Baker County

Mason Dam Hydroelectric Project
FERC No. P-12686

Erosion and Sediment Control Plan

October 2010

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I. Introduction

Baker County has applied to the Federal Energy Regulatory Commission (FERC) to develop hydroelectric energy at the existing Mason Dam. Mason Dam is located along the Powder River in Baker County, Oregon approximately 15 miles southwest of Baker City off of State Highway 7 and in the Wallowa-Whitman national Forest.

Mason Dam was built by the US Bureau of Reclamation (BOR) on the Powder River for irrigation, water delivery, and flood control. Mason Dam is 173 feet high, 895 feet long and 875 feet wide from toe to toe. Phillips Reservoir is formed from Mason Dam and covers 2,235 acres, has a total of 95,500 acre-feet, with 90,500 acre-feet being active. Water is stored behind Mason Dam in Phillips Reservoir, and is released during the irrigation season by Baker Valley Irrigation District (BVID). Water is generally stored between October and March and released April through September.

The intake of Mason Dam is located within a 17 x 17 x 13.3 foot high barrier with large bars, spaced 6 inches apart that act as a trash rack. There are two pipes that can be used to release water. One is a 56 inch diameter pipe and the other is a 12 inch diameter pipe. The 56 inch pipe is split into two 33 inch, high pressure gates, that are located in the valve house to control the release into the stilling basin via the tail race. The 12 inch pipe uses a sleeve/weir type valve to release water into the stilling basin. The outlet works consists of a tunnel controlled by the two high pressure gates with hydraulic hoists that have a capacity of 875 cfs at a reservoir elevation of 4070.5 feet. The spillway has an uncontrolled crest and is concrete lined with a maximum capacity of 1,210 cfs at a reservoir elevation of 4077.25 feet. The spillway and outlet works share a common stilling basin.

The proposed hydroelectric plant will contain a single horizontal shaft Francis turbine connected to a 3.4 MW 60 hertz, 12,640 volt generator with a brushless exciter. It will operate efficiently over a head range of 10 to 150 feet, and flows from 120 to 300 cfs. An extended downward tilted draft tube will discharge into the tailrace. The draft tube will be fitted with aeration fittings to provide aspiration of air to increase dissolved oxygen in the river. Plant controls will include a synchronous bypass to initiate the operation of the Reclamation slide gates during turbine shut down. A new hydraulic power unit (HPU) will be provided to increase the rate of the slide gates opening to more closely match the rate of flow lost when the turbine shuts down. Power generated will sent to the substation .8 miles away from the powerhouse. The current plan is for the line to be overhead following the Black Mountain Road.

1.0 Purpose and Scope

The purpose of the erosion and sediment control plan is to provide instruction and procedures to control and manage erosion, dust, and soil movement within the project area. The contractor shall comply with Best Management Practices (BMPs) as found in 7.1.

2.0 References

2.1 Erosion and Sediment Control Manual

3.0 Definitions

3.1 Limit Ground Disturbance: All ground disturbing activities will be planned to limit soil disturbance in an effort to reduce the potential for erosion.

3.2 Sediment Barriers: Are barriers such as silt fence, hay bales, and fiber wattles used in conjunction with berms, dikes, sand bag or rock dams, that will take any surface water collected and remove any sediment prior to reaching any undesirable area.

3.3 Revegetation: If an area has been disturbed revegetation will be used for temporary and permanent soil stabilization. Baker County will work with the Forest Service to determine the seed mixture used for revegetation.

3.4 Implementation Schedule: Plans will be reviewed before project work begins and steps taken to limit soil disturbance. Sediment Barriers will be installed prior to and added to if needed during construction. As soon as possible revegetation will occur to stabilize all ground disturbing activities.

4.0 Responsibilities

Baker County will ensure that the contractor(s) fully understand and implement this plan for all construction activities.

5.0 Procedures

5.1 Installation of silt fences, hay bales, swales (sediment barriers) shall be installed prior to project construction. Additional methods such as sand bag dams and sediment traps will be incorporated if deemed necessary.

5.2 The contractor shall perform weekly inspections of the BMPs while construction activities are occurring.

5.3 The designated BMP inspector will maintain a log book/journal of weekly inspections including observations or current conditions and if any improvements are needed.

6.0 Summary of Mitigation Measures

6.1 All displaced soil will be utilized on-site as backfill material

6.2 Incidental travel outside of approved construction areas would be prohibited

6.3 Silt fences roe fiber rolls would be installed between construction areas and adjacent wetlands to streams to prevent construction sediment from entering these areas

6.4 Tailrace construction within the Powder River would occur under dewatered conditions, with a cofferdam placed immediately downstream of the construction area to prevent downstream sedimentation.

6.5 All disturbed areas would be reseeded with native and desirable non-native seed mixes to benefit wildlife and to prevent erosion and the spread of noxious weeds. The seed mix will be determined through consultation with the Forest Service.

7.0 Attachments

7.1 Erosion and Sediment Control Manual Appendix D: Runoff Control BMPS

7.2 Erosion and Sediment Control Manual Appendix E: Erosion Prevention BMPS

7.3 Erosion and Sediment Control Manual Appendix F: Sediment Control BMPS

APPENDIX D

RUNOFF CONTROL BMPS

RC-1	Slope Drain
RC-2	Energy Dissipator
RC-3	Diversion of Run-on
RC-4	Temporary Diversion Dike
RC-5	Grass-lined Channel (Turf Reinforcement Mats)
RC-6	Trench Drain
RC-7	Drop Inlet
RC-8	Minimizing TSS During Instream Construction
RC-9	Instream Diversion Techniques
RC-10	Instream Isolation Techniques
RC-11	Check Dams

Construction Specifications:

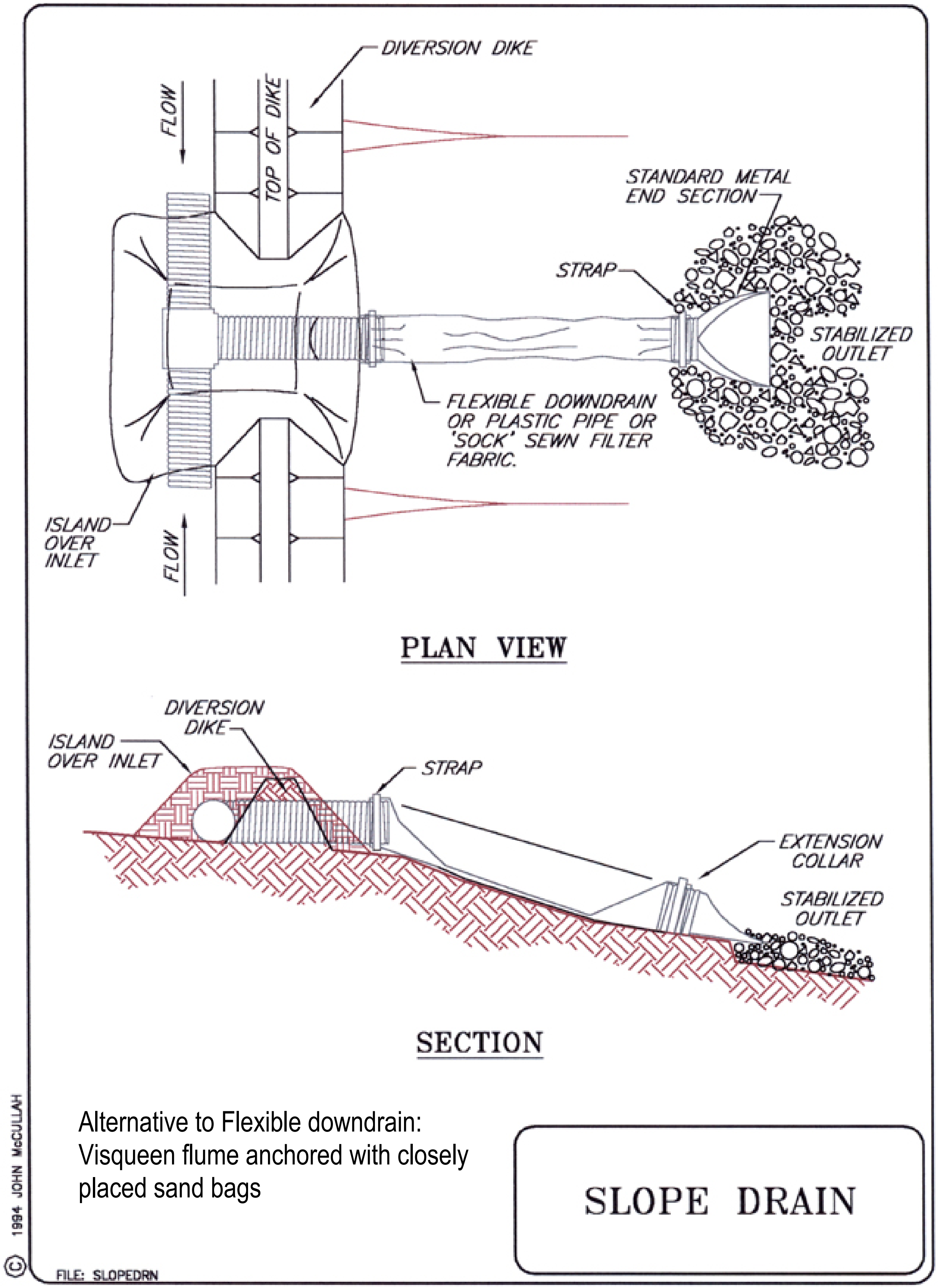
A common failure of slope drains is caused by water saturating the soil and seeping along the pipe. Proper backfilling around and under the pipe haunches with stable soil material and hand compacting in 6 inch (0.2 m) lifts to achieve firm contact between the pipe and the soil at all points will reduce this type of failure.

- Place slope drains on undisturbed soil or well-compacted fill at locations and elevations shown on the plans.
- Slightly slope the section of pipe under the dike toward its outlet.
- Compact the soil under and around the entrance section in lifts not to exceed 6 inches.
- Ensure that fill over the drain at the top of the slope has a minimum depth of 1.5 feet (0.5 m) and a minimum top width of 4 feet (1.2 m). The sides should have a 3:1 slope.
- Ensure that all slope drain connections are watertight.
- Ensure that all fill material is well-compacted. Securely fasten the exposed section of the drain with grommets or stakes spaced no more than 10 feet (3.1 m) apart. If the drain is longer than 10 feet (3.1 m), the drain must be anchored within each 10 foot (3.1 m) section and at the end section. Anchoring methods can vary depending on site conditions. At a minimum, the drain should be staked such that it is not able to move laterally or separate from the upstream diversion culvert.
- Extend the drain beyond the toe of the slope and adequately protect the outlet from erosion (see EC-10).
- Make the settled, compacted dike ridge no less than 1 foot (0.3 m) higher than the top of the pipe inlet.
- As an alternative to slope drains visqueen flume down drains may be used to convey runoff to a stabilized downstream conveyance. The visqueen shall be anchored at the top of a slope similar to erosion control blankets (EC-10). Use sandbags to stabilize the sides of the visqueen flume similar to sand bag barriers (SC-2). The visqueen (plastic sheet) shall meet the following specifications:
    - Plastic sheeting shall have a minimum thickness of 6 mil, and shall be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft (3 m) apart. Seams are typically taped or weighted down their entire length, and there shall be at least a 12 to 24 inches (300 mm to 600 mm) overlap of all seams. Edges shall be embedded a minimum of 6 inches (150 mm) in soil.
    - All sheeting shall be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures shall be repaired immediately. If washout or breakages occurs, the material shall be re-installed after repairing the damage to the slope.
- Immediately after grading, stabilize all disturbed areas as appropriate (see Erosion Prevention BMPs).

Minimum BMP standards are provided on the following detail.

Inspection and Maintenance:

- Inspect the slope drain and supporting diversions before, during, and after every storm event and promptly make necessary repairs.
- When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.


DIVERSION DIKE
FLOW
TOP OF DIKE
STANDARD METAL END SECTION
STRAP
STABILIZED OUTLET
FLEXIBLE DOWNDRAIN OR PLASTIC PIPE OR 'SOCK' SEWN FILTER FABRIC.
ISLAND OVER INLET
FLOW
PLAN VIEW
DIVERSION DIKE
ISLAND OVER INLET
STRAP
EXTENSION COLLAR
STABILIZED OUTLET
SECTION
Alternative to Flexible downdrain: Visqueen flume anchored with closely placed sand bags
SLOPE DRAIN
© 1994 JOHN McCULLAH
FILE: SLOPEDRN

ENERGY DISSIPATOR – RC-2

This BMP provides specifications for riprap type energy dissipators. Alternative energy dissipation methods such as mats, plates, or other stabilization techniques may be used in the project ESCP as approved by DEQ or a local agency acting as DEQ's agent.

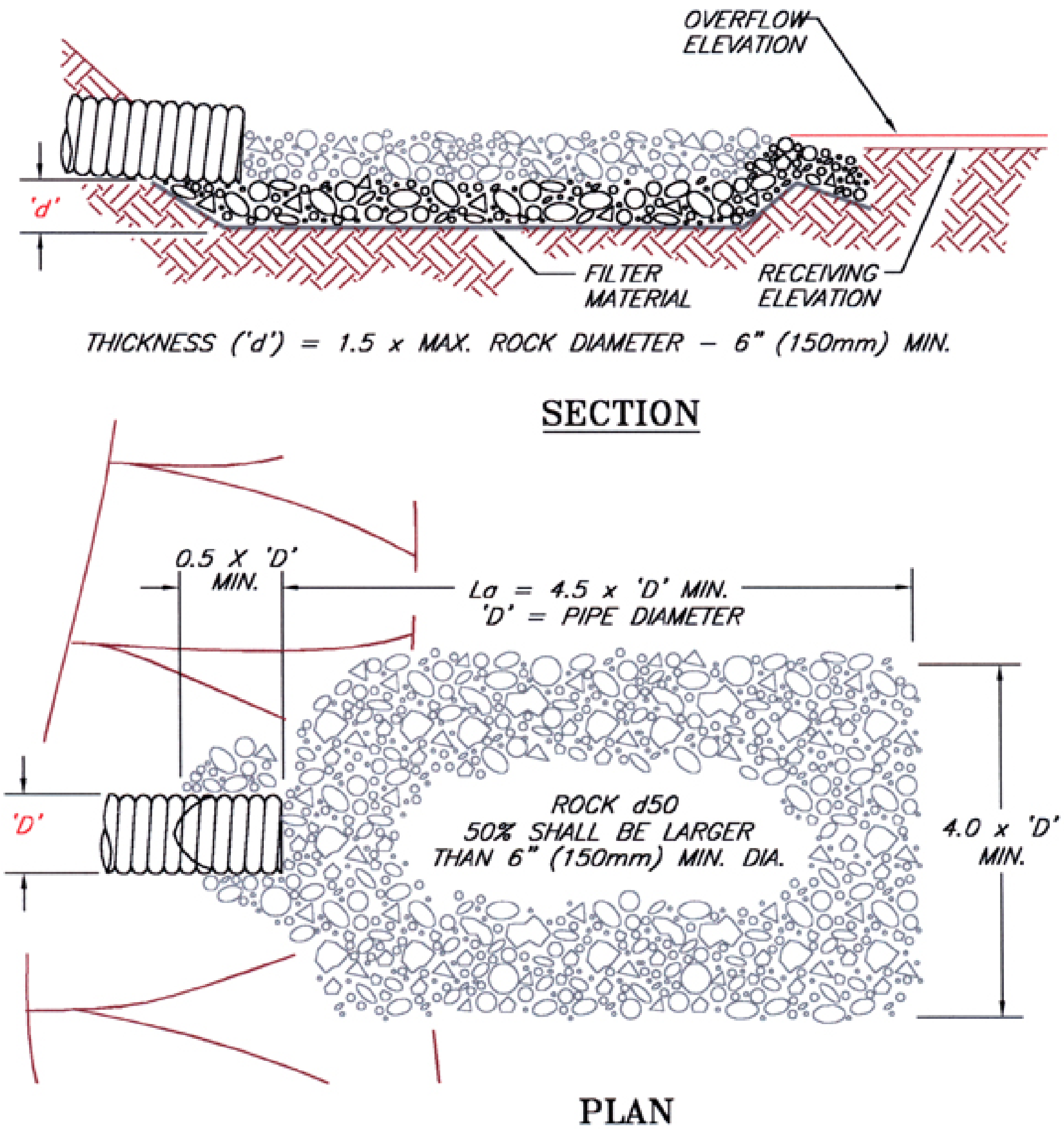
Construction Specifications:

- Ensure that the subgrade for the filter and riprap follows the required lines and grades shown on the plans. Compact any fill required in the subgrade to the density of the surrounding undisturbed material. Low areas in the subgrade on undisturbed soil may also be filled by increasing the riprap thickness.
- The riprap and gravel filter must conform to the specified grading limits shown on the plans.
- Filter fabric, when used, must meet design requirements and be properly protected from punching or tearing during installation. Repair any damaged fabric by removing the riprap and placing another piece of filter fabric over the damaged area. All connecting joints should overlap a minimum of 1 foot (0.3 m). If the damage is extensive, replace the entire filter cloth.
- Riprap may be placed by equipment, but take care to avoid damaging the fabric.
- The minimum thickness of the riprap should be 1.5 times the maximum stone diameter.
- Riprap may be field stone or rough quarry stone. It shall be hard, angular, highly weather-resistant and well graded.
- Construct the apron on zero grade with no overflow at the end. Make the top of the riprap at the downstream end level with the receiving area or slightly below it.
- Ensure that the apron is properly aligned with the receiving stream and preferably straight throughout its length. If a curve is needed to fit site conditions, place it in the upper section of the apron.
- Immediately after construction, stabilize all disturbed areas with vegetation.
- Outlets of all water conveyances must be stabilized.

Minimum BMP standards are provided on the following detail.

Inspection and Maintenance:

- Inspect riprap outlet structures before, during, and after rains to see if any erosion around or below the riprap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.
- Clean out energy dissipation as necessary when approximately half of the void space is filled with sediment and debris.



NOTES:

1. 'La' = LENGTH OF APRON. DISTANCE 'La' SHALL BE OF SUFFICIENT LENGTH TO DISSIPATE ENERGY.
2. APRON SHALL BE SET AT A ZERO GRADE AND ALIGNED STRAIGHT.
3. FILTER MATERIAL SHALL BE FILTER FABRIC OR 6" (150mm) THICK MINIMUM GRADED GRAVEL LAYER.

ENERGY DISSIPATOR

FILE: ENRGYDIS

DIVERSION OF RUN-ON – RC-3

Diversion consists of measures that intercept, divert and convey surface run-on, generally sheet flow, to prevent erosion and transport of pollutants through and from the site.

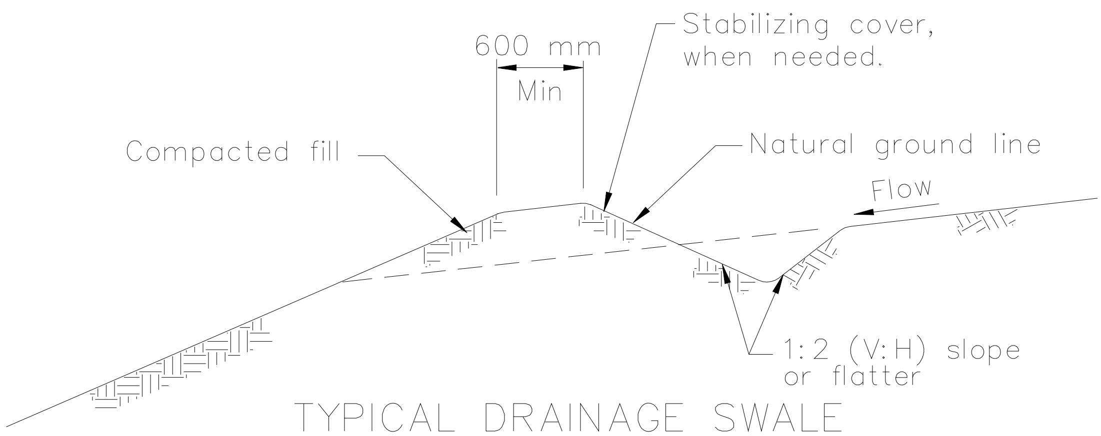
Construction Specifications:

- Construct diversion channels consisting of drainage swales; earth dikes; or other means such as sand bag barriers to intercept and divert run-on to avoid sheet flow over sloped surfaces and work areas (See SC-2 “Sand Bag Barrier”).
- Construct diversion structure to adequately convey storm flows based on careful evaluation of the risks due to erosion of the measure, soil types, over topping, flow backups, washout, and drainage flow patterns for each project site.
- Use other soil stabilization and sediment controls, such as check dams, plastics, and blankets, as necessary to prevent scour and erosion in newly graded dikes, swales and ditches.
- Correctly size and locate earth dikes, drainage swales and lined ditches. Excessively steep, unlined dikes and swales are themselves subject to erosion and gully formation.
- Stabilize conveyances as necessary and use a lined ditch for high flow velocities. Refer to EC-10 entitled “Erosion Control Blankets and Mats” or line with permanent, erosion-resistant material.
- Where appropriate, use natural streambed materials such as large cobbles and boulders for temporary embankment/slope protection, or other temporary soil stabilization methods.
- Compact any fills to prevent unequal settlement.
- Divert runoff to an appropriate downstream location.
- Use level spreaders (i.e., outlets for dikes and flow channels consisting of an excavated depression constructed at zero grade across a slope), to convert concentrated runoff into sheetflow onto areas stabilized by existing vegetation.
- Do not divert runoff from the project to adjacent properties without permission.
- When possible, install and utilize permanent dikes, swales and ditches early in the construction process.
- Convey collected run-on/concentrated flows down slopes in accordance with the RC-1 (“Slope Drain”)
- Provide stabilized outlets. Refer to RC-2 entitled “Energy Dissipator.”

Minimum BMP standards are provided on the following detail.

Inspection and Maintenance:

- Inspect temporary measures before, during and after rain events, and regularly.
- 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 or as directed by the engineer.
- Temporary conveyances shall be completely removed as soon as the surrounding drainage area has been stabilized, or at the completion of construction.

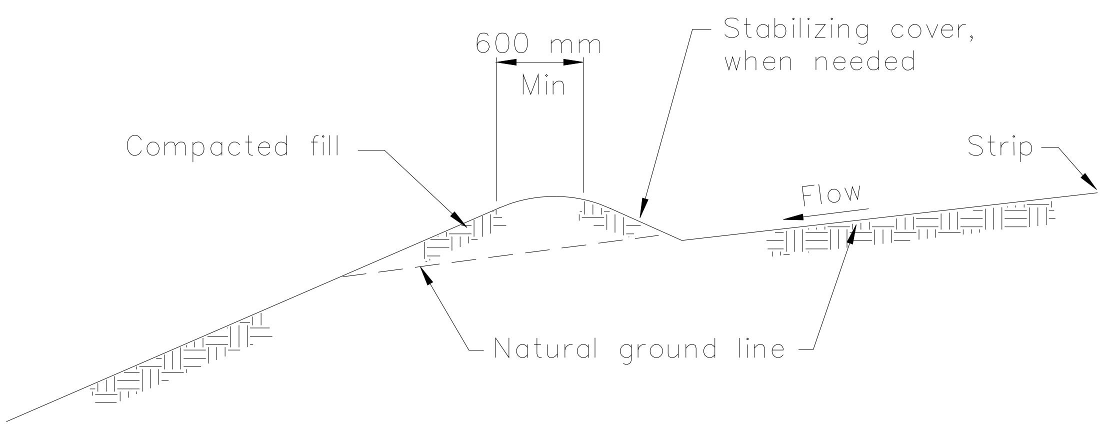


TYPICAL DRAINAGE SWALE

NOT TO SCALE

NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade, in conformance with Section 19–5 of the Caltrans Standard Specifications.



