Block and Gravel Inlet Protection (BIP)

Practice Description

Block and gravel inlet protection is a sediment control barrier formed around a storm drain inlet by the use of standard concrete block and gravel. The purpose is to help minimize sediment entering storm drains during construction. This practice applies where use of the storm drain system is necessary during construction and inlets have a drainage area of 1 acre or less and an approach slope of 1% or less. The practice will pond water causing hazardous conditions to motorists and should only be used when there is no public transportation allowed on the street.

Planning Considerations

Storm sewers which are made operational before their drainage area is stabilized can convey large amounts of sediment to natural drainageways. In case of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

This practice is for drainage areas of less than 1 acre. Runoff from large disturbed areas should be routed through a Sediment Basin. This method is for areas where heavy flows are expected and where overflow capacity is necessary to prevent excessive ponding around the structure.

The best way to prevent sediment from entering the storm sewer system is to minimize erosion by leaving as much of the site undisturbed as possible and...
disturbing the site in small increments, if possible. After disturbance, stabilize the site as quickly as possible to prevent erosion and sediment delivery.

**Design Criteria**

**Drainage Area**

Drainage area should be less than 1 acre per inlet.

**Capacity**

The design storm for the inlet should be able to enter the inlet without bypass flow.

**Approach**

The approach to the block and gravel structure should be less than 1%.

**Height**

The height of the block structure should be 1 to 2 feet.

**Side Slopes**

Gravel placed around the concrete block structure should have 2:1 side slopes or flatter.

**Dewatering**

Place a minimum of 1 block on the bottom row (more as needed) on its side to allow for dewatering the pool.

**Block Placement**

The foundation for the blocks should be excavated at least 2” below the crest of the storm drain. The bottom row of blocks should be placed against the edge of the storm drain for lateral support and to avoid washouts when overflow occurs. If needed, lateral support may be given to subsequent rows by placing 2” x 4” wood studs through block openings.

Place 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 on design needs, by stacking combinations of 4”, 8” and 12” wide blocks. The barrier of blocks should be at least 12” high and no greater than 24” high.

The top elevation of the structure must be at least 6” lower than the ground elevation downslope from the inlet. It is important that all storm flows pass over the structure and into the storm drain and not past the structure. Temporary dikes below the structure may be necessary to prevent bypass flow. Material may be excavated from inside the sediment pool for this purpose.
Wire mesh should be placed over the outside vertical face (webbing) of the concrete blocks to prevent stone from being washed through the holes in the blocks. Hardware cloth or comparable wire mesh with ½” openings should be used.

**Gravel**

Stone should be piled against the wire to the top of the block barrier, as shown in the typical details in Figure BIP-1. Alabama Highway Department No. 57 Coarse Aggregate or similar gradations should be used.

If the stone filter becomes clogged with sediment so that it no longer adequately performs its function, the stone must be pulled away from the blocks, cleaned and replaced.

**Maintenance**

Sediment shall be removed and the trap restored to its original dimensions when the sediment has accumulated to ½ the design depth. Removed sediment shall be deposited in a suitable area and in such a manner that it will not erode.

The sediment trap shall be removed and the area stabilized when the constructed drainage area has been properly stabilized.

**Safety**

Do not use this practice when there is public transportation allowed on the street. Provide protection to prevent children from entering the area.
Figure BIP-1  Typical Details of Block and Gravel Inlet Protection
Brush/Fabric Barrier (BFB)

Practice Description

A brush/fabric barrier is a dam-like structure constructed from woody residue and faced with a non-woven geotextile fabric to provide a temporary sediment basin. This practice is applicable on sites with a small drainage area where brush and other woody debris are available from a clearing and grubbing operation.

Planning Considerations

This practice is intended to be a temporary sediment basin with a limited life span and applicable only for small drainage areas.

The barrier should be located downslope from areas with potential sheet and rill erosion, with adequate storage volume in front of the barrier, and with no more than 2 acres of drainage area.

Adequate woody material from clearing and grubbing required on the site must be available for the construction of the barrier.

The practice should be located and designed so adequate storage volume and detention time can be obtained, and that failure of the barrier will not result in hazard to the public or damage to either work on-site or off-site property.
Design Criteria

Drainage Area

Brush/fabric barriers should be designed with no more than 2 acres of drainage area. A sediment basin should be considered for larger drainage areas (see Sediment Basin).

Structure Life

The design life of the structure should be 1 year or less. The barrier should be removed and sediment accumulations properly stabilized prior to completion of the construction project.

Sediment Storage

The barrier should be designed to provide 67 cubic yards of sediment storage per acre of disturbed drainage area. Sediment should be removed and properly utilized on site when ½ the sediment storage volume has been filled.

Site Location and Preparation

The site for the barrier should be located so that a basin capable of providing the sediment storage required can be obtained or created. The site for the barrier should be smoothed prior to placement of the brush.

Brush Placement

The barrier should be mostly on a contour or constant elevation with each end of the barrier turned up to a higher elevation so that excessive flows will overtop the barrier instead of bypassing the barrier. Brush should be placed in a longitudinal dense pile with main stems oriented perpendicular to the direction of flow. Generally, the barrier should be at least 3 feet tall, but no more than 6 feet tall. The width of the barrier perpendicular to the direction of flow should be at least 5 feet at its base. Small stems and limbs protruding from the bundle that could damage the fabric should be trimmed.

Fabric

The fabric used to face the upstream surface of the brush should be non-woven geotextile. The geotextile shall be of the strength and durability required for the project. Generally, the non-woven geotextile should meet the requirements found in ASSHTO M288.

The fabric to be used should be supplied in lengths and widths to minimize vertical splices and eliminate horizontal splices. The minimum vertical splice overlap should be 3 foot. Vertical splices must be securely fastened to each other so that flows will not short-circuit through the splice.

The fabric should be securely buried at the bottom of an excavated trench that is at least 6” deep in front of the barrier. Prior to compacting backfill in the trench, the
fabric should be securely staked at 3-foot centers with wooden stakes a minimum of 18” long.

The top edge of the fabric should be secured so that it will not sag below the designed storage elevation. The upper edge can be anchored with twine fastened to the fabric and secured to stakes behind the barrier.
**Fabric Drop Inlet Protection (FIP)**

**Practice Description**

Fabric drop inlet protection is a structurally supported geotextile barrier placed around or over a drop inlet to prevent sediment from entering storm drains during construction. This practice applies where early use of the storm drain system is necessary prior to stabilization of the disturbed drainage area. This practice is suitable for inlets with a drainage area of less than 1 acre and a gentle approach slope generally of 1% or less. This practice will cause runoff water to pond. If used at a storm drain for a road, the practice could cause hazardous conditions to motorists and should only be used when there is no public transportation allowed on the street.

**Planning Considerations**

Storm sewers which are made operational before their drainage area is stabilized can convey large amounts of sediment to natural drainage ways. In case of extreme sediment loading, the storm sewer itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets which discharge directly to waters of the state.

The best way to prevent sediment from entering the storm sewer system is to stabilize the site as quickly as possible, preventing erosion and stopping sediment at its source. Sediment is best treated by preventing erosion. Leave as much of the site undisturbed as possible in the total site plan. Clear and disturb the site in small increments, if possible.
Numerous products have been developed to facilitate the capture of suspended soil particles at inlets. The Design Criteria for performance should be considered when evaluating alternative products. Products that will likely not meet performance goals or that usually fail under storm conditions should not be selected.

**Design Criteria**

*Drainage Area*

Drainage area should be less than 1 acre per inlet.

*Height*

The height of the structurally supported geotextile should be at least 1 foot but no more than 2.5 foot. The base of the fabric should be buried with compacted earth fill at least 12” into the soil or extend horizontally and be adequately secured with ballast material according to the manufacturer’s recommendations. Ensure the height of the structure when fully ponded does not cause unintentional damage or hazards to adjacent areas.

*Approach*

The approach to the inlet protection practice should generally be less than 1% slope.

*Sediment Storage*

The basin created at the inlet should provide 67 cubic yards per disturbed acre of sediment storage.

*Structural Frame*

The structural frame should be designed to withstand soil and hydrostatic loads without failure due to buckling, fabric sagging, or undermining.

*Performance*

Either the system of protection for the project or the drop inlet protection that discharges directly to the outfall of the project must be designed to meet the NTU requirements for discharge.

*Maintenance*

When sediment has accumulated to ½ the height of the structure, it should be removed and properly disposed of.

