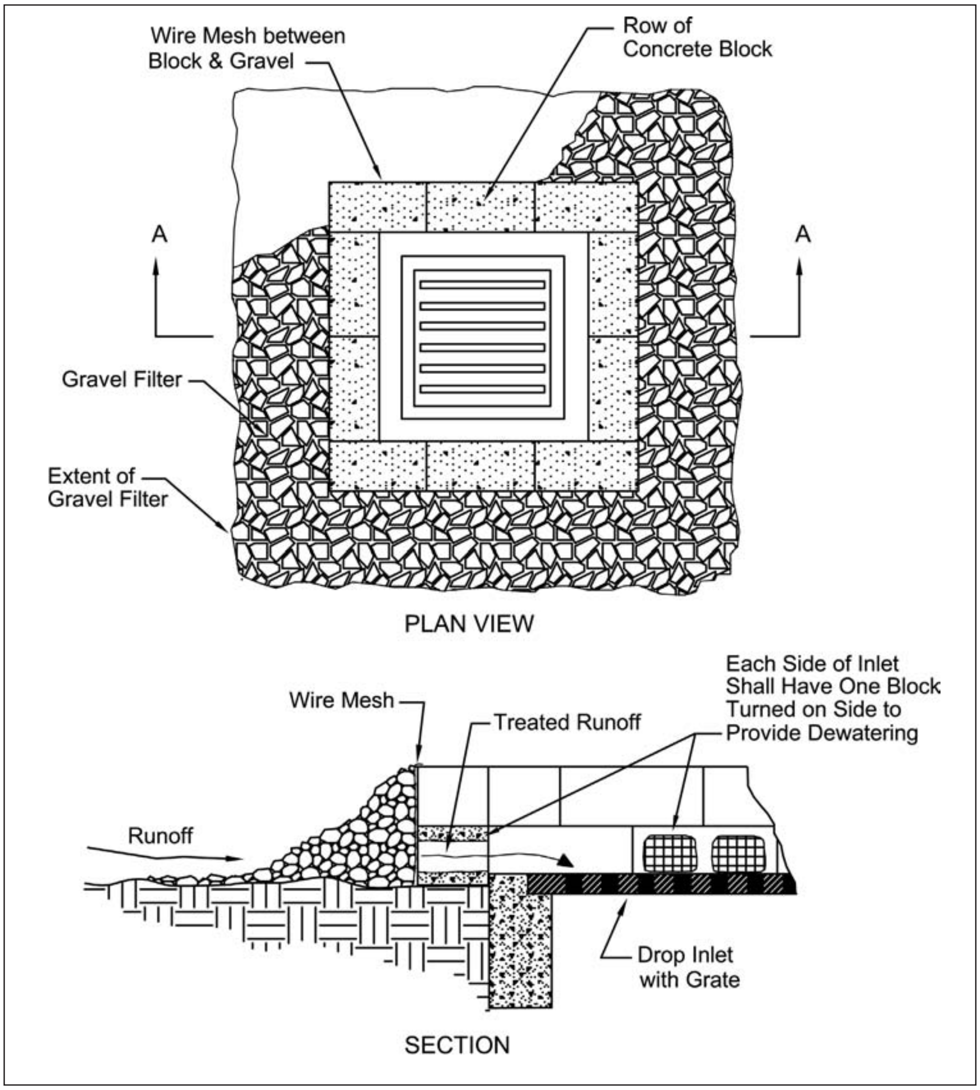
Specifications
for

Geotextile-Stone Inlet Protection for Curb Inlets

1. Inlet protection shall be constructed either before upslope land disturbance begins or before the inlet becomes functional.
2. Construct a wooden frame of 2-by-4-in. construction-grade lumber. The end spacers shall be a minimum of 1 ft. beyond both ends of the throat opening. The anchors shall be nailed to 2-by-4-in. stakes driven on the opposite side of the curb.
3. The wire mesh shall be of sufficient strength to support fabric and stone. It shall be a continuous piece with a minimum width of 30 in. and 4 ft. longer than the throat length of the inlet, 2 ft. on each side.
4. Geotextile cloth shall have an equivalent opening size (EOS) of 20-40 sieve and be resistant to sunlight. It shall be at least the same size as the wire mesh.
5. The wire mesh and geotextile cloth shall be formed to the concrete gutter and against the face of the curb on both sides of the inlet and securely fastened to the 2-by-4-in. frame.
6. Two-inch stone shall be placed over the wire mesh and geotextile in such a manner as to prevent water from entering the inlet under or around the geotextile cloth.
7. This type of protection must be inspected frequently and the stone and/or geotextile replaced when clogged with sediment.