TYPICAL EARTH DIKE

NOT TO SCALE

Construction Specifications

A Diversion Dike is a low berm (or ditch and berm combination) that is constructed along the crest or top of a streambank. The purpose of a diversion is to intercept and divert runoff away from the face of a steep slope or streambank. Diverted runoff should outlet onto a stabilized area, a prepared level spreader, or into a slope protection structure, e.g., a slope drain. Diversion dikes are constructed from compacted earthen fill and should be used on drainage areas of 5 acres (2 ha) or less. In addition to protecting the face of a streambank from overbank runoff, diversions may also improve general slope stability by preventing runoff from infiltrating into and saturating the face of the bank.

Conditions Where Practice Applies

Diversion Dikes should be used only on drainage areas of 5 acres (2 ha) or less.

Design Guidelines / Typical Drawings

Diversion dikes are constructed from compacted earthen fill to a height of 18 in (45 cm) with side slopes 1V:2H or flatter. Height is measured from the upslope toe to the top of the dike (see Figure 1).

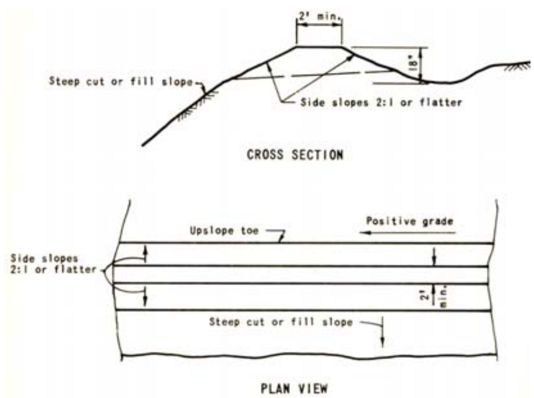


Figure 1. Cross section and plan views of diversion dike

Figure 2. Diversion dike used in combination with a flexible slope drain

The dike should have a minimum top width of 2 ft (60 cm). A conceptual design for a diversion dike, either a berm only or a berm and ditch combination is shown in Figure 1. A shallow trench or swale to contain the diverted runoff is normally incorporated into the design. Soil from the ditch can be used to construct the berm, provided it has sufficient fines to hold a 1V:2H side slope and be relatively impermeable when compacted. The swale or drainage ditch must have positive drainage to an outlet. Vegetative or mechanical stabilization may be required where grades are excessive.

Materials and Equipment

Construction of a low dike requires soil with sufficient fines to hold a 1V:2H side slope and to be relatively impermeable when compacted. The dike can be constructed by hand or with the aid of a backhoe or front-end loader.

Construction / Installation

- If overbank runoff is a problem, construction of a diversion dike or interceptor should precede other bank stabilization treatments.
- The height of the dike should be kept under 18 in (45 cm) so as not to interfere with bank access.
- Use of a ditch and bank combination allows more efficient capture and diversion of runoff.

- In addition, the soil excavated from the ditch can be used to construct the dike. Down drains or slope drains should be inserted through the dike periodically to convey the collected runoff to the stream below.
- Alternatively, the ditch should be constructed with sufficient positive grade to some other type of outlet.

Inspection and Maintenance

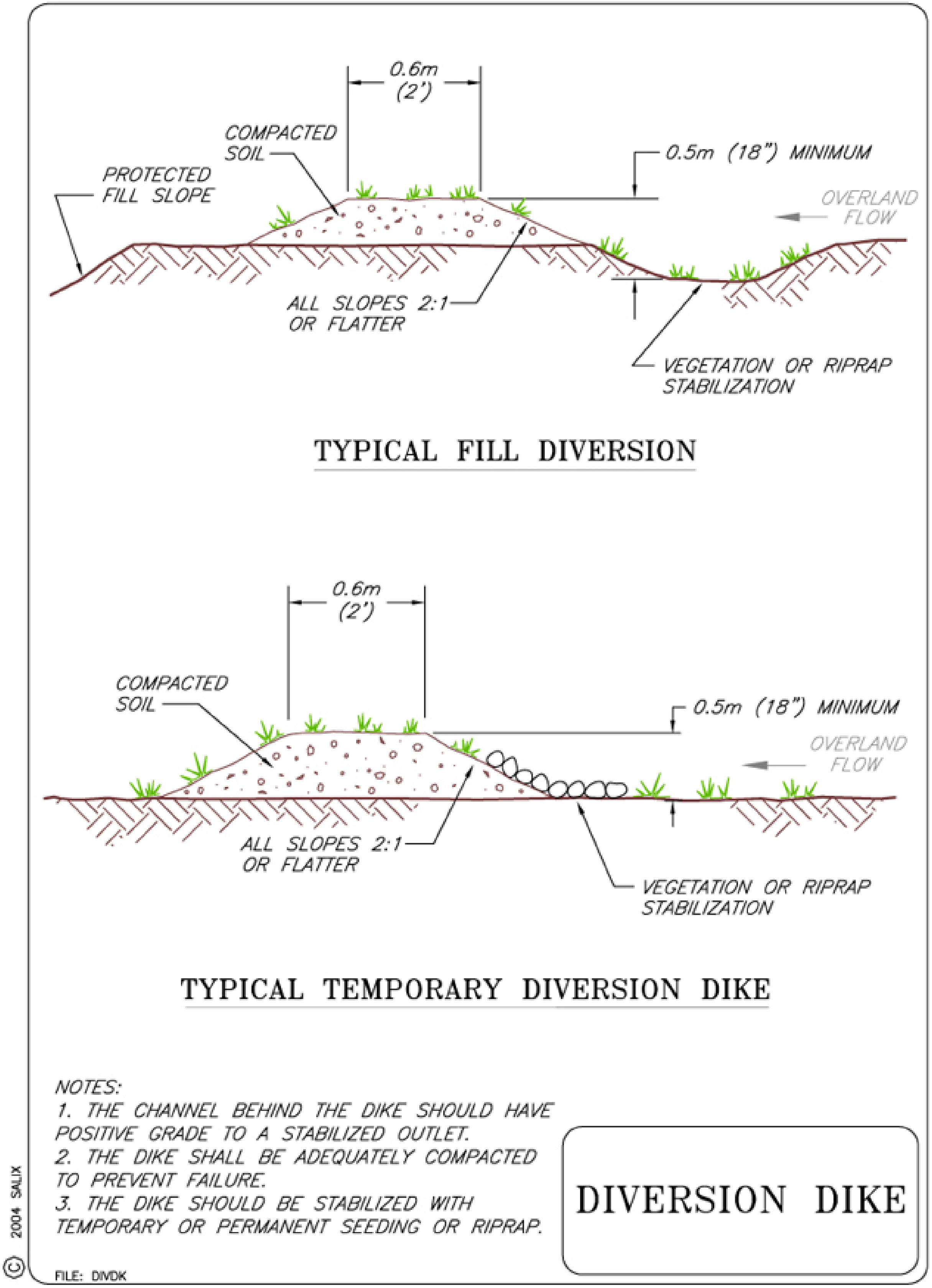
The dike or berm should be inspected to check that it has not been breached. Repair as needed. The ditch or swale behind the dike should also be checked for accumulation of sediment and debris. Excessive sediment accumulations should be removed.

Common Reasons / Circumstances for Failure

The most common reasons for failure are:

1. Overtopping and/or breaching of the dike or berm,
2. Excessive sediment accumulation in the ditch or swale behind the berm, and
3. Inadequate or insufficient outlet capacity of any appurtenant drop inlet and/or slope drains.

TEMPORARY DIVERSION DIKE RC-4



Construction Specifications

Turf Reinforcement Mats (TRMs) are similar to Erosion Control Blankets, but they usually are intended for lining channels. They are composed of ultraviolet (UV) stabilized polymeric fibers, filaments, nettings and/or wire mesh, integrating together to form a three-dimensional matrix ¼ to ¾ in (5 to 20 mm) thick. The types of polymer include polypropylene, polyethylene, polyamides, and polyvinyl chloride. Often TRMs are combined with organic material such as coir to aide vegetation establishment and provide the initial temporary erosion control necessary to resist the forces of running water until the vegetation can become established. Typical vegetation includes grasses that can withstand inundation.

Conditions Where Practice Applies

TRMs are designed to provide protection to resist channel and streambank erosion, and are useful when underlying soil boundaries may subside or shift slightly after installation.

Design Specifications / Typical Drawings

There are three types of TRMs, and their application depends on the site condition, as shown in Table 1.

TRMs can be installed after applying seed to the prepared soil surface or deployed first, and then seeded following infilling with soil. The former method allows the roots and shoots to grow through and interlock with the geosynthetic matrix, as shown in the second figure above. The channel or bank surface requires careful preparation, must be uniform and relatively free of rocks, stumps, clods etc, to ensure that there is complete contact between the TRM and the soil surface.

The number of anchoring stakes or staples per ft (or per m) is site and product specific, and should be determined according to the manufacturer's specifications. See Table 2 for stake sizing recommendations. Live willow stakes may be substituted for metal or wooden anchoring stakes, although it should be noted that willows could shade out turf grass. Willow wattles or fascines may be used to anchor the mats into the slots.

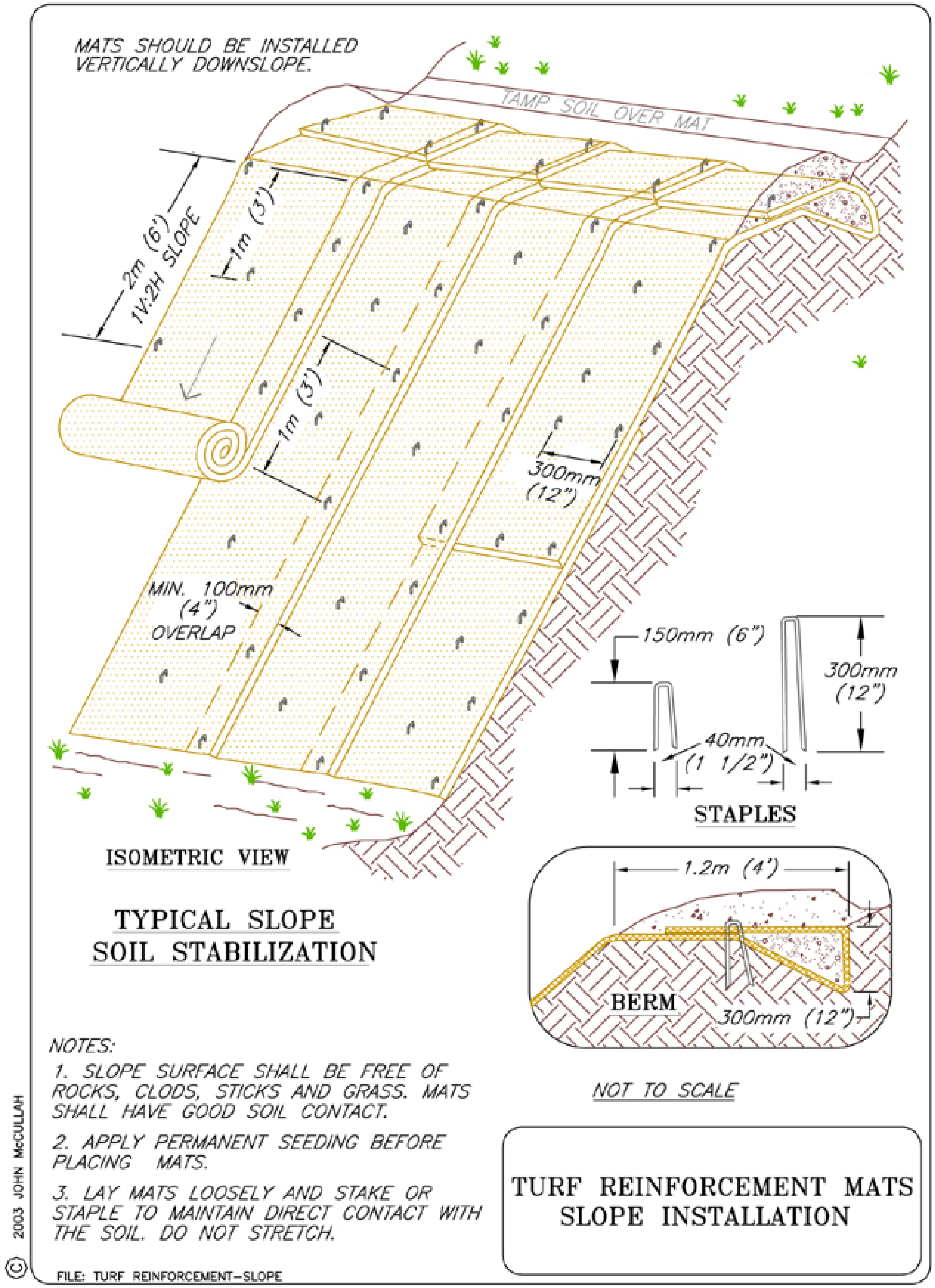
Table 1. Recommendations for TRM applications (ECTC, 2001)

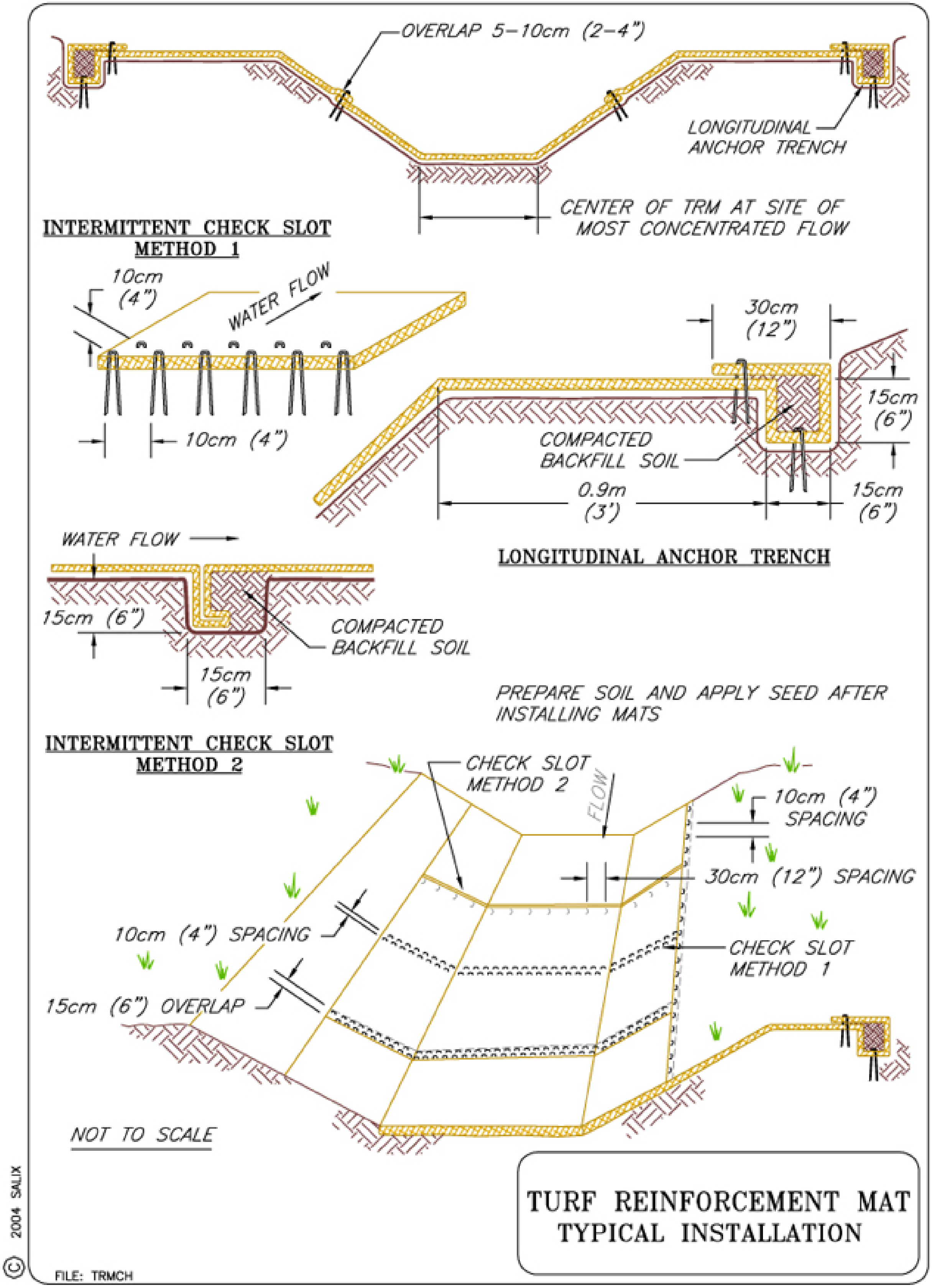
Type	UV Stability Minimum tensile strength retained after 1000 hr. (ASTM D 4355) (%)	Tensile Strength[1,2] (ECTC[4] mod. ASTM D5035) lb/ft (kN/m)	Application	
			Slope V:H	Channel max. shear stress[3] (ASTM D6460 or other ECTC approved tests) lb/ft^2 (Pa)
A	80	125 (1.82)	1:1	6 (288)
B	80	150 (2.19)	1:0.5	8 (384)
C	80	175 (2.55)	1:0.5	10 (480)

[1]Minimum average roll values, machine direction.
[2]Field conditions with high loading and/or high survivability requirement may warrant the use of TRMs with tensile strength of 3000 lb/ft (44 kN/m) or greater
[3]Max. shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion during a 30-minute flow event. (Note: fully vegetated shear stress properties for TRMs containing degradable components must be obtained on the nondegradable portion of the matting alone.)
[4]Erosion Control Technology Council – Technical Guidance Manual for Testing Rolled Erosion Control Products.

Table 2. Recommendations for TRM stake selection

Stake Length	**Soil Conditions**
6 inches	Typical soil conditions. Six-inch staples used in all but loose soil types.
8 inches	Loam, relatively loose sandy loam to sandy soils. Eight-inch staples are typically used in high velocity channel applications.
> 12 inches	Excessively loose soils, slopes containing fine silt, sand, or soft mud. Deep and soft fills, loose sands, silts, loams or "quick" conditions. Staples 12 inches and longer are used in shoreline applications in which wave action is a factor or in instances where soils remain saturated for long periods of time.


MATS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE.
TAMP SOIL OVER MAT
2m (6') 1V:2H SLOPE
1m (3')
1m (3')
300mm (12")
MIN. 100mm (4") OVERLAP
150mm (6")
300mm (12")
40mm (1 1/2")
STAPLES
ISOMETRIC VIEW
1.2m (4')
BERM
300mm (12")
TYPICAL SLOPE SOIL STABILIZATION
NOTES:
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING MATS.
3. LAY MATS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
NOT TO SCALE
TURF REINFORCEMENT MATS SLOPE INSTALLATION
© 2003 JOHN McCULLAH
FILE: TURF REINFORCEMENT-SLOPE


OVERLAP 5–10cm (2–4")
LONGITUDINAL ANCHOR TRENCH
CENTER OF TRM AT SITE OF MOST CONCENTRATED FLOW
INTERMITTENT CHECK SLOT METHOD 1
10cm (4")
WATER FLOW
10cm (4")
30cm (12")
15cm (6")
COMPACTED BACKFILL SOIL
0.9m (3')
15cm (6")
WATER FLOW
LONGITUDINAL ANCHOR TRENCH
15cm (6")
COMPACTED BACKFILL SOIL
15cm (6")
PREPARE SOIL AND APPLY SEED AFTER INSTALLING MATS
INTERMITTENT CHECK SLOT METHOD 2
CHECK SLOT METHOD 2
FLOW
10cm (4") SPACING
30cm (12") SPACING
10cm (4") SPACING
CHECK SLOT METHOD 1
15cm (6") OVERLAP
NOT TO SCALE
TURF REINFORCEMENT MAT TYPICAL INSTALLATION
© 2004 SALIX
FILE: TRMCH

Materials and Equipment

TRMs may be installed either with hand labor or equipment; the main tools or equipment required consist of hammers, stapling devices, and shovels or equipment for trenching.

Construction / Installation

TRMs (in channels) typically require very special installation and construction techniques.

Site Preparation

The site should be fine graded to a smooth profile and relatively free from all weeds, clods, stones, roots, sticks, rills, gullies, crusting and caking.

Fill any voids and make sure that the channel is compacted properly.

Seeding

Seed the area to be vegetated with a seed mix adapted to the local geographical area and soil conditions.

Choosing the appropriate seed mix will ensure optimum germination, root system development, vegetation density, and long term functionality. The types of seeds planted above the anticipated water line may differ from those below the anticipated water line.

If the prepared seed bed becomes crusted or eroded, or if ruts or depressions exist for any reason, prior to RECP installation the contractor should rework the soil until it is smooth and re-seed reworked areas.

TRM Installation in Channel Bottom

TRMs should always be unrolled in the direction of water flow.

First, install the TRM in the channel bottom. Try to minimize the number of seams that are placed on the bottom of the channel, as these are sites of weakness. Do not put seams in the center of the channel bottom or in areas of concentrated water flow. When installing two TRMs side by side in a waterway, the center of the TRM should be centered in the area of concentrated water flow. Install adjoining TRMs away from the center of the channel bottom. Follow the manufacturer's recommendations for overlapping the TRM; generally the overlap will be 50 to 100 mm (2 to 4 in).

Secure the TRM at the beginning of the channel with a 150 mm x 150 mm (6" x 6") check slot dug perpendicular to the direction of water flow across the entire width of the channel.

Lay the TRM in the check slot with 750 mm (30 in) extending upstream of the check slot. Stake or staple the TRM in the check slot on 300 mm (12 in) centers.

Backfill the anchor trench and compact the soil. Place seed over the compacted soil if necessary.

Cover the compacted soil with the remaining 300 mm (12 in) of the terminal end of the TRM. Staple or stake the terminal end of the TRM down slope of the anchor trench on 300 mm (12 in) centers.

Check Slots

"Check slots" (cutoff trenches) must be provided every 7.5 to 15 m (25-50 ft) to ensure water moving under the TRM is forced back to the surface. Longitudinal check slots are required to ensure off site "side flows" do not get under the TRM. Similarly, beginning and terminal check slots are critical.

Check slots can be installed in one of two ways, depending upon the Engineers discretion and/or the manufacturer's recommendations.

One type of check slot is constructed by installing a double row of staples or stakes staggered and spaced 100 mm (4 in) apart.

The second option is to install a check slot 150 mm (6 in) wide by 150 mm (6 in) deep, and secure the TRM in the upstream side of the check slot with staples or stakes on 300 mm (12 in) centers.

Flip the TRM roll on the upstream edge. Back fill the check slot and compact the soil. Continue rolling the TRM downstream over the completed check slot.

Installation on Side Slopes

As the TRM is installed from the channel bottom up the slope, a shingle-type installation is recommended with the up-slope TRM overlapping the lower TRM approximately 50 to 100 mm (2 to 4 in).

Anchor the TRMs with a minimum of one staple every 60 mm (24 in) across the width and one staple every 90 mm (36 in) down the length.

If the TRM needs to be spliced, "shingle" it as discussed above, with a 100 mm (4 in) overlap. Use a staple check slot to secure the overlap.

Anchor the RECP placed at the top of the channel slope in the same manner as described in the slope section.

Terminal End

Secure the TRM at the terminal end of the channel with a check slot similar to the one made at the beginning of the channel.

Alternative Channel Installation Method

Another installation method for TRMs is to install them vertically and approximately 1 m (3 ft) onto the flat of the channel bottom. Construct a check slot in areas of concentrated water flow. Use a 50 to 100 mm (2 to 4 in) shingle-type overlap upstream to downstream.

