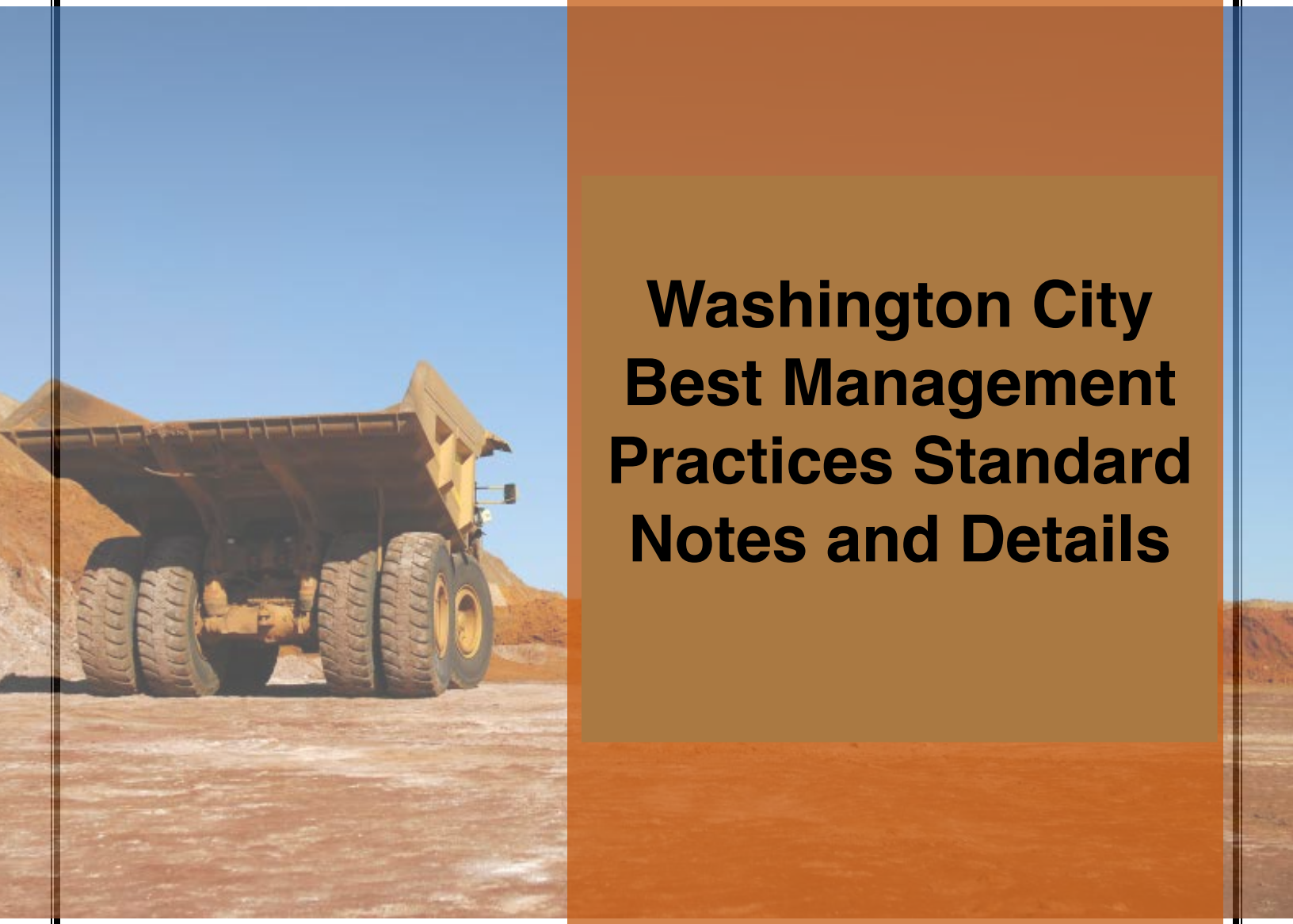
Washington City
Where Dixie Begins



Washington City Best Management Practices Standard Notes and Details

Prepared by:

ALLIANCE CONSULTING

A Planning and Engineering Firm

Appendix C:
Washington City Best Management Practices
Standard Notes and Details

CD: Check Dams

Description & Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales
- In small open channels that drain 10 acres or less
- In steep channels where stormwater runoff velocities exceed 5 ft/s
- During the establishment of grass linings in drainage ditches or channels
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows
- Not appropriate in channels that drain areas greater than 10 acres
- Not appropriate in channels that are already grass-lined unless ersoion is expected, as installation may damage vegetation
- Require extensive maintenance following high velocity flows
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Objectives

EC	Erosion Control
SE	Sediment Control

Potential Alternatives

FR	Fiber Rolls
GB	Gravel Bag Berm
SB	Sandbag Barrier

Implementation

General
Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. As sediment trap (ST) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout
Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity must be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Don't use check dams. Consider alternative BMPs
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower that the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of log or lumber and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Due to their high failure rate, check dams should not be constructed from straw bales or silt fences since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawing at the end of the BMP fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions. If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%.

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- Backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be re-suspended in subsequent storms, the sediment trap must be cleaned following each storm event.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.
- Gravel bags may be used as check dams with the following specifications:

Materials
Gravel bags used for check dams should conform to the requirements of GB, Gravel Bag Berms. Sandbags used for check dams should conform to SB, Sandbag Barrier. Fiber rolls used for check dams should conform to FR, Fiber Rolls.

Do. *Properly installed series of check dams creating settling ponds and slowing water velocity.*

Don't. *Straw or Hay bales should not be used as check dams. Even if "properly" installed, they have a high failure rate.*

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section.
- Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls and straw bales must be trenched in and firmly staked in place.

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Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

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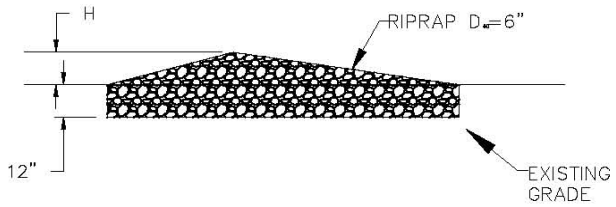
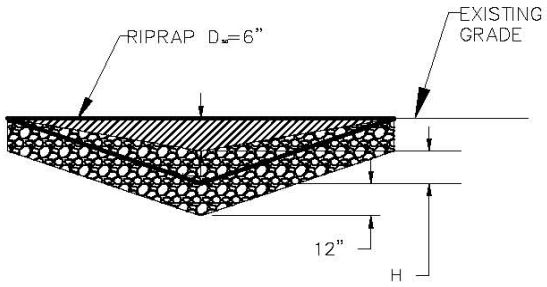
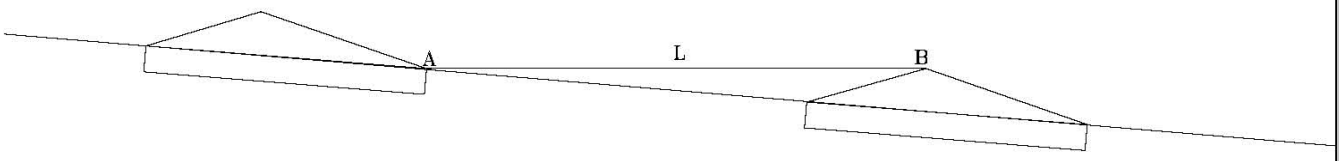
CHECK DAM





A. ROCK DAM



L=THE DISTANCE SUCH THAT POINTS A AND B ARE AT THE SAME ELEVATION.

B. SPACING CHECK DAM

HM: Hydraulic Mulch

Description & Purpose

Hydraulic mulch consists of applying a mixture of shredded wood fiber of a hydraulic matrix, and a stabilizing emulsion of tackifier with hydro-mulching equipment, which temporarily protects exposed soil from erosion by raindrop impact or wind.

Suitable Applications

Hydraulic Mulching may be appropriate in the following situations:

- Disturbed areas requiring temporary protection until permanent stabilization is established
- Disturbed areas that will be re-disturbed following an extended period of time.

Limitations

- Hydraulic mulches are generally short lived
- A minimum of 24 hours is required for drying before effective
- May required more than one application to last a full rainy season

Objectives

EC	Erosion Control
WE	Wind Erosion Control

Potential Alternatives

HS	Hydroseeding
GM	Geotextiles and Mats
WM	Wood Mulch
SM	Straw Mulch
SLB	Soil Binders

Implementation

General
Prior to application, roughen embankment and fill areas by rolling crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.

To be effective, hydraulic matrices require 24 hours to dry before rainfall occurs.

Avoid mulch spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Paper based hydraulic mulches alone shall not be used for erosion control.

Hydraulic Mulches
Wood fiber much can be applied alone or as a component of hydraulic matrices. Wood fiber applied alone is typically applied at the rate of 2,000 to 4,000 lb/acre. Wood fiber mulch is manufactured from wood or wood waste from lumber mills of from urban sources.

Hydraulic Matrices
Hydraulic matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder. Apply as a liquid slurry using a hydraulic application machine (i.e., hydro seeder) at the following minimum rates, or as specified by the manufacturer to achieve complete coverage of the target area: 2,000 to 4,000 lbs/acre wood fiber mulch, and 5 to 10% (by weight) of tackifier (acrylic copolymer, guar, psyllium, etc.)

Bonded Fiber Matrix
Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation and prevents soil erosion. BFM's are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should no dissolve or disperse upon re-wetting. Typically, biodegradable BFM's should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damager will require re-application of BMPs.
- Maintain an unbroken, temporary mulched ground cover throughout the period of construction.

HS: Hydroseeding

Description & Purpose

Hydroseeding typically consists of applying a mixture of wood fiber, seed fertilizer, and stabilizing emulsion with hydro-mulch equipment, to temporarily protect exposed soils from erosion by water and wind.

Suitable Applications

Hydroseeding may be appropriate in the following situations:

- Disturbed areas requiring temporary protection until permanent stabilization is established
- Disturbed areas that will be re-disturbed following an extended period of time.

Limitations

- May be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydroseeding must be used in conjunction with mulching (i.e., straw mulch).
- Steep slopes are difficult to protect with temporary seeding
- Temporary seeding may not be appropriate in dry periods without supplemental irrigation
- Temporary vegetation may have to be removed before permanent vegetation is applied
- Temporary vegetation is not appropriate for short term inactivity.

Objectives

EC	Erosion Control
WE	Wind Erosion Control

Potential Alternatives

HM	Hydraulic Mulch
GM	Geotextiles and Mats
WM	Wood Mulch
SM	Straw Mulch
SLB	Soil Binders

Implementation

General
In order to select appropriate hydroseeding mixtures, and evaluation of site conditions shall be performed with respect to:

- Soil Condition
- Site Topography
- Season and climate
- Vegetation types
- Maintenance requirements
- Sensitive adjacent areas
- Water availability
- Plans for permanent vegetation

The local office of the U.S.D.A. Natural Resource Conservation Service (NRCS) is an excellent source of information on appropriate seed mixes.

The following steps shall be followed for implementation:

- Avoid use of hydroseeding in areas where the BMP would be incompatible with future earth work activities and would have to be removed.
- Hydroseeding can be accomplished using a multiple step or one step process. The multiple step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture of fiber, seed, etc, the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.
- Prior to application, roughen the area to be seeded with the furrows trending along the contours.
- Apply a straw mulch to keep seeds in place and to moderate soil moisture and temperature until the seeds germinate and grow.
- Commercial fertilizer shall conform to the requirements of the Utah Food and Agricultural codes. Fertilizers shall be pelleted or granular form.
- Follow up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damager will require re-application of BMPs.
- Where seeds fail to germinate, or the germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than half the original application rates.
- Irrigation systems, if applicable, should be inspected daily while in use to identify system malfunctions and line breaks. When line breaks are detected, the system must be shut down immediately and breaks repaired before the system is put back into operation.
- Irrigation systems shall be inspected for complete coverage and adjusted as needed to maintain complete coverage.

SLB: Soil Binders

Description & Purpose

Soil binders consist of applying and maintaining a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water induced erosion of exposed soils on construction sites. Soil binders also prevent wind erosion.

Suitable Applications

Soil Binders may be appropriate in the following situations:

- Disturbed areas requiring short term temporary protection until permanent stabilization is established.
- Because soil binders can often be incorporated into the work, they are good alternatives to mulches where grading activities will soon resume.
- Stockpiles.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after storm events.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down the slope.
- Soil binders do not hold up to pedestrian or vehicular traffic across treated areas.
- Soil binders may not penetrate soil surfaces made up primarily of silt and clay, particularly when compacted.
- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.
- Soil binders may not cure if low temperatures occur within 24 hours after application.
- The water quality impacts of soil binders are relatively unknown and some may have water quality impacts due to their chemical makeup.
- A sampling and analysis plan must be incorporated into the Grading Plan as soil binders could be a source of non-visible pollutants.

Objectives

EC	Erosion Control
WE	Wind Erosion Control

Potential Alternatives

HM	Hydraulic Mulch
GM	Geotextiles and Mats
WM	Wood Mulch
SM	Straw Mulch
HS	Hydroseeding

Implementation

General

- Regional soil types will dictate appropriate soil binder to be used.
- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Soil binders should not pollute stormwater.
- Some soil binders may not be compatible with existing vegetation.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.
- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

Selection a Soil Binder

Properties of common soil binders used for erosion control are provided on Table 1 ate the end of this BMP. Use Table 1 to select an appropriate soil binder.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation – Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders
- Soil types and surface materials – Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application – The frequency of application can be affected by subgrade conditions, surface type, climate, and maintenance schedule. Frequent application could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean up.

Plant-Material Based (Short Lived) Binders

Guar – Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It should be mixed with water at the rate of 11 to 15 lb per 1,000 gallons. Recommended minimum application rates are as follows:

Slope (H:V)	Flat	4:1	3:1	2:1	1:1
lb/acre	40	45	50	60	70

Psyllium - Psyllium is composed of the finely ground mucilloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates should be from 80 to 200 lb/acre, with enough water in solution to allow for a uniform slurry.

Starch – Starch is a non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 lb/acre. Approximate drying time is 9 to 12 hours.

Plant-Material Based (Long Lived) Binder

Pitch and Rosin Emulsion – Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and should be applied as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil: 10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

Polymeric Emulsion Blend Binders

Acrylic Copolymers and Polymers – Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain and anti-foaming agent. The polymeric emulsion should not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should re-emulsify when cured. The applied compound should air cure within a maximum of 36 to 48 hours. Liquid copolymer should be diluted at rate of 10 parts water to 1 part polymer and the mixture applied to soil at a rate of 1,175 gallon/acre.

Liquid Polymers of Methacrylates and Acrylates – This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization application, it is diluted with water in accordance with manufacturer's recommendations and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after application.

Copolymers of Sodium Acrylates and Acrylamides – These materials are non-toxic, dry powders that are nopolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rats that are determined by slope gradient:

Slope Gradient (H:V)	lb/acre
Flat to 5:1	3.0 – 5.0
5:1 to 3:1	5.0 – 10.0
2:1 to 1:1	10.0 – 20.0

Polyacrylamide and Copolymer of Acrylamide – Linear copolymer polyacrilamide is packaged as a dry flowable solid. When used as a stand-alone stabilizer, it is diluted at a rate of 11 lb/1,000 gal of water and applied at the rate of 5.0 lb/acre.

Hydro-Colloid Polymers - Hydro-Colloid Polymers are various combinations of dry flowable polyacrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 lb/acre. Drying time is 0 to 4 hours.

Cementitious-Based Binders

Gypsum – This is a formulated gypsum-based product that readily mixes with water and much to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in hydraulic seeder and applied at rates 4,000 to 12,000 lb/acre. Drying time is 4 to 8 hours.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. In general, the following steps should be followed:

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.
- Prior to application, roughen embankment and fill areas,
- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should no be applied during or immediately before rainfall.
- Avoid over spray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Soil binders should not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 40°F during the curing period.
- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.
- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacture's instructions for specific cure time.
- For liquid agents:
  - Crown or slope ground to avoid ponding.
  - Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 or according to manufacturer's recommendations
  - Apply solution under pressure. Overlap solution 6 to 12 in.
  - Allow treated area to cure for the time recommended by the manufacturer; typically, at least 24 hours.
  - Apply second treatment before first treatment becomes ineffective, using 50% application rate
  - In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damager will require re-application of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

Table 1 Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	**Plant Material Based (Long Lived)**	**Polymeric Emulsion Blends**	**Cementitious-Based Binders**
Relative Cost	Low	Low	Low	Low
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time Before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/Chemically Degradable	Photodegradable/Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies[(1)]	Varies[(1)]	Varies[(1)]	4,000 to 12,000 lbs/acre

[(1)] See Implementation for Specific Rates.

SM: Straw Mulch

Description & Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soul with a studded roller or anchoring it with a tackifier stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.

Suitable Applications

Straw Mulching may be appropriate in the following situations:

- A disturbed area requiring temporary protection until permanent stabilization is established.
- For disturbed areas requiring protection until permanent vegetation is installed.
- In combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of straw and straw blowing equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- There is a potential for introduction of weed seed and unwanted plant material.
- May required more than one application to last a full rainy season
- When straw blowers are used to apply straw mulch, the treatment areas must be within 150 ft of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.
- Wind may limit application of straw and blow straw into undesired locations.
- May have to be removed prior to permanent seeding or prior to further earthwork.
- "Punching" of straw does not work in sandy soils, necessitating the use of tackifiers.

Objectives

EC	Erosion Control

Potential Alternatives

HS	Hydroseeding
GM	Geotextiles and Mats
WM	Wood Mulch
HM	Hydraulic Mulch
SLB	Soil Binders

Implementation

General

- Straw shall be derived from wheat, rice, or barley. Where required by the plans, specifications, permits, or environmental documents, native grass straw shall be used.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track walking may be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.
- Avoid placing straw onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.
- Use of straw near wood frame home construction may be frowned on by the fire marshal.

Application Procedure

- Apply straw at a minimum rate of 4,000 lbs/acre, either by machine or by hand distribution.
- Roughen embankments and fill rills before placing the straw mulch by rolling with a crimping or punching type roller or by track walking.
- Evenly distributing straw mulch on the soil surface.
- Anchor straw mulch to the soil surface by "punching" it into the soil mechanically (incorporating). Alternatively, use tackifier to adhere straw fibers.
- Methods for holding straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity.
    - On small areas, a spade or shovel can be used to punch in straw mulch.
    - On slopes with soil that are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife blade roller or a straight bladed coulter, known commercially as a "crimper".
    - On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using 11-gauge wire staples, geotextile pins or wooden stakes as described in GM, Geotextiles and Mats.
    - A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place. A tackifier is typically applied at a rate of 125 lb/acre. In windy conditions, the rates are typically 180 lbs/acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damager will require re-application of BMPs.
- The key consideration in inspection and maintenance is that the straw needs to last long enough to achieve erosion control objectives.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are inactive. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required to maintain effective soil stabilization over disturbed areas and slopes.

WM: Wood Mulch

Description & Purpose

Wood mulching consists of applying a mixture of shredded wood mulch, bark, or compost to disturbed soils. The primary Function of wood mulching is to reduce erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff.

Suitable Applications

Wood Mulching may be appropriate in the following situations:

- A disturbed area requiring temporary protection until permanent stabilization is established.

Limitations

- Not suitable for use on slopes steeper than 3:1 (H:V). Best suited to flat areas or gentle slopes or 5:1(H:V) or flatter
- Wood much and compost may introduce unwanted species.
- Not suitable for areas exposed to concentrated flows.
- May need to be removed prior to further earthwork.

Objectives

EC	Erosion Control
WE	Wind Erosion

Potential Alternatives

HS	Hydroseeding
GM	Geotextiles and Mats
SM	Straw Mulch
HM	Hydraulic Mulch
SLB	Soil Binders

Implementation

Mulch Section
There are many types of mulches. Selection of the appropriate typed of mulch should be based on the type of application, site condition, and compatibility with planned or future uses.

Application Procedure
Prior to application, existing vegetation has been removed, roughen embankment and fill areas by rolling with a device such as a punching type roller or by track walking. The construction application procedures for mulches vary significantly depending upon the type of mulching method specified. Two methods are highlighted here:

- Green Material – This type of mulch is produced by the recycling of vegetation trimmings such as grass, shredded shrubs, and trees. Methods of application are generally by hand although pneumatic methods are available.
    - Green material can be used as a temporary ground cover with or without seeding.
    - The green material should be evenly distributed on site to a depth not more than 2 in.
- Shredded Wood – Suitable for ground cover in ornamental or revegetated plantings.
    - Shredded wood/bark is conditionally suitable. See note under limitations.
    - Distribute by hand or use pneumatic methods.
    - Evenly distribute the mulch across the soil surface to a depth of 2 to 3 in.
- Avoid mulch placement onto roads, sidewalks, drainage channels, existing vegetation, etc.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damager will require re-application of BMPs.
- Regardless of the mulching technique selected, the key consideration in inspection and maintenance is that the mulch needs to last long enough to achieve erosion control objectives. If the mulch is applied as a stand-alone erosion method over disturbed areas (without seed), it should last the length of time the site will remain barren or until final re-grading and revegetation.
- Where vegetation is not the ultimate cover, such as ornamental and landscape application of made or wood chips, inspection and maintenance should focus on longevity and integrity of the mulch
- Reapply mulch when bare earth becomes visible.