*Safety*

Protection should be provided to prevent children from entering open-top structures. Do not use the practice if it ponds water on roads used by motorist.
Filter Strip (FS)

Practice Description

A filter strip is a wide belt of vegetation designed to provide infiltration, intercept sediment and other pollutants, and reduce stormwater flow and velocity. Filter strips are similar to grassed swales except that they are designed to intercept overland sheet flow (not channel flow). They cannot treat high velocity flows. Surface runoff must be evenly distributed across the filter strip. Vegetation may consist of existing cover that is preserved and protected or be planted to establish the strip. Once a concentrated flow channel forms in the filter strip, the filter strip is no longer effective. This practice applies on construction sites and other disturbed areas.

Planning Considerations

Filter strips provide their maximum benefit when established as early as possible after disturbances begin. This concept should receive strong consideration during the scheduling of practices to be installed. In some instances the existing vegetation may be preserved to serve as a filter strip.

Filter strips should be strategically located on the contour to reduce runoff, and increase infiltration. They should be situated downslope from the disturbed site and where runoff water enters environmentally sensitive areas.

Overland flow entering filter strips should be primarily sheet flow. All concentrated flow should be dispersed prior to entering the filter strip.
Flow length should be based on slope percent and length, predicted amount and particle size distribution of sediment delivered to the filter strip, density and height of the filter strip vegetation, and runoff volume.

The slope of the drainage area above a filter strip should be greater than 1% but less than 10%. The ratio of the drainage area to the filter strip area should be less than 10:1. The minimum width of an effective filter strip is 15 feet.

Existing vegetation may be used if it meets stand density and height requirements and has uniform flow through the existing vegetation. The existing vegetation strip must be on a contour to be effective.

Site preparation for filter strips requires that the filter strip be placed on the contour. Variation in placement on the contour should not exceed a 0.5% longitudinal (perpendicular to the flow length) gradient.

All soil amendments should be applied according to a soil test recommendation for the planned vegetation.

The vegetation for filter strips must be permanent herbaceous vegetation of a single species or a mixture of grasses or legumes, which have stiff stems and a high stem density near the ground surface. Stem density should be such that the stem spacing does not exceed 1”.

**Design Criteria**

*Installation (preservation of existing vegetation)*

Designate the areas for preserving vegetation on the design plan map.

Indicate in the plan that the designated areas will be fenced or flagged and will not be disturbed. This includes avoiding surface disturbances that affect sheet flow of stormwater runoff and not storing debris from clearing and grubbing, and other construction waste material in the filter strips during construction.

*Installation (planting)*

*Site Preparation*
If the upper edge of the filter strip does not have a level edge, remove any obstructions and grade the upper edge of the filter strip so that runoff evenly enters the filter strip.
Fill and smooth any rills and gullies that exist over the filter strip area to ensure that overland flow will discharge across the filter strip along a smooth surface

*Seedbed Preparation*
Grade and loosen soil to a smooth firm surface to enhance rooting of seedlings and reduce rill erosion. If existing, break up large clods and loosen compacted, hard or crusted soil surfaces with a disk, ripper, chisel, harrow or other tillage equipment. Avoid preparing the seedbed under excessively wet conditions.
For broadcast seeding and drilling, tillage should adequately loosen the soil to a depth of at least 6", alleviate compaction, and smooth and firm the soil for the proper placement of seed.

For no-till drilling, the soil surface does not need to be loosened unless the site has surface compaction. If compaction exists, the area should be chiseled across the slope to a depth of at least 6”.

**Applying Soil Amendments**

**Liming**
Follow soil test recommendation. If a soil test is not available, use 2 tons/acre of ground agricultural lime on clayey soils (approximately 90 lbs/1000 ft\(^2\)) and 1 ton/acre on sandy soils (approximately 45 lbs/1000 ft\(^2\)). Exception: If the cover is tall fescue and clover, use the 2 tons/acre rate (90 lbs/1000 ft\(^2\)) on both clayey and sandy soils.

Spread the specified amount of lime and incorporate into the top 6” of soil after applying fertilizer.

**Fertilizing**
Apply fertilizer at rates specified in the soil test recommendation. In the absence of soil tests, use the following as a guide:

Grass alone: 8-24-24 or equivalent - 400 lbs/acre (9.2 lbs/1000 ft\(^2\)). When vegetation has emerged to a stand and is growing, 30 to 40 lbs/acre (0.8 lb/1000 ft\(^2\)) of additional nitrogen fertilizer should be applied.

Grass-Legume Mixture: 8-24-24 or equivalent-400 lbs/acre (9.2 lbs/1000 ft\(^2\)). When vegetation has emerged to a stand and is growing, 30 to 40 lbs (0.8 lb/1000 ft\(^2\)) of additional nitrogen fertilizer should be applied.

Legume alone: 0-20-20 or equivalent-500 lbs/acre (11.5 lbs/1000 ft\(^2\)).

Incorporate lime and fertilizer to a minimum depth of at least 6” or more by diskimg or chiseling on slopes of up to 3:1.

**Planting**
Select adapted species from Figure FS-1 and Table FS-1.

Apply seed uniformly using a cyclone seeder, drill seeder, cultipacker seeder or hydroseeder.

When using a drill seeder, plant grasses and legumes ¼” to ½” deep. Calibrate equipment in the field.

When planting by methods other than a drill seeder or hydroseeder, cover seed by raking, or dragging a chain, brush or mat. Then firm the soil lightly with a roller. Seed can also be covered with hydro-mulched wood fiber and tackifier. Legumes
require inoculation with nitrogen-fixing bacteria to ensure good growth. Purchase inoculum specific for the seed and mix with seed prior to planting.

### Table FS-1  Commonly Used Plants for Permanent Cover

<table>
<thead>
<tr>
<th>Species</th>
<th>Seeding Rates/Ac</th>
<th>North</th>
<th>Central</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>PLS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahiagrass, Pensacola</td>
<td>40 lbs</td>
<td>--</td>
<td>Mar 1-July 1</td>
<td>Feb 1-Nov 1</td>
</tr>
<tr>
<td>Bermudagrass, Common</td>
<td>10 lbs</td>
<td>Apr 1-July 1</td>
<td>Mar 15-July 15</td>
<td>Mar 1-July 15</td>
</tr>
<tr>
<td>Bahiagrass, Pensacola</td>
<td>30 lbs</td>
<td>--</td>
<td>Mar 1-July 1</td>
<td>Mar 1-July 15</td>
</tr>
<tr>
<td>Bermudagrass, Common</td>
<td>5 lbs</td>
<td>--</td>
<td>Mar 1-July 1</td>
<td>Mar 1-July 15</td>
</tr>
<tr>
<td>Bermudagrass, Hybrid (Lawn Types)</td>
<td>Solid Sod</td>
<td>Anytime</td>
<td>Anytime</td>
<td>Anytime</td>
</tr>
<tr>
<td>Bermudagrass, Hybrid (Lawn Types)</td>
<td>Sprigs 1/sq ft</td>
<td>Mar 1-Aug 1</td>
<td>Mar 1-Aug 1</td>
<td>Feb 15 - Sep 1</td>
</tr>
<tr>
<td>Fescue, Tall</td>
<td>40-50 lbs</td>
<td>Sep 1-Nov 1</td>
<td>Sep 1-Nov 1</td>
<td>--</td>
</tr>
<tr>
<td>Sericea</td>
<td>40-60 lbs</td>
<td>Mar 15-July 15</td>
<td>Mar 1-July 15</td>
<td>Feb 15-July 15</td>
</tr>
<tr>
<td>Sericea &amp; Common Bermudagrass</td>
<td>40 lbs</td>
<td>Mar 15-July 15</td>
<td>Mar 1-July 15</td>
<td>Feb 15-July 15</td>
</tr>
</tbody>
</table>

1 PLS means pure live seed and is used to adjust seeding rates. For example, to plant 10 lbs of a species with germination of 80% and with purity of 90%, PLS = 0.8 x 0.9 = 72%, 10 PLS = 10/0.72 = 13.9 lbs

2 A late fall planting of Bahiagrass should include 45 lbs./ac. of small grain to provide cover during winter months.

**Mulching**

Cover approximately 75% of the surface with the specified mulch materials. Crimp, tack or tie down straw mulch with netting. Mulching is extremely important for successful seeding (See Mulching practice for more details).