Inspection and Maintenance

Basic monitoring consists of visual inspections to determine mat integrity and attachment performance. Rill development beneath the mat or edge lifting are evidence of inadequate attachment. Additional staking and trenching can be employed to correct defects. Recently placed mats may be replaced, but once vegetation becomes established, replacement is not a reasonable option.

Common Reasons / Circumstances for Failure

Critical points in conveyance system applications where mats can lose support include points of overlap between mats, projected water surface boundaries and channel bottoms.

Coir TRM channel installation, Guadalupe River, San Jose CA., October 2003

Same site during first large winter storms, winter 2004

Construction Specifications

A drainage trench is excavated parallel to and just behind the crest of a streambank. Ideally, the bottom of the trench should be keyed into an impermeable layer in the slope. The trench should be backfilled with a coarse graded aggregate that meets filtration criteria; i.e., it should allow unimpeded flow of groundwater while excluding fines from the seepage water. Alternatively, the trench can first be lined with a filter fabric (geotextile) that meets the filtration requirements and then be backfilled with a coarse aggregate. The purpose of the trench is to intercept and divert shallow seepage away from the face of the streambank. Note that trench drains must connect to a surface discharge pipe or otherwise may be classified as a Class V Underground Injection (UIC) well.

Conditions Where Practice Applies

Should be considered when shallow, water bearing strata conduct groundwater that emerges (daylights) at the streambank. A good example would be relatively permeable surface strata or water bearing sands up to 10 ft (3 m) thick, e.g., outwash sand or coarse alluvium, overlying relatively impermeable silty clay deposits, e.g., clay till or fine alluvium. This is a fairly common stratigraphic sequence in glaciated terrain and alluvial valleys.

Design Guidelines/ Typical Drawings

Trench Drains constructed without a pipe at the bottom are commonly known as French Drains (see Figure 1a). An efficient, well-constructed Trench Drain requires the use of perforated, jointed, slotted, or porous pipe placed near the bottom of a trench (see Figure 1b) that is surrounded with pea gravel or selected pervious filter aggregate. When a drain is excavated in erodible materials, synthetic filter fabrics (geotextiles) should be used (see Figure 1c) to line the sides and bottom of the trench to prevent soil fines from entering the coarse backfill in the drain. The main backfill should be specially selected pervious filter aggregate designed to allow unrestricted flow of water to the pipes.

Most drains should be equipped with pipes because gravel or rock-filled trenches have limited discharge capabilities even when clean aggregates are used. The discharge capabilities of drainage trenches backfilled with clean stone or coarse gravel, as estimated by Darcy's law, are given in Table 1. The required diameters of corrugated metal, concrete, and polymeric (smooth) drain pipes for a wide range of discharge quantities can be determined from the nomograph in Figure 2.

- The location of perforations and open joints in pipes should always be placed to allow unobstructed flow to pipes.

- If a drainage pipe is completely surrounded with specially selected coarse filter aggregate (refer to Figure 1b), perforations can completely surround the pipe.

Unjointed sections of pipe should be used to convey water across areas where the discharge of water into the soil from drains must be prevented. The same injunction holds for the final discharge of collected drain water, viz., it must not be allowed to discharge on to a slope and instead must be conducted safely down a slope using a chute or slope drain.

Materials and Equipment

Suitable drainage rock or gravel in addition to a perforated polymeric pipe. A small backhoe is required for excavating and backfilling the trench. A geotextile filter fabric will be required if the trench is to be lined.

Construction / Installation

- Maximum trench depths are restricted to the reach of a backhoe/excavator or approximately 2 to 2.7 m (6 to 8 ft).
- Trench widths are also determined by the width of the excavator bucket, which can range from 0.3 to 0.6 m (12 to 24 in).
- The water transmission characteristics of the drainage trench can be improved by placing a perforated or slotted drainage pipe on a slight grade at the bottom.
- The discharge from a trench drain should be conveyed in a safe, non eroding manner down the slope directly to the stream.

Inspection and Maintenance

Subsurface drains, including trench drains, are difficult to access and inspect once installed. A possible way to monitor the performance of a trench drain is to check the outflow from the pipe at the bottom of the interceptor trench. If there is steady shallow seepage towards a streambank, this exit pipe should flow continuously. The effectiveness of a trench drain for intercepting shallow seepage can be monitored indirectly by examining for signs of seepage and/or slumping/sliding at the bank face.

Common Reasons / Circumstances for Failure

The limitations of trench drains cited previously are the most common reasons for failure. Failure to excavate the trench deep enough to reach the impermeable base of a perched groundwater system may let ground water pass under the trench. Loss of drainage capacity from clogging of a drain can lead to the saturation and buildup of pore pressure in the streambank itself. Either of these conditions can lead to mass stability failure of a streambank or seepage induced erosion of the bank face.

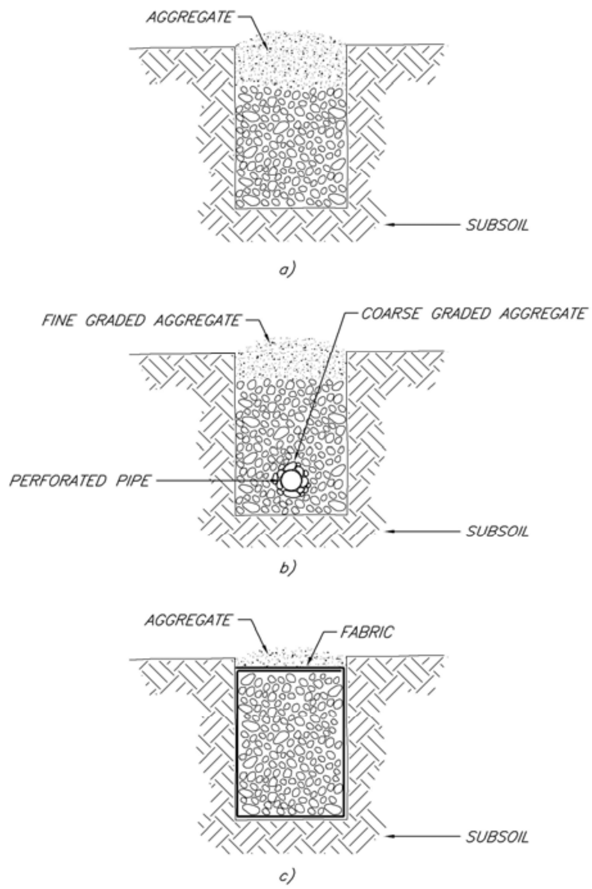


Figure 1. Cross sections of subsurface drains. a) French drain, b) conventional trench drain with pipe, c) trench drain with filter fabric.

Size of stone	Permeability, ft/day	Slope	Capacity cu ft/day	Capacity gpm
$\frac{3}{4}$ to 1 in.	120,000	0.01	7200	38
$\frac{3}{4}$ to 1 in.	120,000	0.001	720	4
$\frac{3}{8}$ to $\frac{1}{2}$ in.	30,000	0.01	1800	9
$\frac{3}{8}$ to $\frac{1}{2}$ in.	30,000	0.001	180	1
$\frac{1}{4}$ to $\frac{3}{8}$ in.	6,000	0.01	360	2
$\frac{1}{4}$ to $\frac{3}{8}$ in.	6,000	0.001	36	0.2

Table 1. Discharge capacities of 1 x 0.7 m (3 x 2 ft) cross sections of stone filled, trench drains.

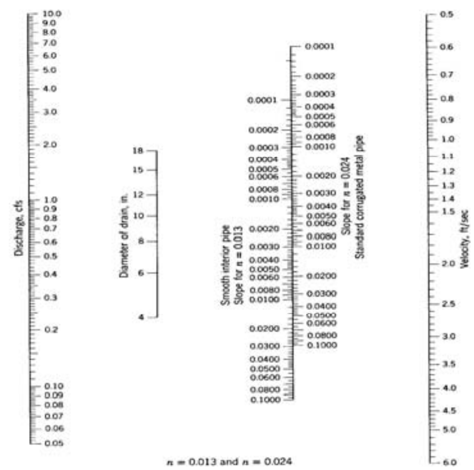


Figure 2. Nomograph for computing required size of circular drain, flowing full.

Construction Specifications

Concentrated overbank runoff can be a major cause of erosion, especially along deeply incised channels. Runoff passing over the top of banks frequently triggers gully development and expansion, and water that is ponded at the top of high, steep banks, and infiltrates or seeps into the ground behind the slope face is often a major factor in erosion by piping or slope failure from the development of high pore water or seepage pressures. The gully erosion and downcutting can be addressed using a drop inlet, which is a water control structure that consists of an L-shaped corrugated pipe passing through an earthen embankment placed at the downstream end of the gully.

Conditions Where Practice Applies

Used where large amounts of surface runoff flow across a steep high, streambank along an existing tributary gully or small ravine. Small amounts of overbank runoff flowing across a relatively intact or non-incised bank crest are best handled with a diversion dike and slope drains.

Design Guidelines / Typical Drawings

The following criteria are based on practices employed by the U.S. Army Corps of Engineers and the Natural Resources Conservation Service in the Southeast USA.

- Drop pipe structures are generally placed in gullies deeper than 10ft (3 m), and embankments are typically 15 to 20 ft (4.5 to 6 m) high.

- Minimum safety factors for embankments are 1.3, dictating side slopes of 1:2 to 1:3 (V:H).

- Pipes are sized to convey the 2- to 10-year event based on standard SCS runoff curve number computations, and an emergency spillway is provided to convey flows larger than the design discharge.

- Design discharges are typically less than 200 cfs (5.7 m^3/s), and the vertical distance from the inlet weir crest to the outlet pipe invert is less than 30 ft (9 m). Pipe diameter and length are used to compute head-discharge relations, and pipe diameter is adjusted to avoid orifice flow at discharges less than or equal to design flow.

Drop pipes may be designated non-storage structures, which are sized to pass the two- to five-year event, or as temporary storage structures, which are designed to impound run-off from the 25-year event. Water retention is governed by site factors (soils, topography, and water supply) and by the elevation of the inlet weir and emergency spillway.

If uncontrolled erosion occurs in the drainage area behind the slope crest, the runoff may carry large amounts of sediment. A drop inlet can convey this sediment-laden runoff directly into an adjoining stream. If erosion is extensive, the drain itself may clog and lose a significant portion of its capacity. In these cases, sediment should be prevented from entering the drop inlet by providing some type of filtering and/or inlet protection, either filter fabric, gravel & wire mesh, or block and gravel sediment barrier. A photograph of a trash rack used to prevent large debris from entering and clogging a drop pipe is shown in Figure 1.

- Pipe materials can be aluminized or galvanized polymer-coated metal or polymeric materials. Seepage through the earthen embankment is controlled with seepage collars for structures with conduits 4 ft (1.2 m) in diameter or smaller, and with annular filter drainage rings for larger conduits.

- Where the structure will impound water permanently, a filter drainage diaphragm is used. Concrete pads are provided at the top and bottom of the vertical pipe, and an anti-vortex baffle is placed in the inlet to maintain weir flow and avoid vibration during very large events (see Figure 2). Outlets are supported with grouted riprap and secured with screw anchors. In addition, stone erosion protection is provided at the outlet for structures larger than 4 ft (1.2 m) in diameter.

Materials and Equipment

Earthmoving equipment and standard erosion control measures are needed for construction of the embankment. A source of fill for the dam is needed, and pipes, trashracks, and stone for scour protection are essential materials. Pipe materials can be aluminized or galvanized polymer-coated metal or polymeric materials.

Common Reasons / Circumstances for Failure

- Clogging of the down-pipe can lead to possible overtopping of the containment embankment and erosion of the downstream face of the dam in the absence of a properly designed emergency spillway.

- Excessive sediment in the runoff can be conveyed to the stream channel below in the absence of suitable filtering at the inlet and/or a long enough residence time in the ponded area behind the embankment dike.

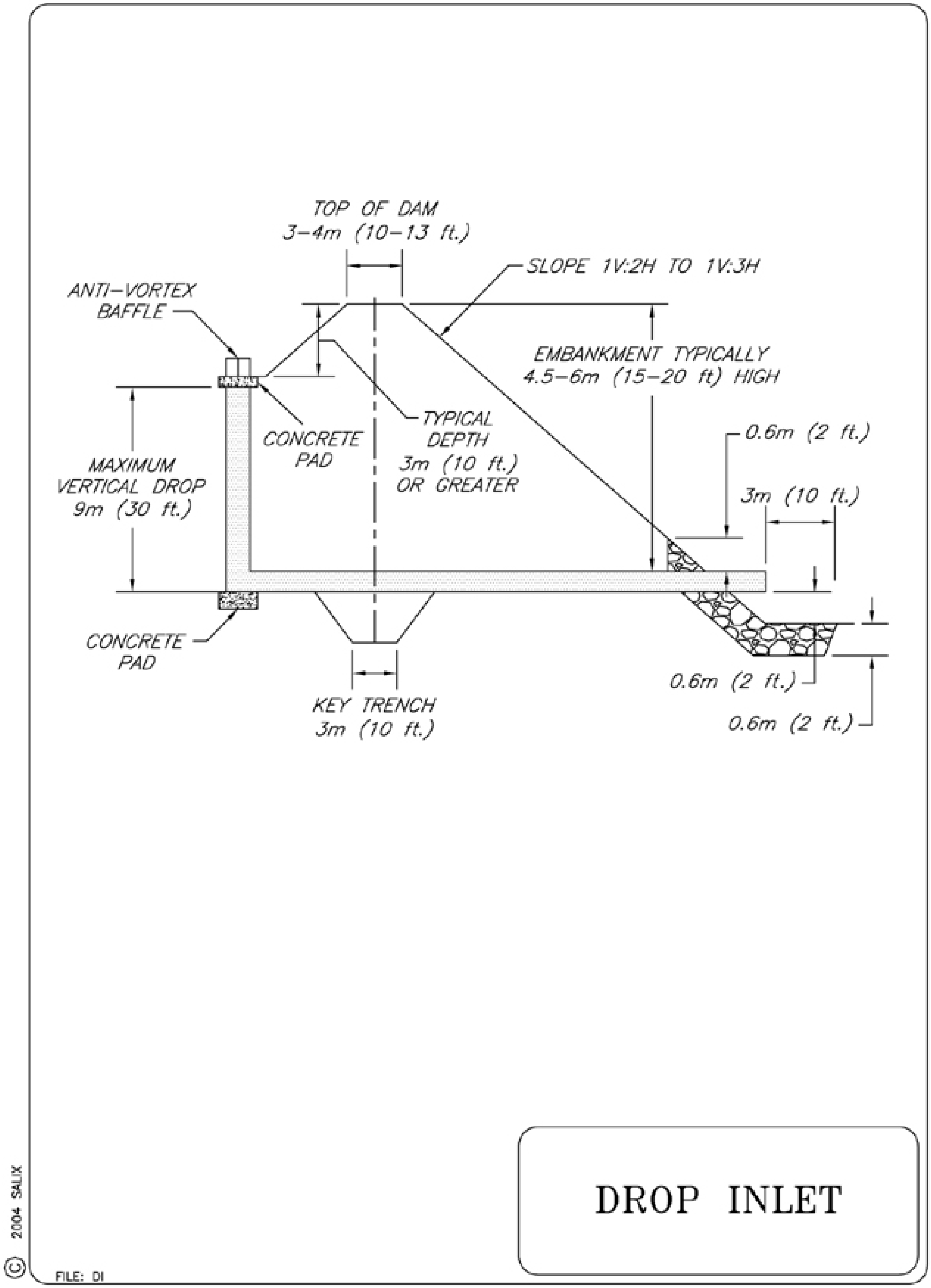
- Ponding of water atop a streambank can exacerbate piping and seepage related bank instability. This latter problem is minimized, however, if the embankment and pond are located at the downstream end of the gully and if pond water levels are maintained as low as possible.

Inspection and Maintenance

Clogging of the inlet can be prevented by periodic inspection of the entrance protection structure or trash rack (see Figure 1 and 2). If sediment in the pond behind the dam accumulates to the base of the pipe entrance, it may be necessary to raise the entrance elevation of the pipe. A gully treatment program in the upstream reaches of the gully or gully network can also be employed to reduce sediment loading.

Figure 1. Metal trash rack used to protect drop inlet

Figure 2. Drop inlet pipe with anti-vortex baffle and trash rack


TOP OF DAM
3–4m (10–13 ft.)
SLOPE 1V:2H TO 1V:3H
ANTI–VORTEX BAFFLE
EMBANKMENT TYPICALLY 4.5–6m (15–20 ft) HIGH
TYPICAL DEPTH 3m (10 ft.) OR GREATER
CONCRETE PAD
MAXIMUM VERTICAL DROP 9m (30 ft.)
0.6m (2 ft.)
3m (10 ft.)
CONCRETE PAD
KEY TRENCH 3m (10 ft.)
0.6m (2 ft.)
0.6m (2 ft.)
DROP INLET
© 2004 SALIX
FILE: DI

Construction Specifications

Whatever technique you decide to implement, an important thing to remember is that dilution can sometimes be the solution. A probable “worst time” to release high TSS into a stream system might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. Conversely, the addition of high TSS or sediment during a big storm discharge might have a relatively low impact, because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system. The optimum time to “pull” in-stream structures may be during the rising limb of a storm hydrograph.

Techniques to Minimize Total Suspended Solids (TSS)

Padding
Padding, usually manufactured from coir and or other natural fibers, that is laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in revegetation.

Clean, washed gravel
Clean, washed gravel can be placed on the stream bottom both during and after construction to minimize re-mobilizing the “fines”. Clean gravel or spawning gravel can often be specified to mitigate or enhance the existing substrate. Therefore, gravel “injection” can minimize TSS during construction while providing environmental and habitat enhancements with long-term benefits.

Excavation using a large bucket
Each time a bucket of soil is excavated or placed in the stream, a portion is of the soil is suspended. The resulting amount of sediment suspended increases proportionally to the number of scoops rather than the total of excavated soil. Therefore, using a large excavator bucket instead of a small one will reduce the total amount of soil that is suspended and available to wash downstream. Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount.

Use of dozer for backfilling
Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.

Partial dewatering with a pump
Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment.

How to know if you have high TSS:

Some commonly accepted standards for high TSS are:

- 50 mg/l or
- 10 mg/l above background TSS or,
- 10% above background TSS.

These standards are very stringent, and are very difficult to achieve in many situations. The background + 10 % (mg/l) is probably the most realistic and reasonable standard for protecting the aquatic resources, while allowing a restoration project to be implemented. Check with local ordinances for standards.

Inspection and Maintenance

- Inspect the stability and performance of all erosion and sediment control measures during construction.
- Monitor TSS levels before, during and after construction.

Construction Specifications

A stream diversion is a temporary bypass through a pipe, flume, or excavated channel that carries water flow around work areas. Stream diversion is commonly used during culvert installation or replacement. Where possible, a stream diversion should be the first choice to control erosion and sediment during the construction of culverts or other in-stream structures. During construction in a watercourse, particularly culvert installation and repair, these temporary water bypass structures are an effective sediment and erosion control technique. Check with local, state and federal regulatory authorities for permitting and design requirements.

Design Considerations

The selection of which stream diversion technique to use will depend upon the type of work involved, physical characteristics of the site, and the volume of water flowing through the project.

Advantages of a pumped diversion include:

- Downstream sediment transport can almost be eliminated
- De-watering of the work area is possible
- Pipes can be moved about to allow construction operations
- The dams can serve as temporary access.
- Increased flows can be managed by adding more pumping capacity.

Some disadvantages of a pumped diversion are:

- Flow volume is limited by pump capacity
- Requires 24-hour monitoring of pumps
- Sudden rain could overtop dams
- Minor in-stream disturbance to install and remove dams

Advantages of excavated channels and flumes are:

- Isolates work from water flow and allows dewatering
- Can handle larger flows than pumps

Disadvantages of excavated channels and flumes are:

- Bypass channel or flume must be sized to handle flows, including possible floods
- Channels must be protected from erosion
- Flow diversion and then re-direction with small dams causes in-stream disturbance and sediment

Stream diversions should not be used:

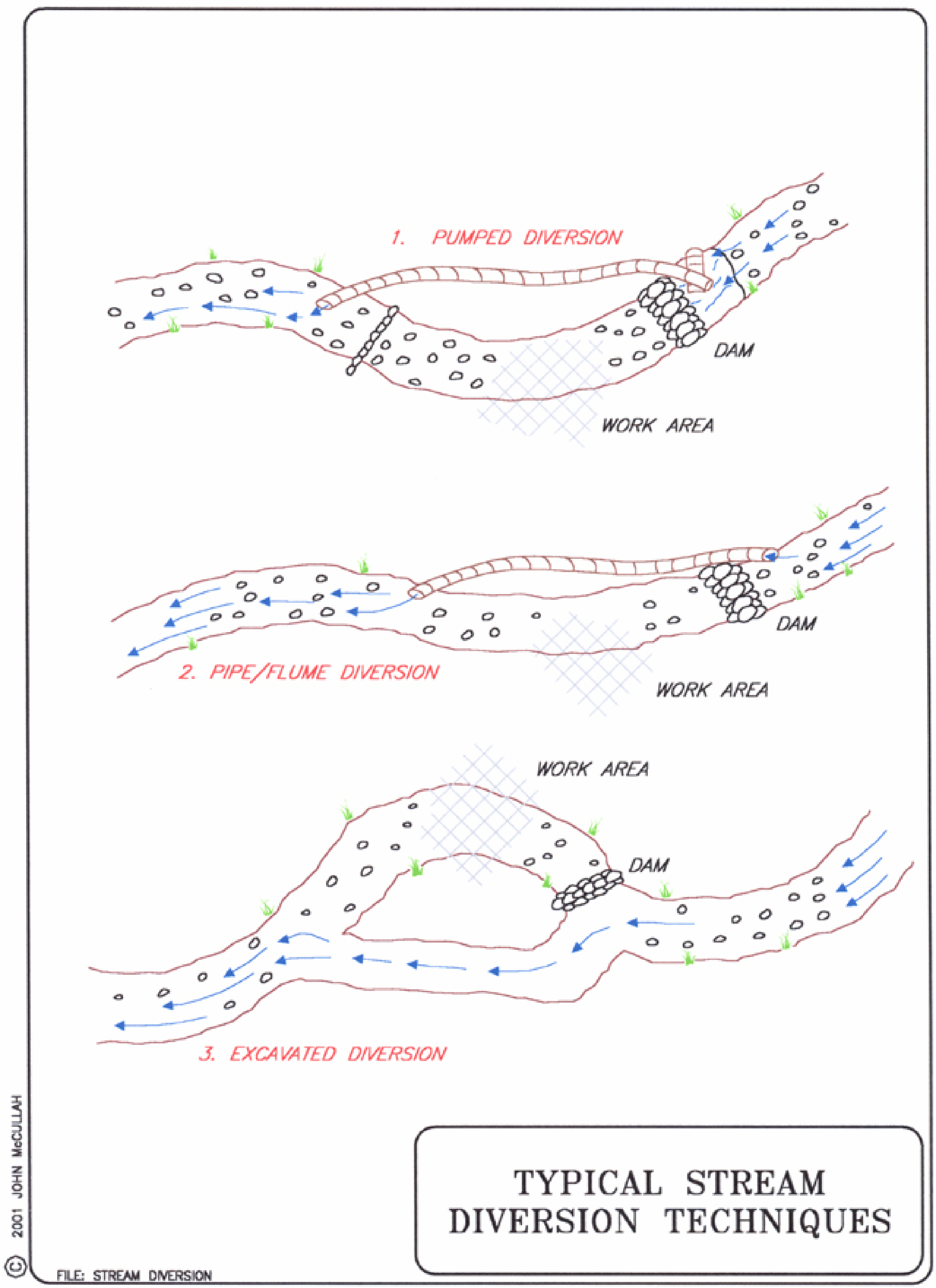
- Without identifying potential impacts to the stream channel
- In or adjacent to water bodies until all necessary permits have been obtained

Installation

- The pumped diversion is suitable for intermittent and low flow streams that can be pumped. Pump capacity must be sufficient for design flow. The upper limit is about 10ft^3/sec (0.28 m^3/sec), the capacity of two 8 inch (20 cm) pumps.
- A temporary dam is constructed upstream and downstream of the work area and water is pumped through the construction project in pipes. Dam materials should be selected to be erosion resistant, such as steel plate, sheetpile, sandbags, continuous berms, inflatable water bladders, etc.
- A temporary bypass channel can also be constructed by excavating a temporary channel or passing the flow through a heavy pipe (called a “flume”), and excavating a trench under it. Typical stream sizes are less than 20 ft (6 m) wide and less than 100 ft^3/sec (2.8 m^3/sec).