VD: Velocity Dissipation Devices

Description & Purpose

Outlet protection is a physical device composed of rock or grouted riprap, which is place at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Velocity dissipation devices are required in the following situations:

- Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach.

Velocity dissipation devices may be used at the following locations:

- Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, of channels.
- Outlets located at the bottom of mild to steep slopes.
- Discharge outlets that carry continuous flows of water.
- Outlets subject to short, intense flows of water, such as flash floods.
- Points where lined conveyances discharge into unlined conveyances.

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.
- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause to grouted riprap to break up due to the resulting hydrostatic pressure.

Objectives

EC Erosion Control

Potential Alternatives

None

Implementation

General
Outlet protection is needed where discharged velocities and energies at the outlets of culvers, conduits, or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small, eroded pools (plunge pools), and protects against gully erosion resulting from scouring at a culvert mouth.

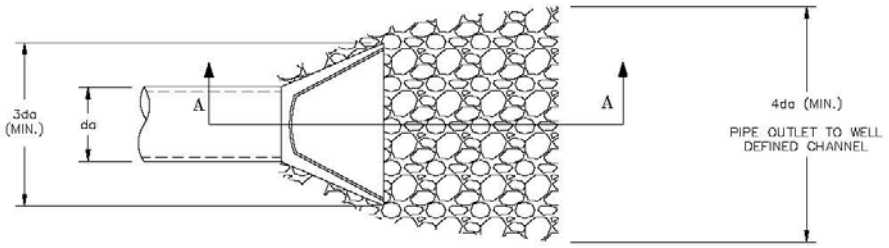
Design and Layout
As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimated discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but nevertheless than the peak 5-year flow for temporary structures planned for one rainy season, or the 10-year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging filter fabric.
  - Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
  - Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.
  - Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.
- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
- Outlets on slopes steeper than 10 percent should have additional protection.

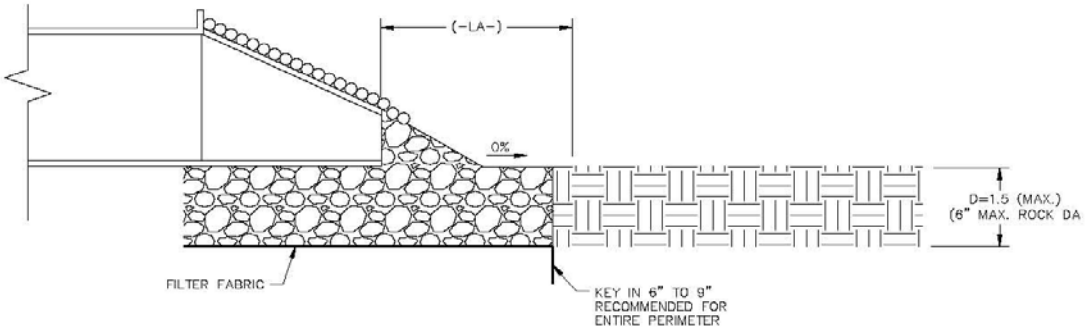
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharge occurs.
- Inspect aprons for displacement of the riprap and damage to the underling fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

VELOCITY DISSIPATION DEVICES



PLAN VIEW
NOT TO SCALE



SECTION A-A
NOT TO SCALE

PIPE DIAMETER (IN INCHES)	DISCHARGE (FT^3/S)	APRON LENGTH, (-LA- IN FEET)	RIP RAP DIAMETER (MIN. INCHES)
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
18	30	16	8
	40	26	8
	50	26	12
	60	30	16

SD: Slope Drain

Description & Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Slope drain may be appropriate where:

- Concentrated flow of surface runoff must be conveyed down a slope in order to prevent erosion.
- Drainage for top of slope diversion dikes or swales.
- Drainage for top of cut and fill slopes where water can accumulate.
- Emergency spillway for a sediment basin.

Limitations

Installation is critical for effective use of the pipe slope drain to minimize potential gully erosion.

- Maximum drainage area per slope drain is 10 acres. (For large areas used a paved chute, rock lined channel, or additional pipes.)
- Severe erosion may result when slope drains fail by overtopping, piping, or pipe separation.
    - During large storms, pipe slope drains may become clogged or over charged, forcing water around the pipe and causing extreme slope erosion.
    - If the sectional downdrain is not sized correctly, the runoff can spill over the drain sides causing gully erosion and potential failure of the structure.
- Dissipation of high flow velocities at the pipe outlet is required to avoid downstream erosion.

Objectives

EC Erosion Control

Potential Alternatives

ED Earthen Dike

DS Drainage Swell

Implementation

General

The slope drain is applicable for any construction site where concentrated surface runoff can accumulate and must be conveyed down the slope in order to prevent erosion. The slope drain is effective because it prevents the stormwater from flowing directly down the slope by confining all the runoff into an enclosed pipe or channel. Due to the time lag between grading slopes and installation of permanent stormwater collection systems and slope stabilization measures, temporary provisions to intercept runoff are sometimes necessary. Particularly in steep terrain, slope drains can protect unstabilized areas from erosion.

Design and Layout

The capacity for temporary drains should be sufficient to convey at least the peak runoff from a10-year rainfall event. The pipe size may be computed using the Rational Method or a method established by the local municipality. Higher flows must be safely stored or routed to prevent any offsite concentration of flow and any erosion of the slope. The design storm is purposely conservative due to the potential impacts associated with system failures.

As a guide, temporary pipe slope drains should not be sized smaller than shown in the following table:

Minimum Pipe Diameter (Inches)	Maximum Drainage Area (Acres)
4	1.0
6	3.0
8	5.0
10	7.0
12	10.0

Larger drainage areas can be treated if the area can be subdivided into areas of 10 acres or less and each area is treated as a separate drainage.

Materials

Soil type, rainfall patterns, construction schedule, local requirements, and available supply are some of the factors to be considered when selecting materials. The following types of slope drains are commonly used:

- Rigid Pipe – This type of slope drain is also known as a pipe drop. The pipe usually consists of corrugated metal pipe or rigid plastic pipe. The pipe is placed on undisturbed or compacted soil and secured onto the slope surface or buried in a trench. Concrete thrust bocks must be used when warranted by the calculated thrust forces. Collars should be properly installed and secured with metal strapping or watertight collars.
- Flexible Pipe – The flexible pipe slope drain consists of a flexible tube of heavy-duty plastic, rubber, or composite material. The tube material is securely anchored onto the slope surface. The tube should be securely fastened to the metal inlet and outlet conduit sections with metal strappings or watertight collars.
- Section Downdrains – The section downdrain consists of pre-fabricated, section conduit or half round or third round material. The sectional downdrain performs similar to a flume or chute. The pipe must be placed on undisturbed or compacted soil and secured into the slope.
- Concrete-lined Terrace Drain – This is a concrete channel for draining water from a terrace on a slope to the next level. These drains are typically specified as permanent structures and, if installed early, can serve as slope drains during construction, which should be designed according to local drainage design criteria.

Installation

The slope drain may be a rigid pipe, such as corrugated metal, a flexible conduit, or a lined terrace drain with the inlet placed on the top of the slope and outlet at the bottom of the slope. This BMP typically is used in combination with a diversion control, such as an earth dike or drainage swale at the top of the slope.
The following criteria must be considered when sitting slope drains:

- Permanent structures included in the project plans can often serve as construction BMPs if implemented early. However, the permanent structures must meet or exceed the criteria for the temporary structure.
- Inlet structures must be securely entrenched and compacted to avoid severe gully erosion.
- Slope drains must be securely anchored to the slope and must be adequately sized to carry the capacity of the design storm and associated forces.
- Outlets must be stabilized with riprap, concrete, or other type of energy dissipater, or directed into a stable sediment trap or basin. See VD, Velocity Dissipation Devices.
- Debris racks are recommended at the inlet. Debris racks located several feet upstream of the inlet can usually be larger than racks at the inlet, and thus provide enhanced debris protection and less plugging.
- Safety racks are also recommended at the inlet and outlet of pipes where children and animals could become entrapped.

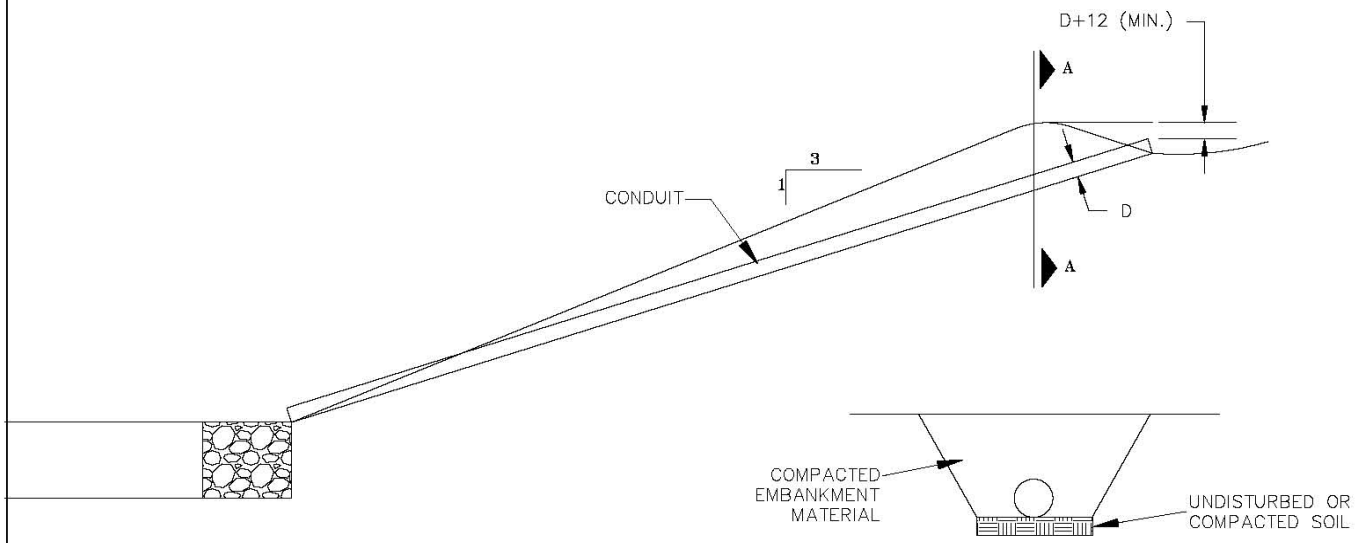
Do. *Properly installed slope drains to ensure erosion of the slope will not occur*

- Secure inlet and surround with dikes to prevent gully erosion and anchor pipe slope.
- When using slope drains, limit drainage area to less than 10 acres per pipe. For larger areas, use a rock lined channel or a series of pipes.
- Size to convey at least the peak flow of a 10-year storm. The design storm is conservative due to the potential impact of system failures.
- Maximum slope generally limited to 2:1 (H:V) as energy dissipation below steeper slopes is difficult.
- Direct surface runoff to slope drains with interceptor dikes. See BMP ED, Earth Dikes and Drainage Swales. Top of interceptor dikes should be 12 in. higher than the top of the slope drain.
- Slope drains can be placed on or buried underneath the slope surface.
- Recommended materials include both metal and plastic pipe, either corrugated or smooth wall. Concrete pipe can also be used.
- When installing slope drains:
  - Install slope drains perpendicular to slope contours.
  - Compact soil around and under entrance, outlet, and along length of pipe.
  - Securely anchor and stabilize pipe and appurtenances into soil.
  - Check to ensure that pipe connections are watertight.
  - Protect area around inlet with filter fabric cloth. Protect outlet with riprap or other energy dissipation device. For high energy discharges, reinforce riprap with concrete or use reinforced concrete device.
  - Protect outlet of slope drains using a flared end section when outlet discharges to a flexible energy dissipation device.
  - A flared end section installed at the inlet will improve flow into the slope drain and prevent erosion at the pipe entrance. Use a flared end section with a 6 in. minimum to plate to help prevent undercutting. The flared section should slope towards the pipe inlet.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharge occurs.
- Inspect outlet for erosion and downstream scour. If eroded, repair damage and install additional energy dissipation measures. If downstream scour is occurring, it may be necessary to reduce flows being discharged into the channel unless preventative measures are implemented.
- Inspect inlet for clogging or undercutting. Remove debris from inlet to maintain flows. Repair undercutting at inlet and if needed, install flared section or riprap around the inlet to prevent further undercutting.
- Inspect pipes for leakage. Repair leaks and restore damaged slopes.
- Inspect slope drainage for accumulations of debris and sediment.
- Remove built up sediment from entrances and outlets as required. Flush drains if necessary; capture and settle out sediment from discharge.
- Make sure water is not ponding onto inappropriate areas (e.g., active traffic lanes, material storage areas, etc.)
- Pipe anchors must be checked to ensure that the pipe remains anchored to the slope. Install additional anchors if pipe movement is detected.

SLOPE DRAIN



SECTION A

SLOPE DRAIN NOTES

INSTALLATION REQUIREMENTS

1. THE SLOPE DRAIN IS TO BE DESIGNED TO CONVEY THE PEAK RUNOFF FOR THE 2–YEAR STORM EVENT.

2. PIPE MATERIAL MAY INCLUDE CORRUGATED METAL, OR RIDGID OR FLEXIBLE PLASTIC.

3. EMBANKMENT MATERIAL SHALL CONSIST OF SOIL WITH A MINIMUM OF 15% PASSING A #200 SIEVE. EXCAVATED SOIL CAN BE USED IF IT MEETS THIS REQUIREMENT.

4. EMBANKMENT IS TO BE COMPACTED TO AT LEAST 90% OF MAXIMUM DENSITY AND WITHIN 2% OF THE OPTIMUM MOISTURE CONTENT ACCORDING TO ASTM D698.

5. SLOPE DRAIN SECTIONS ARE TO BE SECURELY FASTENED TOGETHER AND HAVE WATERTIGHT FITTINGS.

6. THE OUTLET IS TO BE STABILIZED AND, UNLESS THE DRAIN DISCHARGES DIRECTLY TO A SEDIMENT BASIN, A TEMPORARY SURFACE IS TO BE PROVIDED TO CONVEY FLOWS DOWN STREAM.

7. IMMEDIATELY STABILIZE ALL AREAS DISTURBED BY INSTALLATION OR REMOVAL OF THE PIPE SLOPE DRAIN.

MAINTENANCE REQUIREMENTS

1. INLET AND OUTLET POINTS ARE TO BE CHECKED REGULARLY, AND AFTER HEAVY STORMS FOR CLOGGING AND OVERCHARGING. ANY BREAKS IN THE PIPE ARE TO BE PROMPTLY REPAIRED, AND CLOGS REMOVED AS NEEDED.

2. WATER IS NOT TO BYPASS OR UNDERCUT THE INLET OR PIPE. IF THESE PROBLEMS DO EXIST, THE HEADWALL NEEDS TO BE REINFORCED WITH COMPACT EARTH OR SANDBAGS.

3. THE OUTLET POINT IS TO BE FREE OF EROSION AND, IF NECESSARY, ADDITIONAL OUTLET PROTECTION SHOULD BE INSTALLED.

4. CONSTRUCTION TRAFFIC IS NOT TO CROSS THE SLOPE DRAIN AND MATERIALS ARE NOT TO BE PLACED ON IT.

5. THE SLOPE DRAIN IS TO REMAIN IN PLACE UNTIL THE SLOPE HAS BEEN COMPLETELY STABILIZED OR UP TO 30 DAYS AFTER PERMANENT SLOPE STABILIZATION.

GM: Geotextiles and Mats

Description & Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Geotextiles and Mats may be suitable in the following situations:

- Short, steep slopes where erosion hazard is high and vegetation will be slow to establish.
- Stream banks where moving water at velocities between 3 ft/sec and 6 ft/sec are likely to wash out new vegetation.
- In areas where the soil surface is disturbed and where existing vegetation has been removed.
- When seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season).
- When the soils are fine grained and potentially erosive. These measures should be considered in the following situations:
  - Steep slopes, generally steeper than 3:1 (H:V).
  - Slopes where the erosion potential is high.
  - Slopes and disturbed soils where mulch must be anchored
  - Disturbed areas where plants are slow to develop.
  - Channels with flows exceeding 3.3 ft/sec.
  - Channels to be vegetated.
  - Stockpiles.
  - Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs).

Objectives

EC	Erosion Control

Potential Alternatives

HS	Hydroseeding
WM	Wood Mulch
SM	Straw Mulch
HM	Hydraulic Mulch
SLB	Soil Binders

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly that other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g., channel, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and Mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through on imminent storm event) until alternative measures, such as seeding and mulching, may be installed
- Geotextiles, mats plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) – e.g., pad areas around buildings under const.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture weed growth, and availability of materials. The following natural and synthetic mattings are commonly used:

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D_{4355}. Geotextile blankets must be secured in place with wire staples or sandbags and be keying into tope of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils and must be keyed n at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in the soil.
- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakage occurs, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials.
  - Jute – a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the solid with u-shaped staples or stakes in accordance with manufacturer's recommendations.
  - Excelsior – (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80% of the fiber 6in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide and should have an average weight of 0.8 lb/yd^2, ±10%, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11-gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
  - Straw Blanket – Should be machine produced mats of straw with lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw

blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11-gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Wood Fiber Blanket – Composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished n rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufactures' recommendation.
- Coconut Fiber Blanket – Should be machine produced, 100% coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be furnished in rolled strips with a minimum of 6. ft wide, a minimum of 80 ft long and a minimum of0.5 lb/yd^2. Coconut fiber blankets must be secured tin place with wire staples. Staples should be made of minimum 11-gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Coconut Fiber Mesh – A thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has a longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staple of stakes in accordance with manufacturers' recommendations.
- Straw Coconut Fiber Blanket – Should be machine produced mats of 70% straw and 30% coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber blanket should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lbs/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11-gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon, or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

  - Plastic Netting – Is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting supplied in rolled strips, which must be secure with U-shaped staples or stake in accordance with the manufactures' recommendations.
  - Plastic Mesh – An open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less that $^1/_4$in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material supplied in rolled strips, which must be secure with U-shaped staples or stake in accordance with the manufactures' recommendations.
  - Synthetic Fiber w/Netting – A mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense three-dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secure with U-shaped staples or stake in accordance with the manufactures' recommendations.
  - Bonded Synthetic Fibers – A three dimensional geomatrix nylon (or other synthetic) matting. Typically, it has more than 90% open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, if becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secure with U-shaped staples or stake in accordance with the manufactures' recommendations.
  - Combination Synthetic and Biodegradable RECPs – Biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched tot eh top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secure with U-shaped staples or stake in accordance with the manufactures' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.

- Grade and shape the area of installation
- Remove all rocks, clods, vegetation, or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.
- Prepared seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Layering and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed mad free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the of the manufacturer's recommendations.
- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet fabric manufacturer's recommendations.

Anchoring

- U-shaped wire staple, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets tot eh ground surface.
- Wire staples should be made of minimum 11-gauge steel wire and should be u-shaped with 8 in legs and 2 in. crown.
- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.
- Wire staples and metal stakes should be driven flush with the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the sloe and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.
- When blankets must be spliced place blanket end over end (shingle style) wit 6 in. overlap. Staple through overlapping area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do no stretch.
- Staple blankets sufficiently to anchor blankets and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of $1^{1}/_{2}$ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 o 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial en of the first roll in the anchor trench and secure with fasting devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.

- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then folds back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.
- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of it necessary.

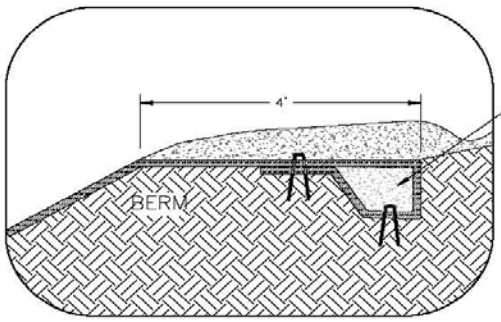
Don't. Leave the blanket unsecured and edges untrenched into the ground.