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**Figure FS-1  Geographical Areas for Species Adaptation and Seeding Dates**

*Note: Site conditions related to soils and aspect in counties adjacent or close to county boundaries may justify adjustments in planting dates by qualified design professionals.*
Figure FS-1 Geographical Areas for Species Adaptation and Seeding Dates

Note: Site conditions related to soils and aspect in counties adjacent or close to county boundaries may justify adjustments in planting dates by qualified design professionals.
Floating Turbidity Barrier (FB)

Practice Definition

A floating turbidity barrier consists of geotextile material (curtain) with floats on the top, weights on the bottom, and an anchorage system that minimizes sediment transport from a disturbed area that is adjacent to or within a body of water. The barrier provides sedimentation and turbidity protection for a watercourse from upslope land disturbance activities where conventional erosion and sediment controls cannot be used or need supplemental sediment control, or from dredging or filling operations within a watercourse. The practice can be used in non-tidal and tidal watercourses where intrusion into the watercourse by construction activities has been permitted and subsequent sediment movement is unavoidable.

Planning Considerations

Soil loss into a watercourse results in long-term suspension of sediment. In time, the suspended sediment may travel long distances and affect widespread areas. A turbidity barrier is designed to deflect and contain sediment within a limited area and provide enough residence time so that soil particles will fall out of suspension and not travel to other areas.

Turbidity barrier types must be selected based on the flow conditions within the waterbody, whether it is a flowing channel, lake, pond, or a tidal watercourse. The specifications contained within this practice pertain to minimal and moderate flow conditions where the velocity of flow may reach 5 ft/sec (or a current of approximately 3 knots). For situations where there are greater flow velocities or currents, a qualified design professional and product manufacturer should be consulted.
Consideration must also be given to the direction of water movement in channel flow situations. Turbidity barriers are not designed to act as water impoundment dams and cannot be expected to stop the flow of a significant volume of water. They are designed and installed to trap sediment, not to halt the movement of water itself. In most situations, turbidity barriers should not be installed across channel flows. There is an exception to this rule. This occurs when there is a danger of creating a sediment buildup in the middle of a watercourse, thereby blocking access or creating a sediment bar. Curtains have been used effectively in large areas of moving water by forming a very long-sided, sharp “V” to deflect clean water around a work site, confining a large part of the sediment-laden water to the work area inside the “V” and direct much of the sediment toward the shoreline. Care must be taken, however, not to install the curtain perpendicular to the water current.

In tidal or moving water conditions, provisions must be made to allow the volume of water contained within the barrier to change. Since the bottom of the barrier is weighted and external anchors are frequently added, the volume of water contained within the curtain will be much greater at high tide verses low tide and measures must be taken to prevent the curtain from submerging. In addition to allowing slack in the curtain to rise and fall, water must be allowed to flow through the curtain if the curtain is to remain in roughly the same place and maintain the same shape. Normally, this is achieved by constructing part of the curtain from a heavy woven filter fabric. The fabric allows the water to pass through the curtain, but retains the sediment particles. Consideration should be given to the volume of water that must pass through the fabric and sediment particle size when specifying fabric permeability.

Sediment, which has been deflected and settled out by the curtain, may be removed if so directed by the on-site inspector or the permitting agency. However, consideration must be given to the probable outcome of the procedure, which may create more of a sediment problem by resuspension of particles and by accidental dumping of the material by the equipment involved. It is, therefore, recommended that the soil particles trapped by a turbidity curtain only be removed if there has been a significant change in the original contours of the affected area in the watercourse. Regardless of the decision made, soil particles should always be allowed to settle for a minimum of 6-12 hours before removal by equipment or before removal of a turbidity curtain.

It is imperative that all measures in the erosion control plan be used to keep sediment out of the watercourse. However, when proximity to the watercourse makes successfully mitigating sediment loss impossible, the use of the turbidity curtain during land disturbance is essential. Under no circumstances should permitted land disturbing activities create violations of water quality standards.
Design Criteria

Floating turbidity barriers are normally classified into 3 types:

- **Type I** (see Figure FB-1) is used in protected areas where there is no current and the area is sheltered from wind and waves.

- **Type II** (see Figure FB-1) is used in areas where there may be small to moderate current (up to 2 knots or 3.5 ft/sec) and/or wind and wave action can affect the curtain.

- **Type III** (see Figure FB-2) is used in areas where considerable current (up to 3 knots or 5 ft/sec) may be present, where tidal action may be present, and/or where the curtain is potentially subject to wind and wave action.

Turbidity curtains should extend the entire depth of the watercourse whenever the watercourse in question is not subject to tidal action and/or significant wind and wave forces. This prevents sediment-laden water from escaping under the barrier, scouring and resuspending additional sediments.

In tidal and/or wind and wave action situations, the curtain should never be so long as to touch the bottom. A minimum 1 foot gap should exist between the weighted, lower end of the skirt and the bottom at “mean” low water. Movement of the lower skirt over the bottom due to tidal reverses or wind and wave action on the flotation system may fan and stir sediments already settled out.

In tidal and/or wind and wave action situations, it is seldom practical to extend a turbidity curtain depth lower than 10 to 12 feet below the surface, even in deep water. Curtains which are installed deeper than this will be subjected to very large loads with consequent strain on curtain materials and the mooring system. In addition, a curtain installed in such a manner can "billow up" toward the surface under the pressure of the moving water, which will result in an effective depth which is significantly less than the skirt depth.

Turbidity curtains should be located parallel to the direction of flow of a moving body of water. Turbidity curtains should not be placed across the main flow of a significant body of moving water.

When sizing the length of the floating curtain, allow an additional 10-20% variance in the straight-line measurements. This will allow for measuring errors, make installing easier and reduce stress from potential wave action during high winds.

An attempt should be made to avoid an excessive number of joints in the curtain. A minimum continuous span of 50 feet between joints is a good “rule of thumb.”

For stability reasons, a maximum span of 100 feet between anchor or stake locations is also a good rule to follow.

The ends of the curtain, both floating upper and weighted lower, should extend well up onto the shoreline, especially if high water conditions are expected.
ends should be secured firmly to the shoreline to fully enclose the area where sediment may enter the water.

When there is a specific need to extend the curtain to the bottom of the watercourse in tidal or moving water conditions, a heavy woven pervious filter fabric may be substituted for the normally recommended impervious geotextile. This creates a “flow-through” medium, which significantly reduces the pressure on the curtain and will help to keep it in the same relative location and shape during the rise and fall of tidal waters.

Typical installation layouts of turbidity curtains can be seen in Figure FB-3. The number and spacing of external anchors will vary depending on current velocities and potential wind and wave action. Manufacturer’s recommendations should be followed.

In navigable waters, additional permits may be required from the Corps of Engineers or other regulatory agencies if the barrier creates an obstruction to navigation.

**Materials and Installation Requirements**

Barriers should be a bright color (yellow or “international” orange) that will attract the attention of nearby boaters. The curtain fabric must meet the minimum requirements noted in Table FB-1.

Seams in the fabric should be either vulcanized welded or sewn, and should develop the full strength of the fabric.

Flotation devices should be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain. Buoyancy provided by the flotation units should be sufficient to support the weight of the curtain and maintain a freeboard of at least 3” above the water surface level.

Load lines must be fabricated into the bottom of all floating turbidity curtains. Type II and Type III curtains must have load lines also fabricated into the top of the fabric. The top load line should consist of woven webbing or vinyl-sheathed steel cable and should have break strength in excess of 10,000 pounds (5 t). The supplemental (bottom) load line should consist of a chain incorporated into the bottom hem of the curtain of sufficient weight to serve as ballast to hold the curtain in a vertical position. Additional anchorage should be provided as necessary. The load lines should have suitable connecting devices which develop the full breaking strength for connecting to load lines in adjacent sections (See Figures FB-1 and FB-2 which portray this orientation).
### Table FB-1  Curtain Fabric Material Requirements for Floating Turbidity Barriers

<table>
<thead>
<tr>
<th>Characteristic Test Method</th>
<th>16 Oz Nominal Laminated</th>
<th>18 Oz Laminated</th>
<th>22 Oz Coated Geotextile Filter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Vinyl Laminate On 1300 Denier 9 X 9 Scrim</td>
<td>Vinyl Laminate On 1300 Denier 9 X 9 Scrim</td>
<td>Vinyl Coated On Woven 6 Oz Polyester Base</td>
</tr>
<tr>
<td>Weight</td>
<td>Nominal 16 Oz/Sq Yd 376 Gr/Sq M</td>
<td>18 Oz/Sq Yd 423 Gr/Sq M</td>
<td>22 Oz/Sq Yd 517 Gr/Sq M</td>
</tr>
<tr>
<td>Adhesion</td>
<td>15 Lb/In 14 Dan/5 Cm</td>
<td>15 Lb/In 14 Dan/5 Cm</td>
<td>14 Lb/In 13 Dan/5 Cm</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>324 X 271 Lb/In 308 X 258 Dan/5 Cm</td>
<td>397 X 373 Lb/In 378 X 363 Dan/5 Cm</td>
<td>500 X 400 Lb/In 476 X 389 Dan/5 Cm</td>
</tr>
<tr>
<td>Tear Strength</td>
<td>76 X 104 Lb/In 72 X 99 Dan/5 Cm</td>
<td>96 X 86 Lb/In 91 X 82 Dan/5 Cm</td>
<td>132 X 143 Lb/In 126 X 136 Dan/5 Cm</td>
</tr>
<tr>
<td>Hydrostatic</td>
<td>385 Lb/Sq In 2674 Kpa</td>
<td>385 Lb/Sq In 2674 Kpa</td>
<td>881 Lb/Sq In 6118 Kpa</td>
</tr>
</tbody>
</table>

External anchors may consist of 2” x 4” or 2½” minimum diameter wooden stakes, or 1.33 pounds/linear foot steel posts when Type I installation is used. When Type II or Type III installations are used, bottom anchors should be used.