Inspection and Maintenance

- All stream diversions must be closely maintained and monitored
- Pumped diversions require 24-hour monitoring of pumps
- Upon completion of the work performed, the stream diversion should be removed and flow should be re-directed through the new culvert or back into the original stream channel.



Portable dams installed in Santa Cruz Ca. and in Alberta Canada.

Construction Specifications

An instream isolation technique is a temporary structure built into a waterway to enclose a construction area and reduce sediment pollution from construction work in or adjacent to water. The structures may be made of rock, sand bags, wood or water-filled geotextiles (aqua barriers). During construction in a watercourse, these structures are designed to reduce turbidity and sediment discharge, allowing contractors to follow clean water regulations.

Design Considerations

Isolation structures may be used in construction activities such as streambank stabilization, culvert installation, bridges, piers or abutments. It may be used in combination with other methods such as clean water bypasses and/or pumps.

This technique should not be used:

- If there is insufficient streamflow to support aquatic species.
- In deep water unless designed or reviewed by and engineer.
- To completely dam streamflows.

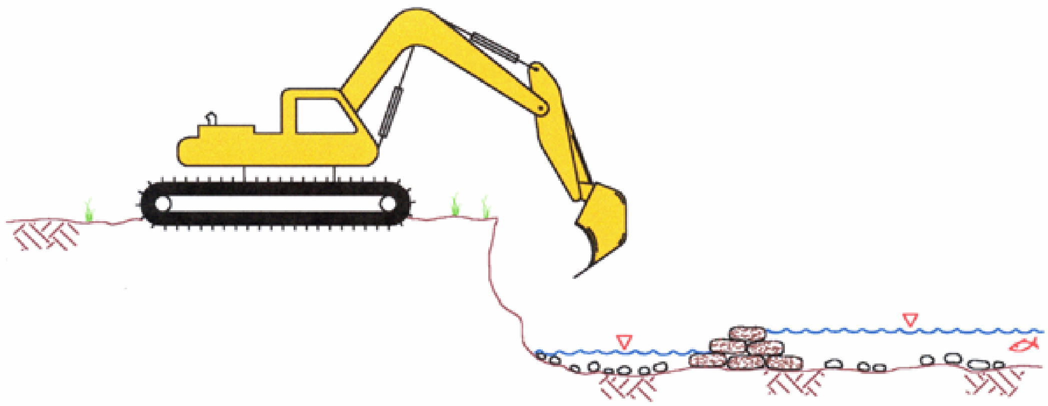
Installation

When used in watercourses or streams, cofferdams must be used in accordance with permit requirements. Materials for cofferdams should be selected based on ease of maintenance and complete removal following construction activities.

Inspection and Maintenance

- During construction, inspect daily.
- Schedule additional inspections during storm events.
- Immediately repair any gaps, holes or scour.
- Upon construction completion, the structure is removed.
- Remove sediment buildup.
- Remove structure. Recycle or re-use if applicable.
- Revegetate areas disturbed by cofferdam removal if applicable.

BENEFITS/LIMITATIONS
- *Difficult to dewater*
- *Inexpensive*
- *Labor intensive to install and remove*
- *Sand may be deposited in stream if bags break, better to use clean gravel*

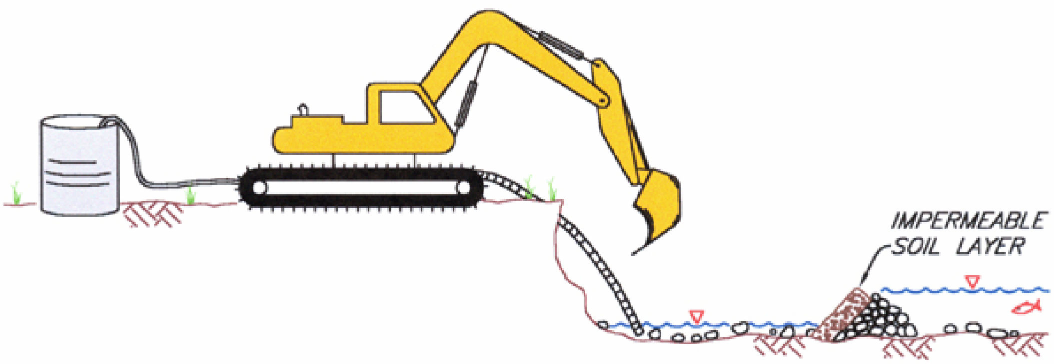


SAND BAG/GRAVEL BAG TECHNIQUE

INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES

FILE: INSTREAM TECHNIQUES3

BENEFITS/LIMITATIONS
- *Allows partial dewatering*
- *Relatively inexpensive*
- *Useful for small streams*
- *Minimal TSS when removed*



NOTES:

Step 1. Install clean gravel

Step 2. Place impermeable soil

Step 3. Do work

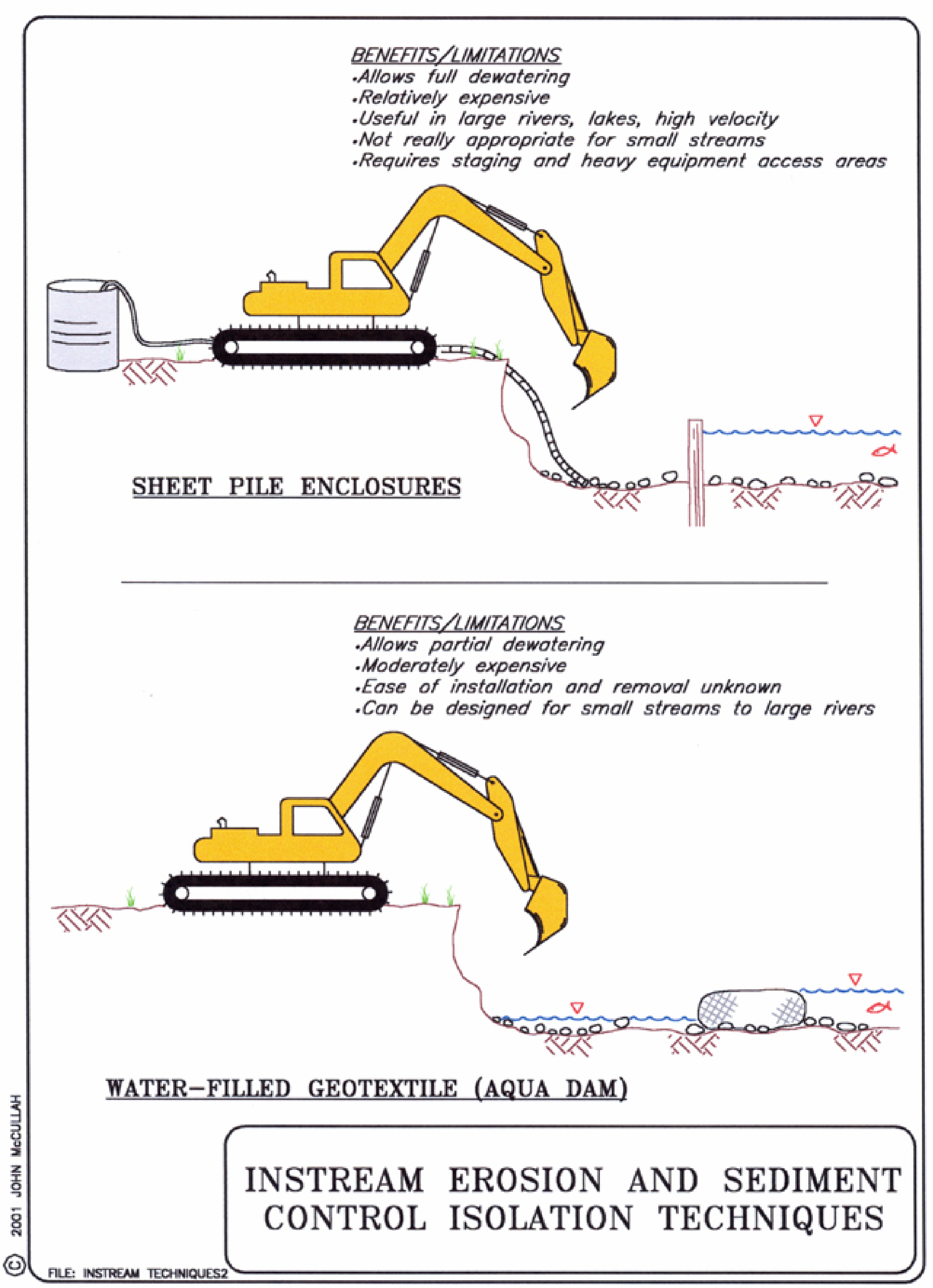
Step 4. Decommission berm by removing soil layer first

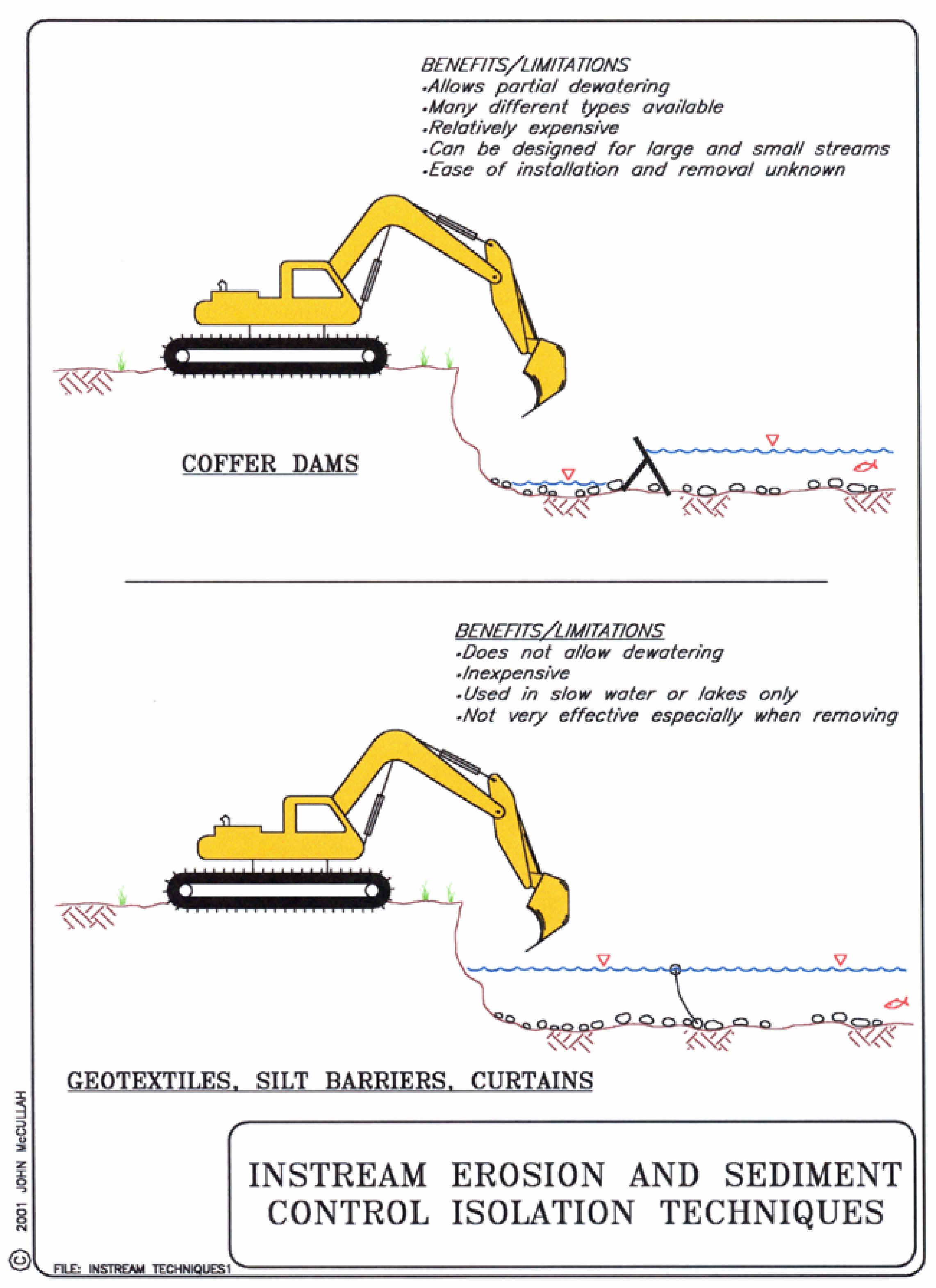
Step 5. Pump work area. Head differential will cause turbid water to flow into work area through gravel

Step 6. Remove or spread gravel

GRAVEL/SOIL BERM INSTREAM ISOLATION TECHNIQUE

FILE: BERM INSTREAM TECHNIQUES


BENEFITS/LIMITATIONS
•Allows full dewatering
•Relatively expensive
•Useful in large rivers, lakes, high velocity
•Not really appropriate for small streams
•Requires staging and heavy equipment access areas
SHEET PILE ENCLOSURES
BENEFITS/LIMITATIONS
•Allows partial dewatering
•Moderately expensive
•Ease of installation and removal unknown
•Can be designed for small streams to large rivers
WATER-FILLED GEOTEXTILE (AQUA DAM)
INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES
© 2001 JOHN McCULLAH
FILE: INSTREAM TECHNIQUES2


BENEFITS/LIMITATIONS
•Allows partial dewatering
•Many different types available
•Relatively expensive
•Can be designed for large and small streams
•Ease of installation and removal unknown
COFFER DAMS
BENEFITS/LIMITATIONS
•Does not allow dewatering
•Inexpensive
•Used in slow water or lakes only
•Not very effective especially when removing
GEOTEXTILES, SILT BARRIERS, CURTAINS
INSTREAM EROSION AND SEDIMENT CONTROL ISOLATION TECHNIQUES
© 2001 JOHN McCULLAH
FILE: INSTREAM TECHNIQUES1

Construction Specifications:

- Check dams shall be placed at a distance and height to allow small pools to form behind them. The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.
- High flows (typically a 2-year storm or larger) shall 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 shall be removed when grass has matured sufficiently to protect the ditch or swale.
- Construct rock dams such that structures are not damaged by vehicles and do not impede travel ways.
- Rock dams shall be constructed of 2 to 15-inch rock.
- Keep the center rock (spillway) section at least 6 inches lower than the outer edges.
- Extend the abutments 18" into the channel bank.
- Only gravel bags may be used as check dams with the following specifications:

  Materials

  - Bag Material: Bags shall be either polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four ounces per square yard (135 g/m^2), mullen burst strength exceeding 300 psi (2,070 kPa) in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
  - Bag Size: Each gravel-filled bag shall have a length of 18 in (450 mm), width of 12 in (300 mm), thickness of 3 in (75 mm), and mass of approximately 33 lb (15 kg). Bag dimensions are nominal, and may vary based on locally available materials. Alternative bag sizes shall be submitted to the engineer for approval prior to deployment.
  - Fill Material: Fill material shall be between 10 mm and 20 mm (0.4 and 0.8 inch) in diameter, and shall be clean and free from clay balls, organic matter, and other deleterious materials. The opening of gravel-filled bags shall be secured such that gravel does not escape. Gravel-filled bags shall be between 28 and 48 lb (13 kg and 22 kg) in mass. Fill material is subject to approval by the engineer.

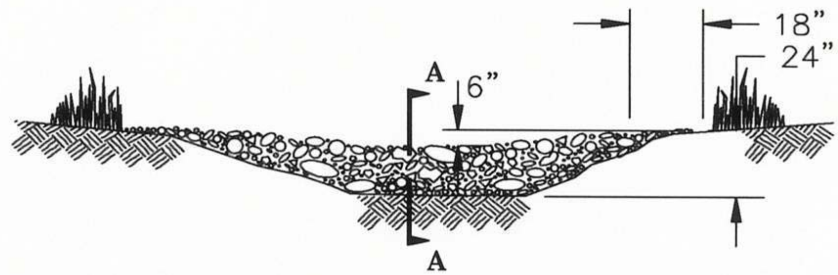
  Installation

  - Install along a level contour.
  - Tightly abut bags and stack gravel bags using a pyramid approach. Gravel bags shall not be stacked any higher than 3.2 ft (1 meter).
  - Upper rows of gravel bags shall overlap joints in lower rows.
  - Local and state requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

Minimum BMP standards are provided on the following illustrations.

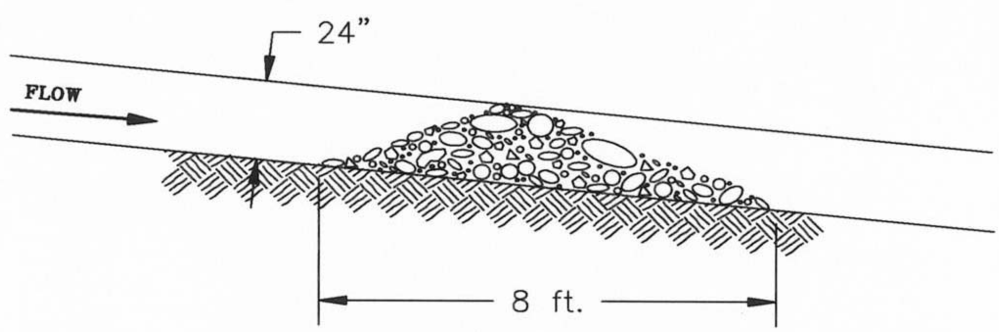
Inspection and Maintenance:

- Inspect check dams before, during, and after each rainfall event. Repair damage as needed.
- Remove sediment when depth reaches one-third of the check dam height.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.
- Removed sediment shall be incorporated in the project or disposed of properly.



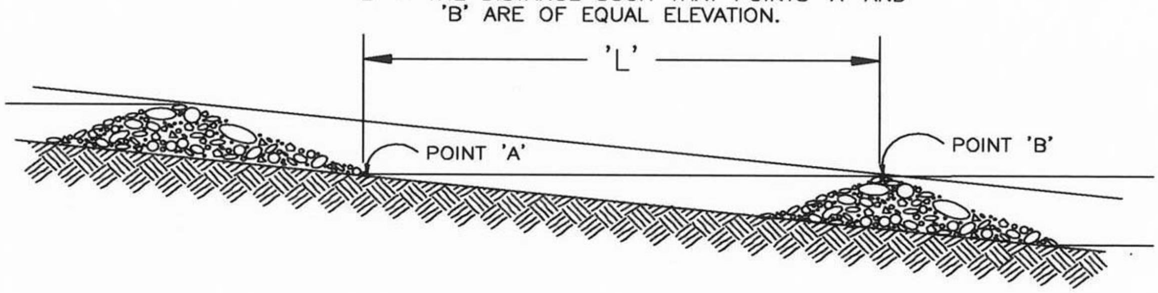
VIEW LOOKING UPSTREAM

NOTE:
KEY STONE INTO THE CHANNEL BANKS AND EXTEND CHECK DAM A MINIMUM OF 18” TO PREVENT FLOW AROUND DAM.

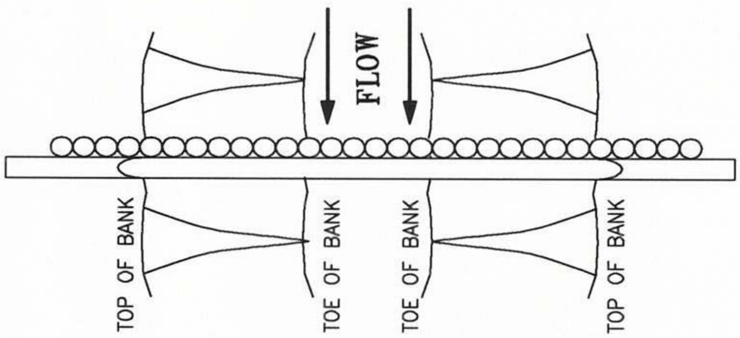


SECTION A – A

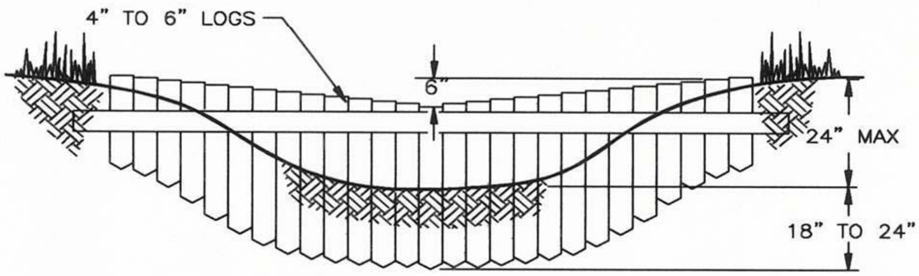
'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION.



SPACING BETWEEN CHECK DAMS

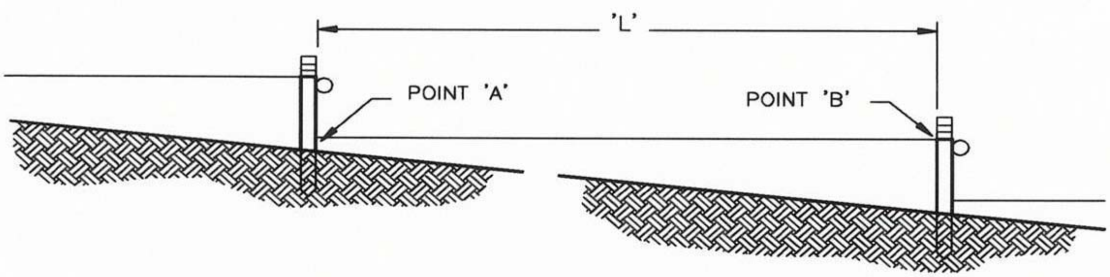


PLAN VIEW



VIEW LOOKING UPSTREAM

'L' = THE DISTANCE SUCH THAT POINTS 'A' AND 'B' ARE OF EQUAL ELEVATION



SPACING BETWEEN CHECK DAMS

NOTE:
KEY THE ENDS OF THE CHECK DAM INTO THE CHANNEL BANK. LOGS SHALL BE PRESSURE TREATED IF GRADE STABILIZATION STRUCTURE IS INTENDED TO BE PERMANENT.

APPENDIX E

EROSION PREVENTION BMPS

EP-1	Scheduling
EP-2	Preservation of Existing Vegetation
EP-3	Surface Roughening
EP-4	Topsoiling
EP-5	Temporary Seeding and Planting
EP-6	Permanent Seeding and Planting
EP-7	Mycorrhizae / Biofertilizers
EP-8	Mulches
EP-9	Compost Blankets
EP-10	Erosion Control Blankets and Mats
EP-11	Soil Binders
EP-12	Stabilization Mats
EP-13	Wind Erosion Control
EP-14	Live Staking
EP-15	Pole Planting
EP-16	Live Fascines and Brush Wattles
EP-17	Brush Box
EP-18	Fascines with Subdrains
EP-19	Live Pole Drains
EP-20	Brush Packing or Live Gully Fill Repair
EP-21	Sodding

SCHEDULING – EP-1

Scheduling involves sequencing construction activities and the installation of erosion and sediment control measures to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking. The timing of soil-disturbing activities and the timing of implementation of BMPs are both critical to the prevention of accelerated erosion and transport of sediment off-site. The scheduling of grading should take into account the rainy season and should minimize the length of the time that soils are left exposed, and reduce the total area of exposed soil during the rainy season. Consideration should be given to phasing the grading and construction so that critical areas (such as highly erodible soils, areas adjacent to receiving waters, etc.) are not disturbed until the non-rainy season, and so the entire area that is disturbed at any one time is kept to a size that can be controlled effectively.