Specifications
for

Block and Gravel Drop Inlet Filter



1. Place 4-inch by 8-inch by 12-inch concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, with the ends of adjacent blocks abutting. The height of the barrier can be varied, depending upon the design needs, by stacking combinations of the same size blocks. The barrier of blocks should be at least 12-inches high but no greater than 24-inches high.
2. Wire mesh should be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the block cores. Hardware cloth or comparable wire mesh with ½-inch openings should be used.
3. Two-inch stone should be piled against the wire to the top of the block barrier, as shown below.
4. If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, pull stone away from the blocks, clean and/or replace.

6.5 Filter Berm

Description

Filter berms are sediment trapping practices that utilize a compost/mulch material. They are typically installed with pneumatic equipment. Filter berms reduce sediment from runoff by slowing and filtering runoff, and dissipating flow.

Conditions Where Practice Applies

Filter berms are appropriate on nearly level ground or slopes up to 5:1, where runoff occurs as sheet flow. Filter berms cannot effectively treat flows in gullies, ditches or channels. For more severe conditions see specifications for temporary diversions, sediment traps, and sediment basins.

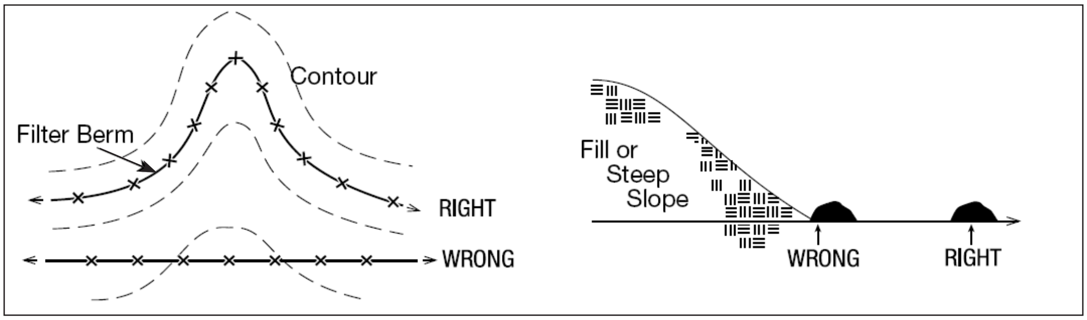
Design Criteria

Compost filter berms used as sediment control practice require an adequately constructed berm constructed on the contour, that is, on a level line across the site's topography. While silt fences rely primarily on settling, compost filter berms filter runoff as it passes through the practice. To accomplish this, runoff must be intercepted on the contour to insure that sheet flow is not concentrated into rills or channels.

Materials – Compost/mulch used for filter berms shall be weed free and derived from a well-decomposed source of organic matter. The compost shall be produced using an aerobic composting process meeting CFR 503 regulations, including time and temperature data indicating effective weed seed, pathogen and insect larvae kill. The compost shall be free of any refuse, contaminants or other materials toxic to plant growth.

Materials should meet the following requirements: pH between 5.0-8.0; 100% passing a 3" sieve, 90% to 100% passing a 1" sieve, 70% to 100% passing a 3/4", no more than 50% shall pass a 1/4" sieve; moisture content is less than 60%; material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.

Level Contour – Filter berms must be placed on the level contour of the land so that flows are dissipated into uniform sheet flow that has less energy for transporting sediment. Filter berms should never concentrate runoff, which will occur if it is placed up and down slopes rather than on the level contour.



Flat Slopes – If at all possible, filter berms should be placed away from the toe of a slope and on the flattest area available. This allows the sheet flow energy to dissipate and allows for a greater storage area for sediments.