Bottom anchors must be sufficient to hold the curtain in the same position relative to the bottom of the watercourse without interfering with the action of the curtain. The anchor may dig into the bottom (grappling hook, plow or fluke-type) or may be weighted (mushroom type) and should be attached to a floating anchor buoy via an anchor line. The anchor line would then run from the buoy to the top load line of the curtain. When used with Type III installations, these lines must contain enough slack to allow the buoy and curtain to float freely with tidal changes without pulling the buoy or curtain down and must be checked regularly to make sure they do not become entangled with debris. As previously noted, anchor spacing will vary with current velocity and expected wind and wave action. Manufacturer’s recommendations should be followed. See orientation of external anchors and anchor buoys for tidal installation in Figure FB-2.

Installing 2 parallel curtains, separated at regular intervals by 10 feet long wooden boards or lengths of pipe can increase the effectiveness of the barrier.
Figure FB-1  Type I and II Floating Turbidity Barriers
(Source: American Boom and Barrier Corp. product literature)
Figure FB-2  Type III Floating Turbidity Barrier
(Source: American Boom and Barrier Corp. product literature)
Figure FB-3  Typical Installation Layouts
(Source Florida Department of Transportation Road and Design Specifications)
Flocculant (FL)

Practice Definition

Flocculation is the chemical process of causing small, suspended soil particles to be drawn together to form “flocs”. These flocs more readily settle out compared to the individual particles due to their relatively greater mass. Products that cause flocculation of suspended soil particles (Flocculants) are often used to help polish, or minimize turbidity of stormwater runoff from construction sites. These products may contain both manufactured and natural polymers.

Planning Considerations

Products containing polyacrylamide (PAM) are commonly used in construction. PAM is a term describing a wide variety of chemicals based on the acrylamide unit. Products containing chitosan have also shown to be effective in reducing turbidity in stormwater runoff and are also commonly used in the US. Chitosan is a naturally occurring polymer.

When properly applied at the recommended rates, flocculants can be used as polishing agents to remove sediments from turbid runoff water on a construction site. If conventional erosion and sediment control are not being properly implemented to the fullest extent, flocculants will have little or no effect on the quality of the runoff from a construction site. Most flocculant products are available in emulsions, powders, gel bars, logs, tablets, and socks.
When including flocculant as a treatment option on a project, the following items must be addressed:

- Some states do not allow the use of flocculants for turbidity management. Flocculants are allowed in Alabama.
- Flocculant products should be tested for ecotoxicity and proven to not be toxic if used in accordance with the manufacturer’s recommended application rates.
- Material Safety Data Sheets (MSDS) should be stored and available onsite.
- Areas where flocculant is applied must drain to a sediment basin or other BMP that promotes settling for final flocculation prior to discharging from the site.
- Adequate mixing is necessary for flocculant to be fully effective. Passive treatment using the turbulent flow of water in a channel or at the outlet of a pipe as the mixing method is encouraged.
- Adequate time and laminar flow (calm flow) or ponding is necessary to promote effective and efficient flocculation.
- Flocculant must be reapplied as it becomes bound with sediment particles with each rain event or other new flow.
- Flocculants that are water soluble dissolve slowly and may require considerable agitation and time to dissolve.
- Soil tests, such the “jar test”, are required to ensure that the flocculant is properly matched with the anticipated soils suspended in the runoff.
- Manufacturer’s application or dosage rates and application instructions should be followed closely based on specific site conditions and soils.

**Design Criteria**

Flocculants mixed with water after heavy sediment loads and particles have been removed can greatly reduce turbidity and suspended solids concentrations. Flocculants are commonly used to passively treat construction stormwater runoff in a conveyance, within sediment basins, or with other sediment traps, barriers or other practices. Flocculants may also be used in conjunction with erosion control practices and products to better manage raindrop and rill erosion. Flocculant is also used as a part of active treatment systems. It is critical that precautions are taken to minimize the potential for over application of flocculant or the release of flocs into receiving waters.

The following basic guidelines, at a minimum, should be followed when specifying or using flocculant:

1. Completely understand any regulatory requirements concerning the use of flocculants.
2. Choose the appropriate flocculant for the soil type.
3. Choose flocculants deemed non-toxic based on toxicity reports related to the planned use.
4. Adhere to manufacturer recommendations and MSDS for specification and application.
5. Use flocculants in conjunction with other appropriate BMPs. Pretreatment to remove heavy loads and larger particles should take place in advance of flocculant introduction when possible.

6. Do not apply flocculants directly to streams, wetlands, or other waters of the state.

7. Provide provisions for capturing flocs prior to their entering receiving waters.

8. Use of multiple types of flocculants in the same watershed should be avoided. Without a full understanding of the chemical interactions of each flocculant there is a possibility the two flocculants could interact with each other, reducing the overall effectiveness.

9. Dry form (powder) may be applied by hand spreader or mechanical spreader. Mixing with dry silica sand will aid in spreading. Pre-mixing of dry form flocculants into fertilizer, seed or other soil amendments is allowable.

10. Solid forms of flocculant shall be applied following site testing results to ensure proper placement and performance and shall meet or exceed state and federal water quality requirements. Logs, blocks, and tablets must be installed up gradient from the sediment capture BMP. Solid forms of flocculant should be protected from the sun and remain hydrated if possible.

11. Some flocculants involves a two-component system and generally are provided in the form of “socks.” Manufacturer recommendations for installation and matching the components should be followed closely.

**Materials and Installation Requirements**

One of the key factors in making a flocculant work is to ensure that it is dissolved and thoroughly mixed with the runoff water, which can be accomplished in several ways. Introducing the flocculant to the runoff at a point of high velocity will help to provide the turbulence and mixing needed to maximize the suspended sediment exposure to the flocculant. Examples include a storm drain junction box where a pipe is dropping water, inside a slope drain, or other areas of falling or fast moving water upslope from a sediment capture BMP.

Another option for introducing flocculant into runoff involves running the water over a solid form of flocculant. Powders can be sprinkled on various practices such as check dams and materials, such as jute, coir, or other geotextiles. When wet, flocculants could become very sticky, and bind to the geotextile fabric. The product binds to the material, and resists removal by flowing water rendering it ineffective for turbidity control.

Flocculant logs are designed to be placed in flowing water to dissolve the flocculant from the log somewhat proportionately to flow. While using these solid forms does not have the same challenges as liquid forms, they do have drawbacks. The amount of flocculant released is not adjustable and is generally unknown, so the user has to adjust the system by moving or adding logs to get the desired effect. Because flocculant blocks can be sticky when wet, it can accumulate materials...
from the runoff and become coated, releasing little flocculant. The solid forms also tend to harden when allowed to dry. This causes less flocculant to be released initially during the next storm until the log becomes moist again.

To avoid these problems, the user must do two things to ensure flocculant releases from the solid form:

- Reduce sediment load in the runoff upstream of the flocculant location. This avoids burying the flocculant under accumulated sediment.
- Create constant flow across or onto the solid flocculant. The flow will help dissolve and mix the flocculant as well as prevent suspended solids from sticking to the product.
Rock Filter Dam (RD)

Practice Description

A rock filter dam is a stone embankment designed to help capture sediment in natural or constructed drainageways on construction sites. This practice can be used as a fore bay to a sediment basin to help capture coarser particles of sediment. It is usually located so that it intercepts runoff primarily from disturbed areas, is accessible for periodic sediment removal and does not interfere with construction activities.

Planning Considerations

Rock filter dams are used across drainageways to help remove coarser sediment particles and reduce off-site sediment delivery. Since rock filter dams are installed in flowing water, all local, state and federal laws and regulations must be followed during the design and construction process.

Dams should be designed so that impounded water behind the structures will not encroach on adjoining property owners or on other sediment and erosion control measures that outlet into the impoundment area.