Construction Specifications:

- The optimum grading period is when the chance for precipitation is minimized (e.g., the non-rainy season), particularly for the critical areas. If precipitation is likely during grading, minimize the length of time that soils are exposed, and the total area of exposure.
- Materials used for erosion and sediment control shall be on site at all times.
- Take the following measures when precipitation is forecast:
  - Minimize the length of time that the soils are left exposed.
  - Reduce the total area of exposed soil.
  - Protect critical areas such as drainage channels, streams, and natural water courses.
  - Stabilize exposed areas quickly.
- The schedule shall clearly show how regional precipitation trends relate to soil-disturbing and re-stabilization activities. The construction schedule shall be incorporated into the Erosion and Sediment Control Plan.
- The schedule shall include detail on the implementation and deployment of temporary soil stabilization measures, temporary sediment controls, tracking controls, wind erosion controls, non-storm water pollution controls (including waste management and materials pollution controls).
- The schedule shall also include dates for significant long-term operations or activities that may have planned non-storm water discharges such as dewatering, saw cutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, bridge cleaning, etc.
- Develop the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, pouring foundations, installing utilities, etc., to minimize the active construction area during the rainy season.
- Schedule major grading operations when the chances of precipitation are minimized when practical.
- Schedule the installation, removal, or modification of run-on controls and flow conveyance structures for the non-rainy season or when there is a low probability of precipitation to reduce the likelihood of uncontrolled flow across and from the site.
- Stabilize non-active areas after the cessation of soil-disturbing activities or prior to the onset of precipitation in accordance with local requirements.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment controls and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year-round to deploy soil stabilization and sediment control practices. Erosion may be caused during dry seasons by unseasonable rainfall, wind, and vehicle tracking. Keep the site stabilized year-round, and retain and maintain sediment trapping devices in operational condition.
- Sequence trenching activities so that most open portions are closed before new trenching begins.
- Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
- Consider scheduling when establishing permanent vegetation (appropriate planting time for specified vegetation).

Inspection and Maintenance:

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule to show updated information on the deployment and implementation of construction site BMPs.

Maintaining existing vegetation or placing vegetative buffer strips can have numerous benefits for stormwater quality, erosion and sediment control, as well as landscape beautification, dust control, noise reduction, shade and watershed protection.

Construction Specifications:

Preservation of Existing Vegetation:

Timing

- Preservation of existing vegetation shall be provided prior to the commencement of clearing and grubbing operations or other soil-disturbing activities in areas identified on the plans to be preserved, especially on areas designated as Environmentally Sensitive Areas (ESAs) or where no construction activity is planned or will occur at a later date.
- Limits of clearing and grubbing should be clearly marked prior to any grading or clearing activities.
- Preservation of existing vegetation shall conform to scheduling requirements and local permitting agency requirements.

Design and Layout

- Mark areas to be preserved with temporary fencing made of orange polypropylene that is stabilized against ultraviolet light. The temporary fencing shall be at least 3.2. ft (1 meter) tall and shall have openings not larger than 2 in by 2 in (50 mm by 50 mm).
- Fence posts shall be either wood or metal as appropriate for the intended purpose. The post spacing and depth shall be adequate to completely support the fence in an upright position.
- Minimize the disturbed areas by locating temporary roadways to avoid stands of trees and shrubs and to follow existing contours to reduce cutting and filling.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Construction materials, equipment storage, and parking areas shall be located where they will not cause root compaction.
- Keep equipment away from trees to prevent trunk and root damage at least to drip line.
- Maintain existing irrigation systems.
- Employees and subcontractors shall be instructed to honor protective devices. No heavy equipment, vehicular traffic, or storage piles of any construction materials shall be permitted within the drip line of any tree to be retained. Removed trees shall not be felled, pushed, or pulled into any retained trees. Fires shall not be permitted within 100 ft (30 m) of the drip line of any retained trees. No toxic or construction materials (including paint, acid, nails, gypsum board, chemicals, fuels, and lubricants) shall be stored within 50 ft (15 m) of the drip line of any retained trees, nor disposed of in any way which would injure vegetation.

Trenching and Tunneling

- Trenching shall be as far away from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching and/or tunneling near or under trees to be retained, tunnels shall be at least 18 in (450 mm) below the ground surface, and not below the tree center to minimize impact on the roots.
- Tree roots shall not be left exposed to air; they shall be covered with soil as soon as possible, protected, and kept moistened with wet burlap or peat moss until the tunnel and/or trench can be completed.

- The ends of damaged or cut roots shall be cut off smoothly.
- Trenches and tunnels shall be filled as soon as possible or in accordance with local requirements. Careful filling and tamping will eliminate air spaces in the soil which can damage roots.
- Remove any trees intended for retention if those trees are damaged seriously enough to affect their survival.
- After all other work is complete, fences and barriers shall be removed last. This is because protected trees may be destroyed by carelessness during the final cleanup and landscaping.

Vegetative Buffer Strips:

- Vegetated buffer strips (vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and allowing sediment and other pollutants (e.g., total and dissolved metals) to settle and partially infiltrate into underlying soils. With proper design and maintenance, filter strips can provide relatively high pollutant removal.
- Designate watercourse buffer-filter strips on the site design plan.
- The width of a buffer strip (i.e., flow path length) shall be maximized to the extent feasible with a 15 foot suggested minimum width. Buffer strips shall be sized in accordance with site conditions and local requirements.

SURFACE ROUGHENING – EP-3

Surface roughening involves roughening surface soils by mechanical methods including sheepsfoot rolling, track walking, scarifying, stair stepping, and imprinting. All slopes prepared by surface roughening must meet engineering compaction requirements required by the project design and local grading requirements. This BMP is intended to only affect surface soils and is not intended to compromise slope stability or overall compaction.

Construction Specifications:

Cut Slope Roughening:

- Stair-step grade or groove the cut slopes that are steeper than 3:1.
- Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.
- Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
- Do not make individual vertical cuts more than 2 feet (0.6 m) high in soft materials or more than 3 feet (0.9 m) high in rocky materials.
- Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening:

- Place on fill slopes with a gradient steeper than 3:1 in lifts not to exceed 8 inches (0.2 m), and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4-6 inches (0.1-0.2 m) deep.
- Use grooving or tracking to roughen the face of the slopes, if necessary.
- Do not blade or scrape the final slope face.

Roughening for Slopes to be Mowed:

- Slopes which require mowing activities shall not be steeper than 3:1.
- Roughen these areas to shallow grooves by track walking, scarifying, sheepsfoot rolling, or imprinting.
- Make grooves close together (less than 10 inches (0.3 m)), and not less than 1 inch (25.4 mm) deep, and perpendicular to the direction of runoff (i.e., parallel to the slope contours).
- Excessive roughness is undesirable where mowing is planned.

Roughening With Tracked Machinery:

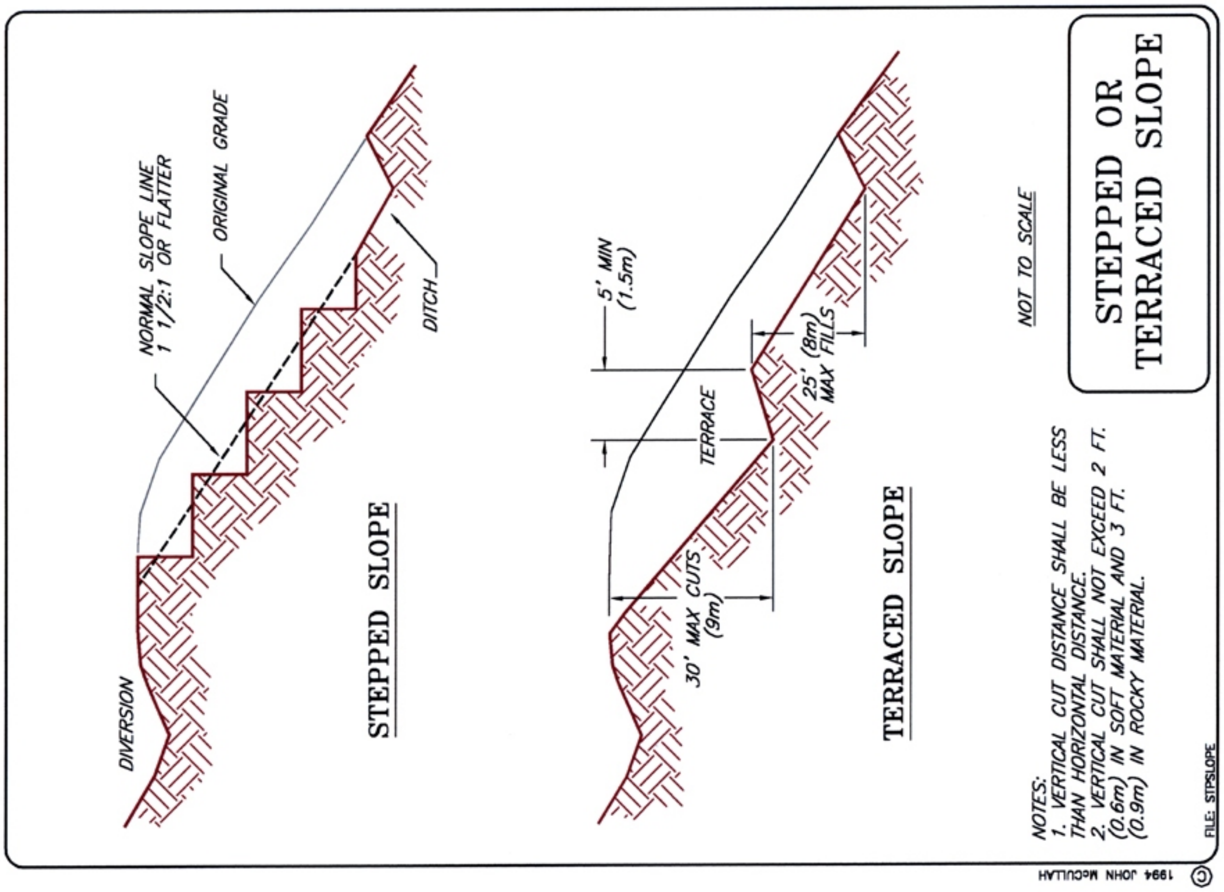
- Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.
- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.
- Seed and mulch roughened areas as soon as possible to obtain optimum seed germination and growth.

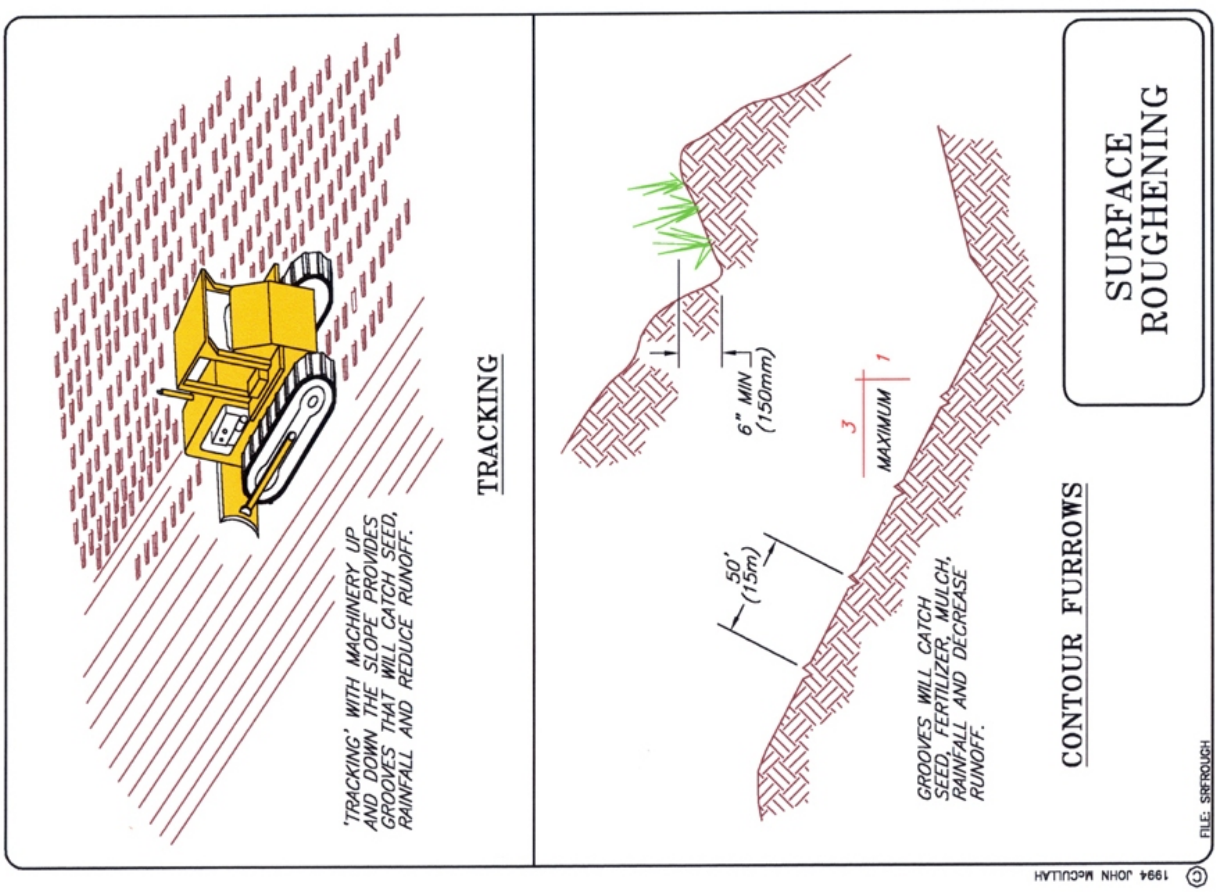
Minimum BMP standards are presented in the attached detail.

Inspection and Maintenance:

Check the seeded slopes for signs of erosion such as rills and gullies. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

SURFACE ROUGHENING – EP-3





TOPSOILING – EP-4

Topsoiling is the practice of stripping and stockpiling existing topsoil and then spreading it in graded areas to encourage future vegetation growth.

Construction Specifications:

Planning:

- Determine whether the quality and quantity of available topsoil justifies selective handling and in consideration of local requirements.
- Soils of the textural class of loam, sandy loam, and silt loam are best; sandy clay loam, silty clay loam, clay loam, and loamy sand are fair. Do not use heavy clay and organic soils such as peat or muck as topsoil.

Stripping and Stockpiling:

- Strip topsoil only from those areas that will be disturbed by excavation, filling, or compacting by equipment. A 4-6 inch (0.1-0.2 m) stripping depth is common, but depth varies depending on the site.
- Determine depth of stripping by taking soil cores at several locations within each area to be stripped. Topsoil depth generally varies along a gradient from hilltop to toe of the slope.
- Put sediment basins, diversions, and other controls into place before stripping.
- Select stockpile location to avoid slopes, natural drainage ways, and traffic routes. On large sites, re-spreading is easier and more economical when topsoil is stockpiled in small piles located near areas where they will be used.
- Use sediment fences or other barriers where necessary to retain sediment.
- Protect topsoil stockpiles by temporarily seeding and/or mulching as soon as possible to assure the stored material is not unnecessarily exposed and allowed to erode. Use locally grown and native seed stocks when possible that are mycorrhizal-dependent.
- Topsoil stockpiles should be low n height (ideally <1 meter) and flat and be used within 6 months to promote healthy soil organisms and microbes. Stockpiles not used within 6 months should be reseeded with a species that is mycorrhizal-dependent to avoid the development of anaerobic conditions in the stockpile. In addition, topsoil stockpiles can be turned periodically to keep organisms alive for larger stockpiles and during extremely hot weather.

Spreading:

- Before spreading topsoil, establish erosion and sediment control practices such as diversions, berms, dikes, waterways, and sediment basins.
- Where the pH of the existing subsoil is 6.0 or less, or the soil is composed of heavy clays, incorporate agricultural limestone in amounts recommended by soil tests or specified for the seeding mixture to be used. Incorporate lime to a depth of at least 2 inches (51 mm) by disking. Ensure that all of the lime mixture is incorporated into the soil to minimize direct contact with storm water runoff and handle lime in accordance with manufacturing recommendations or NS-7 (Materials Delivery and Storage).
- Immediately prior to spreading the topsoil, loosen the subgrade by disking or scarifying to a depth of at least 3 inches (76 mm), to ensure bonding of the topsoil and subsoil. If no amendments have been incorporated, loosen the soil to a depth of at least 6 inches (0.15 m) before spreading topsoil.
- Uniformly distribute topsoil to a minimum compacted depth of 2 inches (51 mm) on 3:1 slopes and 4 inches (0.1 m) on flatter slopes.
- Do not spread topsoil while it is frozen or muddy or when the subgrade is wet or frozen.
- Correct any irregularities in the surface that result from topsoiling or other operations to prevent the formation of depressions or water pockets.
- Compact the topsoil enough to ensure good contact with the underlying soil, but avoid excessive compacting, as it increases runoff and inhibits seed germination. Light packing with a roller is recommended where high maintenance turf is to be established.

TEMPORARY SEEDING AND PLANTING EP-5

Temporary seeding and planting consists of the establishment of temporary vegetative cover on disturbed areas to reduce erosion by seeding with appropriate and rapidly growing annual grasses and forbs.

Construction Specifications

Conditions Where Practice Applies

- Cleared or graded areas that are exposed and subject to erosion for extended periods (e.g., 14 to 30 days depending on local requirements).
- Cleared or graded areas exposed to seasonal rains.
- Areas that will not be subjected to heavy wear by construction equipment.
- Temporary seeding is encouraged whenever possible to aid in reducing erosion on construction sites. Temporary seeding is an important component of "phased" construction activities. Permanent seeding shall be applied to areas intended to be left dormant for a year or more.

The following chart shows recorded shear stress and velocities withstood by grass mixtures and applications.

Bank Material/Protection	**Shear**		**Velocity**			**Reference**
	lb/ft^2	**N/m^2**	**ft/s**	**m/s**		
Sandy Loam	0.0167		1.75	0.53	Design	Temple, 1980
Silt Loam	0.0218		2	0.61	Design	Temple, 1980
Alluvial silts	0.0218		2	0.61	Design	Temple, 1980
Ordinary firm loam	0.0341		2.5	0.76	Design	Temple, 1980
Very light loose sand, no vegetation or protection			1-1.5	.3-.46	Limit	Fortier & Scobey, 1926
Average sandy soil			2-2.5	.61-.76	Limit	Fortier & Scobey, 1926
Stiff clay, ordinary gravel soil			4-5	1.2-1.5	Limit	Fortier & Scobey, 1926
Bermuda grass, erosion resistant soils, 0-5% slope			8	2.4	Design	USDA, 1947
Bermuda grass, erosion resistant soils, 5-19% slope			7	2.1	Design	USDA, 1947
Bermuda grass, erosion resistant soils, over 10% slope			6	1.8	Design	USDA, 1947
Bermuda grass, easily eroded soils, 0-5% slope			6	1.8	Design	USDA, 1947
Bermuda grass, easily eroded soils, 5-10% slope			5	1.5	Design	USDA, 1947
Bermuda grass, easily eroded soils, over 10% slope			4	1.2	Design	USDA, 1947
Grass mixture, erosion resistant soils, 0-5% slope			5	1.5	Design	USDA, 1947
Grass mixture, erosion resistant soils, 5-10% slope			4	1.2	Design	USDA, 1947
Grass mixture, easily eroded soils, 0-5% slope			4	1.2	Design	USDA, 1947
Grass mixture, easily eroded soils, 5-10% slope			3	0.91	Design	USDA, 1947

1" riprap	0.33	16			Limit	Chen & Cotton, 1988
2" riprap	0.67	33			Limit	Chen & Cotton, 1988
6" riprap	2	98			Limit	Chen & Cotton, 1988
12" riprap	4	196			Limit	Chen & Cotton, 1988
Dense sod, fair condition (class D/E), moderately cohesive soil	0.35	17			Limit	Austin & Theisen, 1994
Bermuda grass, fair stand <12 cm tall, dormant	0.9	44			Limit	Parsons, 1963
Bermuda grass, good stand <12 cm tall, dormant	1.1	54			Limit	Parsons, 1963
Bermuda grass, excellent stand 20 cm tall, dormant	2.7	132			Limit	Parsons, 1963
Bermuda grass, excellent stand 20 cm tall, green	2.8	137			Limit	Parsons, 1963
Bermuda grass, excellent stand >20 cm tall, green	3.2	156			Limit	Parsons, 1963
12.5 cm of excellent growth of grass/woody veg on outside bend	1	49			Limit	Parsons, 1963
Flume trials, fabric reinforced vegetation – failed after 50 hours	5	244			Limit	Theisen, 1992
Flume trials, fabric reinforced vegetation – failed after 8 hours	8	391			Limit	Theisen, 1992
Sod revetment, short period of attack	0.41	20.09			Design	Schoklitsch, 1937
Wattle (coarse sand between)	0.2	9.8			Design	Schoklitsch, 1937
Wattles (gravel between)	0.31	15.19			Design	Schoklitsch, 1937
Wattles (parallel or oblique to current)	1	49			Design	Schoklitsch, 1937
Fascine revetment	1.4	68.6			Design	Schoklitsch, 1937
Cribs with stone	30	1470			Design	Schoklitsch, 1937
Turf (immediately after construction)	0.2	10			Limit	Schiechtl & Stern, 1994
Turf (after 3-4 seasons)	2.04	100			Limit	Schiechtl & Stern, 1994

Site Considerations

- Prior to seeding, install necessary erosion control practices such as temporary continuous berms, diversion dikes, channels, and sediment basins.
- Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.
- Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Consider mixes because they are more adaptable than single species.
- Check with local municipalities for local specifications and requirements prior to seeding and planting.

- Mulching is commonly used with seeding practices for temporary cover and to aid in the establishment of vegetation.
- Temporary seeding also prevents costly maintenance operations on other erosion control systems. For example, sediment basin maintenance (clean-out) will be reduced if the drainage area has temporary vegetative cover when grading and construction are not taking place. (Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as diversion dikes, and sediment basins)
- To reduce the amount of fertilizer, pesticides and other inputs needed, choose adapted varieties based on environmental conditions, management level desired, and the intended use. Check with local municipalities prior to use of fertilizer or pesticides.

Timing

The proper time to seed is dependent upon the climate of the area and the species of seed selected. To determine seeding dates for temporary cover, consult the seed supplier.

Seed Mixes

- All seed should be selected in accordance with local municipality requirements.
- Select plants appropriate to the season and site conditions**.**
- The seeding rates are based on a minimum acceptable pure live seed (PLS) of 80%. When PLS is below 80% adjust rates accordingly.
- Legumes should be inoculated with the proper rhizobium bacteria before planting. Pellet inoculated seed can be purchased or inoculation can be done in the field. Use only fresh, age dated inoculate specifically labeled for use with the legume you are using.