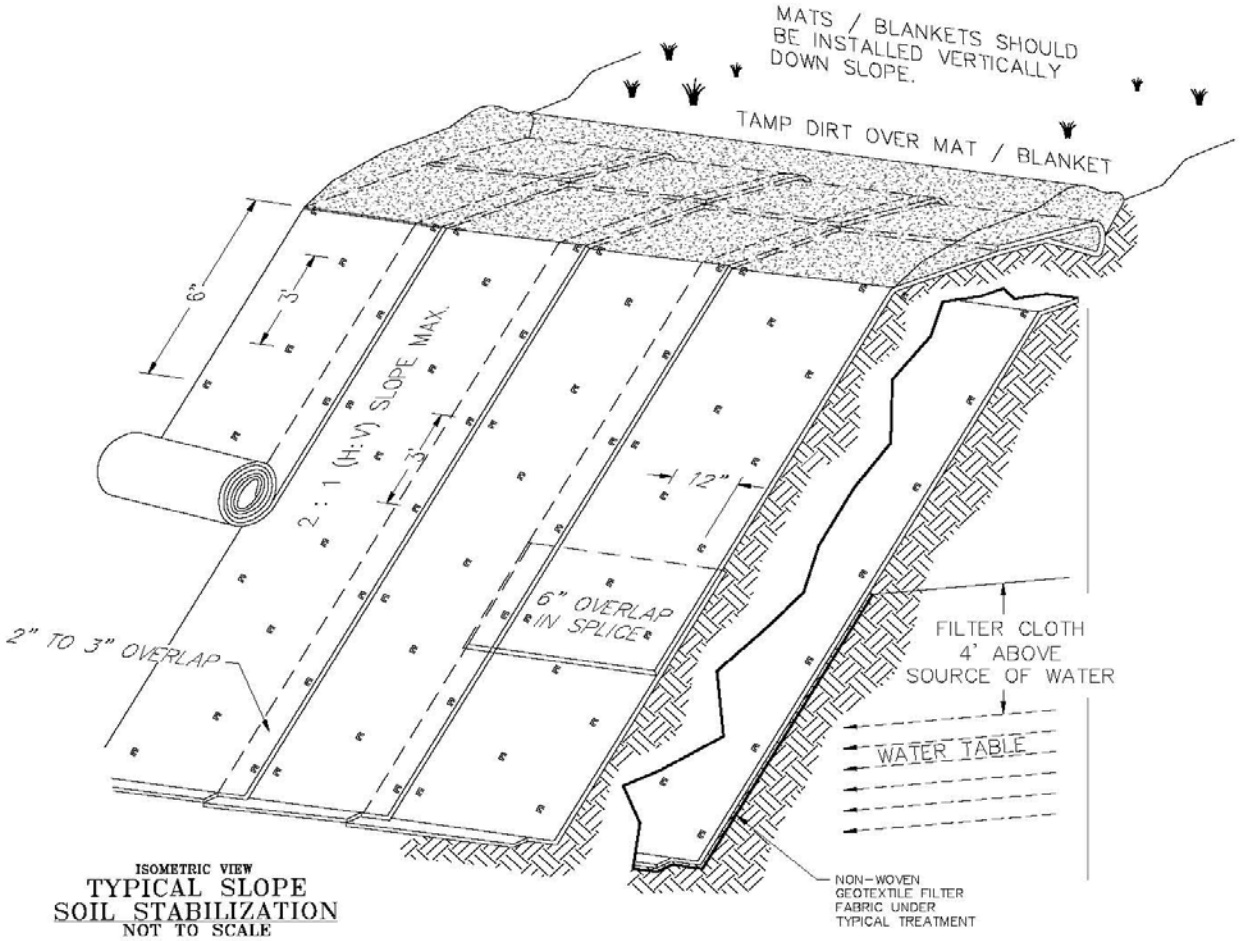
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

Do. *Properly overlap seam to ensure slope protection.*

GEOTEXTILES AND MATS





ISOMETRIC VIEW
TYPICAL SLOPE SOIL STABILIZATION
NOT TO SCALE

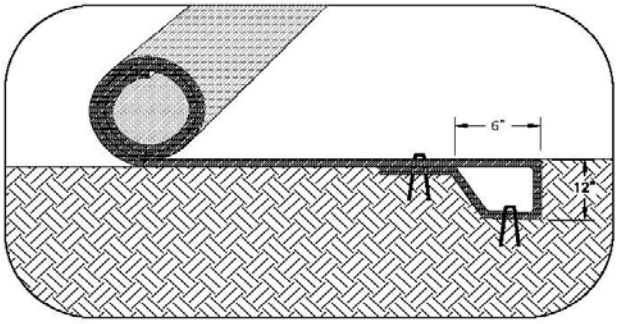
WET SLOPE LINING
NOT TO SCALE

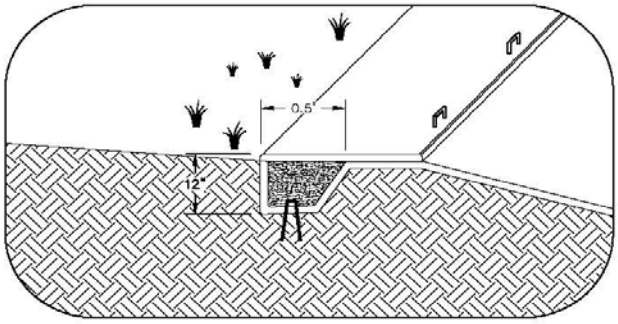
NOTES:

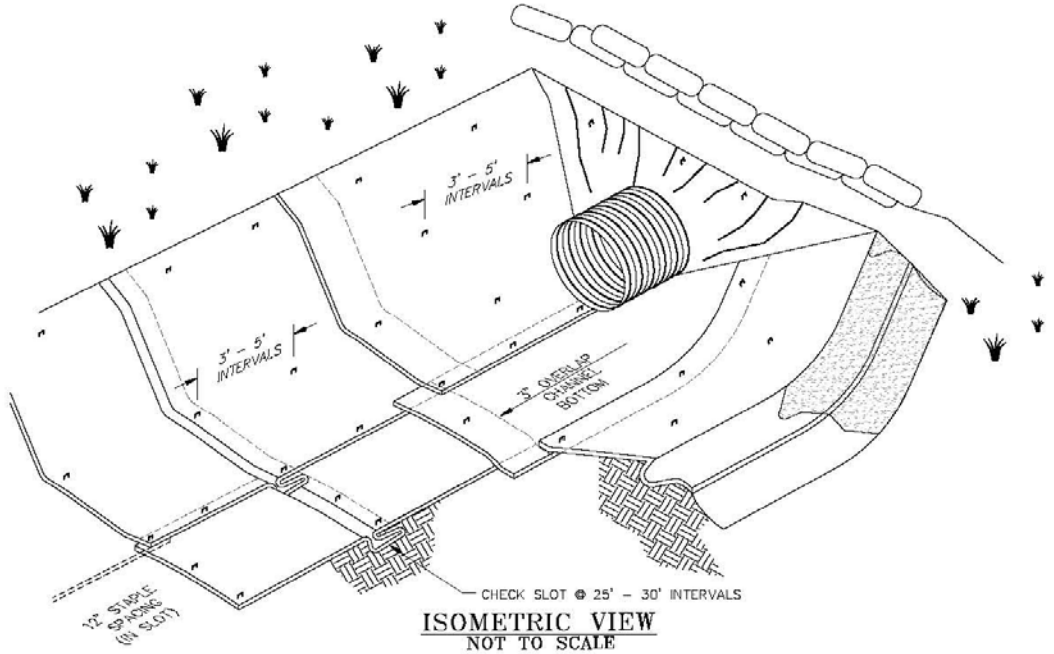
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, STICKS CLODS AND GRASS. MATS / BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH SOIL.
3. INSTALL AS PER MANUFACTURER'S RECOMMENDATIONS.

TYPICAL INSTALLATION DETAIL

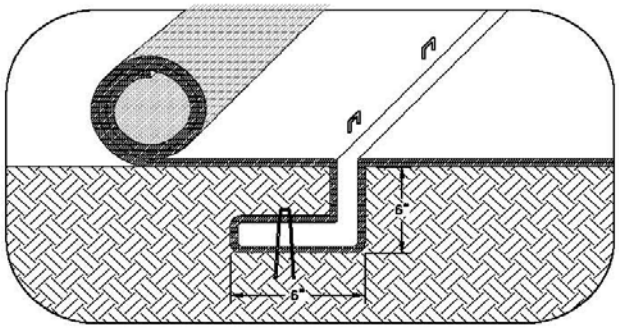
GEOTEXTILES AND MATS



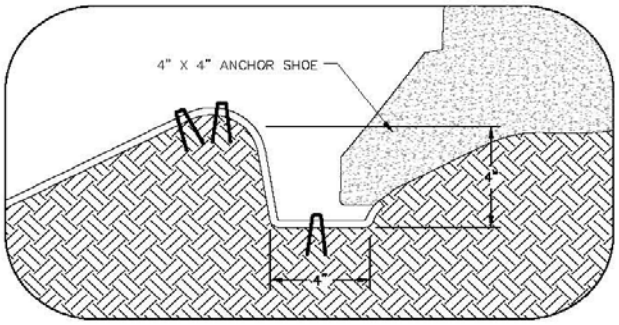




ISOMETRIC VIEW
NOT TO SCALE



INTERMITTENT CHECK SLOT
NOT TO SCALE

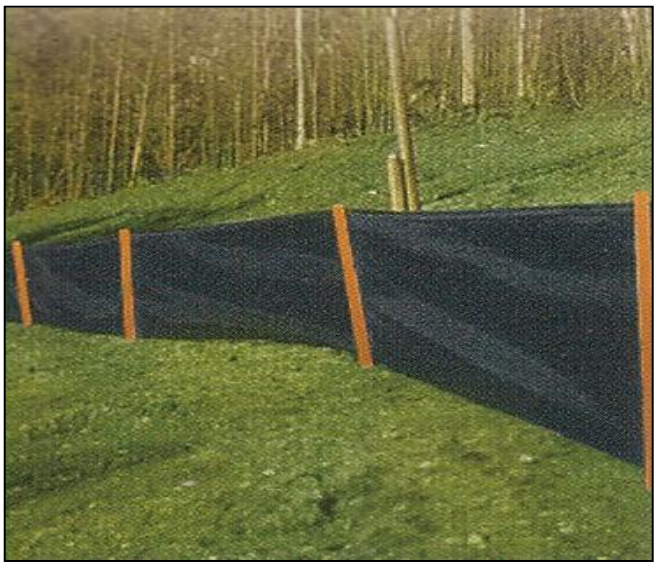


LONGITUDINAL ANCHOR TRENCH
NOT TO SCALE

NOTES:
1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.
3. INSTALL AS PER MANUFACTURERS RECOMMENDATIONS.

TYPICAL INSTALLATION DETAIL

SF: Silt Fence



Description & Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences may be suitable in the following situations:

- Perimeter control, placed below areas where sheet flows discharge from the site.
- Interior controls below disturbed areas where runoff may occur.
- Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows.
- When used in combination with erosion controls.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small, cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Objectives

EC Erosion Control

Potential Alternatives

FB Fiber Rolls
GBB Gravel Bag Berm
SBB Sandbag Barrier
SWB Straw Bale Barrier

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed.

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don't use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, cased on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more that 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1,200ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave and undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selecting of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria are recommended for selection of the equivalent opening size:

1. If 50% or less of eh soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85% of the soil. The EOS should not be finer than EOS 70.
2. For all soil types, the EOS should be no larger than the opening in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, wetland will occur, then the EOS should be no larger that Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with a EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F to 120°F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent tot eh bottom of the slope, prior to installing silt fence. Additional protection may be chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.
- Don't use below slopes subject to creep, slumping, or landslides.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D_{4632} and should have an integral reinforcement layer. The reinforcement later should be polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D_{4491}.
- Wood stakes should be commercial Quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than

Do. *Protect slopes from concentrated flows.*

Don't. *Install silt fence where flow velocity and volume will compromise structural integrity. If necessary, reinforce silt fence in sensitive areas.*

the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.
- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence.
- Bottom of the silt fence should be keyed-in a minimum of 12 in.
- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the top of the trench.
- When standard strength filter fabric is used, a plastic or wire mesh support should be fastened securely to the upslope side of posts using heavy-duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric should be purchased in a long roll then cut to the length of the barrier. When joints are necessary 6 in. filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.
- The trench should be backfilled with compacted native material.
- Construct silt fences with a setback of at least 3 ft from the toe of the slope. Where a silt fence is determined to be not practical due to specific site condition, the silt fence may be constructed at the toe of the slope but should be constructed as far from the toe of the slope as practical. Silt fence close to the toe of the slope will be less effective and difficult to maintain.
- Construct the length of each reach so that the change in base elevation along the reach does not exceed $^{1}/_{3}$ the height of the barrier, in no case should the reach exceed 500 ft.

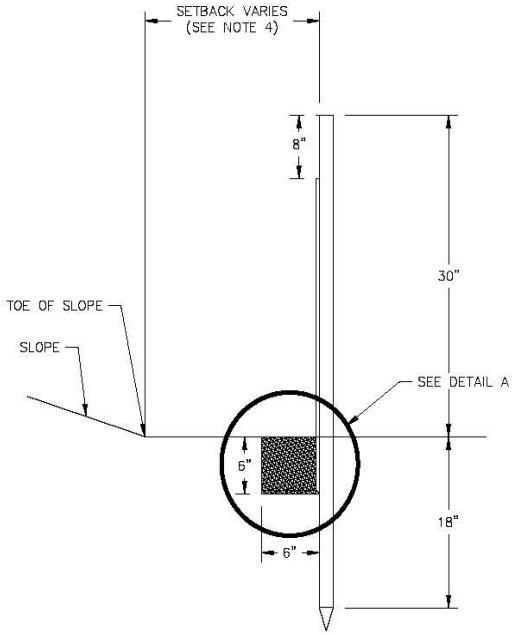
Do. Install silt fence to keep sediment laden runoff on site.

Inspection and Maintenance

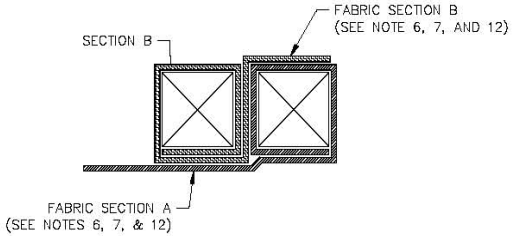
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the sire of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of eh barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fence should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

Don't. Use silt fence as a check dam.

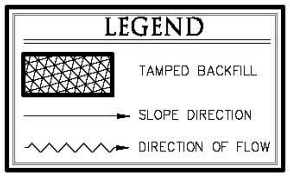
SILT FENCE

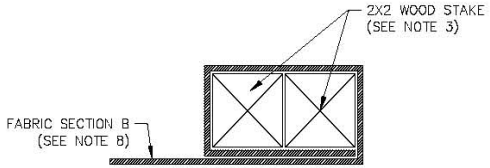


SECTION
A-A
NOT TO SCALE

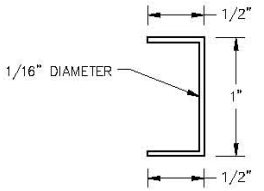


JOINING SECTION DETAIL (TOP VIEW)
NOT TO SCALE

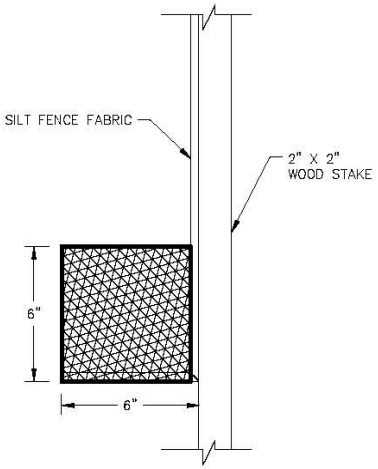




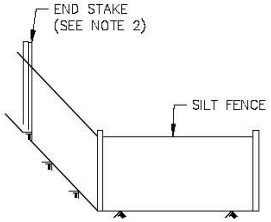
END STAKE DETAIL (TOP VIEW)
NOT TO SCALE



STAPLE DETAIL
(SEE NOTE 9)
NOT TO SCALE



DETAIL A
NOT TO SCALE



END DETAIL
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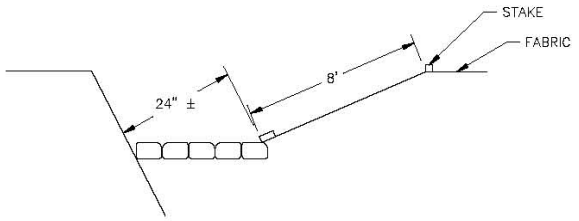
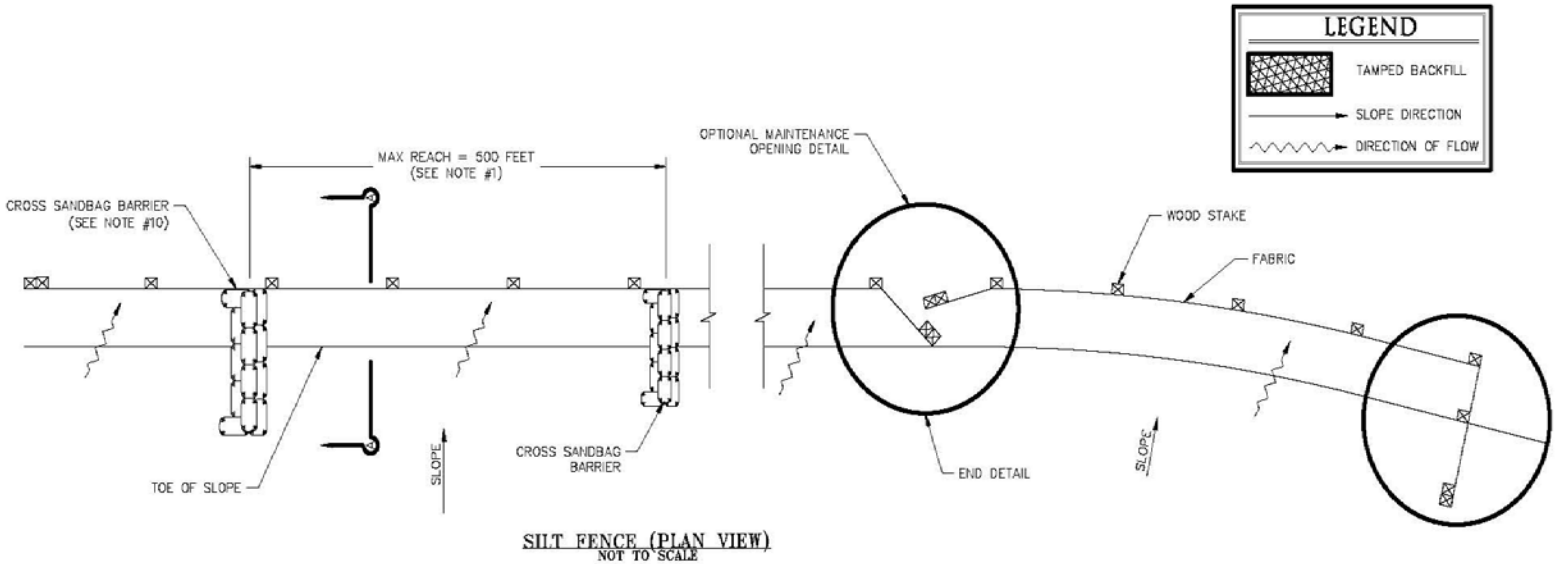


OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
NOT TO SCALE

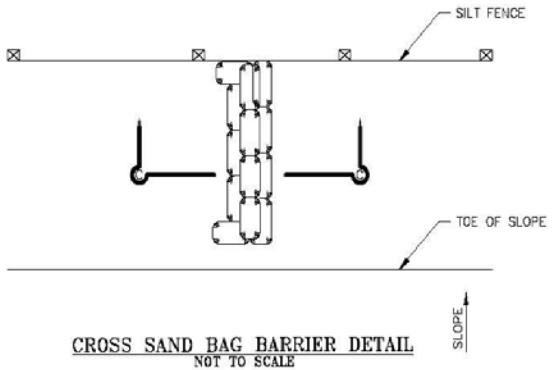
SILT FENCE



SILT FENCE (PLAN VIEW)
NOT TO SCALE

NOTES

1. CONSTRUCT THE LENGTH OF EACH REACH SO THAT THE CHANGE IN BASE ELEVATION ALONG THE REACH DOES NOT EXCEED 1/3 THE HEIGHT OF THE LINEAR BARRIER. IN NO CASE SHALL THE REACH LENGTH EXCEED 500 FEET.
2. THE LAST 8'-0" OF THE FENCE SHALL BE TURNED UP SLOPE
3. STAKE DIMENSIONS ARE NOMINAL.
4. DIMENSIONS VARY TO FIT FIELD CONDITION.
5. STAKES SHALL BE PLACED 8'-0" MAXIMUM AND SHALL BE POSITIONED ON DOWN SLOPE SIDE OF FENCE.
6. STAKES TO OVERLAP AND FENCE FABRIC TO FOLD AROUND EACH STAKE ONE FULL TURN. SECURE FABRIC TO STAKE WITH FOUR (4) STAPLES.
7. STAKES SHALL BE DRIVEN TIGHTLY TOGETHER TO PREVENT POTENTIAL FOLLOW-THROUGH OF SEDIMENT AT JOINT. THE TOPS OF THE STAKES SHALL BE SECURED WITH WIRE.
8. FOR END STAKE, FENCE FABRIC SHALL BE FOLDED AROUND TWO STAKES ONE FULL TURN AND SECURED WITH FOUR (4) STAPLES.
9. MINIMUM OF STAPLES OF PER STAKE. DIMENSIONS AS SHOWN.
10. CROSS BARRIER SHALL BE A MINIMUM OF 1/3 AND A MAXIMUM OF 1/2 THE HEIGHT OF THE LINEAR LINER BARRIER.
11. MAINTENANCE OPENINGS SHALL BE CONSTRUCTED IN A MANNER TO ENSURE SEDIMENT REMAINS BEHIND FENCE.
12. JOINING SECTIONS MAY NOT BE PLACED AT SUMP LOCATIONS.
13. SANDBAG ROWS AND LAYERS SHALL BE OFFSET TO ELIMINATE GAPS.



CROSS SAND BAG BARRIER DETAIL
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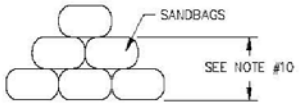


SECTION C-C
NOT TO SCALE

ED: Earth Dikes and Drainage Swales

Description & Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to diver off site runoff around the construction site; divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth Dikes and Drainage Swales may be suitable in the following situations:

- Where runoff needs to be diverted from one area and convey to another.
- To convey surface runoff down sloping terrain.
- To intercept and divert runoff to avoid sheet flow over steep sloped surfaces.
- To divert and direct runoff toward a stabilized watercourse, drainage pipe or channel.
- To intercept runoff from paved surfaces
- Below steep grades where runoff begins to concentrate.
- Along roadways and facility improvements subject to flood drainage.
- At the top of slopes to divert run-on from adjacent or undisturbed slopes.
- At bottom and mid slope location to intercept sheet flow and convey concentrated flows.
- Divert sediment laden runoff into sediment basins or traps.