Steeper Slopes – For placement on steeper slopes follow the spacing recommendations on the following table.

Drainage Area – Follow recommendations on following table

Table 6.5.1 Filter Berm Spacing for General Applications *Install Parallel Along Contours As Follows		
Ratio (H:V)	% Slope	Recommended Spacing
< 20:1	5% or less	300 foot with a maximum of 1 acre per 500 lineal feet
20:1 - 10:1	5 to 10%	75 foot intervals
9:1 - 5:1	10 to 20%	50 foot intervals

Flow Around Ends – To prevent water from flowing around the ends of the Filter berm each end must be constructed up-slope so that the ends are at a higher elevation.

Vegetation – Filter berm may be vegetated for a more permanent placement such as wetlands and natural areas.

References

Standard Specification for Compost for Erosion/Sediment Control (Filter Berms) http://www.iaasla.org/NEWS/FILES/AASHTO-Filterberm6.doc

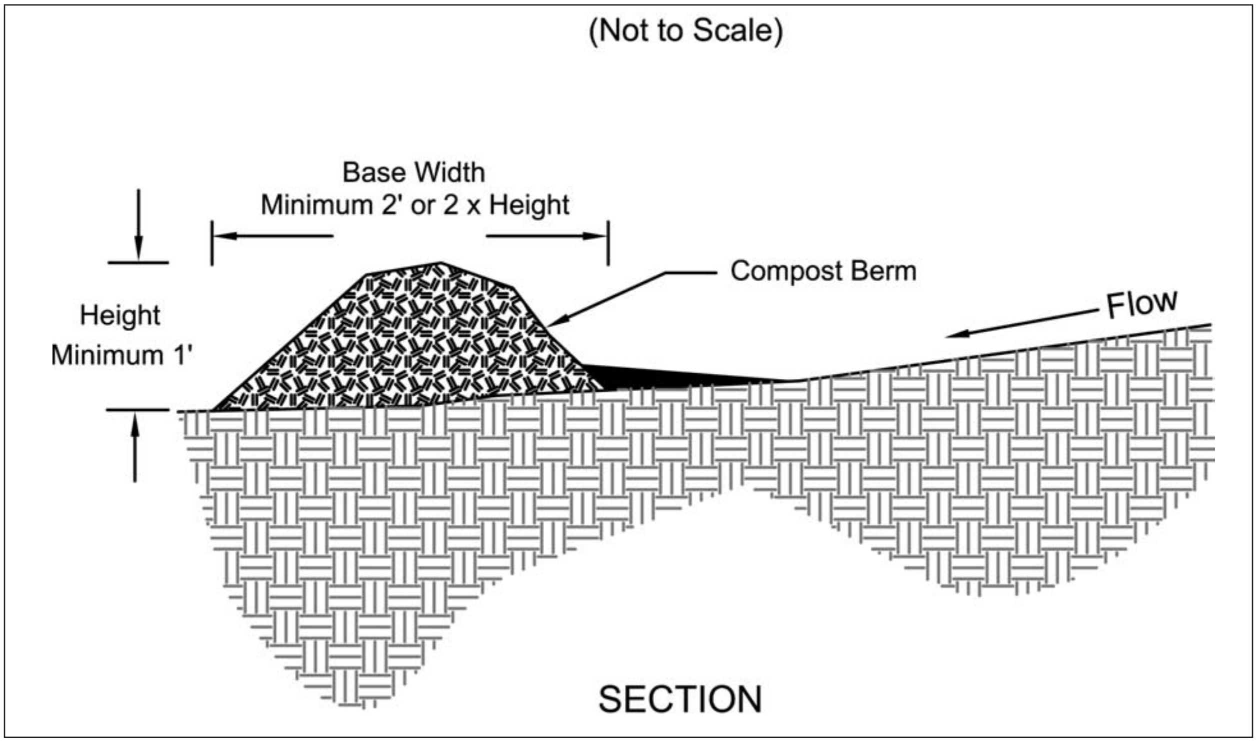
www.dot.state.pa.us/Penndot/Bureaus/ ChiefEng.nsf/spec%20filter%20berms?OpenPage - 28k

http://tammi.tamu.edu/erosion_control_fact_sheet.pdf Using compost for eroison controls and revegetation, S. Mukhtar Texas Cooperative Extension, The Texas A & M Universtiy System.Prepared in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency.