Site Preparation

- Grade as needed and feasible to permit the use of equipment for seedbed preparation.
- Install needed erosion control practices, such as sediment basins, diversion dikes and channels, prior to seeding. Divert concentrated flows away from seeded areas.
- Soil tests should be done to determine the nutrient and pH content of soil. Depending on the results of soil tests, soil management may be necessary to adjust the pH to between 6.5 and 7.0 (for most conditions). All lime, fertilizer and other soil amendments should be added following sound soil management practices.
- Surface roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted or hardened the soil should be loosened with discing, raking or harrowing. Tracking with bulldozer cleats is very effective on sandy soils.
- Hydroseeding and hydraulic planting generally require less seedbed preparation.
- Generally, slopes steeper than 2:1 that cannot have good seedbed preparations with equipment will require hydraulic planting techniques.
- Seed to soil contact is the key to good germination. Prepare a 3-5 inch (76-127 mm) deep seedbed, with the top 3-4 inches (76-102 mm) consisting of topsoil. Note that the earth bed upon which the topsoil is to be placed should be at the required grade.
- The seedbed should be firm but not compact. The top 3 inches (76 mm) of soil should be loose, moist and free of large clods and stones. For most applications, all stones larger than 2 inches (51 mm) in diameter, roots, litter and any foreign matter should be raked and removed. The topsoil surface should be in reasonably close conformity to the lines, grades and cross sections shown on the grading plans.

Hydroseeding site in September 2003

December 2003

April 2004

Planting:

- Seed should be applied as soon after seedbed preparation as possible, when the soil is loose and moist.
- Always apply seed before mulch, unless seed is applied with a hydraulic matrix or bonded fiber matrix (See BMP EP-8, Mulches).
- Apply seed at the rates specified using calibrated spreaders, cyclone seeders, mechanical drills, or hydroseeders so the seed is applied uniformly on the site.
- If seed is applied with a bonded fiber matrix, apply BFM from multiple directions to adequately cover the soil. Application from a single direction can result in shadowing, uneven coverage, and failure of the BFM.
- Apply fertilizer if required. Seed and fertilizer should be incorporated into the soil by raking or chain dragging, or otherwise floated, then lightly compacted to provide good seed-soil contact.
- Straw mulch, erosion control blankets or mulch and tackifiers/soil binders should be applied over the seeded areas.

***Inspection and Maintenance*:**

- Newly seeded areas need to be inspected frequently to ensure the grass is growing. Areas that fail to establish cover adequate to prevent sheet and rill erosion will be reseeded as soon as such areas are identified. Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.
- If the seeded area is damaged due to concentrated runoff, additional practices may be needed.
- Temporary vegetated areas will be maintained until permanent vegetation or other erosion control practices can be established.

PERMANENT SEEDING AND PLANTING EP-6

Permanent seeding involves the establishment of a permanent, perennial vegetative cover on disturbed areas from seed. Refer to BMP EP-21 for installation of sod. Planting of shrubs, trees, and container plants should be conducted in accordance with project landscaping specifications and local requirements.

The use of native, indigenous, or naturally-occurring grasses is recommended for biotechnical works. These "native" grasses have evolved in a manner that will not compete with or preclude the establishment, or natural recruitment, of naturally-occurring woody vegetation. Establishment of permanent vegetation provides natural erosion and sediment control by trapping particulates, slowing runoff velocities and enhancing infiltration. Permanent vegetation also is beneficial for long-term aesthetics and wildlife habitat.

Construction Specifications

Conditions Where Practice Applies

- Graded, final-graded or cleared areas where permanent vegetative cover is needed to stabilize the soil. Permanent seeding with perennial grasses is recommended when fibrous and deeply rooted are needed to provide slope and soil reinforcement.
- Slopes designated to be treated with erosion control blankets should be seeded first.
- Grass-lined channels or waterways designed to be treated with turf reinforcement mats, fiber roving systems, or other channel liners will require special grass blends.

Materials

Proper seed selection is very important. Choose climatically adapted perennial species that are long-lived, hearty and require low inputs of fertilizer, irrigation and mowing. You may consider a locally occurring species for native grass establishment. Consider seed blends because they are more adaptable.

Use seeds appropriate to the season and site conditions. Use a seed blend, which include annuals, perennials and legumes. Legumes should be inoculated with the proper rhizobium bacteria before planting. Pellet inoculated seed can be purchased or inoculation can be done in the field. Unless otherwise specified by local requirements, use seed rates based on minimum pure live seed (PLS) of 80%. When PLS is below 80% adjust rates accordingly. Consult a local seed supplier, landscape architect, or erosion control specialist for appropriate seed blends. Seed should be selected in accordance with local regulations.

Installation

The probability of successful plant establishment can be maximized through good planning, knowledge of soil characteristics, selection of appropriate seed blends for the site, good seedbed preparation, and timely planting. Prior to seeding, install necessary erosion control practices such as diversion dikes, channels, and sediment basins. Site area should be at final grade and not be disturbed by future construction activities.

Timing

- Apply permanent seeding on areas left dormant for 1 year or more.
- Apply permanent seeding when no further disturbances are planned.
- To determine optimum seeding schedule, consult a local agronomist or erosion control specialist.
- Apply permanent seeding before seasonal rains or freezing weather is anticipated.
- Use dormant seeding for late fall or winter seeding schedules.

Seed Mixes

- Use seeds appropriate to the season and site conditions.
- Consult local agronomist or erosion control specialists for seed mix.
- Use a seed blend to include annuals, perennials and legumes.

- Use seed rates based on pure live seed (PLS) of 80%. When PLS is below 80% adjust rates accordingly.

Site Preparation

- Bring the planting area to final grade and install the necessary erosion control BMPs (i.e., sediment basins and temporary diversion dikes).
- Divert concentrated flows away from the seeded area.
- Conduct soil test to determine pH and nutrient content. Roughen the soil by harrowing, tracking, grooving or furrowing.
- Apply amendments as needed and permitted by local municipalities to adjust pH to 6.0-7.5. Incorporate these amendments into the soil. Prepare a 3-5 in (76-127 mm) deep seedbed, with the top 3-4 in (76-102 mm) consisting of topsoil. The seedbed should be firm but not compact. The top three inches of soil should be loose, moist and free of large clods and stones. The topsoil surface should be in reasonably close conformity to the lines, grades and cross sections shown on the grading plans.

Planting:

- Seed to soil contact is the key to good germination.
- Seed should be applied immediately after seedbed preparation while the soil is loose and moist. If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed with a disk, spring tooth drag, spike tooth drag, or other equipment designed to conditions the soil for seeding.
- Harrowing, tracking or furrowing should be done horizontally across the face of the slope.
- Always apply seed before applying mulch, unless using a hydraulic matrix or bonded fiber matrix where seed is mixed with mulch prior before application.
- Apply seed at the rates specified using calibrated seed spreaders, cyclone seeders, mechanical drills, or a hydroseeder so the seed is applied uniformly on the site.
- Broadcast seed should be incorporated into the soil by raking or chain dragging, and then lightly compacted to provide good seed-soil contact.
- Apply fertilizer as specified and allowed by local municipalities.
- Apply mulch or erosion control blanket, as specified, over the seeded areas.

Inspection and Maintenance

- Newly seeded areas need to be inspected frequently to ensure the grass is growing.
- If the seeded area is damaged due to runoff, additional stormwater measures may be needed.
- Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.
- Irrigation/watering should be used as necessary and recommended to establish vegetation in accordance with local regulations.

MYCORRHIZAE AND BIOFERTILIZERS EP-7

Biofertilizers and mycorrhizae are very important to any revegetation effort, as they help to rebuild the living soil that can get damaged by any earthwork. Most desirable species will have a very difficult time out competing weeds without mycorrhizae, or the slowly released nutrients provided by biofertilizers.

Biofertilizers

Biofertilizers are fertilizers containing living microorganisms, which increase microbial activity in the soil. Often, organic food is included to help the microbes get established.

Important functions of soil microbes:

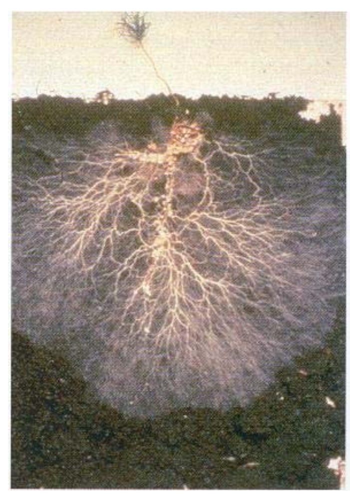
- Convert ambient nitrogen into forms that the plants can use (Nitrate and Ammonia),
- Increase soil porosity by gluing soil particles together.
- Defend plants against pathogens by out-competing pathogens for food.
- Saprophytic fungi in the soil break leaf litter down into usable nutrients.

The high soil porosity (large spaces between soil particles) caused by microbes is important, because it aids water infiltration. If pore spaces are too small, they cannot break the surface tension of a water droplet, and water will run off, instead of saturating the soil, where it can be taken up by plant roots.

Chemical fertilizers are often over-applied, and end up polluting the water because they are not used up. The chemicals are less expensive in the short term, but must be continuously reapplied, and are therefore more expensive over the long-term.

A combination of chemical fertilizers and biofertilizers gives the plants a jump-start and maintains them until the microbes can get established.

Mycorrhizal Fungi



Mycorrhizal fungi form a bridge between the roots and the soil, gathering nutrients from the soil and giving them to the roots. There are two major types of mycorrhizae: Ectomycorrhizal Fungi (EM) and Endomycorrhizal Fungi (AM). While both types penetrate the plant roots, ectomycorrhizae spread their hyphae between root cells, while endomycorrhizae hyphae penetrate root cells. Ectomycorrhizae hosts include members of the Pine, Oak and Beech families, as well as few others in scattered families, and involves a “higher” (often mushroom-forming) fungus. ECM-dominated forests tend to be low in species diversity compared to arbuscular (AM) forests, and have a thick layer of organic debris on the forest floor.

Endomycorrhizae are the most common, and are found in grasses, shrubs, trees including redwood and cedar, most domestic plant species and many other members of the forest understory. EM fungi are usually specific to a certain host species, but most species of endomycorrhizae will form relationships with almost any AM host plant, and is therefore much easier to specify. There are four major plant families that usually do not form mycorrhizae: *Amaranthaceae* (Pigweed family), *Brassicaceae* (Mustard family), *Chenopodiaceae* (Goosefoot family) and *Zygophyllaceae* (Caltrop family). These plant families are well known as weeds. Therefore, if you do not ensure an adequate supply of mycorrhizae, you may inadvertently inhibit growth of desirable species and allow for rapid growth of undesirable species.

Relationships between Biofertilizers and Mycorrhizal Fungi

Plant roots secrete "food" for bacteria and fungi, which attracts nematodes (worms) to the roots, because nematodes eat bacteria and fungi, and excrete Nitrogen, Sulphur and Phosphorus in a form that the plants can use. The nematodes only keep 1/6 of the nitrogen that they process – 5/6 is excreted to the plant. Once the nematodes have excreted the nutrients, the hyphae of the mycorrhizal fungi pick them up and transfer them into the plant. Because of this symbiotic relationship, the least-leachable form of Nitrogen you can apply is bacteria and fungi, and bacteria are the most Nitrogen-rich organisms on earth.

AM hyphae pick up more nutrients than just those excreted by nematodes, however. One of the most beneficial properties of AM mycorrhizae is its ability to "mine" the soil great distances from the roots for nutrients, especially those, such as Phosphorus, that are poorly mobile in the soil. AM Mycorrhizae also assist in picking up water further away from the roots, and block pest access to roots.

Mycorrhizae also benefit plants indirectly by enhancing the structure of the soil. AM hyphae excrete gluey, sugar-based compounds called Glomalin, which helps to bind soil particles, and make stable soil aggregates. This gives the soil structure, and improves air and water infiltration, as well as enhancing carbon and nutrient storage.

Most natural, undisturbed soils have an adequate supply of mycorrhizae for plant benefits; however, the following practices can reduce mycorrhizae populations to inadequate levels.

- Erosion
- Grading
- Excavation
- Occupation with non-Mycorrhizal plants (weeds)
- Loss of original topsoil

The best way to be sure that appropriate mycorrhizal levels exist in soil onsite is to get a soil sample analyzed for mycorrhizal presence.

To maintain healthy mycorrhizae populations (Peters, 2002):

- Do not apply too much phosphorus, as high levels will limit mycorrhizal effectiveness, low to moderate levels, or slow-release phosphorus will maximize plant benefits.
- Limit fungicide use, as some fungicides damage AM fungi.
- Limit soil disturbance, as disruption of the hyphae in the soil limits water and nutrient movement into the root.

Application

Endomycorrhizae should be applied at a rate of 3,600,000 propagules per acre (8,900,000 propagules per hectare), which equates to 60 lbs per acre (67.5 kg/ha) or 1.4 lbs/1000 ft^2, assuming the standard 120 propagules/cc. Mycorrhizae is most frequently applied via hand seeding, seed drilling, hydroseeding, broadcast and till, planting, or as a nursery medium.

If installing container plants, packets of mycorrhizae may be planted along with the plant, at a rate of 1 packet per foot of plant height or container width (RTI, 2003).

Maintenance / Inspection

No maintenance should be necessary, although if plants do not appear to be growing vigorously, analysis of mycorrhizal density in the soil can help to determine if you need to apply more.

MULCHES – EP-8

Mulching is the process of applying bulk materials to the soil surface to reduce rainfall impact, increase infiltration and in some cases, aid in revegetation. Common types of mulch include vegetable fibers, green material, hydraulic mulches from recycled paper or wood fibers, hydraulic matrices, and straw mulch. Mulches may include a tackifier to increase the longevity of the application.

Construction Specifications:

- Mulch should be used for temporary applications only; permanent erosion control measures should also be applied.
- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.
- Avoid mulch over-spray onto the traveled way, sidewalks, lined drainage channels, and existing vegetation.

Wood Fiber Mulch – Materials and Application Procedures

- Wood fiber mulch is a component of hydraulic applications. It is usually used in combination with seed and fertilizer. It is typically applied at the rate of 2,000 to 4,000 lb/ac (2,250 to 4,500 kg/ha) with 0-5% by weight of a stabilizing emulsion or tackifier (e.g., guar, psyllium, acrylic copolymer) and applied as a slurry. This type of mulch is manufactured from wood or wood waste from lumber mills or from urban sources.
- Wood fiber mulch can be specified with or without a tackifier; previous work has shown that wood fiber mulches with tackifiers have better erosion control performances.
- Materials for wood fiber based hydraulic mulches and hydraulic matrices shall conform to Oregon DOT Standard Specifications Sections 01030.15 and 01030.16 and local municipality requirements and specifications.

Recycled Paper Mulch – Materials and Application Procedures

- Recycled paper mulch contains fibers of shorter length than wood fiber mulches and is typically made from recycled newsprint, magazine, or other waste paper sources. It is a component of hydraulic applications and is usually used in combination with seed and fertilizer. It is typically applied at the rate of 1 to 2 tons/ac (2,250 to 4,500 kg/Ha). It can be specified with or without a tackifier.

Green Material – Materials and Application Procedures

- This type of mulch is produced by recycling vegetation trimmings such as grass, shredded shrubs and trees. Methods of application are generally by hand, although pneumatic methods are available. Mulch shall be composted to kill weed seeds.
- It may be used as a temporary ground cover with or without seeding.
- The green material shall be evenly distributed on site to a depth of not more than 2 in (50 mm).

Hydraulic Matrix – Materials and Application Procedures

- Hydraulic matrix is a combination of wood fiber mulch and a tackifier applied as a slurry. It is typically applied at the rate of 2,000 to 4,000 lb/ac (2,250 to 4,500 kg/ha) with 5-10% by weight of a stabilizing emulsion or tackifier (e.g., guar, psyllium, acrylic copolymer).
- Materials for wood fiber based hydraulic mulches and hydraulic matrices shall conform to Oregon DOT Standard Specifications Sections 01030.15 and 01030.16 and local municipality requirements and specifications.
- Hydraulic matrices require 24 hours to dry before rainfall occurs to be effective unless approved by Oregon DEQ.

Bonded Fiber Matrix – Materials and Application Procedures

- 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. BFMs are typically applied at rates from 3,000 to 4,000 lb/ac (3,400 to 4,500 kg/ha) based on the manufacturer's recommendation. The biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM shall also be biodegradable and shall not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs require 12 to 24 hours to dry to become effective.
- BFM should be selected and used in accordance with local municipality requirements and specifications.
- Apply bonded fiber matrices from multiple directions to adequately cover the soil. Application from a single direction can result in shadowing, uneven coverage, and failure of the BFM.

Straw Mulch - Materials

- All materials shall conform to Oregon DOT Standard Specifications Sections 01030.15(b) and any local municipality requirements.
- Straw shall be derived from wheat, rice, or barley. The straw mulch contractor shall furnish evidence that clearance has been obtained from the County Agricultural Commissioner, as required by law, before straw obtained from outside the county in which it is to be used is delivered to the site of the work. Straw that has been used for stable bedding shall not be used.

Straw Mulch – Application Procedures

- Apply loose straw at a minimum rate of 4,000 lb/ac (3,570 kg/ha), or as indicated in the project's Erosion and Sediment Control Plan, either by machine or by hand distribution.
- The straw mulch must be evenly distributed on the soil surface.
- Avoid placing straw onto the traveled way, sidewalks, lined drainage channels, walls, and existing vegetation.
- Anchor the mulch in place by using a tackifier (preferred) or by "punching" it into the soil mechanically (incorporating).
- If using a tackifier to anchor the straw mulch in lieu of incorporation, roughen embankment or fill areas by rolling with a crimping or punching-type roller or by track walking before placing the straw mulch. Track walking should only be used where rolling is impractical.
- 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 (see Oregon DOT Standard Specifications Section 01030.16).
- A tackifier is typically applied at a rate of 125 lb/ac (140 kg/ha). In windy conditions, the rate is typically 178 lb/ac (200 kg/ha).
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.
- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions and longevity. If the selected method is incorporation of straw mulch into the soil, then do as follows:
    - Applying and incorporating straw shall follow the requirements in Oregon DOT Standard Specifications Section 01030.48(b) and any local municipality's specifications and requirements.
    - On small areas, a spade or shovel can be used.
    - On slopes with soils, which are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw may 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 may 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. Refer to EP-10, "Erosion Control Blankets and Mats."

Inspection and Maintenance:

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked. Inspect before expected rain events and repair any damaged ground cover and re-mulch exposed areas of bare soil.
- The key consideration in maintenance and inspection is that the mulch needs to last long enough to achieve erosion control objectives. Mulch is a temporary ground cover and not suitable for long-term erosion control.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are non-active. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of mulch and tackifier may be required by Oregon DEQ and local municipalities to maintain effective soil stabilization over disturbed areas and slopes.
- After any rainfall event, maintain all slopes to reduce or prevent erosion.

Construction Specifications

A compost blanket is a layer of compost designed to prevent erosion, especially rills and gullies that may form under more traditional methods of erosion control. In many cases, a compost blanket can be more effective at vegetation establishment, weed suppression and erosion control than an Erosion Control Blanket (ECB) or Hydroseeding. Compost blankets can be applied by hand, conveyor system or compost spreader; however, the most cost-effective and efficient method is the use of a pneumatic delivery system, i.e. a compost blower truck.

Purpose

A compost blanket is used on slopes to prevent raindrop erosion and in some cases, to increase infiltration rates. A trademarked form of a compost blanket, the Rexius EcoBlanket™ increased infiltration rates and decreased sediment delivery by 99% as compared to bare soil, in a study conducted by the San Diego State Erosion Control Laboratory. The success of compost blankets is dependent upon the blanket not being undermined by water; this can be accomplished by keying in the top of the blanket, or the use of a compost berm or sock at the top of the slope.

EcoBlanket™ Photo Courtesy of Rexius

When applied correctly, compost blankets provide nearly 100% surface coverage.

Compost binds heavy metals and can break hydrocarbons down into carbon, salts and other unharmful compounds. Many communities now have municipal recycle or "Greenwaste" programs whereby vegetation is diverted from landfills and quality compost is manufactured.

Advantages

Compost blankets can be more effective than ECBs, because they come in better contact with the underlying soil, reducing the chance of rill formation.

Compost is organic, biodegradable, renewable, and can be left onsite. This is particularly important near streams.

Compost does not generally leach nutrients. Field tests in Connecticut have shown that run-off from compost treated sites has very low soluble salts, and all metals and nutrients are well within pollution leaching limits.

Compost has been shown to suppress weeds.

Conditions Where Practice Applies

Testing has shown that compost blankets are effective on up to a 2:1 slope. For steeper slopes, there are products designed to enhance adhesion of the compost to the slope, but the effectiveness of such products are unknown. Adding components such as a tackifier, or using compost blankets in conjunction with other techniques such as compost berms as slope interrupters can increase the allowable steepness of the slope to be treated. However, slopes of this steepness would likely require customized stabilization techniques recommended by an engineer.

Photo Courtesy of Texas DOT

Compost blankets should be extended 3-6 feet over the top shoulder of the slope to prevent water from flowing underneath.

Compost blankets should not be applied in areas of concentrated flow, and can be used in conjunction with compost berms or socks.

Blankets can be applied in a variety of thicknesses from ½" to 4", depending upon the intended purpose. As a general rule, the more precipitation an area receives, the thicker the application.

For best vegetation establishment, a depth of 1 ½" is optimum. For maximum unvegetated erosion control, use thicker blankets.

Compost Specifications:

There are many types of compost, all with different properties, so it is best to determine what application the compost is being used for. Compost can be derived from feedstocks, biosolids, leaf and yard trimmings, manure, wood, or mixed solid waste, and must be treated with heat to remove pathogens and destroy noxious weeds.

One of the most important criteria for quality compost is the temperature it was "cooked" at and the duration of composting. For instance, California Compost Regulations require that "windrowed compost" be kept at 131°F for 15 days and turned 5 times. Compost manufactured in bags is referred to as "in vessel" which the regulations require be kept at 131°F for only 5 days. Quality compost will then be cured for 60 days (D.Carvalo, personal communication, 2004).

All types of vegetation have different nutrient or moisture needs; therefore, a compost sample should be inspected by a qualified individual and compost specifications modified as necessary. For compost blankets, compost should have the specifications presented in Table 1 (AASHTO).

Compost that is too dry is harder to apply, while that which is too wet is heavier and harder to transport. In drier areas, use compost with higher moisture content; in wet areas, use the drier compost, as it will absorb water.

Organic matter content: The percentage of carbon based materials in finished compost should range between 40-70%. However, Texas DOT specifies no less than 70%.

Compost must be weed and pesticide free, with manmade materials comprising less than 1%.

Installation

- Compost blankets can be applied in a variety of ways, however the most efficient and cost-effective way is through the use of a pneumatic blower truck.
- Prepare the slopes by removing loose rocks, roots, clods, stumps and debris over 2" in diameter.
- Trackwalk slopes if feasible before application.
- For very steep slopes (2H:1V to 1V:1V), compost berms can be installed along the contour at intervals over the compost blanket in much a similar manner as fiber rolls and tackifier applied to improve effectiveness .

Photo courtesy Texas DOT

Table 1. Compost Specifications.

Parameters [1,4]	**Reported as (Units of measure)**	**Surface mulch to be Vegetated**	**Surface Mulch to be left Unvegetated**
pH [2]	pH units	5.0-8.5	N/A
Soluble Salt Concentration [2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5	Maximum 5
Moisture Content	%, wet weight basis	30-60	30-60
Organic Matter Content	%, wet weight basis	25-65	25-100
Particle Size	% passing a selected mesh size, dry weight basis	3" (75mm), 100% passing 1" (25 mm), 90% to 100% passing ¾" (19mm), 65%-100% passing ½" (6.4mm), 0%-75% passing Maximum particle length of 6 (152mm)	3" (75mm), 100% passing 1" (25 mm), 90% to 100% passing ¾" (19mm), 65%-100% passing ½" (6.4mm), 0%-75% passing Maximum particle length of 6 (152mm)
Stability [3] Carbon Dioxide Evolution Rate	Mg CO_2-C per g OM per day	<8	N/A
Physical Contaminants (man-made inerts)	%, dry weight basis	<1	<1

[1]Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, the US Composting Council)

[2]Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to the compost in use.