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10%. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local and municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.

Objectives

EC Erosion Control

Potential Alternatives

None

- Dikes should not be constructed of souls that may be easily eroded.
- Re-grading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream of downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap of directing runoff away from erodible areas. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations and should not be used in areas with slopes greater than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (se SD, Slope Drain). A combination dike and swale is easily constructed be a single pass of a bulldozer of grader and compacted be a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed, and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock riprap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner.

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (ST) or Sediment Basin (SB) when either the dike channel or the drainage area above the dike are not adequately stabilized.
- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either riprap or sod for slopes in excess of 5%. In either case stabilization of the earth dike should be completed immediately after construction or prior tot eh first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following specifications apply:

Channel Grade	Riprap Stabilization
0.5 – 1.0%	4 in. Rock
1.1 – 2.0%	6 in. Rock
2.1 – 4.0%	8 in. Rock
4.1 – 5.0%	8 in. – 12 in. Riprap

- The stone riprap used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.

- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike of the downhill side is the most cost-effective diversion. Standard engineering design criteria for small open channel and closed conveyance systems should be used. Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft.
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage swales should be laid at a grade of at least 1%, but not more than 15%.
- The swale must no be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any dill material along the path of the swale.
- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5% and use riprap or sod for swales with a slope between 5 and 15%. For temporary swales, geotextiles and mats may prove immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be design by a professional engineer.
- At a minimum, the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach and erosive velocity.

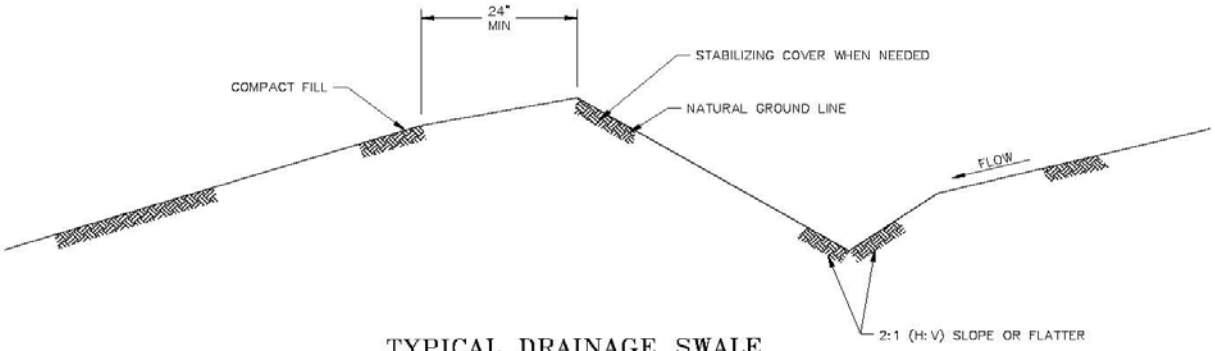
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharge occurs.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

Do. *Line the channel when highly erodible soils may be encountered.*

Don't. *Wait until the runoff has already created severe erosion areas.*

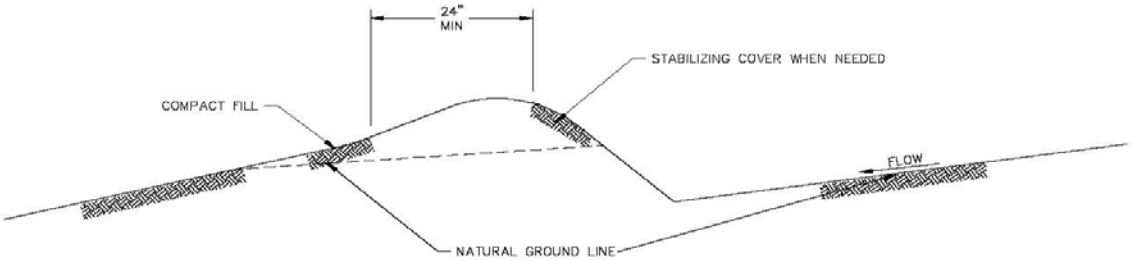
EARTH DIKES AND DRAINAGE SWALES



TYPICAL DRAINAGE SWALE
NOT TO SCALE

NOTES:

1. STABILIZE INLET, OUTLETS AND SLOPES.
2. PROPERLY COMPACT THE SUBGRADE.



TYPICAL EARTH DIKE
NOT TO SCALE

SB: Sediment Basin

Description & Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under latent conditions, allowing sediment to settle out before the runoff is discharged.

Objectives

SC Sediment Control

Potential Alternatives

ST Sediment Trap (for small areas)

Suitable Applications

Sediment basins may be suitable in the following situations:

- Large projects with room enough to construct the basin.
- Where sediment-laden water may enter the drainage system or watercourse.
- On construction projects with disturbed areas during the rainy season.
- At the outlet of disturbed watersheds between 5 acres and 75 acres.
- At the outlet of large, disturbed watersheds, as necessary.
- Where post construction detention basins are required.
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas.

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the grading plan and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern basin may require protective fencing.
- Sediment basins designed according to this detail are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.

- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from Division of Dam Safety
- Standing water may cause mosquitoes of other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion of a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural of undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in Washington City will be required by local ordinance to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70 – 80% of the sediment that flows into them if designed according to this detail. Therefore, they should be used in conjunction with erosion control practices such as mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales. The basin must not be located in a stream, but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use of service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in stream
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and local dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert run off from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

- The volume of the settling zone should be sized to capture runoff from a 2-year storm or other appropriate design storms specified by Washington City. A detention time of 24 to 40 hours should allow 70 to 80% of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- Sediment basins are best used in conjunction with erosion controls. Sediment basins that are used in conjunction with upstream erosion and sediment control should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.
- The length of the basin should be more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to

divert run off from undisturbed areas away from the sediment basin.

- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impound area to the highest point of eh levee, and basins capable of impounding more that 35,000 ft^3, should be designed be a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- Basins should be designed to drain within 72 hours following storm events. If a basin fails to drain within 72 hours, it must be pumped dry.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include and emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen of vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- A forebay constructed upstream of the basin may be provided to remove debris and larger particles.
- The outflow from the sediment basin should be provided with velocity dissipation devices to prevent erosion and scouting of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstruction the system. This principal structure should be designed to accommodate the inflow design storage.
- A rock pile or rock-filled gabions can serve as alternative to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent flotation.
- Attach riser pipe (watertight collection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Proper hydraulic design of the placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single and perforated riser outlets follow:
  - Flow Control Using a Single Orifice at the Bottom of the Basin (Figure 1): The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H - H_o)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H - H_o)^{0.5}}{CT}$$

Where: a = area of orifice
A = surface area of the basin at mid elevation (ft^2)
C = orifice coefficient
T = draw down time of full basin (hrs)
g = gravity (32.2 ft/sec^2)
H = elevation when the basin is full (ft)
H_o = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x16^{-6})A(H - H_o)^{0.5}}{C}$$

  - Flow Control Using Multiple Orifices (see Figure 2):

$$a_t = \frac{2A(h_{\max})}{3600CT(2g[h_{\max} - h_{centroid\_of\_orifices}])^{0.5}}$$

With terms as described above except:
a_t = total area of orifice

h_{max} = maximum height from lowest orifice to the maximum water surface (ft)

$h_{centroid\ of\ orifice}$ = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120° horizontally (refer to figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulic of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods.
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

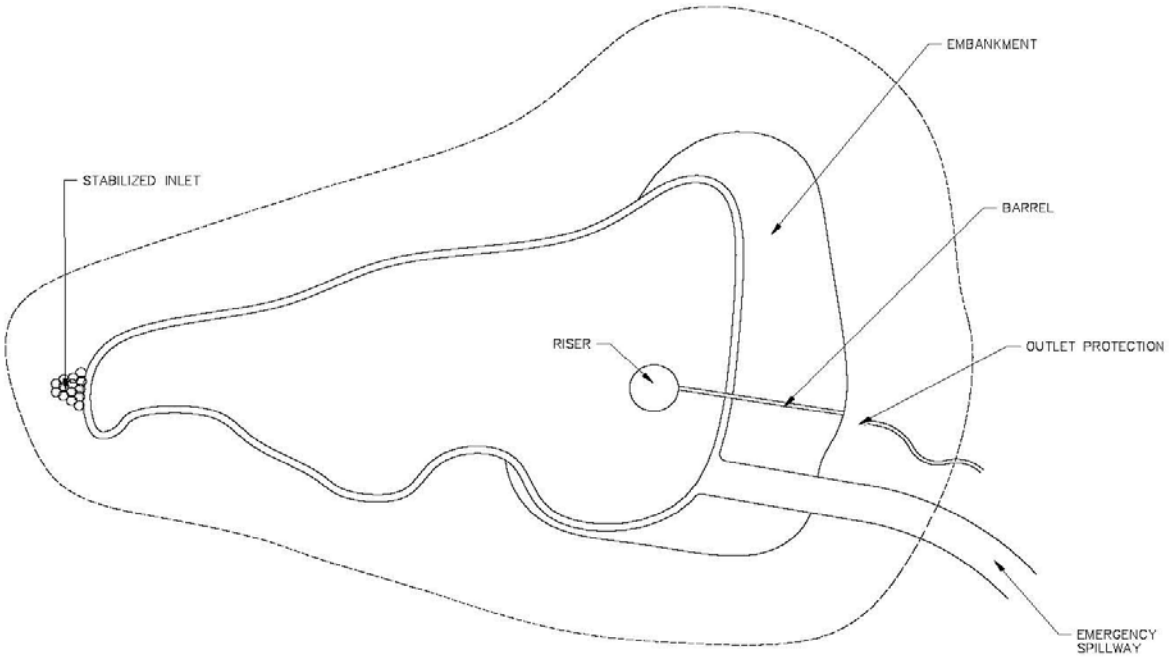
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstruction. Repair damage and remove obstruction as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be used at all times during dewatering.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

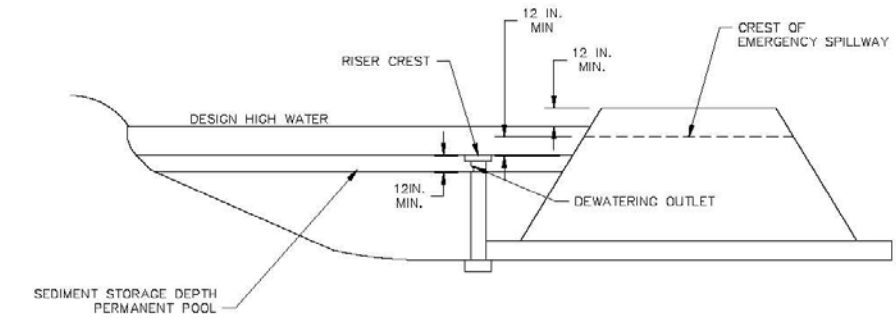
Do. *Design an outlet structure that slows the flow to allow sediment to settle out of the runoff.*

Don't. *Build a sediment basin without an armored spillway.*

SEDIMENT BASIN



TOP VIEW
NOT TO SCALE

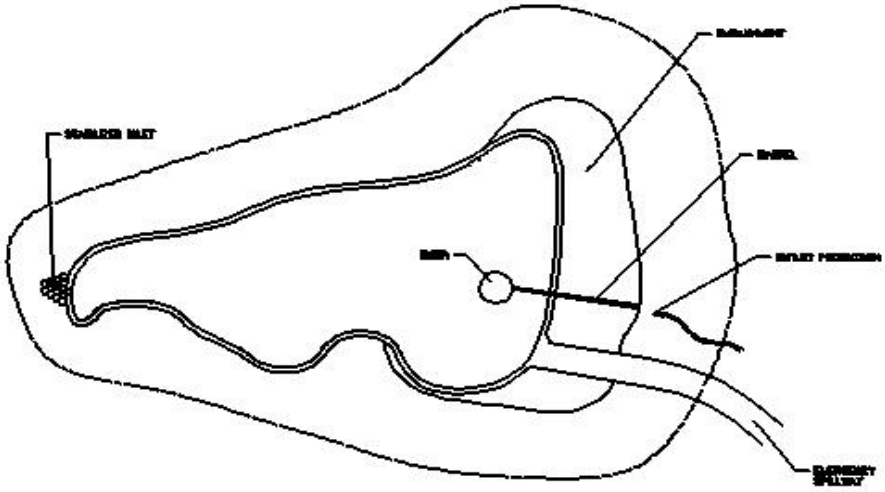


NOTE:
THIS OUTLET PROVIDES NO DRAINAGE FOR PERMANENT POOL

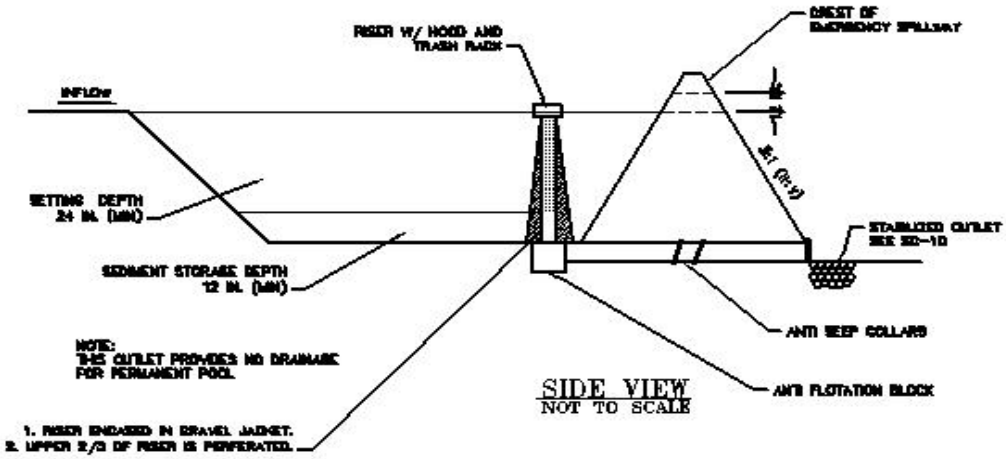
SIDE VIEW
NOT TO SCALE

FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
SINGLE ORIFICE DESIGN
NOT TO SCALE

SEDIMENT BASIN



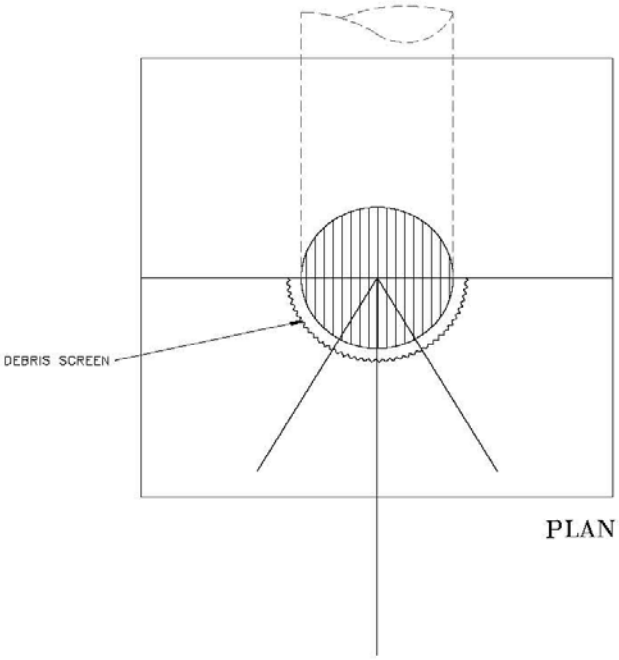
TOP VIEW
NOT TO SCALE



SIDE VIEW
NOT TO SCALE

FIGURE 2: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

SEDIMENT BASIN



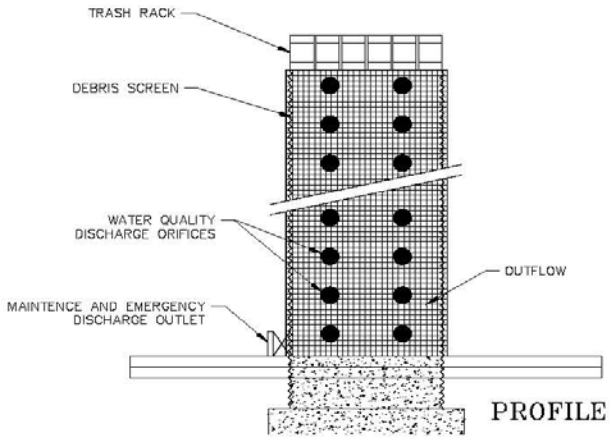


FIGURE 3: MULTIPLE OFIFICE OUTLET RISER
NOT TO SCALE

ST: Sediment Trap

Description & Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under latent conditions, allowing sediment to settle out of before the runoff is discharged. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway of low drainage area.

Suitable Applications

Sediment traps may be suitable in the following situations:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Construction projects where the drainage area is less than 5 acres. Traps would be placed where sediment-laden stormwater may enter a storm drain or watercourse.
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conductive to vector production
- Should not be located in live streams.

Objectives

SC Sediment Control

Potential Alternatives

SB Sediment Basin (for larger areas)

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SB, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The drainage plan should detail how this sediment is to be disposed of, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to homes of buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desire sediment removal efficiency. As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. The runoff volume from a 2-year storm is a common design criterion for a sediment trap. The sizing criterion below assumes that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish broad spectrum standards, the following criteria should trap moderate to high amounts of sediment in most areas of Washington County:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3 should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the reap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or crating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut and fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.
- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally.

Do. *Provide sediment trap for areas not large enough to require a sediment basin.*

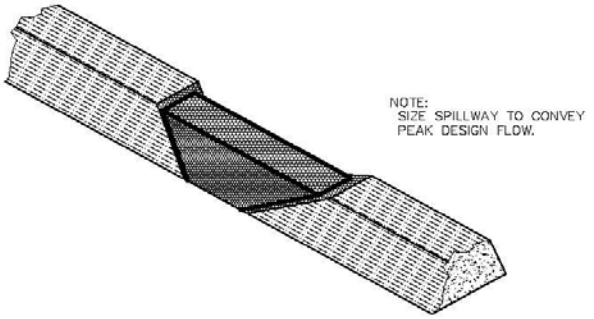
Don't. *Allow sediment to discharge escape the site.*

- When an earth or stone outlet is use, the outlet crest elevation should be at least 1 ft below the top of the embankment.
- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M_{43}, size No. 2 or 24, or its equivalent. Gravel meeting the above gradation may be used if crushed stone is not available.

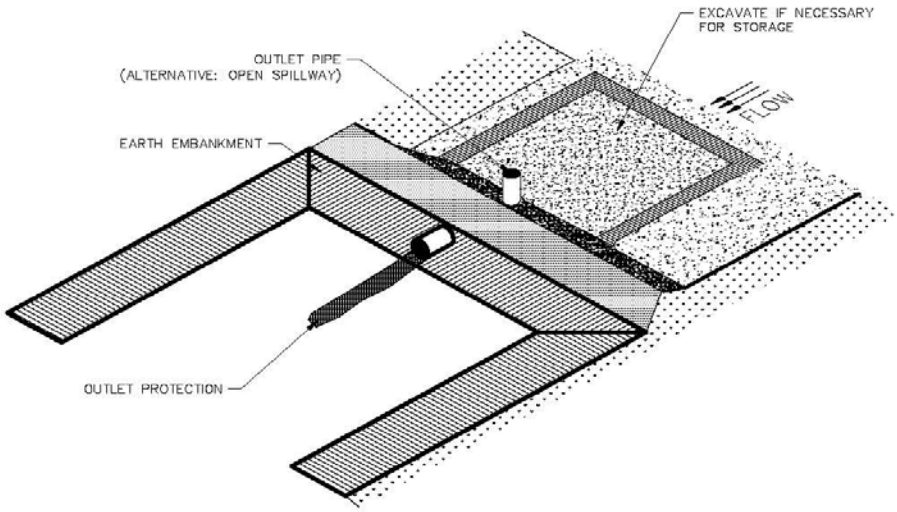
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstruction. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for areas of standing water during every visit. Corrective measures should be taken if the BMP does no dewater completely in 72 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.

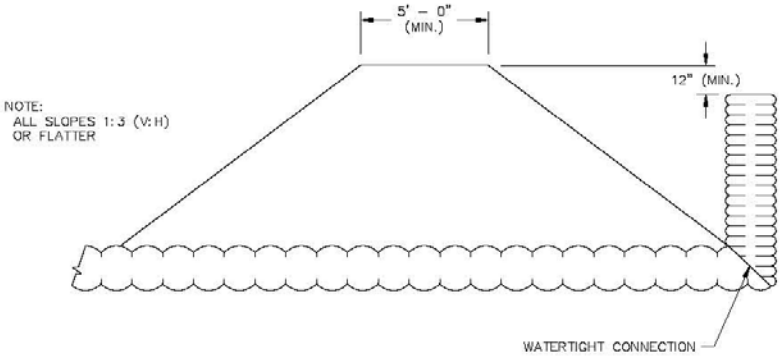
SEDIMENT TRAP



TYPICAL OPEN SPILLWAY
NOT TO SCALE



TYPICAL SEDIMENT TRAP
NOT TO SCALE



EMBANKMENT SECTION THRU RISER

FR: Fiber Rolls

Description & Purpose

A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls re place at the toe and on the face of slopes, they intercept runoff, reduce its velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of the slope, fiber rolls can also re erosion.