Dams should be located so that the basin intercepts runoff primarily from disturbed areas, has adequate storage, and so that the basin can be accessed for sediment removal. Dams should also be located, as much as possible, in areas that do not interfere with construction activities.

Rock filter dams are not permanent structures. The design life of the structure is 3 years or less.
Design Criteria

Drainage Area

The drainage area above the dam should not exceed 10 acres.

Dam Height

The height of dam will be limited by the channel bank height or 8 feet, whichever is less. The dam height should also not exceed the elevation of the upstream property line. Water will bypass over the top of the dam and the back slope of the rock dam should be designed to be stable.

Spillway Capacity

The top of the dam should be designed to handle the peak runoff from a 10 year, 24 hour design storm with a maximum flow depth of 1 foot and freeboard of 1 foot. Therefore, the center portion of the dam should be at least 2 feet lower than the outer edges at the abutment. See Figure RD-1.

Dam Top Width

The minimum top width should be 6 feet. See Figure RD-2.

Dam Side Slopes

Side slopes should be 3:1 or flatter on the back slope and 2.5:1 or flatter on the front slope.

Outlet Protection

The downstream toe of the dam should be protected from erosion by placing larger stone on the back slope and a riprap apron at the toe. The apron should be placed on a zero grade with a riprap thickness of 1.5 feet. The apron should have a length equal to the height of the dam as a minimum and longer if needed to protect the toe of the dam.

Location

The dam should be located as close to the source of sediment as possible so that it will not cause water to back up onto adjoining property.

Basin Requirements

The basin behind the dam should provide a surface area that maximizes the sediment trapping efficiency. The basin should have a sediment storage capacity of 67 cubic yards per acre of drainage area.
Riprap Requirements

Stone for riprap should consist of field stone or rough unhewn quarry stone of approximately rectangular shape. The stone should be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it should be suitable in all other respects for the purpose intended. The specific gravity of the individual stones should be at least 2.5.

The minimum median stone size should be 9”. The gradation of rock to be used should be specified using Tables RD-1 and RD-2. Table RD-1 is used to determine the weight of the median stone size (d50). Using this median weight, a gradation can be selected from Table RD-2, which shows the commercially available riprap gradations as classified by the Alabama Department of Transportation.

The dam should be faced with 1 foot of smaller stone (½” to ¾” gravel) on the upstream side to increase efficiency for trapping coarser particles. Geotextile can also be added between the smaller stone and rock.

<table>
<thead>
<tr>
<th>Weight</th>
<th>Mean Spherical Diameter (ft)</th>
<th>Rectangular Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Length Width, Height (ft)</td>
</tr>
<tr>
<td>50</td>
<td>0.8</td>
<td>1.4 0.5</td>
</tr>
<tr>
<td>100</td>
<td>1.1</td>
<td>1.75 0.6</td>
</tr>
<tr>
<td>150</td>
<td>1.3</td>
<td>2.0 0.67</td>
</tr>
<tr>
<td>300</td>
<td>1.6</td>
<td>2.6 0.9</td>
</tr>
<tr>
<td>500</td>
<td>1.9</td>
<td>3.0 1.0</td>
</tr>
<tr>
<td>1000</td>
<td>2.2</td>
<td>3.7 1.25</td>
</tr>
<tr>
<td>1500</td>
<td>2.6</td>
<td>4.7 1.5</td>
</tr>
<tr>
<td>2000</td>
<td>2.75</td>
<td>5.4 1.8</td>
</tr>
<tr>
<td>4000</td>
<td>3.6</td>
<td>6.0 2.0</td>
</tr>
<tr>
<td>6000</td>
<td>4.0</td>
<td>6.9 2.3</td>
</tr>
<tr>
<td>8000</td>
<td>4.5</td>
<td>7.6 2.5</td>
</tr>
<tr>
<td>20000</td>
<td>6.1</td>
<td>10.0 3.3</td>
</tr>
</tbody>
</table>

Geotextiles

Non-woven geotextiles should be used as a separator between the graded stone, the soil base and the abutments. The geotextile shall be of the strength and durability required for the project to ensure the rock and soil base are stable. Generally, the non-woven geotextile should meet the requirements found in ASSHTO M288. Geotextile should be placed immediately adjacent to the subgrade without any voids between the fabric and the subgrade.
Table RD-2  Graded Riprap

<table>
<thead>
<tr>
<th>Class</th>
<th>$d_{10}$</th>
<th>$d_{15}$</th>
<th>$d_{25}$</th>
<th>$d_{50}$</th>
<th>$d_{75}$</th>
<th>$d_{90}$</th>
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<tr>
<td>1</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>80</td>
<td>-</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>25</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>500</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>500</td>
<td>1000</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
<td>200</td>
<td>1000</td>
<td>-</td>
<td>2000</td>
</tr>
</tbody>
</table>

Figure RD-1  Typical Front View of Rock Filter Dam

Figure RD-2  Typical Section of Rock Filter Dam
Sediment Barrier (SB)

Practice Description

A sediment barrier is a temporary structure used across a landscape mostly on the contour to reduce the quantity of sediment that is moving downslope. The most commonly used barrier is a silt fence (a geotextile fabric which is trenched into the ground and attached to supporting posts and possibly wire fence. Other barrier materials could include sand bags, wattles, and various man-made materials and devices that can be used in a similar manner as a silt fence.

This practice applies where sheet and rill erosion occurs on small disturbed areas. Barriers intercept runoff from upslope to form ponds that temporarily store runoff and allow sediment to settle out of the water and stay on the construction site.

Planning Considerations

Sediment barriers may be used on developing sites. It is most important that they be installed on the contour so that flow will not concentrate and cause bypassing by runoff going around the end of the barrier or overtopping because of lack of storage capacity.

The most commonly used sediment barriers are silt fences, and manufactured sediment logs (often referred to as wattles or sediment retention fiber roll). Manufactured sediment logs should be installed according to manufacturer’s recommendations.

The success of silt fences depends on a proper installation (on the contour with each end turned up slope) that causes the fence to develop maximum efficiency
of sediment trapping. Silt fences should be carefully installed to meet the intended purpose.

A silt fence is specifically designed to retain sediment transported by sheet flow from disturbed areas, while allowing water to pass through the fence. Silt fences should be installed to be stable under the flows expected from the site. Silt fences should not be installed across streams, ditches, waterways, or other concentrated flow areas.

Silt fences are composed of geotextile supported between steel or wooden posts. Silt fences are commercially available with geotextile attached to the post and can be rolled out and installed by driving the post into the ground. This type of silt fence is simple to install, but more expensive than some other installations. Silt fences must be trenched in at the bottom to prevent runoff from undermining the fence and developing rills under the fence. Locations with high runoff flows or velocities should use wire fence reinforcement.

A rather recent innovation that somewhat resembles a double silt fence and referred to as a “sediment retention barrier with flocculant” is used to reduce turbidity in the runoff that will reach sensitive sites. The measure consists of a double row of netting or high flow silt fences installed parallel with loose straw, woodchips or other organic fill spread between the rows and straw or other organic material laid on the ground adjacent to the downslope row (see following picture). An approved flocculant powder is added to the material between the rows and to the organic material below the downslope row prior to runoff events. The measure is located upstream of a filter strip or buffer zone and is installed on the contour. Design professionals should get details needed to design this measure from a qualified industry representative.

![Sediment retention barriers](image)

Sediment retention barriers may be used as a “last line of defense” against sediment leaving the construction site in sensitive areas. Do not use it in lieu of adequate erosion and sediment control practices.
Design Criteria (only for silt fence)

Silt fence installations are normally limited to situations in which only sheet or overland flow is expected because the practice cannot pass the volumes of water generated by channel flows. Silt fences are normally constructed of synthetic fabric (geotextile) and the life is expected to be the duration of most construction projects. Silt fence fabric should conform to the requirements of geotextile meeting the requirements found in ASSHTO M288.

The drainage area behind the silt fence should not exceed ¼ acre per 100 linear feet of silt fence for non-reinforced fence and ½ acre per 100 feet of wire reinforced fence. When all runoff from the drainage area is to be stored behind the fence (i.e. there is no stormwater disposal system in place) the maximum slope length behind the fence should not exceed those shown in Table SB-1.

Table SB-1  Slope Limitations for Silt Fence

<table>
<thead>
<tr>
<th>Land Slope (Percent)</th>
<th>Maximum Slope Length Above Fence (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>100</td>
</tr>
<tr>
<td>2 to 5</td>
<td>75</td>
</tr>
<tr>
<td>5 to 10</td>
<td>50</td>
</tr>
<tr>
<td>10 to 20*</td>
<td>25</td>
</tr>
<tr>
<td>&gt;20</td>
<td>15</td>
</tr>
</tbody>
</table>

*In areas where the slope is greater than 10%, a flat area length of 10 feet between the toe of the slope to the fence should be provided.