http://www.ces.uga.edu/pubcd/B1200.htm

Specifications
for

Filter Berm



1. Materials – Compost used for filter berms shall be weed, pathogen and insect free and free of any refuse, contaminants or other materials toxic to plant growth. They shall be derived from a well-decomposed source of organic matter and consist of a particles ranging from 1/4" to 3".
2. Installation – Filter berms will be placed on a level line across slopes, generally parallel to the base of the slope or other affected area. On slopes approaching 2:1, additional berms shall be provided at the top and as needed mid-slope.

   Filter berms are not to be used in concentrated flow situations or in runoff channels.
3. Maintenance – Inspect filter berms after each significant rain, maintaining the berms in a functional condition at all times.

   Remove sediments collected at the base of the filter berms when they reach 1/3 of the exposed height of the practice.

   Where the filter berm deteriorates or fails it will be, it will be repaired or replaced with a more effective alternative.
4. Removal – Filter berms no longer needed will be dispersed on site in a manner that will facilitate seeding.

6.6 Filter Sock

Description

Filter socks are sediment-trapping devices using compost inserted into a flexible, permeable tube with a pneumatic blower device or equivalent. Filter socks trap sediment by filtering water passing through the berm and allowing water to pond, creating a settling of solids.

Conditions where practice applies

Filter socks are appropriate for limited drainage areas, requiring sediment control where runoff is in the form of sheet flow or in areas that silt fence is normally considered acceptable. The use of filter socks is applicable to slopes up to 2:1 (H:V), around inlets, and in other disturbed areas of construction sites requiring sediment control. Filter socks also may be useful in areas, where migration of aquatic life such as turtles, salamanders and other aquatic life would be impeded by the use of silt fence.

Planning Considerations

Filter socks are sediment barriers, capturing sediment by ponding and filtering water through the device during rain events. They may be a preferred alternative where equipment may drive near or over sediment barriers, as they are not as prone to complete failure as silt fence if this occurs during construction. Driving over filter socks is not recommended; but if it should occur, the filter sock should be inspected immediately, repaired and moved back into place as soon as possible.

Design Criteria

Typically, filter socks can handle the same water flow or slightly more than silt fence. For most applications, standard silt fence is replaced with 12" diameter filter socks. However, proper installation is especially important for them to work effectively.

Materials – Compost/mulch used for filter socks shall be weed free and derived from a well-decomposed source of organic matter. The compost shall be produced using an aerobic composting process meeting CFR 503 regulations, including time and temperature data indicating effective weed seed, pathogen and insect larvae kill. The compost shall be free of any refuse, contaminants or other materials toxic to plant growth. Non-composted products are not acceptable.

Materials should meet the following requirements: pH between 5.0-8.0; 100% passing a 2" sieve and a minimum of 70% greater than the 3/8" sieve; moisture content is less than 60%; material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.

Level Contour – Place filter socks on the level contour of the land so that flows are dissipated into uniform sheet flow. Flow coming to filter socks must not be concentrated and the filter sock should lie perpendicular to flows.

Flat Slopes – When possible, place filter socks at a 5' or greater distance away from the toe of the slopes in order for the water coming from the slopes to maximize space available for sediment deposit (see the illustration). When this is not possible due to construction limitations, additional filter socks may be required upslope of the initial filter sock (see the chart below for appropriate slope lengths and spacing).

Flow Around Ends – In order to prevent water flowing around the ends of filter socks, the ends of the filter socks must be constructed pointing upslope so the ends are at a higher elevation.

Vegetation – For permanent areas, seeding filter socks is recommended to establish vegetation directly in the sock and immediately in front and back of the sock at a distance of 5 feet. Vegetating on and around the filter socks will assist in slowing down water for filtration creating a more effective longer-term sediment control.