Suitable Applications

Fiber rolls may be suitable in the following situations:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched.
- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslides.

Objectives

SC Sediment Control

Potential Alternatives

SF Silt Fence
GBB Gravel Bag Berm
SBB Sandbag Barrier
SWB Straw Bale Barrier

Implementation

Fiber Roll Material

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft long length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) of flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective)
  - Slope inclination 2:1 (H:V) or greater: Fiber rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective)
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum of center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the roll should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.
- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

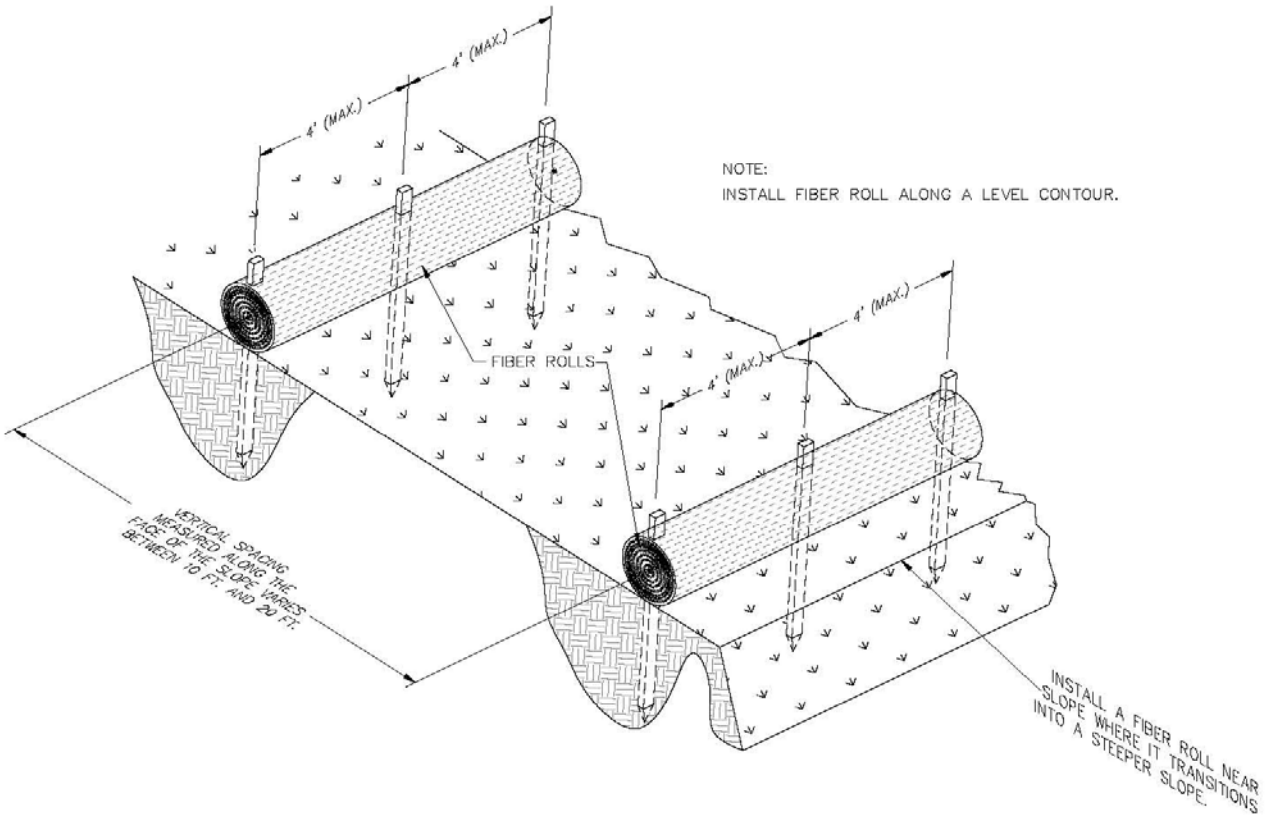
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair of replace split, torn, unraveled or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grad. Sediment control BMPs will likely be required in conjunction with this type of application.

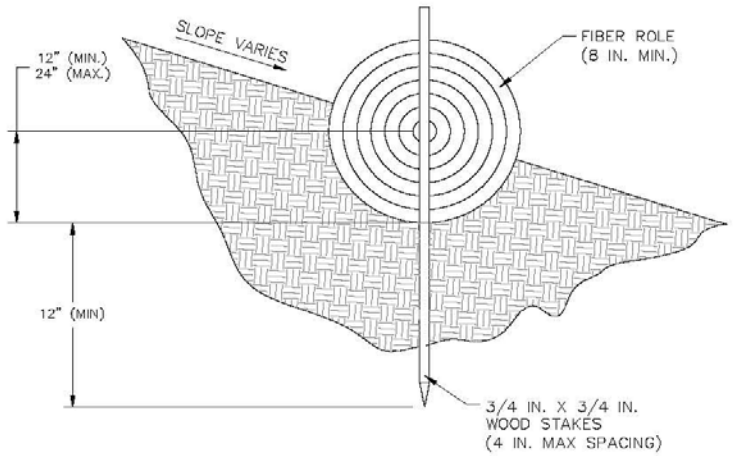
Do. *Securely anchor the fiber roll to level contours with approved stakes.*

Do. *Install fiber rolls with overlapping ends and place end where runoff will accumulate facing uphill.*

FIBER ROLLS



TYPICAL FIBER ROLL INSTALLATION
NOT TO SCALE



ENTRENCHMENT DETAIL
NOT TO SCALE

GBB: Gravel Bag Berm

Description & Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berm may be suitable in the following situations:

- As linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small, cleared areas
  - Along the perimeter of the site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment of paved areas.
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berms may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Berms may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.

Objectives

SC	Sediment Control

Potential Alternatives

SF	Silt Fence
FB	Fiber Roll
SBB	Sandbag Barrier
SWB	Straw Bale Barrier

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides latent conditions allowing sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sandbag barriers, but more porous.

Design and Layout

- Locate gravel bag berms on level contours.
  - Slopes between 20:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) of steeper: Gravel bags should be placed at a maximum interval of 25 ft (a closer spacing is more effective), with the first row placed at the toe of the slope.
- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the gravel bag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as a cross barrier.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum.
  - Top width = 24 in. minimum for three or more-layer construction.
  - Top width = 12 in. minimum for one- or two-layer construction.
  - Side slopes = 2:1 of flatter.
- In Construction Traffic Areas:
  - Height = 12 in. maximum.
  - Top width = 24 in. minimum for three or more-layer construction.
  - Top width = 12 in. minimum for one- or two-layer construction.
  - Side slopes = 2:1 of flatter.
- Butt ends of bags tightly.
- On multiple rows, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.
- See Sandbag Barrier details for placement information.

Materials

- Bag Material – Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D_{3786}, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D_{4355}.
- Bag Size – Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal and may vary based on locally available materials.
- Fill Material – Fill material should be 0.5 to 1 in. Class 2 aggregate base, clean and free from clay, organic matter, and other objectionable material, or other suitable open graded, non-cohesive, porous gravel.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Grave bags exposed to sunlight will need to be replaced every two of three months due to degrading of the bags.
- Reshape or replace gravel bags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove gravel bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize area. Removed sediment should be incorporated in the project or disposed of.

Do. *Stack gravel bags with ends overlapping to create a diversion.*

Don't. *Allow bags to disintegrate and rupture spilling gravel. Gravel bag berms must be maintained to be an effective BMP.*

SSV: Street Sweeping and Vacuuming

Description & Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Street sweeping and vacuuming may be suitable in the following situations:

- Where sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress.
- During preparation of paved surfaces for final paving.

Limitations

- Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Objectives

TC Tracking Control

Potential Alternatives

None

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project.

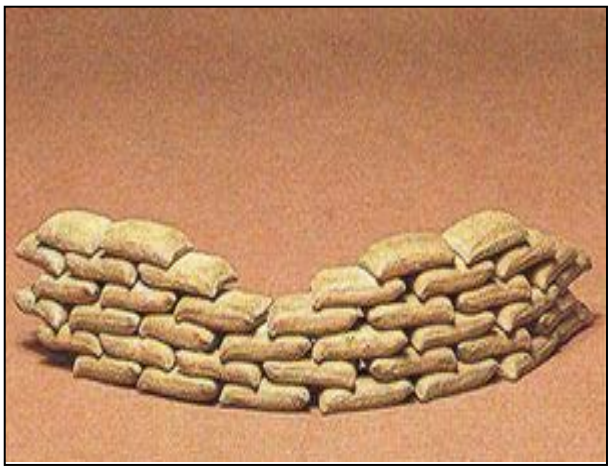
Do. Sweep up sediment frequently before rainfall can transport the sediment to the stormdrain system.

Implementation

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal may be required.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximum efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

Don't. Wash sediment into the catch basins. Sediment can be swept into piles and hauled away in truck or wheelbarrow depending on severity of deposits.

SBB: Sandbag Barrier



Description & Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept sheet flows. Sandbag barriers pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag Barrier may be suitable in the following situations:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small, cleared areas
  - Along the perimeter of the site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment of paved areas.
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Barriers may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.
- Burlap should not be used for sandbags.

Objectives

SC Sediment Control

Potential Alternatives

SF Silt Fence

FB Fiber Roll

GBB Gravel Bag Barrier

SWB Straw Bale Barrier

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides latent conditions allowing sediment to settle. While the sand-filled bags are porous, the fine sand tends to quickly plug with sediment, limiting the rate of flow through the barrier. If a porous barrier is desired, consider Silt Fence, Fiber Rolls, Gravel Bag Berm, or Straw Bale Barriers. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are like ground bag berms, but less porous.

Design and Layout

- Locate sandbag barriers on level contours.
  - Slopes between 20:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) of steeper: Sandbags should be placed at a maximum interval of 25 ft (a closer spacing is more effective), with the first row placed at the toe of the slope.
- Turn the ends of the sandbag barriers up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the sandbag barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the sandbag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as a cross barrier.
- Drainage area should not exceed 5 acres.
- Sack sandbags at least three bags high.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- In Non-Traffic Areas:
  - Height = 18 in. maximum.
  - Top width = 24 in. minimum for three or more-layer construction.
  - Side slopes = 2:1 of flatter.
- In Construction Traffic Areas:
  - Height = 12 in. maximum.
  - Top width = 24 in. minimum for three or more-layer construction.
  - Side slopes = 2:1 of flatter.

Materials

- Sandbag Material – Sandbags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D_{3786}, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D_{4355}.
- Sandbag Size – Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal and may vary based on locally available materials.
- Fill Material – All sandbag fill material should be non-cohesive, Class 1 or Class 2 permeable material free from clay and objectionable material.

Do. *Use high quality, sturdy bags that will withstand the environmental abuse. Bags that have been treated to resist damage from UV-rays are most desirable.*

Inspection and Maintenance

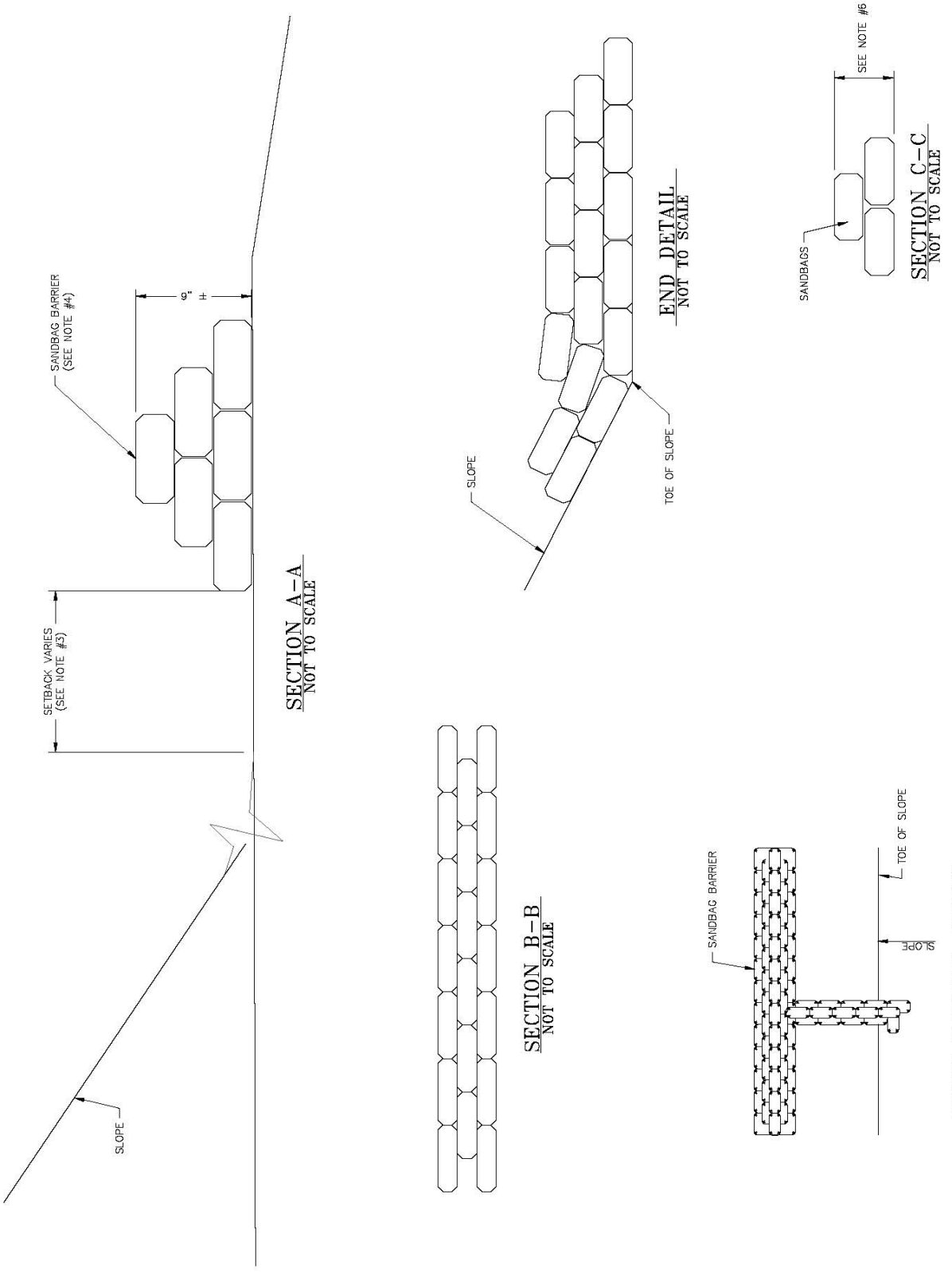
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Sandbags exposed to sunlight will need to be replaced every two of three months due to degrading of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove sandbag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize area. Removed sediment should be incorporated in the project or disposed of.

Do. *Stack sandbags with the ends butted tightly together to create a barrier.*

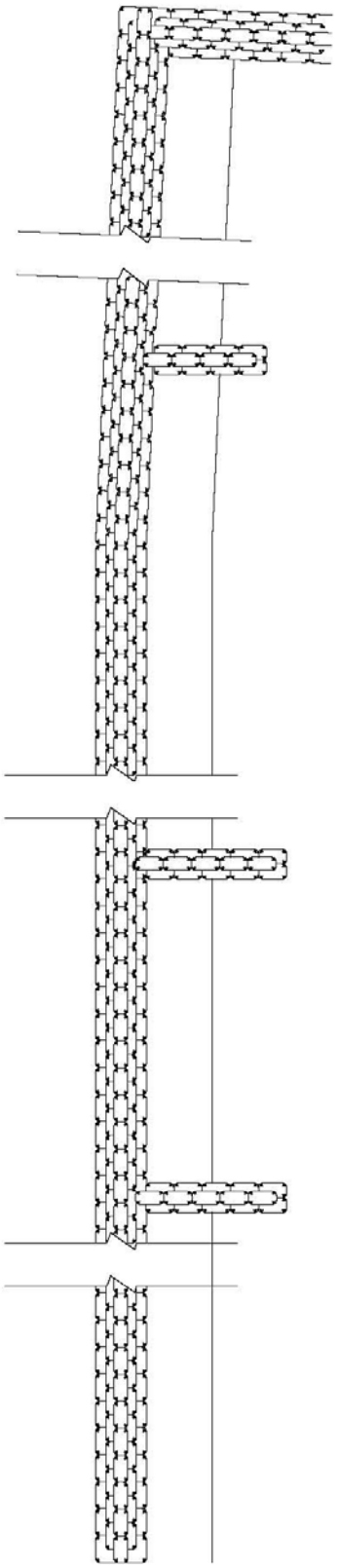
Don't. *Put off maintenance. Sandbags are difficult to cleanup and remove after the bags have ruptured.*

Don't. *Wait until it is raining to place sandbag barriers.*

SANDBAG BARRIERS



SAND BAG BARRIER



SAND BAG BARRIER
NOT TO SCALE

NOTES:

1. CONSTRUCT THE LENGTH OF EACH REACH SO THAT THAT CHANGE IN BASE ELEVATION ALONG THE REACH DOES NOT EXCEED 1/2 THE HEIGHT OF LINEAR BARRIER. IN NO CASE SHALL THE REACH LENGTH EXCEED 500 FEET.
2. PLACE SANDBAGS TIGHTLY.
3. DIMENSION MAY VARY TO FIT FIELD CONDITION.
4. SANDBAG BARRIER SHALL BE MINIMUM OF 3 BAGS HIGH.
5. THE END OF THE BARRIER SHALL BE TURNED UP SLOPE.
6. CROSS BARRIERS SHALL BE A MIN. OF 1/2 AND A MAX. OF 2/3 THE HEIGHT OF THE LINEAR BARRIER.
7. SANDBAG ROWS AND LAYERS SHALL BE STAGGERED TO ELIMINATE GAPS.

SWB: Straw Bale Barrier

Description & Purpose

A straw bale barrier is a series of straw bales placed on a level contour to intercept sheet flows. Sandbag barriers pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Straw Bale Barrier may be suitable in the following situations:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small, cleared areas
  - Along the perimeter of the site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment of paved areas.
  - Along streams and channels.
- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- Are not to be used for extended periods of time because they tend to rot and fall apart.
- Are suitable only for sheet flow on slopes of 0% or flatter.
- Are not appropriate for large drainage areas, limit to one acre or less.
- May require constant maintenance due to rotting.
- Are not recommended for concentrated flow, inlet protection, channel flow, or live stream

Objectives

SC	Sediment Control

Potential Alternatives

SF	Silt Fence
FB	Fiber Roll
GBB	Gravel Bag Barrier
SBB	Sandbag Barrier

- Cannot be made of bale bindings of jute or cotton.
- Requires labor-intensive installation and maintenance.
- Cannot be used on paved surfaces.
- Should not be used for drain inlet protection.
- Should not be used on lined ditches.
- May introduce undesirable non-native plants to the area.

Implementation

General

A straw bale barrier consists of a row of straw bales placed on a level contour. When appropriately placed, a straw bale barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides latent conditions allowing sediment to settle. Straw bale barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils.

Straw bale barriers have not been as effective as expected due to improper use. These barriers have been placed in streams and drainage ways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow. Use of straw bale barriers in accordance with this BMP should produce acceptable results.

Design and Layout

- Locate straw bales barriers on level contours.
  - Slopes up to 10:1 (H:V): Straw bales should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes greater than 10:1 (H:V): Not recommended.
- Turn the ends of the straw bale barriers up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the straw bale barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, consider moving the straw bale barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bales can be placed perpendicular to a berm to serve as a cross barrier.
- Drainage area should not exceed 1 acre, or 0.25 acre per 100 ft of barrier.
- Maximum flow path to the barrier should consist of two parallel rows.
  - Butt ends of bags tightly.
  - Stagger butt joints between front and back row.
  - Each row of bales must be trenched in and firmly staked.
- Straw bale barriers are limited in height to one bale laid on its side.
- Anchor bales with either two wood stakes or four bars driven through the bale and into the soil. Drive the first stake towards the butt joint with the adjacent bale to force the bales together.
- See attached figure for installation details.