[3]Stability/Maturity rating is an area of compost science that is still evolving, and as such, other various test methods could be considered. Also, never base compost quality conclusions on the result of a single stability/maturity test.

[4]Landscape architects and project (field) engineers may modify the allowable compost specification ranges based on specific field conditions and plant requirements.

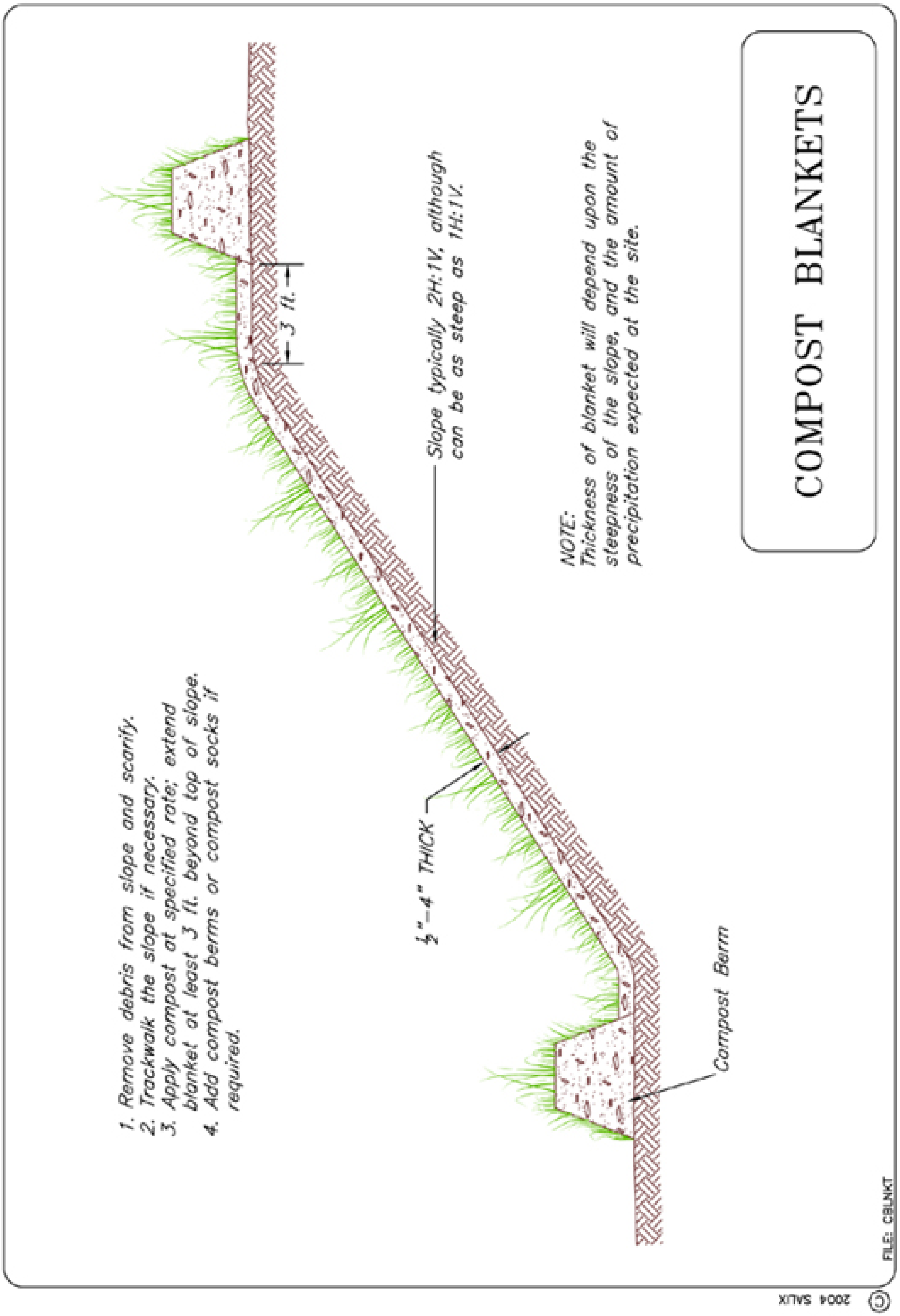
Compost Blanket Application Rates (AASHTO)

Rainfall/ Flow Rate	Total Precipitation and Rainfall Erosivity Index	Application Rate for Vegetated[1] Compost Blanket	Application Rate for Unvegetated* Compost Surface Mulch
Low	1-25" 20-90	½ - ¾" (12.5 mm x 19 mm)	1"-1 ½" (25 mm – 37.5 mm)
Average	26-50" 91-200	3/4 – 1" (19 mm x 25 mm)	1 ½" – 2" (37 mm – 50 mm)
High	51" and above 201 and above	1-2" (25 mm x 50 mm)	2-4" (50 mm – 100 mm)

[1] These lower application rates should only be used in conjunction with seeding, and for compost blankets applied during the prescribed planting season for the particular region.

Inspection and Maintenance

- Inspect blankets after each rain event.
- Re-apply blanket material if needed.
- Blankets can be hydroseeded if vegetation fails to establish.


1. Remove debris from slope and scarify.
2. Trackwalk the slope if necessary.
3. Apply compost at specified rate; extend blanket at least 3 ft. beyond top of slope.
4. Add compost berms or compost socks if required.
3 ft.
Slope typically 2H:1V, although can be as steep as 1H:1V.
½"–4" THICK
NOTE:
Thickness of blanket will depend upon the steepness of the slope, and the amount of precipitation expected at the site.
Compost Berm
COMPOST BLANKETS
FILE: CBLNKT
© 2004 SALIX

Erosion control blankets and mats (a.k.a., rolled erosion control products - RECPs) provide erosion control by protecting the bare soil from rainfall impact, increasing infiltration and promoting vegetation by protecting seeds from predators and moderating soil temperature. Erosion control blankets and mats can be biodegradable or synthetic and can be temporary or permanent erosion control applications.

Construction Specifications:

Site Preparation:

- Proper site preparation is essential to ensure complete contact of the protection matting with the soil.
- Site preparation should be performed in accordance with any local municipality requirements and specifications.
- Grade and shape area of installation.
- Remove all rocks, clods, vegetative or other obstructions so that the installed blankets, or mats will have direct contact with the soil.
- Prepare seedbed by loosening 2-3 inches (50.8-76.2 mm) of topsoil above final grade.
- Incorporate amendments, such as lime and fertilizer, into soil according to soil test and the seeding plan.

Materials:

Erosion control blankets are grouped into three types: biodegradable, non-biodegradable, and a combination of synthetic and biodegradable.

BiodegradableRECPs

Biodegradable RECPs are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials.

- Jute Mesh: Jute is a natural fiber that is made into a yarn which 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 soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Curled Wood Fiber: Excelsior (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 inches (15 cm) or longer. The excelsior blanket should be of consistent thickness. The wood fiber should 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 shall be non-toxic and non-injurious to plant and animal life. Excelsior blanket should be furnished in rolled strips, a minimum of 4 feet (122 cm) wide, and should have an average weight of 0.1 lb/ft^2 (0.5 kg/m^2), ±10 percent, at the time of manufacture. Excelsior blankets should be secured in place with wire staples. Staples should be made of 0.12 inches (3.05-mm) steel wire and should be U-shaped with 8 inches (20 cm) legs and 2 inches (5 cm) crown. Always follow the manufacturer's recommendation on staple types, patterns and the number to use per square yard or meter.
- Straw: Straw blanket should be machine-produced mats of straw with a 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 6.5 feet (2 meters) wide, a minimum of 80 feet (25 meters) long and a minimum of 0.05 lbs/ft^2 (0.27 kg/m^2). Straw blankets should be secured in place with wire staples. Staples should be made of

0.12 inches (3.05-mm) steel wire and should be U-shaped with 8 inches (20 cm) legs and 2 inches (5 cm) crown.

- Wood Fiber: Wood fiber blanket is comprised of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance revegetation. The material is furnished in rolled strips, which should be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Coconut Fiber: Coconut fiber blanket should be machine-produced mats of 100 percent 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 evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 feet (2 meters) wide, a minimum of 80 feet (25 meters) long and a minimum of 0.05 lbs/ft^2 (0.27 kg/m^2). Coconut fiber blankets should be secured in place with wire staples. Staples should be made of 0.12 inches (3.05-mm) steel wire and should be U-shaped with 8 inches (20 cm) legs and 2 inches (5 cm) crown.
- Coconut Fiber Mesh: Coconut fiber mesh is 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 longevity of several years. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Straw Coconut Fiber: Straw coconut fiber blanket should be machine-produced mats of 70 percent straw and 30 percent 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 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 feet (2 meters) wide, a minimum of 80 feet (25 meters) long and a minimum of 0.05 lbs/ft^2 (0.27 kg/m^2). Straw coconut fiber blankets should be secured in place with wire staples. Staples should be made of 0.12 inches (3.05-mm) steel wire and should be U-shaped with 8 inches (20 cm) legs and 2 inches (5 cm) crown.

Non-Biodegradable RECPs

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: 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 is supplied in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Plastic Mesh: Plastic mesh is an open-weave geotextile that is comprised of an extruded synthetic fiber woven into a mesh with an opening size of less than 0.2 inches (0.5 cm). It is used with revegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Synthetic Fiber with Netting: Synthetic fiber with netting is a mat that is comprised 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 revegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.
- Bonded Synthetic Fiber: This type of product consists of three-dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than ninety percent open area, which facilitates root growth. Its 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, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Combination Synthetic and Biodegradable RECPs

Combination synthetic and biodegradable RECPs consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high-strength continuous-filament geomatrix or net stitched to the bottom. The material is designed to enhance revegetation. The material is furnished in rolled strips, which should be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Seeding:

- Seed 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 reseeded.
- Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Anchoring:

- Anchoring of RECPs is the most critical element of installation. Anchoring devices must be selected to be compatible with site soil conditions.
- Where soil conditions are suitable (i.e., topsoil without substantial rocks or cobbles), biodegradable stakes, staples, or pins are preferred. Although biodegradable anchoring devices are preferred they must be compatible with soil conditions to ensure proper blanket installation.
- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats to the ground surface. Wire staples shall be a minimum of 11 gauge. Metal stake pins shall be 3/16 inch (4.8 mm) diameter steel with a 1-1/2 inch (38.1 mm) steel washer at the head of the pin. Wire staples and metal stakes shall be driven flush to the soil surface. Two inches of wood staking shall remain above the soil surface. All anchors shall be 6-18 inches (0.2-0.5 m) long and have sufficient ground penetration to resist pullout. Longer anchors may be required for loose soils.

Installation on Slopes:

- Dig initial anchor trench 12 inches (0.3 m) deep and 6 inches (0.2 m) wide across the channel at the lower end of the project area.
- Begin at the top of the slope and anchor its blanket in a 6 inch (0.2 m) deep x 6 inch (0.2 m) wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of the water flow.
- The edges of adjacent parallel rolls must be overlapped 2-3 inches (51-76 mm) and be stapled every 3 feet (0.9 m).
- When blankets must be spliced, place blankets end over end (shingle style) with 6 inch (0.2 m) overlap. Staple through overlapped area, approximately 12 inches (0.3 m) apart.
- Lay blankets loosely and maintain direct contact with the soil - do not stretch.
- Blankets shall be stapled sufficiently to anchor blanket and maintain contact with the soil in accordance with manufacturer's and local requirements. Guidelines for installation are as follows: Staples shall be placed down the center and staggered with the staples placed along the edges. Steep

slopes, 1:1 to 2:1, require 2 staples per square yard. Moderate slopes, 2:1 to 3:1, require 1-2 staples per square yard (1 staple, 3 feet on center). Gentle slopes require 1 staple per square yard.

Installation in Channels:

- Dig initial anchor trench 12 inches (0.3 m) deep and 6 inches (0.2 m) wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 inches (0.2 m) deep and 6 inches (0.2 m) wide across the channel at 25-30 foot (7.6-9.1 m) intervals along the channel.
- Cut longitudinal channel anchor slots 4 inches (101 mm) deep and 4 inches (101 mm) wide along each side of the installation to bury edges of matting. Whenever possible extend matting 2-3 inches (51-76 mm) above the crest of channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 1 foot (0.3 m) 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 3 inches (7.6 cm).
- Secure these initial ends of mats with anchors at 1 foot (0.3 m) 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 inch (76 mm) overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 1 inch (25.4 mm) intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.

Alternate Installation Method for Slopes <4:1:

- Place two rows of anchors on 6 inch (0.2 m) centers at 25-30 feet (7.6-9.1 m) intervals in lieu of excavated check slots.
- Shingle-lap spliced ends by a minimum of 1 foot (0.3 m) with upstream mat on top to prevent uplifting by water or begin new rolls in a check slot. Anchor overlapped area by placing two rows of anchors, 1 foot (0.3 m) apart on 1 foot (0.3 m) 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 inch (0.3 m) x 6 inch (0.2 m) 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):

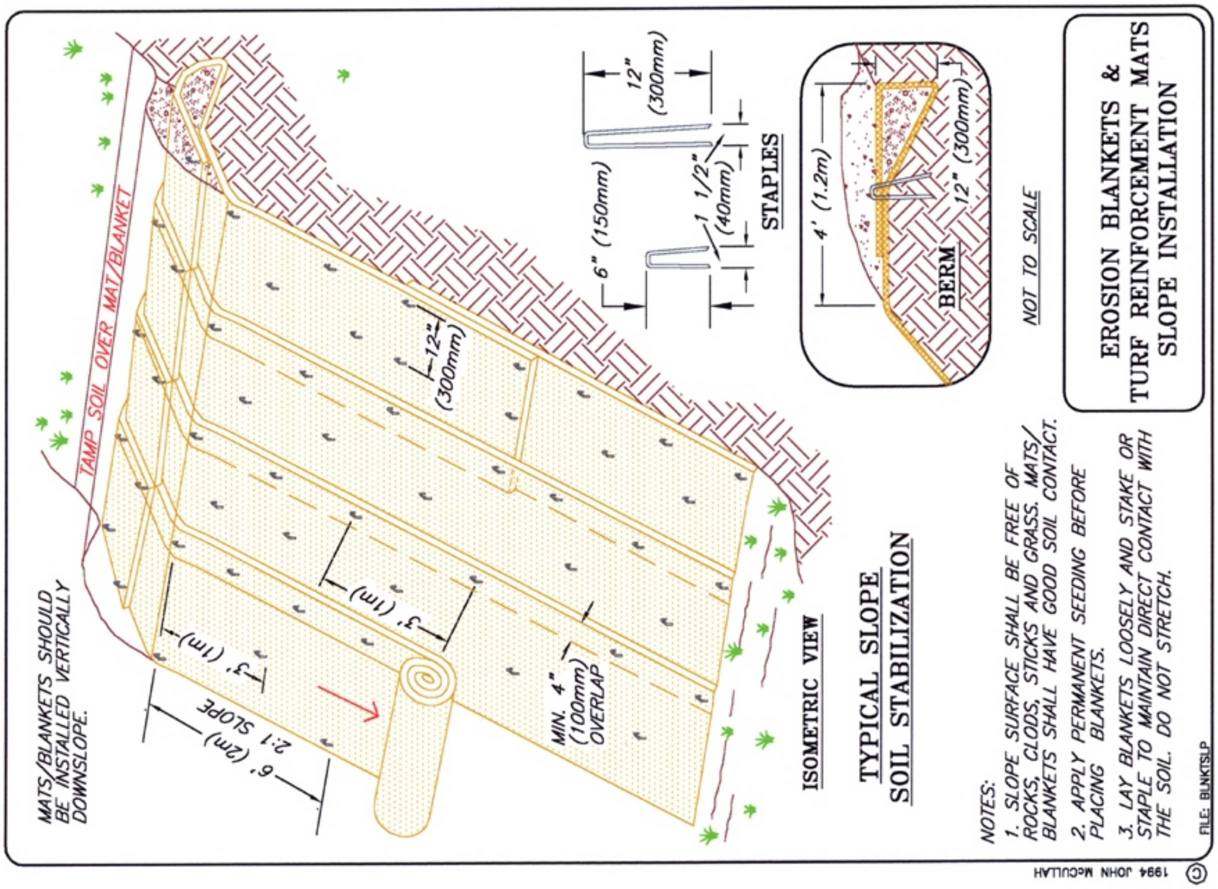
- After seeding, spread and lightly rake 1/2-3/4 inches (12.7-19.1 mm) of fine topsoil into the mat apertures to completely fill mat thickness. Use backside of rake or other flat implement.
- Spread topsoil using lightweight loader, backhoe, or other power equipment. Avoid sharp turns with equipment.

- 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 matrix.

Minimum BMP standards are provided on the following detail.

Inspection and Maintenance:

- All blanket and mats shall be inspected following installation and in accordance with permit requirements.
- Inspect installation before, during, and after storm events to check for erosion and undermining. Any failure shall be repaired immediately.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or drainage way.


MATS/BLANKETS SHOULD BE INSTALLED VERTICALLY DOWNSLOPE.
TAMP SOIL OVER MAT/BLANKET
6' (2m)
2:1 SLOPE
3' (1m)
3' (1m)
12" (300mm)
MIN. 4" (100mm) OVERLAP
6" (150mm)
1 1/2" (40mm)
12" (300mm)
STAPLES
4' (1.2m)
12" (300mm)
BERM
ISOMETRIC VIEW
TYPICAL SLOPE SOIL STABILIZATION
NOT TO SCALE
NOTES:
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
EROSION BLANKETS & TURF REINFORCEMENT MATS SLOPE INSTALLATION
FILE: BLNKTSLP
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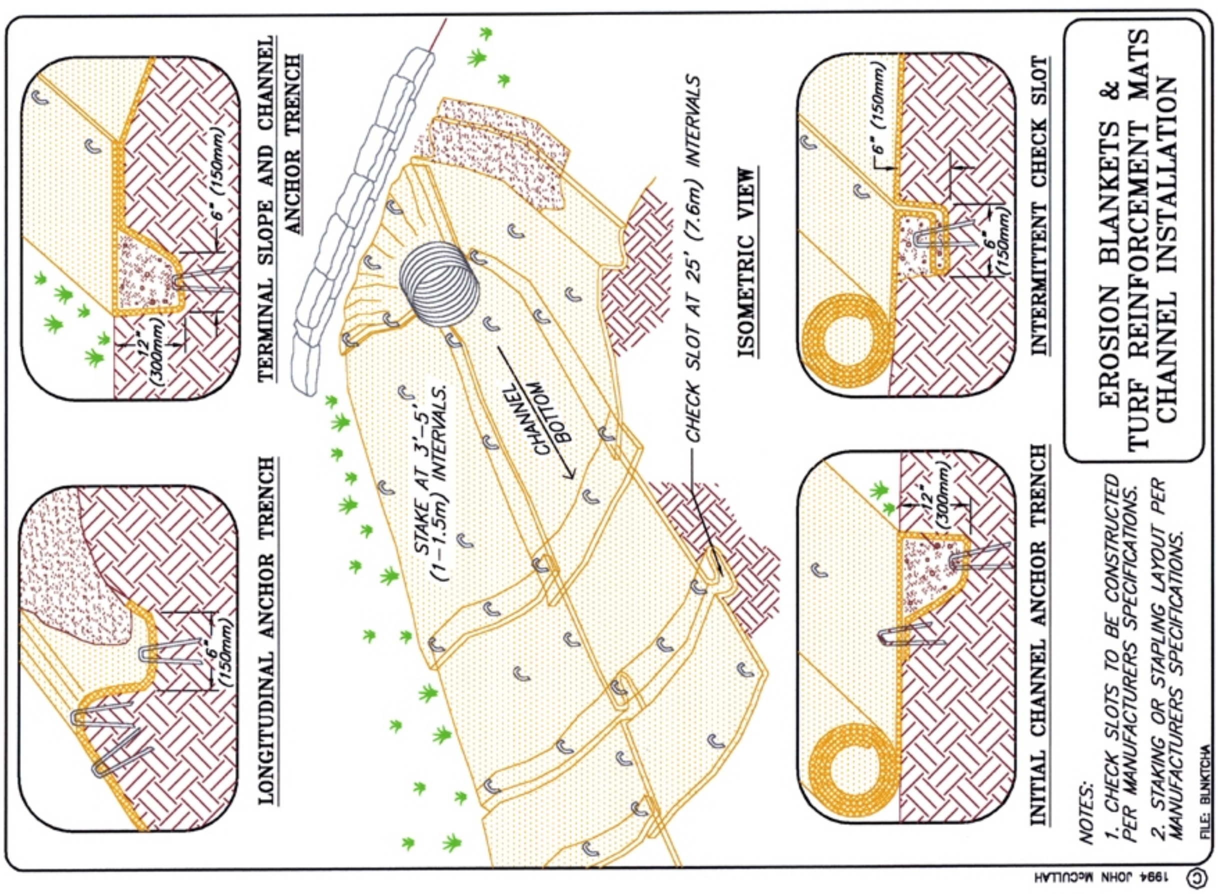
6" (150mm)
LONGITUDINAL ANCHOR TRENCH
12" (300mm)
6" (150mm)
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
STAKE AT 3'–5' (1–1.5m) INTERVALS.
CHANNEL BOTTOM
CHECK SLOT AT 25' (7.6m) INTERVALS
ISOMETRIC VIEW
12" (300mm)
INITIAL CHANNEL ANCHOR TRENCH
6" (150mm)
6" (150mm)
INTERMITTENT CHECK SLOT
NOTES:
1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.
EROSION BLANKETS & TURF REINFORCEMENT MATS CHANNEL INSTALLATION
FILE: BLNKTCHA
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Construction Specifications:

General Considerations

- Site-specific soil types will dictate appropriate soil binders 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 shall not stain paved or painted surfaces, and conform to the following:
  - Local municipality specifications and requirements.
  - Stabilizing emulsion shall be a concentrated liquid chemical that forms a plastic film upon drying and allows water and air to penetrate.
  - Stabilizing emulsion shall be nontoxic to plant or animal life and nonstaining to concrete or painted surfaces. In the cured state, the stabilizing emulsion shall not be re-emulsifiable.
  - Stabilizing emulsion shall be miscible with water at the time of mixing and application.
  - A certificate of compliance for stabilizing emulsion shall be furnished to Oregon DEQ.
- Select a soil binder that is compatible with existing vegetation.
- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.

Selecting a Soil Binder

- Properties of common soil binders used for erosion prevention are provided in Table 1 (see Page 4). 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; determine 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 applications 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.
  - Cure Time – Consider cure time and minimum drying time in binder selection. Refer to Table 1 and confirm cure time and minimum drying time with manufacture's recommendations.
- After considering the above factors, the soil binders in Table 1 will be generally appropriate as follows:

Plant-Material Based (Short Lived)

- Guar: Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It shall be diluted at the rate of 1 to 5 lb per 100 gallons (1.2 to 1.8 kg per 1,000 liters) of water, depending on application machine capacity. Minimum application rates are as follows (follow manufacturers recommended application rates):

Application Rates for Guar Soil Stabilizer

Slope (V:H):	Flat	1:4	1:3	1:2	1:1
lb/ac	40	45	50	60	70
Kg/Ha:	45	50	56	67	78

- Psyllium: Psyllium is composed of the finely ground muciloid 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. Psyllium shall be applied at a rate of 90 to 225 kg/ha (80 to 200 lb/ac), with enough water in solution to allow for a uniform slurry flow.

- Starch: Starch is non-ionic, cold-water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 170 kg/ha (150 lb/ac). Approximate drying time is 9 to 12 hours.