Type A Silt Fence

Type A fence is at least 32” above ground with wire reinforcements and is used on sites needing the highest degree of protection by a silt fence. The wire reinforcement is necessary because this type of silt fence is used for the highest flow situations and has almost 3 times the flow rate as Type B silt fence. Type A silt fence should be used where runoff flows or velocities are particularly high or where slopes exceed a vertical height of 10 feet. Staked tie backs on each end of a Type A silt fence may be necessary to prevent overturning.

Provide a riprap splash pad or other outlet protection device for any point where flow may overtop the sediment fence.

The silt fence should be installed as shown in Figure SB-1. Materials for posts and fasteners are shown in Tables SB-2 and SB-3. Details for overlap of Type A silt fence is available from The Alabama Department of Transportation construction drawings.
Table SB-2  Post Size for Silt Fence

<table>
<thead>
<tr>
<th>Minimum Length</th>
<th>Type of Post</th>
<th>Size of Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>5’</td>
<td>Steel “T” Post</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3lb./ft. min.</td>
</tr>
<tr>
<td>Type B</td>
<td>4’</td>
<td>Soft Wood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3” diameter or 2X4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5” X 1.5”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.3lb./ft. min.</td>
</tr>
<tr>
<td>Type C</td>
<td>3’</td>
<td>Soft Wood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oak</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2” diameter or 2X2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1” X 1”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.75lb./ft. min.</td>
</tr>
</tbody>
</table>

Table SB-3  Wood Post Fasteners for Silt Fence

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Crown</th>
<th>Legs</th>
<th>Staples/Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Staples</td>
<td>17 min.</td>
<td>¾” wide</td>
<td>½” long</td>
</tr>
<tr>
<td>Nails</td>
<td>14 min.</td>
<td>1”</td>
<td>¾” long</td>
</tr>
</tbody>
</table>

Type B Silt Fence

This 36” wide filter fabric should be used on developments where the life of the project is greater than or equal to 6 months.

The silt fence should be installed as shown in Figure SB-2. Materials for posts and fasteners are shown in Tables SB-2 and SB-3. Details for overlap of the silt fence and fastener placement are shown in Figure SB-4.

Type C Silt Fence

Though only 22” wide, this filter fabric allows the same flow rate as Type B silt fence. Type C silt fence should be limited to use on relatively minor projects, such as residential home sites or small commercial developments where permanent stabilization will be achieved in less than 6 months.

The silt fence should be installed as shown in Figure SB-3. Materials for posts and fasteners are shown in Tables SB-2 and SB-3. Details for overlap of the silt fence and fastener placement are shown in Figure SB-4.
Figure SB-1  Silt Fence-Type A
(For post material requirements see Tables SB-2 and SB-3)
Figure SB-2  Silt Fence - Type B

1. For post material requirements see Tables SB-2 and SB-3
Figure SB-3  Silt Fence – Type C

(1) For post material requirements see Tables SB-2 and SB-3
Chapter 4

Figure SB-4  Silt Fence Installation Details
Sediment Basin (SBN)

Practice Description

An earthen embankment suitably located to capture runoff, with an emergency spillway lined to prevent spillway erosion, interior porous baffles to reduce turbulence and evenly distribute flows, and equipped with a floating skimmer or other approved surface dewatering device that removes water from the top of the basin. Flocculants are commonly used with a sediment basin to increase sediment capture.

Planning Considerations

Sediment basins are needed where drainage areas are too large for other sediment control practices.

Select locations for basins during initial site evaluation. Locate basin so that sudden failure should not cause loss of life or serious property damage. Install sediment basins before any site grading takes place within the drainage area.

Select sediment basin sites to capture sediment from all areas that are not treated adequately by other sediment control measures. Always consider access for cleanout and disposal of the trapped sediment. Locations where a pond can be
formed by constructing a low dam across a natural swale are generally preferred to sites that require excavation. Where practical, divert sediment-free runoff away from the basin.

Because the emergency spillway is actually used relatively frequently, it is generally stabilized using geotextile and riprap that can withstand the expected flows without erosive velocities. The spillway should be placed as far from the inlet of the basin as possible to maximize sedimentation before discharge. The spillway should be located in natural ground (not over the embankment) to the greatest extent possible.

The use of approved flocculants properly introduced into the turbid runoff water at the inlet of the basin and/or at the first baffle should be considered to help polish the discharge from the basin for meeting turbidity requirements.

A fore bay or sump area prior to the basin should be considered for capture of heavier particles.

**Baffles**

Porous baffles effectively spread the flow across the entire width of a sediment basin or trap and cause increased deposition within the basin. Water flows through the baffle material, but is slowed sufficiently to back up the flow, causing it to spread across the entire width of the baffle (Figure SBN-1). Spreading the flow in this manner utilizes the full cross section of the basin and reduces turbulence which shortens the time required for sediment to be deposited.

The installation should be similar to a sediment barrier (silt fence) (Figure SBN-2) utilizing posts and wire backing. The most proven material for a baffle is 700 - 900 g/m² coir erosion blanket (See following picture). Other materials proven by research to be equivalent in this application may be used. A support wire or rope across the top will help prevent excessive sagging if the material is attached to it with appropriate ties. Another option is to use a sawhorse type of support with the legs stabilized with rebar inserted into the basin floor. These structures work well and can be prefabricated off site and quickly installed.

Baffles need to be installed correctly in order to fully provide their benefits. Refer to Figure SBN-2 and the following key points:

- The baffle material needs to be secured at the bottom and sides by using staples or stakes, trenching, or securing horizontally to the bottom. Flow should not be allowed under the baffle.
- Most of the sediment will accumulate in the first bay, so this should be readily accessible for maintenance.
Figure SBN-1  Porous baffle in a sediment basin
(from North Carolina Erosion and Sediment Control Planning and Design Manual.)

Figure SBN-2  Cross-section of a porous baffle in a sediment basin
Note there is no weir because the water flows through the baffle material
(from North Carolina Erosion and Sediment Control Planning and Design Manual.)
Basin Dewatering

Sediment basins should be dewatered from the surface. A device often used for this is a skimmer that withdraws water from the basin’s water surface, thus removing the highest quality water for delivery to the uncontrolled environment. One type of skimmer is shown in Figure SBN-3. By properly sizing the skimmer’s control orifice, the skimmer can be made to dewater a design hydrologic event in a prescribed period.

An advantage of the skimmer is that it can be reused on future projects. Skimmers are generally maintenance free, but may require occasional maintenance to remove debris from the orifice.

All basin dewatering devices must dewater the basin from the top of the water surface. The rate of dewatering must be controlled. A dewatering time of 48 to 120 hours (2 to 5 days) is required for the basin to function properly.
Figure SBN-3 Schematic of a skimmer
(from Pennsylvania Erosion and Sediment Pollution Control Manual, March, 2000)

**Design Criteria**

<table>
<thead>
<tr>
<th>Summary</th>
<th>Temporary Sediment Trap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Spillway:</td>
<td>Trapezoidal spillway with non-erosive lining.</td>
</tr>
<tr>
<td></td>
<td>10 – year, 24 – hour rainfall event</td>
</tr>
<tr>
<td>Recommended Maximum Drainage Area:</td>
<td>10 acres</td>
</tr>
<tr>
<td>Minimum Volume:</td>
<td>3,600 cubic feet per acre of drainage area</td>
</tr>
<tr>
<td>Minimum L/W Ratio:</td>
<td>2:1</td>
</tr>
<tr>
<td>Minimum Depth:</td>
<td>2 feet</td>
</tr>
<tr>
<td>Dewatering Mechanism:</td>
<td>Skimmer(s) or other approved basin dewatering device.</td>
</tr>
<tr>
<td>Dewatering Time:</td>
<td>2 – 5 days</td>
</tr>
<tr>
<td>Baffles Required:</td>
<td>3</td>
</tr>
</tbody>
</table>

**Compliance with Laws and Regulations**

Design and construction should comply with state and local laws, ordinances, rules and regulations.
Design Basin Life

Structures intended for more than 3 years of use should be designed as permanent structures. Procedures outlined in this section do not apply to permanent structures.

Dam Height

In order to ensure public safety, the maximum dam height should be 10 feet, measured from the designed (settled) top elevation of the dam to the lowest point at the downstream toe.