Drainage Area: Generally filter socks are limited to ¼ to ½ acre drainage area per 100 foot of the sediment barrier. Specific guidance is given in the chart below.

Table 6.6.1 Maximum Slope Length Above Filter Sock and Recommended Diameter

Slope	Ratio (H:V)	8"	12"	18"	24"
0% - 2%	10% - 20%	125	250	300	350
10% - 20%	50:1 - 10:1	100	125	200	250
2% - 10%	10:1 - 5:1	75	100	150	200
20% - 33%	5:1 - 2:1		50	75	100
>50%	>2:1		25	50	75

Note: For larger drainage areas, see standards for temporary diversions, sediment traps and sediment basins.

Dispersing flow – Sheet flow and runoff should not exceed berm height or capacity in most storm events. If overflow of the berm is a possibility, a larger filter sock should be installed or an alternative sediment control should be used.

Maintenance – Filter socks should be regularly inspected to make sure they hold their shape, are ponding, and allowing adequate flow through. If ponding becomes excessive, filter socks should be replaced. Used filter socks may be cut and the compost dispersed and seeded to prevent captured sediment from being resuspended.

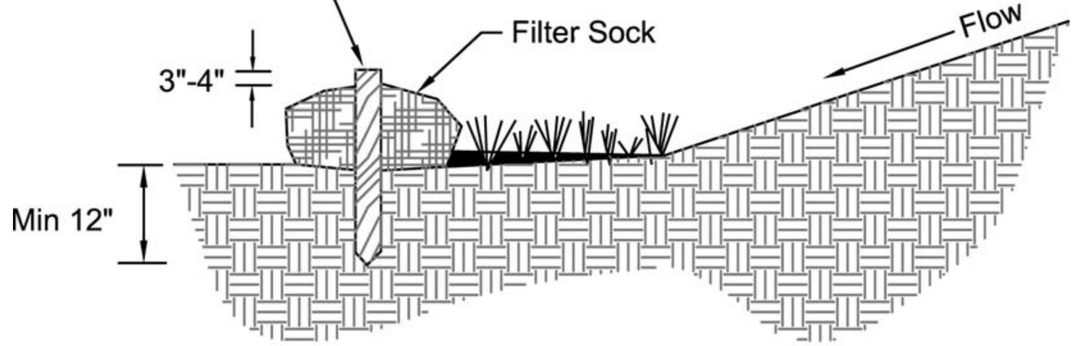
Removal – When construction is completed on site, the filter socks may be cut and dispersed with a loader, rake, bulldozer or other device to be incorporated into the soil or left on top of the soil for final seeding. The mesh netting material will be disposed of in normal trash container or removed by the contractor.

References

Standard Specification for Compost for Erosion/Sediment Control (Filter Berms) AASHTO Designation: MP-9 http://www.iaasla.org/NEWS/FILES/AASHTO-Filterberm6.doc

Specifications
for

Filter Sock



1. Materials – Compost used for filter socks shall be weed, pathogen and insect free and free of any refuse, contaminants or other materials toxic to plant growth. They shall be derived from a well-decomposed source of organic matter and consist of a particles ranging from 3/8" to 2".
2. Filter Socks shall be 3 or 5 mil continuous, tubular, HDPE 3/8" knitted mesh netting material, filled with compost passing the above specifications for compost products.

INSTALLATION:

3. Filter socks will be placed on a level line across slopes, generally parallel to the base of the slope or other affected area. On slopes approaching 2:1, additional socks shall be provided at the top and as needed mid-slope.
4. Filter socks intended to be left as a permanent filter or part of the natural landscape, shall be seeded at the time of installation for establishment of permanent vegetation.
5. Filter Socks are not to be used in concentrated flow situations or in runoff channels.

MAINTENANCE:

6. Routinely inspect filter socks after each significant rain, maintaining filter socks in a functional condition at all times.
7. Remove sediments collected at the base of the filter socks when they reach 1/3 of the exposed height of the practice.
8. Where the filter sock deteriorates or fails, it will be repaired or replaced with a more effective alternative.
9. Removal – Filter socks will be dispersed on site when no longer required in such as way as to facilitate and not obstruct seedings.