Materials

- Straw Bale Size – Each straw bale should be a minimum of 14 in. wide, 18 in. in height, and 36 in. in length and should have a minimum mass of 50 lbs. The straw bale should be composed entirely of vegetative matter, except for the binding material.
- Bale Bindings – Bales should be bound by steel wire, nylon or polypropylene string placed horizontally. Jute and cotton binding should not be used. Baling wire should be a minimum diameter of 14 gauge. Nylon or polypropylene string should be approximately 12 gauge in diameter with a breaking strength of 80 lbs force.
- Stakes – Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

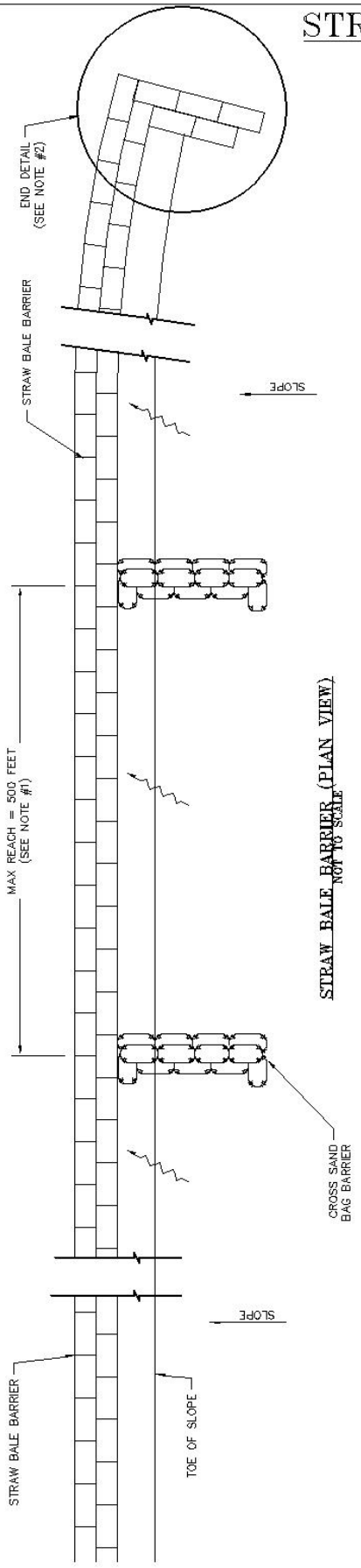
Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Straw bales degrade, especially when exposed to moisture. Rotting bales will need to be replaced on a regular basis.
- Replace or repair damaged bales as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove straw bales when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize area. Removed sediment should be incorporated in the project or disposed of.

Do. *Use straw bale barriers as perimeter protection and to keep flows from concentrating*

Don't. *Straw or Hay bales should not be used as check dams. Even if "properly" installed, they have a high failure rate.*

STRAW BALE BARRIER



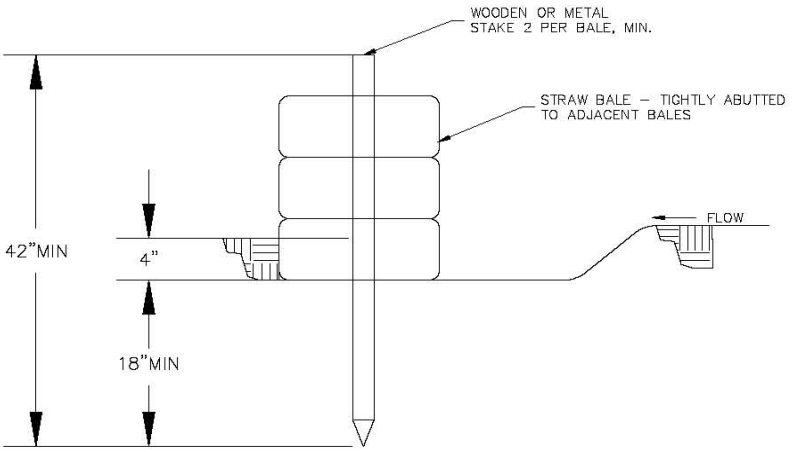
STRAW BALE BARRIER (PLAN VIEW)
NOT TO SCALE

LEGEND
DIRECTION OF FLOW

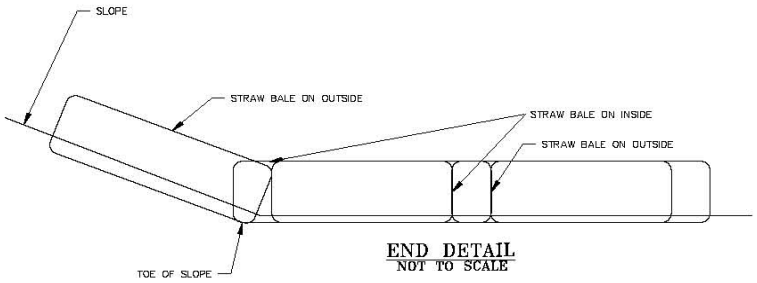
NOTES

1. CONSTRUCT THE LENGTH OF EACH REACH SO THAT THE CHANGE IN BASE ELEVATION ALONG THE REACH DOES NOT EXCEED 1/2 THE HEIGHT OF THE LINEAR BARRIER. IN NO CASE SHALL THE REACH LENGTH EXCEED 500 FEET.
2. THE END BARRIER SHALL BE TURNED UP SLOPE.
3. DIMENSION MAY VARY TO FIT FIELD CONDITION
4. STAKE DIMENSIONS ARE NOMINAL.
5. PLACE STRAW BALES TIGHTLY TOGETHER.
6. TAMP EMBANKMENT SPOILS AGAINST SIDES OF INSTALLED BALES.
7. DRIVE ANGLED WOOD STAKE BEFORE VERTICAL STAKE TO INSURE TIGHT ABUTMENT TO ADJACENT BALE.
8. SANDBAG ACROSS BARRIERS SHOULD BE A MINIMUM OF 1/2 AND A MAX. OF 2/3 THE HEIGHT OF THE LINEAR BARRIER.
9. SANDBAG ROWS AND LAYERS SHOULD BE OFFSET TO ELIMINATE GAPS.

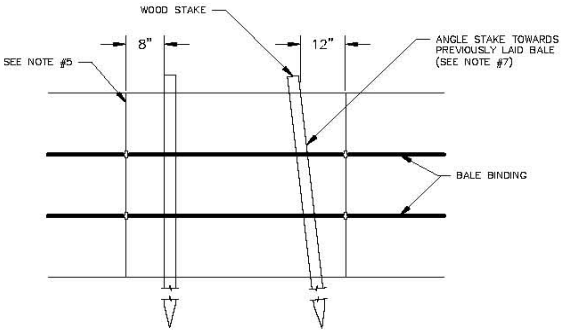
STRAW BALE BARRIER



SECTION VIEW
NOT TO SCALE



END DETAIL
NOT TO SCALE



PROFILE
NOT TO SCALE

SCE: Stabilized Construction Entrance

Description & Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Stabilized construction entrances may be suitable in the following situations:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right-of-way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

Objectives

TC Tracking Control

Potential Alternatives

None

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right-of-way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment for equipment leaving a construction site. The entrance should be built on level ground. Advantages of the stabilized construction entrance/exit are that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will be use on the construction site.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphaltic concrete (AC) grindings for stabilized construction access/roadway.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Do. *Design the entrance with rocks large enough that they will not be easily displaced by exiting vehicles.*

Inspection and Maintenance

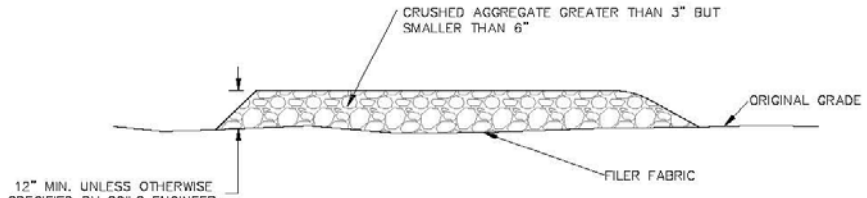
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction.

Do. *Supply ample length to remove the sediment from equipment and vehicles leaving the site.*

Don't. *Allow vehicles to enter and exit the job site at any location that has not been stabilized.*

Don't. *Spread parking, staging, and storage all over the site, it increases disturbance and erosion.*

STABILIZED CONSTRUCTION ENTRANCE / EXIT



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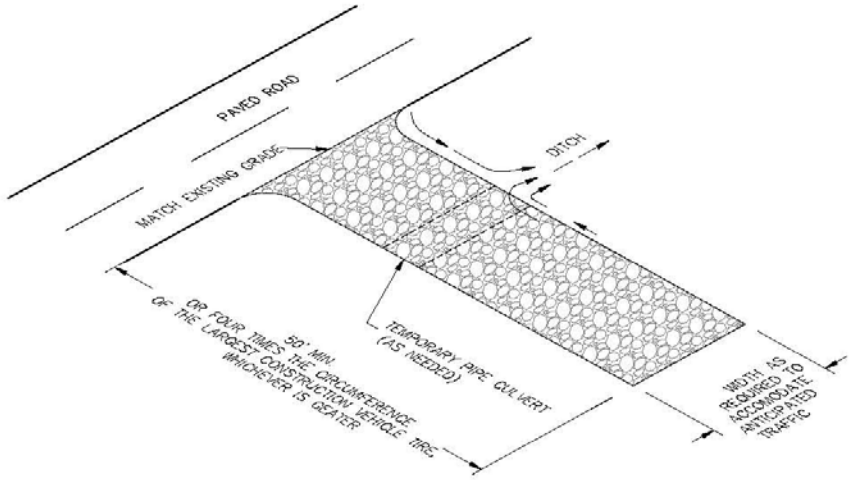

PLAN
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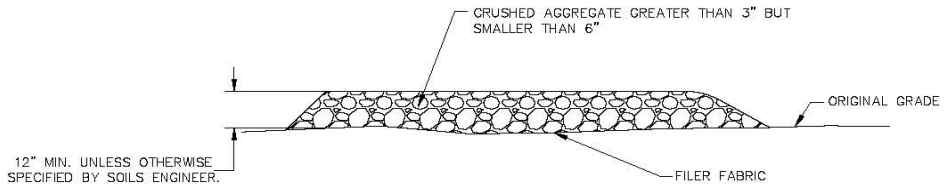
STABILIZED CONSTRUCTION ENTRANCE/EXIT



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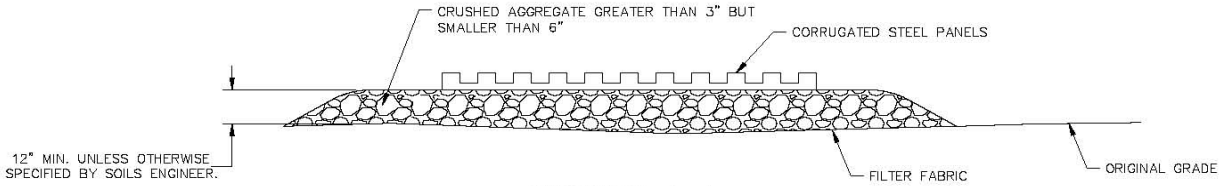

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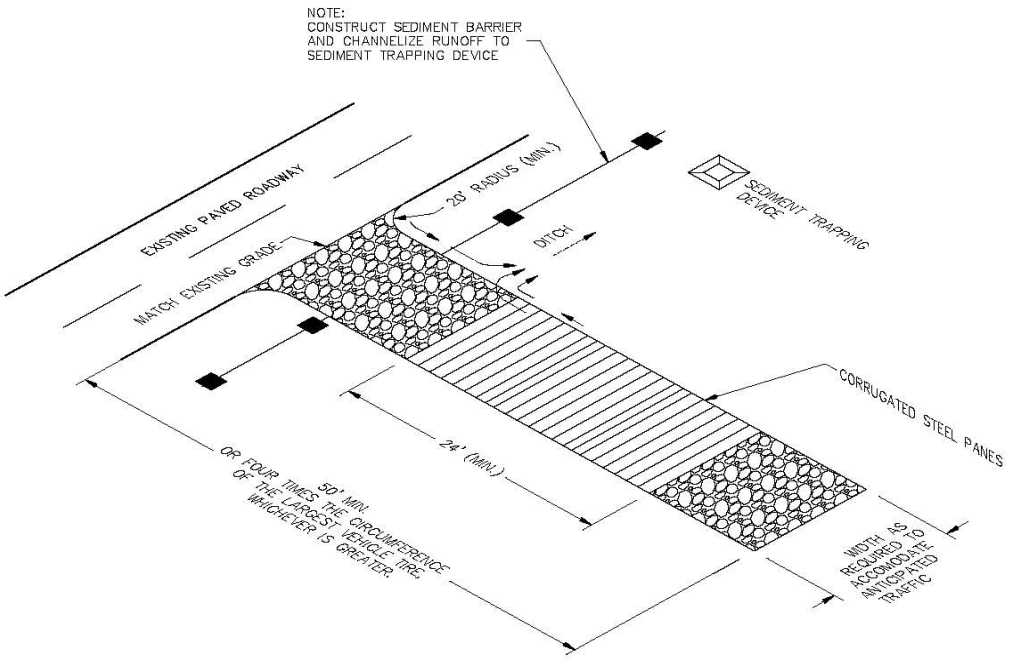


PLAN
NOT TO SCALE

SCR: Stabilized Construction Roadway

Description & Purpose

Access roads, subdivisions roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

Stabilized construction Roadways may be suitable in the following situations:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access.
  - Construction during wet weather.
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather.
  - Where dust is a problem during dry weather.
  - Adjacent to water bodies
  - Where poor soils are encountered.

Limitations

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause stormwater pollution and should not be used.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Objectives

TC Tracking Control

Potential Alternatives

None

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather.

Implementation

Permanent roads and parking areas should be paved as soon as possible after grading. As alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadways should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system. In addition, the following criteria should be considered:

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%
- Water is usually required on gravel or dirt roads to prevent dust.
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.
- Stabilized roadway using aggregate, asphaltic concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphaltic concrete (AC) grindings for stabilized construction roadways is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points. Installation should be accomplished as outlined in the Stabilized Construction Entrance minus corrugated metal sheets.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.
- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Don't. *Allow vehicle to access construction site by any access that is not stabilized.*

EOT: Entrance/Outlet Tire Wash

Description & Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Entrance/outlet tire wash may be suitable in the following situations:

- Construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.
- Must be implemented where 20,000yd^3 of material is moved onto the project, off of the project, or a combination of both.

Limitations

- Incorporate with a stabilized construction entrance/exit.
- Construct on level ground, when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.
- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of significant grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement Street Sweeping and Vacuuming as needed.

Objectives

TC Tracking Control

Potential Alternatives

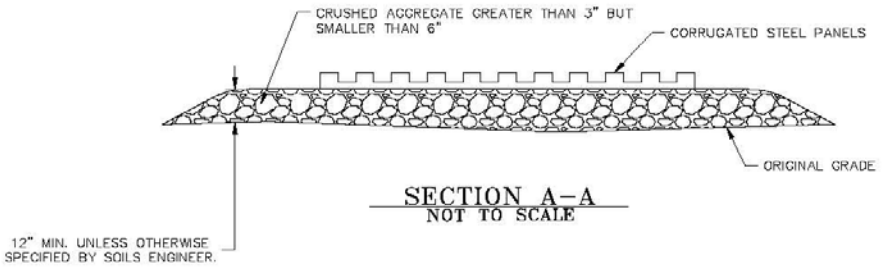
SCE Stabilized Construction Entrance/Exit

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as necessary.

Do. *Establish a designated wash off area that will be utilized for the majority of the project.*

ENTRANCE / OUTLET TIRE WASH



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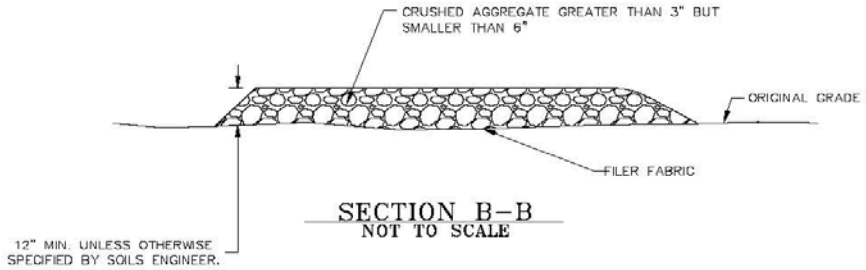

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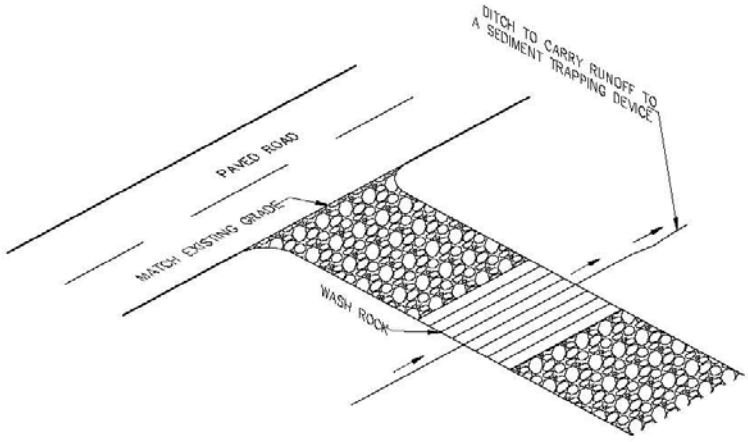


TYPICAL TIRE WASH
NOT TO SCALE

WE: Wind Erosion Control

Description & Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

Suitable Applications

Wind Erosion Control will be suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads.
- Drilling and blasting activities.
- Sediment tracking onto paved roads.
- Soils and debris storage piles.
- Batch drop from front-end loaders.
- Areas with unstabilized soil.
- Final grading/site stabilization.

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.
- Oil and oil-treated subgrade should not be used for dust control because the oil may migrate into drainage ways and/or seep into the soil.
- Effectiveness depends on soil, temperature, humidity, and wind velocity.
- Chemically treated sub grades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24-hour curing time to avoid adherence to equipment, workers shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

Objectives

WE Wind Erosion

Potential Alternatives

None

Implementation

General

Washington City's Climate, with short wet seasons and long hot dry seasons, allows the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventative measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

Site Conditions	Dust Control Practices								
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppresion	Gravel or Asphalt	Silt Fence	Temporary Gravel Construction Entrance/Equipment Wash Down	Haul Truck Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	x	x	x	x	x				x
Disturbed Areas Subject to Traffic			x	x	x		x		x
Material Stock Pile Stabilization			x	x		x			x
Demolition			x				x	x	
Clearing/ Excavation			x	x		x			x
Truck Traffic on Unpaved Roads			x	x	x		x	x	
Mud/Dirt Carry Out					x		x		

Additional preventative measures include:

- Schedule construction activities to minimize exposed area.
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion benefits.
- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide for wet suppression or stabilization of exposed soils.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize inactive construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Check areas protected to ensure coverage.
- Most Dust control measures require frequent, often daily, or multiple times per day attention.

Do. *Keep wind erosion low by applying water or other dust palliative when necessary.*

Don't. *Apply so much water as to cause erosion from the runoff created.*

SDP: Storm Drain Inlet Protection

Description & Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle.

Suitable Applications

Inlet Protection may be suitable in the following situations:

- Whenever a storm drain inlet is receiving or my receive sediment laden runoff.

Limitations

- Drainage area should not exceed 1 acre.
- Straw bales alone cannot be used as inlet protection but can be used to reinforce silt fence inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment laden stormwater and non-stormwater discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use other onsite sediment trapping techniques in conjunction with inlet protection.
- Frequent maintenance is required.
- For drainage areas larger than 1 acre, runoff should be routed to a sediment trapping device designed for larger flow. Such devices are Sediment Traps and Sediment Basins.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capacity is needed.

Objectives

SE	Sediment Control

Potential Alternatives

FB	Fiber Rolls
GBB	Gravel Bag Berm
SBB	Sandbag Barrier
SWB	Straw Bale Barrier
SF	Silt Fence

Implementation

General

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain 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.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through a Sediment Basin or a Sediment Trap. Different types of inlet protection are appropriate for different application depending on site conditions and the type on inlet. Inlet protection methods not presented in this handbook should be approved by the Public Works Department.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment laden surface runoff. Determine if storm drain inlet protection is needed and which methods to use.

- Limit upstream drainage area to 1 acre maximum. For larger areas use Sediment Basins or Sediment Traps upstream of the inlet protection device.
- The key to successful and safe use of storm drain inlet protection devices is to know where runoff will pond or be diverted.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desire areas, and prevent or control diversions.
- Four types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Filter Fabric Fence – Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5cfs.
  - Excavated Drop Inlet Sediment Trap – An excavated area around the inlet to trap sediment.
  - Gravel Bag Barrier – Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5cfs, and where overtopping is required to prevent flooding.
  - Block and Gravel Filter – Appropriate for flows greater than 0.5cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment laden water.
- Excavate sediment sumps (where needed) 1 to 2 feet with 2:1 side slopes around the inlet.

Design and Layout

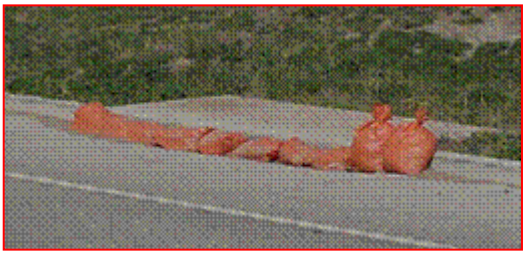
- DI Protection Type 1 – Filter Fabric Fence – The filter fabric fence (Type 1) protection is shown in the attached figure. Similar to constructing a silt fence. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.
  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  2. Place 2 in. by 2 in. wood stakes around the perimeter of the inlet a maximum of 3 ft. apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes must be at least 48 in. long.
  3. Lay fabric along bottom of trench, upside of trench, and then up stake. The maximum silt fence height around the inlet is 24 in.
  4. Staple the filter fabric to the wooden stakes. Use heavy duty wire staples at least 1 in. in length.
  5. Backfill the trench with gravel or compacted earth all the way around.