Drainage Area

In order to minimize risk to the public and environment, the maximum drainage area for each sediment basin should be minimized. The recommended maximum drainage area is 10 acres. The absolute maximum drainage area should be 100 acres.

Basin Locations

Select areas that:
- Are not intermittent or perennial streams
- Allow a maximum amount of construction runoff to be brought into the structure
- Provide capacity for storage of sediment from as much of the planned disturbed area as practical
- Exclude runoff from undisturbed areas where practical
- Provide access for sediment removal throughout the life of the project
- Interfere minimally with construction activities

Basin Shape

Ensure that the flow length to basin width ratio is 2:1 or larger to improve trapping efficiency. Length is measured at the elevation associated with the minimum storage volume. Generally, the bottom of the basin should be level to ensure the baffles function properly. The area between the inlet and first baffle can be designed with reverse grade to improve the trapping efficiency.

Research has shown that the surface area of the basin should be maximized to improve trapping efficiency. Results of tests show that a surface area of 435 sq. ft. per CFS (peak discharge for the 10-year, 24-hour event), is needed for effective trapping efficiency.
Storage Volume

Ensure that the sediment storage volume of the basin is at least 3,600 cubic feet per acre for the area draining into the basin. Volume is measured below the emergency spillway crest. Remove sediment from the basin when approximately one-half of the storage volume has been filled.

Baffles

Space the baffles to create equal zones of volume within the basin.

The top of the baffle should be the same elevation as the maximum water depth flowing through the emergency spillway. Baffles are most effective at a height of 3 feet; however, site conditions may warrant taller baffles.

Baffles should be designed to go up the sides of the basin banks so water does not flow around the baffles. Most of the sediment will be captured in the inlet zone. Smaller particle size sediments are captured in the latter cells.

The design life of the fabric can be up to 3 years, but may need to be replaced more often if damaged or clogged.

Spillway Capacity

The emergency spillway system must carry the peak runoff from the 10-year 24-hour storm with a minimum 1 foot of freeboard (distance between the surface of the water with the spillway flowing full and the top of the embankment). Base runoff computations on the most severe soil cover conditions expected in the drainage area during the effective life of the structure.

Sediment Cleanout Elevation

Determine the elevation at which the invert of the basin would be half-full. This elevation should also be marked in the field with a permanent stake set at this ground elevation (not the top of the stake).

Basin Dewatering

The basin should be provided with a surface outlet. A floating skimmer should be attached to a Schedule 40 PVC barrel pipe of the same diameter as the skimmer arm. The skimmer apparatus will control the rate of dewatering. The skimmer should be sized to dewater the basin in 48-120 hours (2-5 days). The barrel pipe should be located under the embankment with at least one anti-seep collar at the center of the embankment projecting a minimum of 1.5 ft in all directions from the pipe. A drainage diaphragm can be used in lieu of an anti-seep collar. The barrel pipe outlet must be stable and not cause erosion.
Skimmer Orifice Diameter

Skimmer Selection Procedure

The manufacturer’s skimmer performance charts are recommended for use in selecting skimmers for use in dewatering sediment control basins. Always verify performance with the manufacturer’s information.

Required input data:
- Basin volume = __________ ft³
- Desired dewatering time = __________ days

Procedure:
1. First use the basin volume (ft³) and the desired dewatering time (days) and determine the required skimmer outflow rate in cubic feet per day (ft³/d) from the following equation

   \[ Q = \frac{V}{t_d} \]

2. Scan the manufacturer’s skimmer performance charts and select the (a) skimmer size and (b) the skimmer orifice diameter (in inches) if desired.

Example: Select a skimmer that will dewater a 20,000 ft³ sediment basin in 3 days.

Solution: First compute the required outflow rate as

\[ Q = \frac{V}{t_d} = \frac{20000 \text{ ft}^3}{3 \text{ days}} = 6670 \text{ ft}^3 \text{ / d} \]

Now go to the manufacturer’s selection charts and select an appropriate skimmer. For example, a 2-inch skimmer with no orifice could have an outflow rate of 5,429 ft³/d, which will require about 3.5 days to dewater the basin. A 4-inch skimmer with a 2.5 inch diameter orifice could have an outflow rate of 8,181 ft³/d and dewater the basin in about 2.5 days.
**Example: A More Precise Alternative:** Most skimmers come with a plastic plug that can be drilled forming a hole that will limit the skimmer’s outflow to any desired rate. Thus, for a specific skimmer the orifice that will dewater a basin in a more precisely chosen time can be determined. The flow through an orifice can be computed as

\[ Q = CA\sqrt{2gH} \]

where \( C \) is the orifice coefficient (usually taken to be 0.6), \( A \) is the orifice cross-sectional area in \( \text{ft}^2 \), \( g \) is the acceleration of gravity (32.2 \( \text{ft/sec}^2 \)), and \( H \) is the driving head on the orifice center in feet. The orifice equation can be simplified to yield the orifice flow in gpm using the diameter \( D \) (in inches) and the head in feet as

\[ Q = 12D^2\sqrt{H} \text{ gpm}. \]

Or the orifice flow in \( \text{ft}^3/\text{d} \) using the diameter \( D \) (in inches) and the head in feet as

\[ Q = 2310D^2\sqrt{H} \text{ ft}^3/\text{d}. \]

If we solve the orifice equation for the orifice diameter using the desired outflow rate (6670 \( \text{ft}^3/\text{d} \)) and the head driving water through the skimmer (0.333 ft for a 4-inch skimmer) as

\[ D = \frac{Q}{2310\sqrt{H}} = \frac{6670}{2310\sqrt{0.333}} = 2.24 \text{ inches} \]

We see that if the plastic plug were drilled to a diameter of 2.24 inches and placed in a 4-inch skimmer, the dewater rate would be 6,670 \( \text{ft}^3/\text{d} \) and the 20,000 \( \text{ft}^3 \) basin would dewater in 3 days.

**Outlet Protection**

Provide outlet protection to ensure erosion does not occur at the pipe outlet.

**Basin Emergency Spillway**

The emergency spillway should carry the peak runoff from a 10-year storm. The spillway should have a minimum 10 foot bottom width, 0.5 foot flow depth, and 1 foot freeboard above the design water surface.

Construct the entire flow area of the spillway in undisturbed soil to the greatest extent possible. Cross section should be trapezoidal, with side slopes 3:1 or flatter for grass spillways (Figure SBN-4) and 2:1 for riprap. Select vegetated lining to meet flow requirements and site conditions.
Figure SBN-4 Excavated grass spillway views

Note: Neither the location nor the alignment of the control section has to coincide with the centerline of the dam.
Inlet Section

Ensure that the approach section has a slope toward the impoundment area of not less than 2% and is flared at its entrance, gradually reducing to the design width of the control section. The inlet portion of the spillway may be curved to improve alignment.

The Control Section

The control section of the spillway should be level and straight and at least 20 ft long for grass spillways and 10 feet for riprap. Determine the width and depth for the required capacity and site conditions. Wide, shallow spillways are preferred because they reduce outlet velocities.

The Outlet Section

The outlet section of the spillway should be straight, aligned and sloped to assure supercritical flow with exit velocities not exceeding values acceptable for site conditions.

Outlet Velocity

Ensure that the velocity of flow from the basin is nonerosive for existing site conditions. It may be necessary to stabilize the downstream areas or the receiving channels.

Embankment

Embankments should not exceed 10 feet in height, measured at the center line from the original ground surface to the designed (settled) top elevation of the embankment. Keep a minimum of 1 foot between the designed (settled) top of the dam and the design water level in the emergency spillway. Additional freeboard may be added to the embankment height which allows flow through a designated bypass location. Construct embankments with a minimum top width of 8 feet and side slopes of 2.5:1 or flatter.

There should be a cutoff trench in stable soil material under the dam at the centerline. The trench should be at least 2 feet deep with 1.5:1 side slopes, and sufficiently wide (at least 8 ft.) to allow compaction by machine.

Embankment material should be a stable mineral soil, free of roots, woody vegetation, rocks or other objectionable materials, with adequate moisture for compaction. Place fill in 9-inch layers through the length of dam and compact by routing construction hauling equipment over it. Maintain moisture and compaction requirements according to the plans and specifications. Hauling or compaction equipment must traverse each layer so that the entire surface has been compacted by at least one pass of the equipment wheels or tracks.
Excavation

Where sediment pools are formed or enlarged by excavation, keep side slopes at 2:1 or flatter for safety.

Erosion Protection

Minimize the area disturbed during construction. Divert surface water from disturbed areas. When possible, delay clearing the sediment impoundment area until the dam is in place. Keep the remaining temporary pool area undisturbed. Stabilize the spillway, embankment, and all disturbed areas with permanent vegetation. The basin bottom should also be established to a vegetative cover as this promotes sediment deposition.