- DI Protection Type 2 – Excavated Drop Inlet Sediment Trap – The excavated drop inlet sediment trap (Type 2) is shown in the attached figures. Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate of 67 yd^3/acre of drainage area.
- DI Protection Type 3 – Gravel Bag – The gravel bag barrier (Type 3) is shown in the figures. Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with the Gravel Bag Berm requirements. Gravel bags should be used due to their high permeability.
    1. Use sandbag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
    2. Construct on gently sloping street.
    3. Leave room upstream of barrier for water to pond and sediment to settle.
    4. Place several layers of sandbags – overlapping the bags and packing them tightly together.
    5. Leave gap of one bag on top row to serve as a spillway. Flow from a severe storm (e.g., 10-year storm) should not overtop the curb.
- DI Protection Type 4 – Block and Gravel Filter – The block and gravel filter (Type 4) is shown in the figures. Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction.
    1. Place hardware cloth or comparable wire mesh with 0.5 in. opening over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Pace filter fabric over the wire mesh.
    2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
    3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the block. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
    4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

Inspection and Maintenance

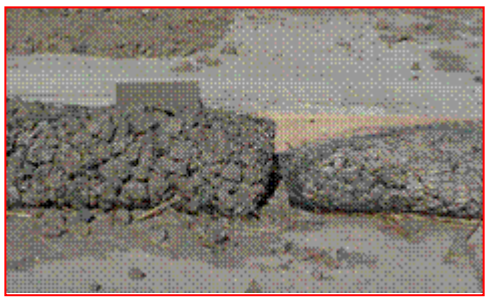
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Filter Fabric Fence – If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splinted, and are reasonably perpendicular to the ground). Replace damaged stakes.
- Gravel Filters – If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.
- Sediment accumulated in the BMP must be removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove storm drain inlet protection once the drainage area is stabilized.
    - Clean and regrade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

Don't. *Allow the silt fence to be damaged. Stakes must be maintained on a regular basis.*

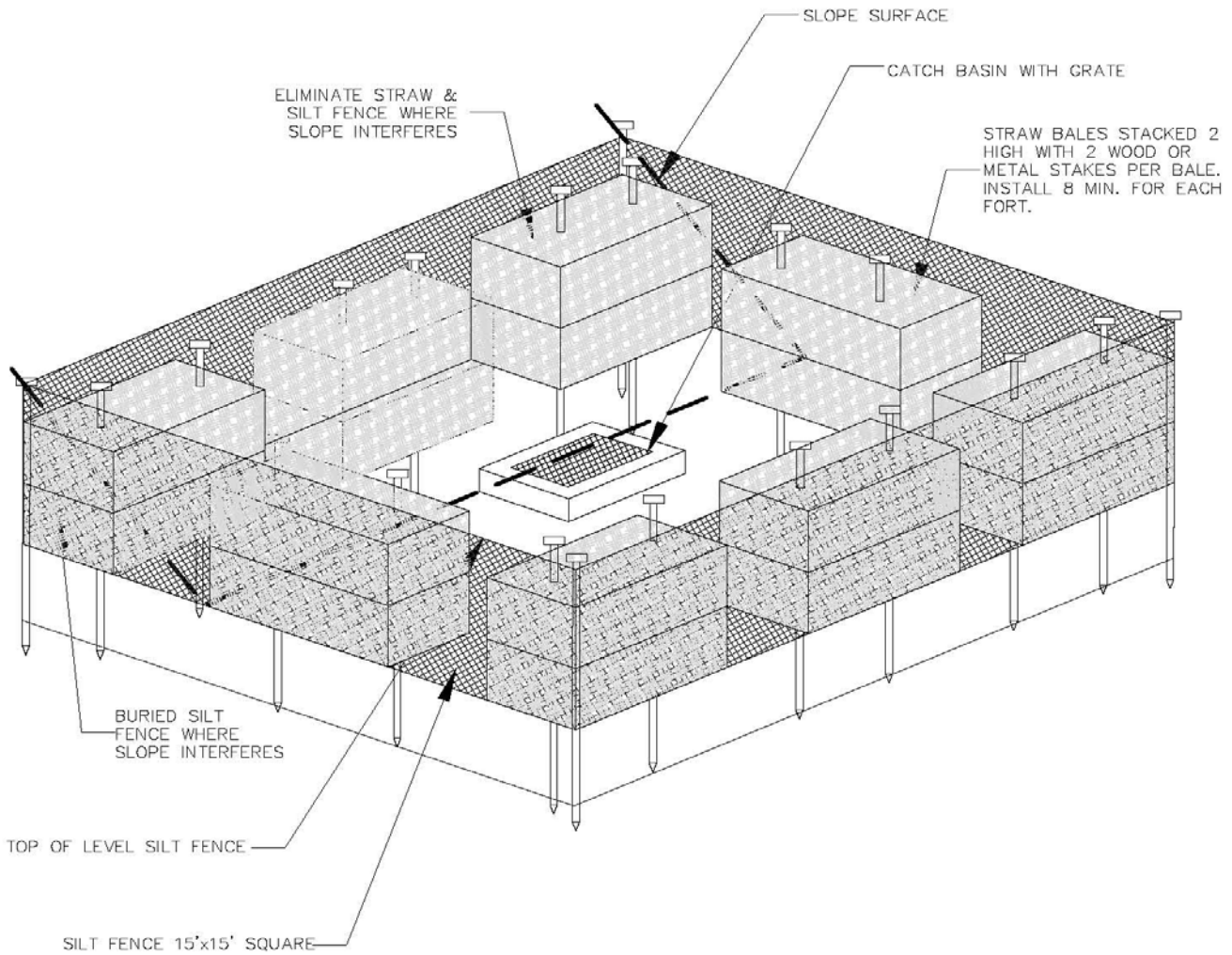


Do. Use gravel filled bags not constructed of burlap to filter out sediment from runoff.

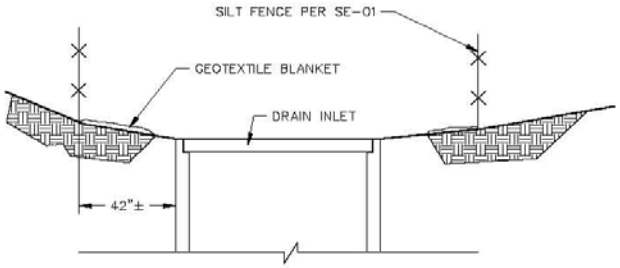
Don't. *Allow sediment laden runoff to enter the storm drain system unimpeded.*



DESILTING FORT



STORM DRAIN INLET PROTECTION



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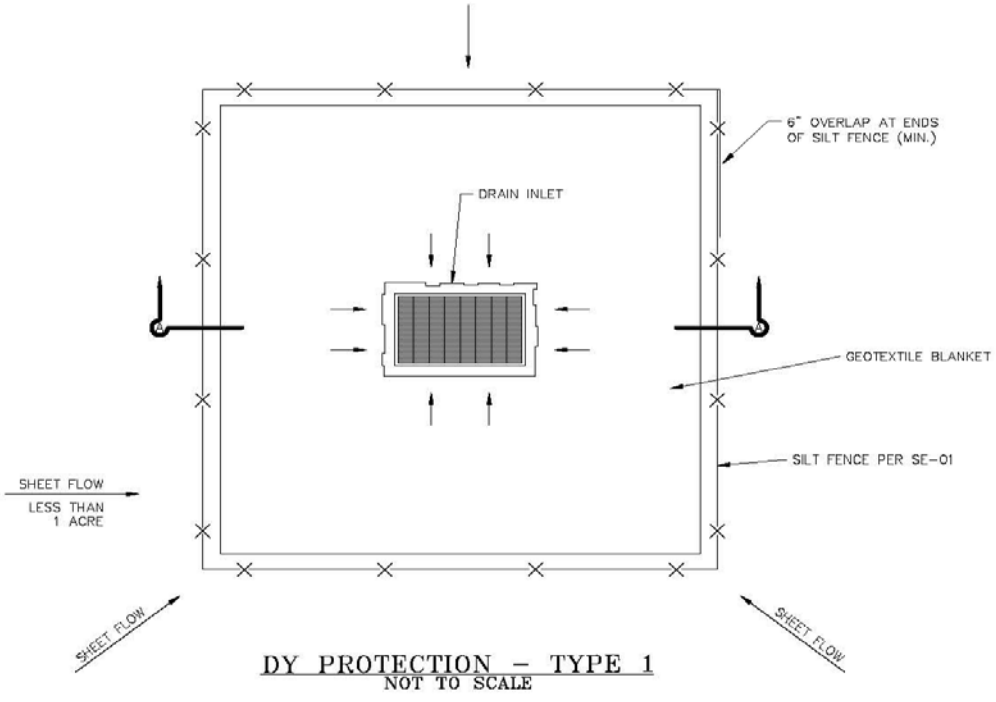
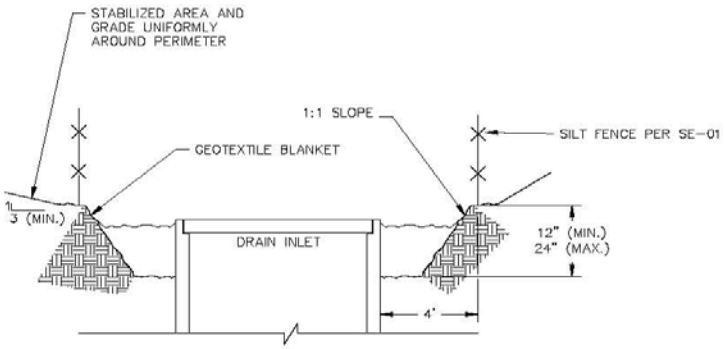


DY PROTECTION - TYPE 1
NOT TO SCALE

NOTES:

1. FOR USE IN AREAS WHERE GRADING HAS BEEN COMPLETED AND FINAL SOIL STABILIZATION AND SEEDING ARE PENDING.
2. NOT APPLICABLE IN PAVED AREAS.
3. NOT APPLICABLE WITH CONCENTRATED FLOWS.

STORM DRAIN INLET PROTECTION



NOTE:
REMOVE SEDIMENT BEFORE REACHING ONE THIRD FULL

SECTION A-A
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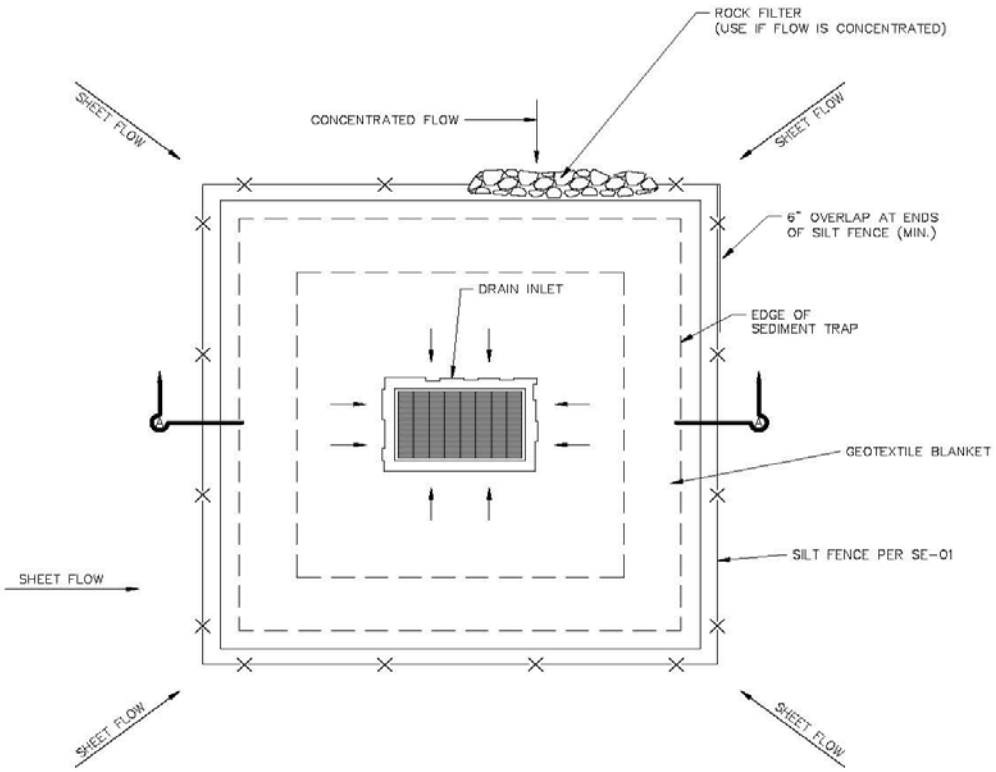
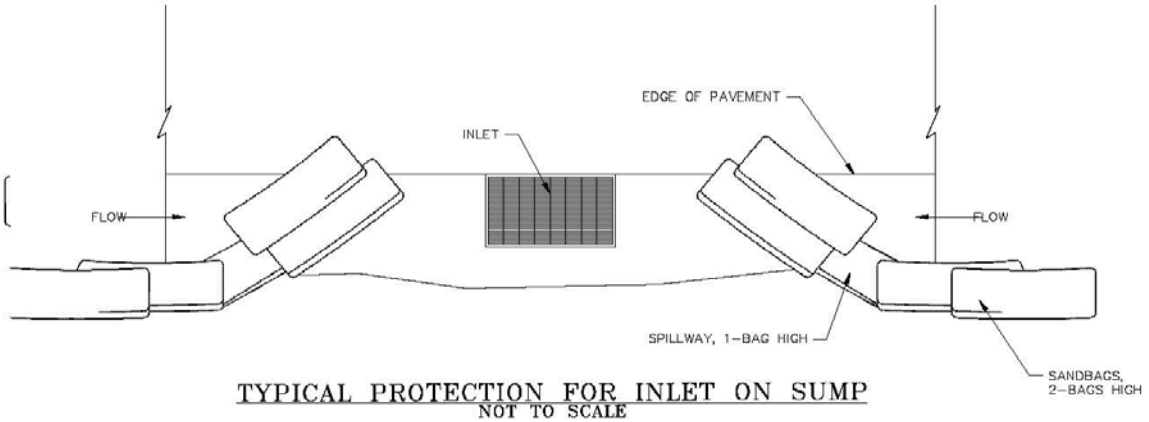


DI PROTECTION - TYPE 2
NOT TO SCALE

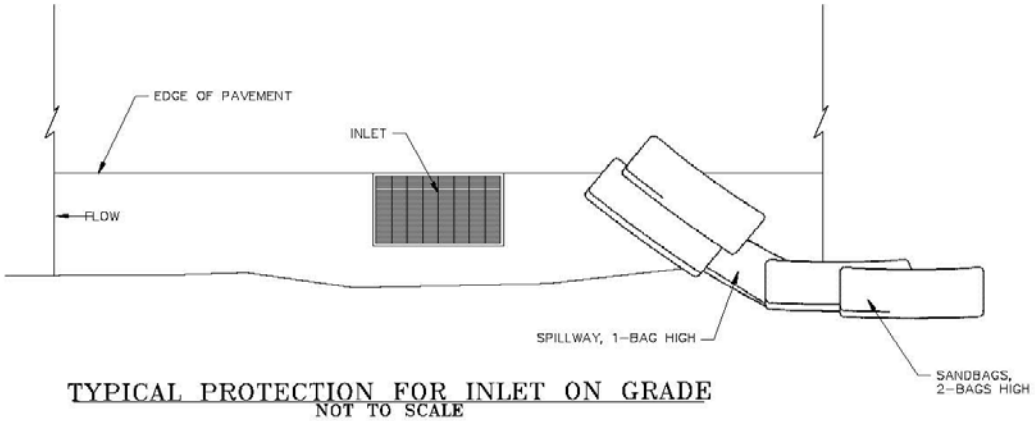
NOTES:

1. FOR USE IN CLEARED, GRUBBED, AND GRADED AREAS
2. SLOPE BASIN SO THAT LONGEST INFLOW AREA FACES LONGEST LENGTH OF TRAP.
3. FOR CONCENTRATED FLOWS, SHAPE BASIN IN 2:1 RATIO WITH LENGTH ORIENTED TOWARDS DIRECTION OF FLOW.

STORM DRAIN INLET PROTECTION



TYPICAL PROTECTION FOR INLET ON SUMP
NOT TO SCALE

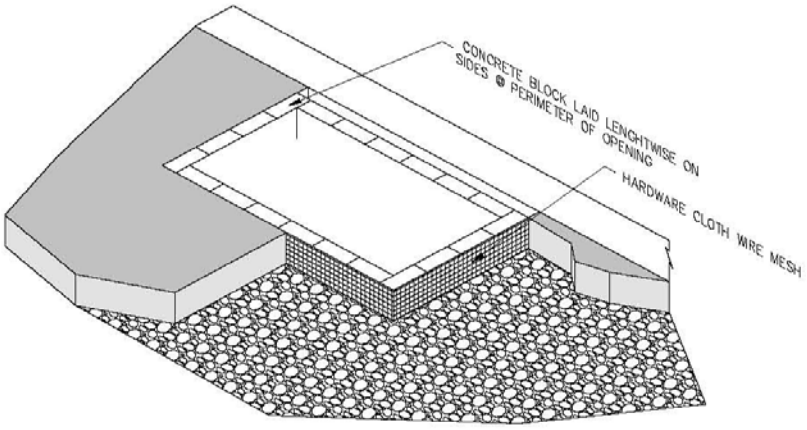


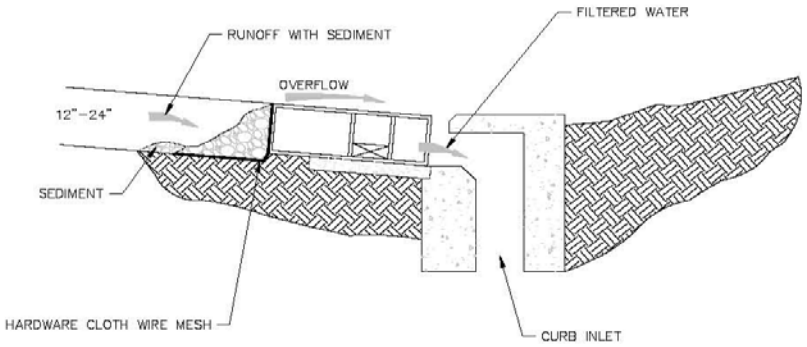
TYPICAL PROTECTION FOR INLET ON GRADE
NOT TO SCALE

NOTES:
1. INTENDED FOR SHORT TERM USE.
2. USE TO INHIBIT SON STORM-WATER FLOW.
3. ALLOW FOR PROPER MAINTENANCE AND CLEANUP.
4. BAGS MUST BE REMOVED AFTER ADJACENT OPERATION IS COMPLETED.
5. NOT APPLICABLE IN AREAS WITH HIGH SILTS AND CLAYS WITHOUT FILTER FABRIC.

TYPICAL DI PROTECTION – TYPE 3

STORM DRAIN INLET PROTECTION





DI PROTECTION TYPE 4
NOT TO SCALE

RR: Rip Rap

Description & Purpose

An arranged layer of rock placed over the soil surface on slopes and at or below storm drain outfalls or temporary dikes. Rip rap used as slope protection against erosion and dissipates the energy of runoff or surface water flow.

Suitable Applications

Rip Rap may be suitable in the following situations:

- Use rip rap on slope greater than 4:1 (H:V)
- In channels where the velocity and water surface elevation occurring during the 100-year storm event has the possibility of damaging the channel banks and/or flowline.
- Around structures that require protection during storm events (i.e., Bridges, Culvert inlets)

Limitations

- The minimum particle size of the rock must be sized for the maximum expected velocity of flow of the outlet and the soil conditions where the outlet will be located.

Objectives

SC Sediment Control

Potential Alternatives

None

Implementation

Design

Riprap should be installed as follows:

- Grade the bank to a maximum slope of two feet of horizontal distance for one foot of vertical rise.
- Place a highly permeable and appropriately sized geotextile filter fabric on the prepared slope following the manufacturer's recommendations. Take care not to tear the filter fabric during installation.
- Place a layer (six inch minimum) of gravel or small rock on the geotextile filter fabric. The underlayer stone needs to be sized appropriately so it will not wash through any gaps between the riprap stones.
- Place the layer of riprap, 1.5 times the thickness of the largest stone, on top of the gravel. The heaviest rocks should be placed along the bottom of the bank. Riprap should be placed onto position, not dumped over the bank edge.
- Entrench the bottom row of stone into the stream bed to prevent undercutting.
- Extend the revetment beyond the area of erosion to prevent erosion behind the ends of the structure.
- The rip rap should be sized according to the following table:

Velocity of Stream	Size Range Largest Diameter of Rock
2 - 6 feet/second	4" - 12"; average 6"
6 - 8 feet/second	6" - 18"; average 12"
8 - 10 feet/second	12" - 24"; average 18"
10 - 12 feet/second	18" - 30"; average 24"
12 - 15 feet/second	24" - 42"; average 36"

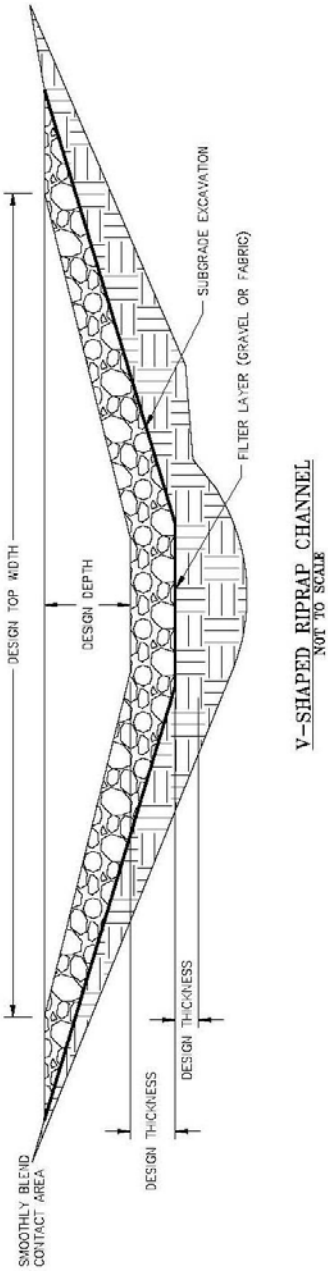
Don't. *Use concrete rubble as rip rap material.*

Inspection and Maintenance

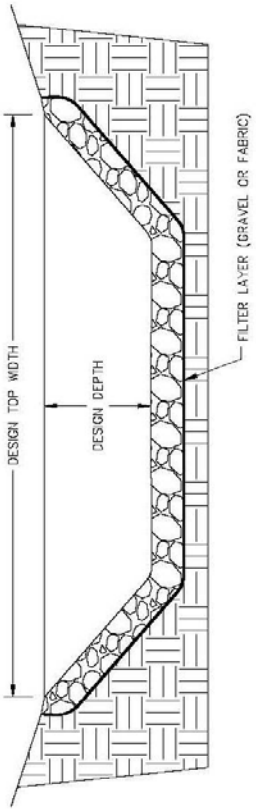
- Rip rap must be inspected every two weeks during the construction phase of the project.
- Rip rap must be inspected quarterly after the construction phase of the project is finished.
- Rip Rap must be inspected after all storm events producing a significant amount of runoff.
- Any rocks displaced during storm events must be replaced immediately after the storm event has ended.

Do. Install rip rap lined channels where erodible channels are constructed or altered.

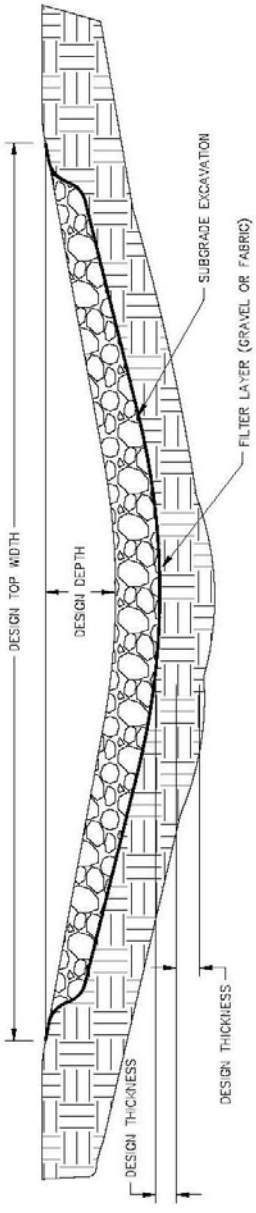
RIP RAP



V-SHAPED RIPRAP CHANNEL
NOT TO SCALE

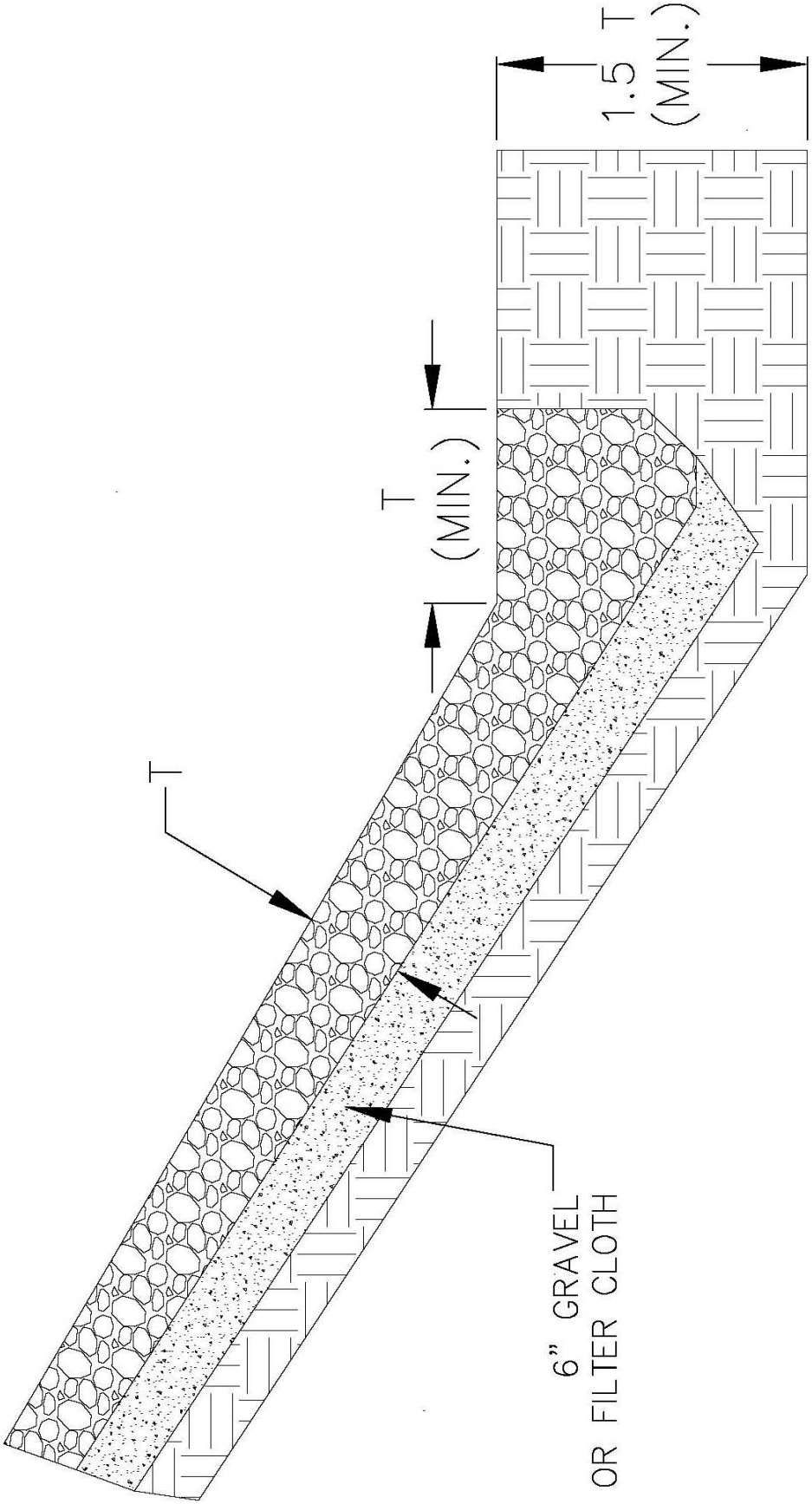


TRAPEZOIDAL RIPRAP CHANNEL
NOT TO SCALE



PARABOLIC-SHAPED RIPRAP CHANNEL
NOT TO SCALE

RIP RAP



CW: Concrete Washout

Description & Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete Washout may be suitable in the following situations:

- Wherever concrete, slurries, or asphalt concrete will be used on a construction site.

Limitations

- Offsite washout of concrete wastes may not always be possible.
- Onsite concrete washout sites must be maintained to remain effective.

Objectives

WM	Waste Management

Potential Alternatives

None

Implementation

The following steps will help reduce stormwater from concrete wastes:

- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before deliveries are made.
- Incorporate requirements for concrete washouts into material supplier and subcontractor agreements.
- Avoid mixing/ordering excess amounts of fresh concrete.
- Perform washout of concrete trucks offsite or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.
- Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and exposed aggregate.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose of properly.

Onsite Temporary Concrete Washout Facility

- Temporary concrete washout facilities should be located a minimum of 50 feet from storm drain inlets, open drainages, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Temporary washout facilities should have a temporary pit or bermed areas sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete washout.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of. Dispose of hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Straw bales, wood stakes, and sandbag materials should conform to the provisions stated in the Straw Bale Barrier BMP.
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.
- Holes, depressions, or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

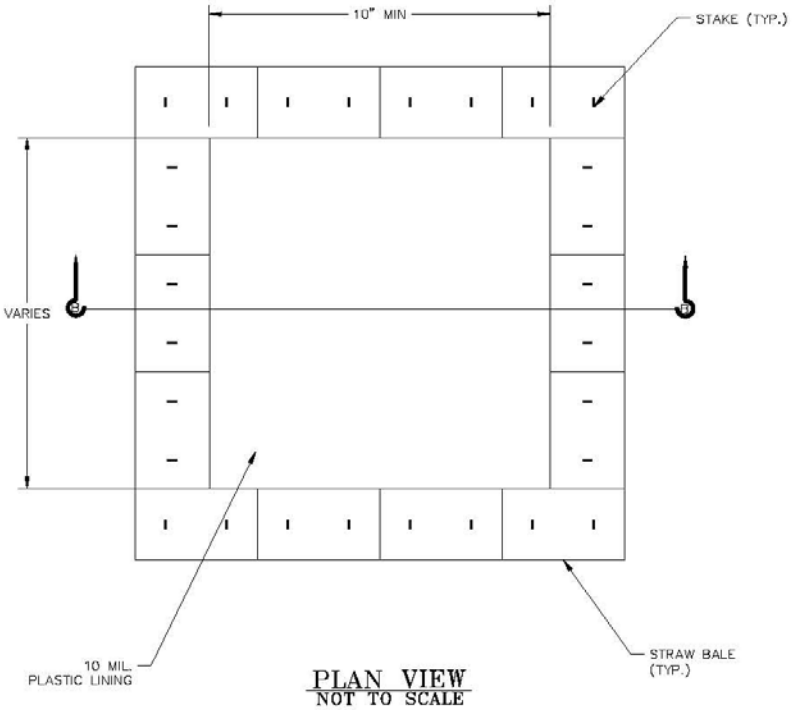
Do. Post signs directing mix trucks to centralized concrete washout facilities.

Don't. Allow concrete mix trucks to dump the excess concrete on the ground. The cleanup is more expensive and difficult to perform.

Inspection and Maintenance

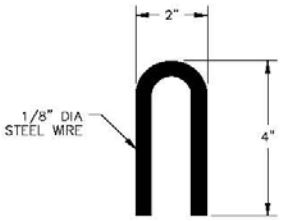
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continues BMP implementation.
- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

CONCRETE WASTE MANAGEMENT



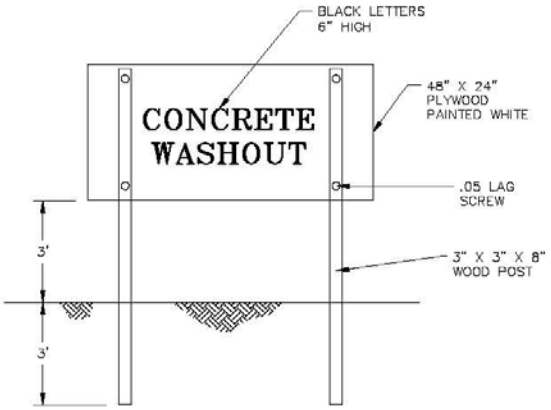
PLAN VIEW
NOT TO SCALE

TYPE: "ABOVE GRADE" (WITH STRAW BALES)

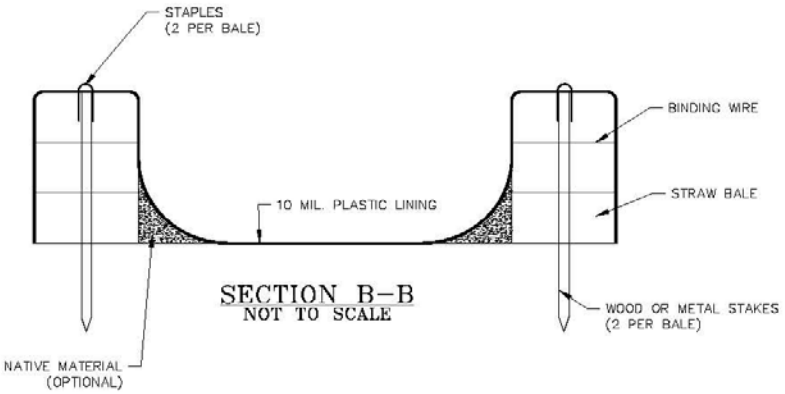


STAPLE DETAIL
NOT TO SCALE

NOTES:
1. ACTUAL LAYOUT DETERMINED IN THE FIELD
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY

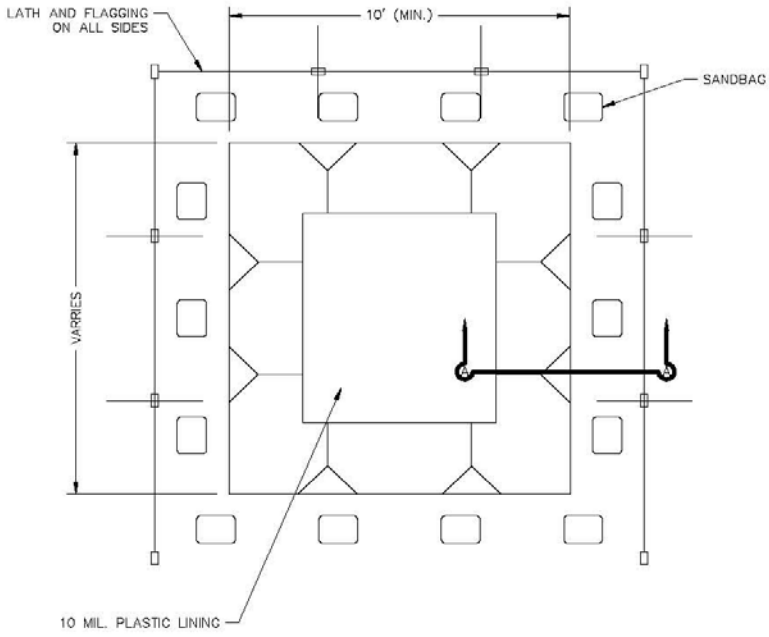


CONCRETE WASHOUT SIGN DETAIL
OR EQUIVALENT



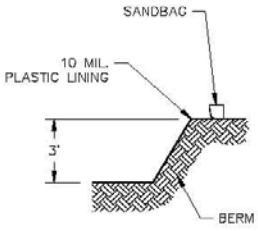
SECTION B–B
NOT TO SCALE

CONCRETE WASTE MANAGEMENT



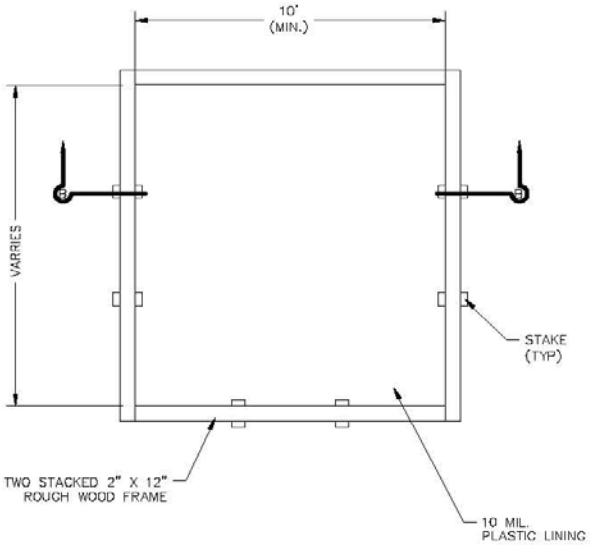
PLAN VIEW
NOT TO SCALE

TYPE: " BELOW GRADE"



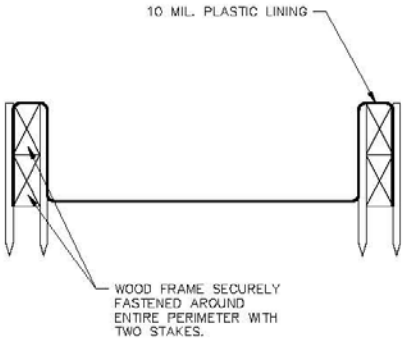
SECTION B–B
NOT TO SCALE

NOTES:
1. ACTUAL LAYOUT DETERMINED IN THE FIELD
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY



PLAN VIEW
NOT TO SCALE

TYPE: " ABOVE GRADE"



SECTION B–B
NOT TO SCALE

SSA: Stabilized Staging Area

Description & Purpose

Provides an onsite location where equipment, deliveries, and project parking can be centralized to reduce mud collection on vehicle tires thus helping to reduce the amount of mud tracking onto adjacent streets.

Suitable Applications

Stabilized Staging Areas may be suitable in the following situations:

- Wherever an onsite construction management office is located.
- Wherever construction vehicles park on a job site.
- Wherever equipment or supplies are to be stored prior to installation.

Limitations

- Adequate space may not be available on very small sites. Stabilized Staging Areas may be incorporated in this situation by enlarging the Stabilized Construction Entrance to a size sufficient to be utilized as a staging area.
- Onsite stabilized staging areas sites must be maintained to remain effective.

Objectives

TC	Tracking Control

Potential Alternatives

None

Implementation

General

A stabilized staging area is a pad of aggregate underlain with filter cloth located at any point where vehicles will be parked, equipment or material are stored, and where construction management offices are maintained. The purpose of a stabilized staging area is to reduce or eliminate the tracking of sediment onto public rights-of-way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized staging areas are moderately effective at preventing the collection of mud onto the tires of vehicles on a construction site when used in conjunction with stabilized construction entrance/exits and stabilized construction roads. The staging area should be built on level ground and should be connected to the main street by either the stabilized entrance or stabilized road or a combination of both. Advantages of the stabilized staging area are that it does prevent some sediment from equipment and serves to channel construction traffic in and out of the site to specified locations.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Provide ample turning radii as part of the staging area.
- Limit speed of vehicles to control dust.
- Properly grade each staging area to prevent runoff from damaging the staging area.
- Connect staging area to the entrance/exit location of the site by utilizing a stabilized construction roadway.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphaltic concrete (AC) grindings for stabilized staging area.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Require that all employees, subcontractors, and suppliers utilize the stabilized staging area.
- Implement removal and replacement of aggregate as needed.
- All staging area locations intended to be used for more than a two-week period should have stabilized staging area BMPs.

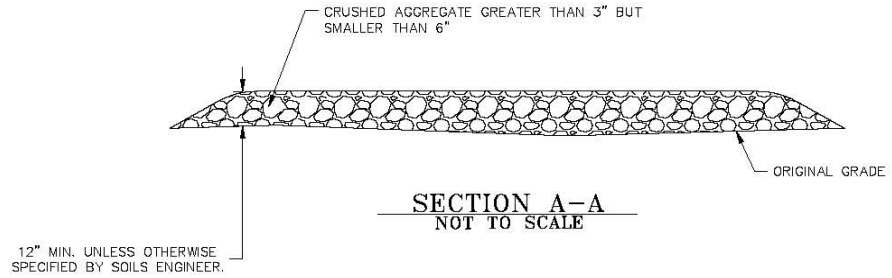
Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Remove aggregate, separate, and dispose of sediment if staging area is clogged with sediment.
- Keep all temporary ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove gravel and filter fabric at completion of construction.

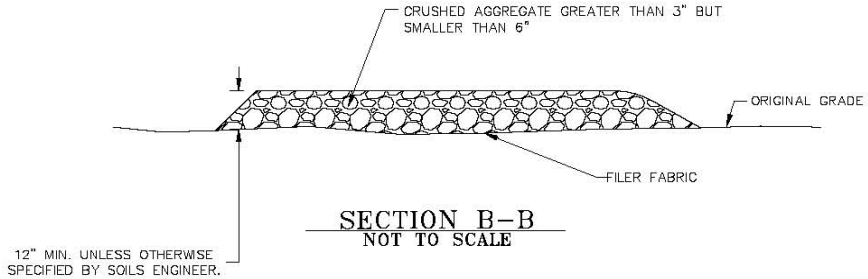
Do.
Construct a stabilized staging area next to an onsite construction manage-ment office.

Don't.
Allow staging to spread over the entire construction site.

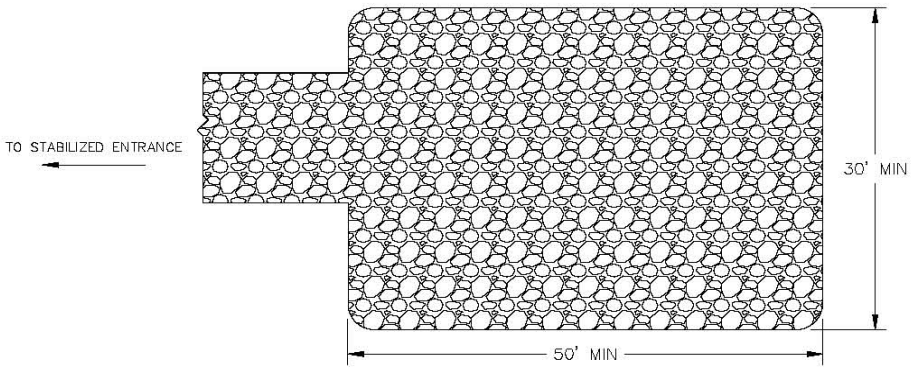
STABILIZED STAGING AREA



SECTION A–A
NOT TO SCALE



SECTION B–B
NOT TO SCALE



TYPICAL STAGING AREA
NOT TO SCALE