Trap Efficiency

Improve sediment basin trapping efficiency by employing the following considerations in the basin design:

- Surface area—In the design of the settling pond, allow the largest surface area possible. The shallower the pool, the better.
- Length—Maximize the length-to-width ratio of the basin to provide the longest flow path possible.
- Baffles—Provide a minimum of three porous baffles to evenly distribute flow across the basin and reduce turbulence.
- Inlets—Area between the sediment inlets and the basin bottom should be stabilized by geotextile material, riprap with geotextile, a pipe drop, or other similar methods (Figure SBN-5 shows the area with rocks). Inlets to basin should be located the greatest distance possible from the spillway.
- Dewatering—Allow the maximum reasonable detention period before the basin is completely dewatered (at least 48 hours).
- Inflow rate—Reduce the inflow velocity to nonerosive rates and divert all sediment-free runoff
- Establish permanent vegetation in the bottom and side slopes of the basin.
- Introduce the appropriate PAM material either at the turbulent entrance of the runoff water into the basin and/or apply to the first baffle. Apply the PAM according to manufacturer’s recommendations.

Safety

Avoid steep side slopes. Fence basins properly and mark them with warning signs if trespassing is likely. Follow all State and local safety requirements.
Figure SBN-5  Example of a sediment basin with a skimmer outlet and emergency spillway  
Design Procedure

**Step 1.** Determine peak flow, $Q_{10}$, for the basin drainage area utilizing the NRCS runoff curve number method.

**Step 2.** Determine any site limitations for the sediment pool elevation, emergency spillway or top of the dam.

**Step 3.** Determine basin volumes:

- Compute minimum volume required ($3,600 \text{ ft}^3$/acre of drainage area).
- Specify sediment cleanout level to be clearly marked (one-half the design volume). Specify that the basin area is to be cleared after the dam is built.

**Step 4.** Determine area of basin, shape of basin, and baffles:

- Check length/width ratio (should be 2:1 or larger) and the surface area ($435 \text{ sq.ft.}/Q_{10}$).
- Ensure the bottom of the basin is level.
- Design and locate a minimum of 3 coir baffles. The baffle spacing should produce equal volumes of storage within the basin when the basin is full. The top elevation of the baffles will be set in Step 7.

**Step 5.** Size the skimmer, skimmer orifice, and barrel pipe.

Use Table SBN-1 or the precise alternative design to size the orifice. Generally, a Schedule 40 PVC barrel pipe the same size as the skimmer arm is used under the embankment.

**Step 6.** Design the anti-seep collar.

Ensure that antiseep collar is no closer than 2 ft from a pipe joint and as close to the center of the embankment as possible. Collar must project at least 1.5 ft from the pipe and be watertight.

**Step 7.** Determine the emergency spillway dimensions.

Size the spillway bottom width and flow depth to handle the $Q_{10}$ peak flow. Tables SBN-1 and SBN-2 can be used for the design process for grassed emergency spillways. Use appropriate design procedures for spillways with other surfaces. Set top of baffles at the elevation of the designed maximum flow depth of the emergency spillway.

**Step 8.** Spillway approach section.

Adjust the spillway alignment so that the control section and outlet section are straight. The entrance width should be 1.5 times the width of the control section with a smooth transition to the width of the control section. Approach channel should slope toward the reservoir no less than 2%. 

Step 9. Spillway control section.

- Locate the control section in natural ground to the greatest extent possible.
- Keep a level area to extend at least 20 ft (grass) or 10 ft (riprap) upstream from the outlet end of the control section to ensure a straight alignment.
- Side slopes should be 3:1 (grass) or 2:1 (riprap).

Step 10. Design spillway exit section.

- Spillway exit should align with the control section and have the same bottom width and side slopes.
- Slope should be sufficient to maintain supercritical flow, but make sure it does not create erosive velocities for site conditions. (Stay within slope ranges in appropriate design tables.)
- Extend the exit channel to a point where the water may be released without damage.

Step 11. Size the embankment.

- Set the design elevation of the top of the dam a minimum of 1 ft above the water surface for the design flow in the emergency spillway.
- Constructed height should be 10% greater than the design to allow for settlement.
- Set side slopes 2.5:1 or flatter.
- Determine depth of cutoff trench from site borings. It should extend to a stable, tight soil layer (a minimum of 2 ft deep).
- Select borrow site remembering that the spillway cut may provide a significant amount of fill.

Step 12. Erosion control

- Select surface stabilization measures to control erosion.
- Select groundcover for emergency spillway to provide protection for design flow velocity and site conditions. Riprap stone over geotextile fabric may be required in erodible soils or when the spillway is not in undisturbed soils.
- Establish all disturbed areas including the basin bottom and side slopes to vegetation.


- Construct a fence and install warning signs as needed.
### Table SBN-1  Design Table for Vegetated Spillways Excavated in Erosion Resistant Soils (side slopes 3 horizontal: 1 vertical)

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<th>Slope Range</th>
<th>Bottom Width Feet</th>
<th>Stage Feet</th>
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### Example of Table Use:

Given: Discharge, $Q_{10} = 87$ cfs, Spillway slope (exit section) = 4%.
Find: Bottom Width and Stage in Spillway.
Procedure: Using a discharge of 90 cfs, note that the spillway (exit section) slope falls within slope ranges corresponding to bottom widths of 24, 28, and 32 ft. Use bottom width of 32 ft, to minimize velocity. Stage in the spillway is 1.14 ft.
Note: Computations are based on: Roughness coefficient, $n = 0.40$ and a maximum velocity of 5.50 ft. per sec.
### Table SBN-2 Design Table for Vegetated Spillways Excavated in Very Erodible Soils
(side slopes 3 horizontal: 1 vertical)

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**Example of Table Use:**

Given: Discharge, Q₁₀ = 38 cfs, Spillway slope (exit section) = 4%.
Find: Bottom Width and Stage in Spillway.
Procedure: Using a discharge of 40 cfs, note that the spillway (exit section) slope falls within slope ranges corresponding to bottom widths of 36 and 40 ft. Use bottom width of 40 ft, to minimize velocity. Stage in the spillway is 0.64 ft.
Note: Computations are based on: Roughness coefficient, n = 0.40 and a maximum velocity of 3.50 ft. per sec.
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Sediment Trap (ST)

Practice Description

A sediment trap is a temporary catch basin used for the purpose of intercepting and detaining small amounts of sediment to prevent it from leaving the construction site. This practice applies within disturbed areas with very small drainage basins that are subject to sheet erosion or in minor swales. Various materials may be used for sediment traps and include straw bales, sand bags, wattles, and various man-made materials and devices.

Planning Considerations

Note: Straw bales are the only sediment trap material covered in this handbook.

In certain situations, straw bales can be used as an alternative to silt fence for trapping sediment. The practice should only be used to trap sediment for a short duration from very small drainage areas. Straw bales comparatively low flow rate should be considered before choosing to use this practice. Ponding above the bales can occur rapidly due to the low flow rate. Overtopping and bypass of the bales can cause significant damage to the site. Additional measures should be used if turbidity leaving the site served by this practice is an issue.
Design Criteria

Drainage Area

For disturbed areas subject to sheet erosion the drainage area should be restricted to ¼ acre per 100 feet of trap. The slope length behind the trap should be restricted according to Table ST-1.

Table ST-1 Criteria for Straw or Hay Bale Placement

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<th>Land Slope (Percent)</th>
<th>Maximum Slope Length Above Bale (Feet)</th>
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<tr>
<td>&gt;20</td>
<td>10</td>
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Bale Size

Bales should be 14” x 18” x 36”.

Anchors

Two 36” long (minimum) 2” x 2” hardwood stakes should be driven through each bale after the bales are properly entranced. Alternate anchors can be 2 pieces of no.4 steel rebar, 36” long (minimum). See Figure ST-1 for details on proper installation of straw bales.

Effective Life

Straw and hay bales have a relatively short period of usefulness and should not be used if the project duration is expected to exceed 3 months. Bale placement should result in the twine or cord being on the side and not the bottom of the bale.

Location

This practice should be used on nearly level ground and be placed at least 10 feet from the toe of any slope. The barrier should follow the land contour. The practice should never be used in live streams or in swales where there is a possibility of washout. The practice should also not be used in areas where rock or hard surfaces prevent the full and uniform anchoring of the bales.
Figure ST-1  Anchoring Technique for Straw Bales

Note:
- Anchor and embed into soil to prevent washout or water working under barrier.
- Repair or replacement must be made promptly as needed.