Plant-Material Based (Long Lived)

- Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin shall be a minimum of 26% of the total solids content. The soil stabilizer shall 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 shall 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/product mixture applied at the rate specified by the manufacturer. Approximate drying time is 19 to 24 hours.

Polymeric Emulsion Blends

- Acrylic Copolymers and Polymers: Polymeric soil stabilizers shall consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound shall be handled and mixed in a manner that will not cause foaming or shall contain an anti-foaming agent. The polymeric emulsion shall not exceed its shelf life or expiration date; manufacturers shall provide the expiration date. Polymeric soil stabilizer shall be readily miscible in water, non-injurious to seed or animal life, non-flammable, shall provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and shall not re-emulsify when cured. The applied compound shall air cure within a maximum of 36 to 48 hours. Liquid copolymer shall be diluted at a rate of 10 parts water to 1 part polymer and applied to soil at a rate of 1,175 gal/ac (11,000 liters/hectare).
- 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 applications, it is diluted with water in accordance with manufacturer's recommendations, and applied with a hydraulic seeder at the rate of 20 gal/ac (190 L/ha). Drying time is 12 to 18 hours after application.
- Copolymers of Sodium Acrylates and Acrylamides: These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Application Rates for Copolymers of Sodium Acrylates and Acrylamides

Slope Gradient (V:H)	lb/ac (kg/ha)
Flat to 1:5	3-5 (3.4 – 5.6)
1:5 to 1:3	5-10 (5.6 – 11.2)
1:2 to 1:1	10-20 (11.2 – 22.4)

- Poly-Acrylamide and Copolymer of Acrylamide: Linear copolymer polyacrylamide is packaged as a dry-flowable solid. When used as a stand-alone stabilizer, it is diluted at a rate of 1 lb/100 gal (1.5 kg/1,000 liters) of water and applied at the rate of 5 lb/ac (5.6 kg/ha).
- Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry-flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 53 to 62 lb/ac (60 to 70 kg/ha). Drying times are 0 to 4 hours.

Cementitious-Based Binders

Gypsum: This is a formulated gypsum-based product that readily mixes with water and mulch 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 a hydraulic seeder and applied at rates 4,000 to 12,000 lb/ac (4,500 to 13,500 kg/ha). Drying time is 4 to 8 hours.

Soil Binders Applications

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 shall be followed:

- Follow manufacturer's recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.
- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where rolling is impractical.
- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders shall not be applied during or immediately before rainfall.
- Avoid over-spray onto the traveled way, sidewalks, lined drainage channels, sound walls, and existing vegetation.
- Soil binders shall not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the air temperature is below 40^{o}F (4^{o}C) 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 manufacturer's instructions for specific cure times.
- For liquid agents:
  - Crown or slope ground to avoid ponding.
  - Uniformly pre-wet ground at 0.03 to 0.3 gal/yd^2 (0.14 to 1.4 L/m^2) or according to manufacturer's recommendations.
  - Apply solution under pressure. Overlap solution 6 to 12 in (150 to 300 mm).
  - Allow treated area to cure for the time recommended by the manufacturer; typically, at least 24 hours.
  - In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd^2 (0.5 to 0.9 L/m^2).

Inspection and Maintenance:

- Reapplying the selected soil binder may be needed for proper maintenance. Inspections should be conducted at the frequencies recommended by local municipalities, and should be performed no less than daily in high traffic areas and weekly in lower traffic areas.
- After any rainfall event, maintain all slopes to reduce or prevent erosion.
- Maintain an unbroken, temporary stabilized area while disturbed soil areas are non-active. Repair any damaged stabilized area and re-apply soil binder to exposed areas.

Table 1
Properties of Soil Binders for Erosion Control

Chemicals	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)	4,000-12,000lb/ac (4,500-13,500 kg/ha)

(1) Dependant on product, soil type, and slope inclination

STABILIZATION MATS – EP-12

There are several techniques that involve the placement of relatively inexpensive and locally available material to stabilize the ground surface, especially for work around sensitive areas such as wetlands and streams. Types of stabilization mats to consider include brush mats; corduroy mats; and board mats. Stabilization mats reduce tracking from the construction site and create a stable pad for heavy equipment.

Construction Specifications:

- Brush mats – Brush mats are constructed of available slash (brush and trees), crushed in-place to form a mat. Their purpose is to support equipment so that there are minimal short term impacts in excessively wet conditions. This practice is limited to areas where brush is of sufficient thickness and density to stabilize the wetland bottom for vehicular/equipment use. In some cases, the brush mats may be left behind to naturally decay, although it may take 8 to 12 years for them to decay completely. According to a study that examined the effects of brush mat use in wetlands, leaving them in place did not restrict water movement or alter water regimes, and revegetation occurred quickly (McMullen and Burger 1999). The use of brush mats can reduce the need for slash management.
- Corduroy Mats - Corduroy mats are constructed of small logs, brush, or mill slabs placed one after the other, perpendicular to the equipment driving path. These types of mats can spread the load over the entire area of the log or slab and are effective in increasing the load bearing capacity of an area. Flotation increases by using longer pieces of material, particularly small logs or mill slabs. These mats may be practical where logs are readily available. Multiple layers of corduroy may be required in some areas. The use of corduroy mats can reduce the need for slash management.
- Board Mats - Board mats consist of “pallet like” units placed one after the other to form a crude yet rapidly placed stabilized surface. Board mats can be placed, used, and easily removed for temporary stabilization for short term equipment use.

Inspection and Maintenance:

- Corduroy mats, and board mats shall be removed upon completion of work activity. Removal activities should be timed to minimize soil disturbance.
- Brush mats may be left to degrade in place if permitted by the regulatory agency.
- Evidence of increased sedimentation, flow disruption, or other adverse effects of using mats should be periodically inspected for, including following significant rain events. Repairs or changes should be made as needed.
- Equipment / vehicles using mats shall be checked for gas leaks and oil leaks.

WIND EROSION / DUST CONTROL – EP-13

Daily dust control shall be provided as needed to stabilize soil from wind erosion and to reduce dust generated by construction activities. Special attention shall be paid to stockpiled materials. Covering of small stockpiles or areas is an alternative to applying water or other dust palliatives.

Construction Specifications:

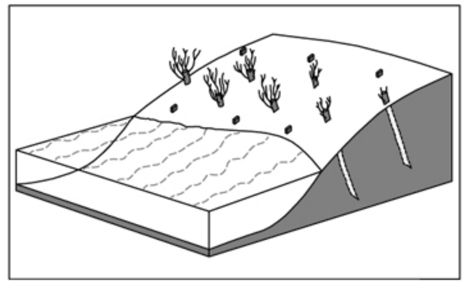
- Dust control shall be provided daily or more often (as deemed necessary based on wind conditions, time of year, and physical conditions of the site) by application of water alone or with addition of magnesium chloride or calcium chloride in accordance with manufacturer's specifications.
- Acrylic co-polymers or other biodegradable products (soil stabilizers/tackifiers) may be used for daily dust control if approved by the project engineer and local regulators.
- Water applied for dust control should be applied evenly and without over-watering which generates runoff and may result in erosion.
- Oil or other petroleum-based products shall not be used for dust control because the oil may migrate into drainage ways or seep into the soil.
- Dust control must be implemented in accordance with local air quality requirements.
- Non-potable water should not be conveyed in tanks or drainpipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes and other conveyances should be marked "NON-POTABLE WATER – DO NOT DRINK."

Inspection and Maintenance

- Check areas protected to ensure appropriate coverage.
- Reapply water or maintain covers, as necessary to maintain their effectiveness.

LIVE STAKING EP-14

Construction Specifications



Live stakes are pieces of freshly cut woody plant stem planted in the ground or into erosion control or streambank stabilization structures. The branches vary from about 18-36 in (50-100 cm) long, and typically (3/4 - 3 in (20 – 75 mm) in diameter. Pole Planting (seeEP-15) is a related technique, however the poles are much longer (3-15 ft (1-5m) long) and can be installed and arrayed differently.

Live stakes are planted with the terminal buds or leaf nodes pointing up and the basal ends down into the soil. The buried portion of the cuttings develop roots, while the exposed portion produces branches and leaves. Depending on the species, the cuttings can grow into shrubs and/or trees. Because of its ability to root easily, the preferred plant species for live staking is Willow (*Salix* spp.) but Cottonwood (*Poplar* spp.), Dogwood (*Cornus* spp.), Elderberry (*Sambucus* spp), Coyotebrush (*Baccharis* spp), and others have been used successfully.

Conditions Where Practice Applies

Live stakes are useful for the following situations:

1. Live staking is useful as a revegetation technique and for establishing riparian plants in high flow or droughty situations.
2. Live staking can be used in irrigated or non-irrigated conditions with the latter being more prevalent. Irrigation can greatly increase vegetative success. Most often live staking is installed during the dormant season or when climactic or soil moisture conditions are favorable for establishment in non-irrigated conditions.
3. Live stakes provide an environmentally-sensitive anchoring technique for geotextiles and erosion control materials. The anchoring can be temporary or permanent depending on whether the stakes “take root”.
4. Adding immediate failure resistance to the soil mass. While providing geotechnical benefits by “buttressing and arching”, deep-seated failure planes underneath the bottom end of the cuttings will not usually be affected by live staking. These plants can remove excess soil moisture via evapotranspiration during the growing cycle, however these benefits will not be realized during dormancy.

Materials and Equipment

Live stakes are typically made of woody riparian plant stems, although fleshy plant stems can have some success as well. Willow, cottonwood, and dogwood are the most used woody plants; however, willow cuttings make the best material for live stakes. Willow species choice is highly dependent on locale; the best species for a given site are those found growing near the site. Stakes are typically harvested and planted when the willows, or other chosen species, are dormant, although the cuttings can do well other times of year when soil moisture is available.

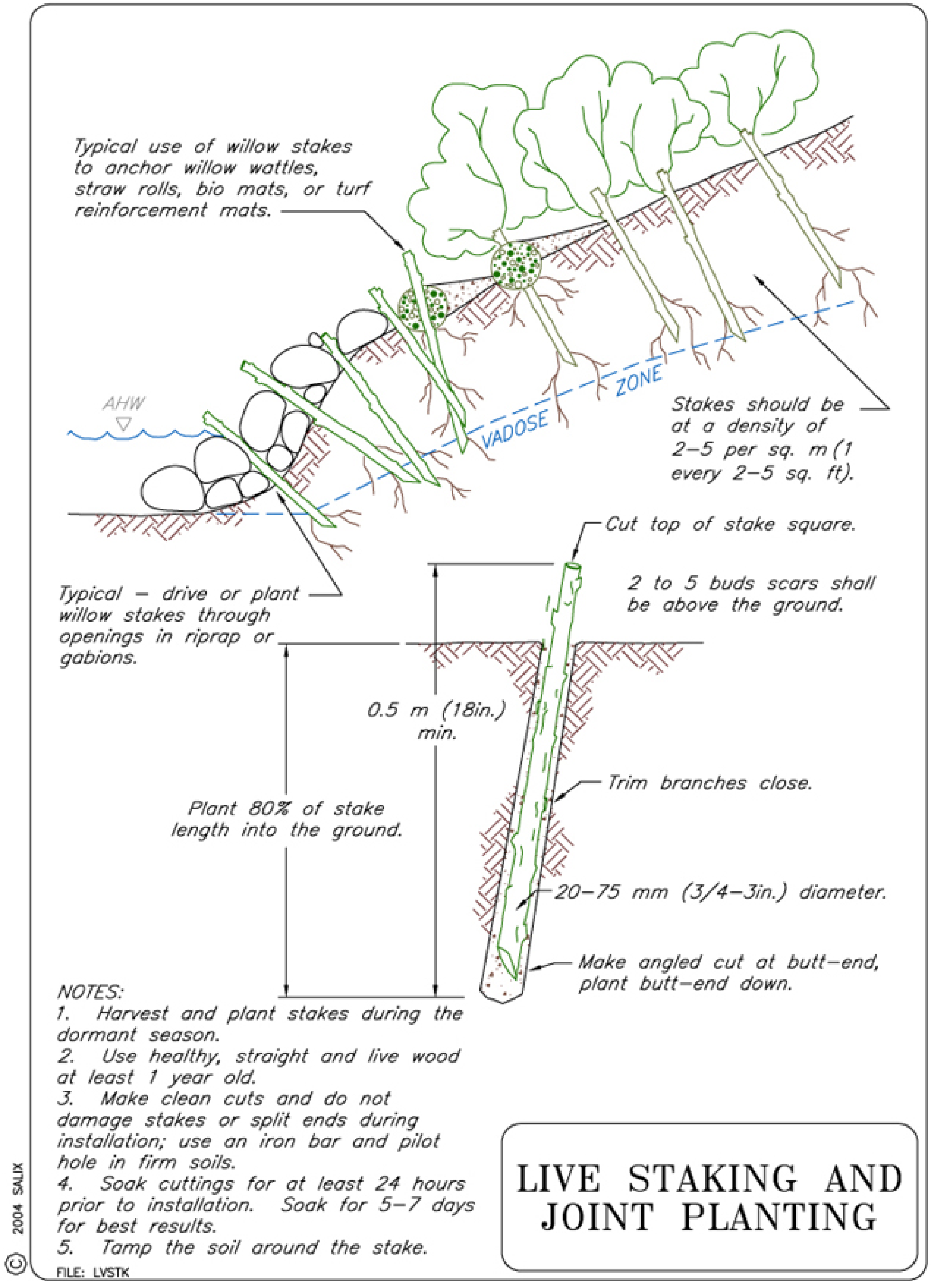
When harvesting cuttings:

- Select healthy, live wood that is reasonably straight, and at least 2 years old.
- Make clean, angular cuts without splitting ends.
- Trim branches from cutting as closely as possible.
- Cuttings should generally be ¾ inch (19 mm) in diameter and a minimum 18 in (50 cm) long, or larger depending on the species.
- The butt end of the cutting should be pointed or angled and the top end should be cut square to help identify the top and bottom when planting.
- The top, square end can be painted and sealed by dipping the top 1-2 in. (2.5 – 5 cm) into a 50-50 mix of light colored latex paint and water. Sealing the top of stake will reduce desiccation, ensure the stakes are planted with the top up, and make the stakes more visible for subsequent planting evaluations.
- Stakes must not be allowed to dry out. All cuttings should be soaked in water for 5-7 days (a minimum of 24 hours) and planted the same day they are removed from the water.

Construction / Installation

- Use an iron stake or bar to make a pilot hole in firm soil.
- Plant the basal ends into the ground, with the leaf bud scars or emerging buds always oriented up. Be careful not to damage the buds, strip the bark, or split the stake during installation.
- Ideally, the stakes should not be planted in rows or at regular intervals, but at random in the most suitable places at a rate of 2-5 cuttings/10ft^2 (2-5 cuttings/m^2). However, if trying to control a group of people planting several thousand stakes, it may be found that it is easier to specify an average set interval.
- Set the stake as deep as possible into the soil, with 80 % of its length into the soil. Deep planting will increase the chances of survival. The stake should never protrude more than 20 % of its length above the ground level to prevent it from drying. The excess stake or any damage or split ends can be cut off after installation. At least 2 buds and/or bud scars should remain above the ground after planting.
- Add soil to the planting hole if necessary to ensure soil contact with the stem. It is important to tamp the soil around the cutting to ensure good soil-stem contact. The best installations, especially on droughty sites, will include "watering in" and slightly compacting the backfill or hole. "Watering in", much like transplanting a container plant, can successfully be accomplished by pouring one to two gallons of water into the soil around the stake and planting hole, then slightly tamping or otherwise jarring the soil. This procedure will ensure complete soil to stem contact.

LIVE STAKING EP-14



Inspection and Maintenance

Stakes should be inspected every few weeks until well established, and irrigation, browse control (from livestock, deer, beavers, etc), pruning, weed control, and fertilization should be implemented as needed.

Common Reasons / Circumstances for Failure

Live staking can fail if vegetation is not handled properly prior to installation, is installed incorrectly (less than 80 % of the cutting in the ground, bud scars facing down, poor soil contact, etc.) or not irrigated or "watered in" when installed in arid areas.

Construction Specifications

Pole Plantings use large diameter cuttings (poles vs. stakes) that are relatively long, 5 to 10 ft (1.5 to 3 m) in length. The cuttings are taken from willow (*Salix spp.*) or cottonwood (*Populus spp.*). The cuttings are intended to sprout and take root, stabilizing the streambank with a dense matrix of roots. Pole plantings are planted deep so they usually require heavy equipment assisted construction techniques. As defined by Schiechtl and Stern, in *Water Bioengineering Techniques*, *1997*, poles are straight, poorly branched stems 3.3 - 8.2 ft (1 - 2.5 m) long.

Conditions Where Practice Applies

Pole planting is suitable for floodplains, streambanks, and other riparian zones. Pole plantings are very useful for highly erodible areas and sites with fluctuating water tables. Pole planting is a useful "stand alone" revegetation technique for replacing and/or reestablishing riparian vegetation and cover. Pole planting is also particularly suitable for conjunctive uses with other streambank stabilization techniques such as vegetated riprap, vegetated gabions, rootwad revetments with vegetated riprap, vegetated deflectors, and longitudinal peaked stone toe protection.

Pole planting areas may need to be accessible to heavy equipment, as the poles should be planted into deep holes. The location of the water table (saturated zone) and vadose zone (moist soil zone including the capillary fringe, located above the saturated zone) should be approximately identified so the pole plantings can access sufficient moisture. Pole plantings are usually planted with a power auger or punch bar ("Stinger").

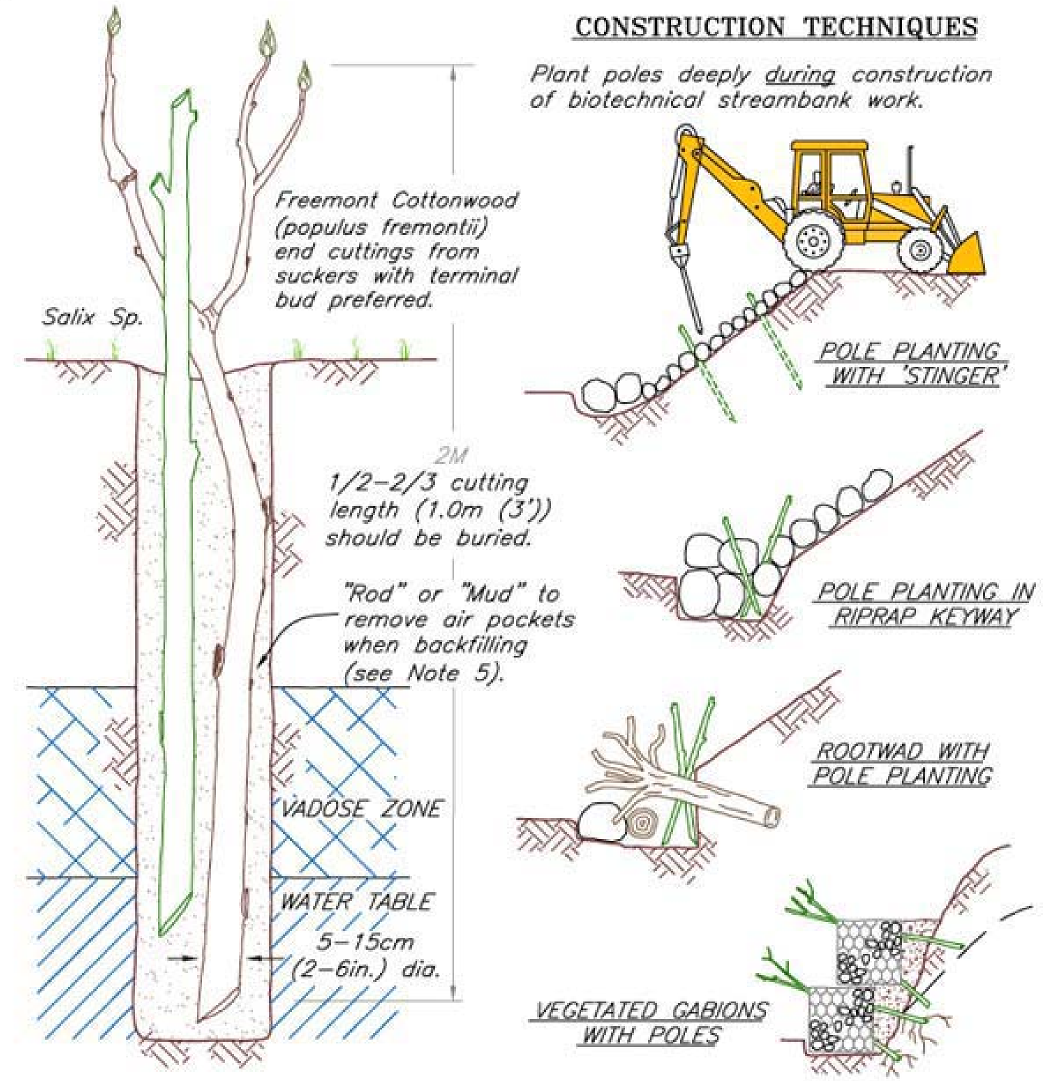
Materials

Cottonwood or willow pole cuttings are the main materials for this technique. A pond or storage area for soaking the cuttings will be necessary. Pole planting techniques may require the use of a power auger, "Stinger", or other method to excavate deep holes. The "Stinger" is a large, pointed metal punch bar that is 4 – 6 in (10-15 cm) diameter, and mounted on a backhoe or hydraulic excavator.

Installation

- Collect and harvest cuttings (ideally during the dormant season) and then soak the poles for 5 to 7 days.
- Plant poles into an augured, "punched", or excavated hole. The holes should extend to approximately 1 ft (30 cm) above the water table and through the vadose zone. This depth can be difficult to determine in areas with reservoirs and streams with widely fluctuating seasonal water levels. In this case, ensure that the ends of the poles reach the low waterline at the time of planting if possible.
- Pole plantings should ideally be installed during the construction of structures. For instance, plant the poles with the placement of riprap, especially into any trenches excavated for keyways or scour trenches. Another example is to plant the poles during riprap placement such that the poles extend through the riprap and backfill and into contact with the "native" bank.
- The backfill can be placed over and around the poles rather than having to "punch" holes through the riprap. Another method is to plant the poles during gabion construction.
- The pole plantings, especially the basal ends, must have good contact with the soil. "Mudding" (filling the hole with water and then adding soil to make a mud slurry) can remove air pockets.

POLE PLANTING EP-15



NOTES:
1. Pole cuttings of willow or cottonwood are longer and have a larger diameter than branch cuttings or live stakes.
2. Larger diameter cuttings have a greater supply of stored energy (stored photosynthesis) than smaller diameter cuttings.
3. Pole cuttings are better suited for highly erodible areas and sites with fluctuating water levels.
4. The pole cuttings should extend through the vadose zone and into the permanent water table. At least 1/2 to 2/3 of the pole should be below the ground, at least 1.0 m (3 ft.), and long enough to emerge above adjacent vegetation.
5. "Muddying" – filling the hole with water and then soil to make a mud slurry can remove air pockets.

WILLOW POSTS & POLES

FILE: WPP

LIVE FASCINES AND BRUSH WATTLES EP-16

Live fascines and brush wattles are bundles of live branch cuttings placed in long rows in shallow trenches across the slope on contour or at an angle. Fascines and brush wattles are used for biotechnical stabilization of slopes and streambanks.

Conditions Where Practice Applies

The technique is applicable where immediate erosion protection is necessary.

This technique works best where flows are sufficient to keep the base of the bundle wet during most of the growing season, but do not exceed the flood tolerance of the fascine.

Construction Specifications

Fascine spacing and configuration vary depending upon slope, exposure and purpose.

- To treat overbank runoff on upper and mid bank areas, rows are installed on the contour.
- To divert runoff in upper and mid bank areas, rows are installed on a gradient.
- To trap sediment, rows are installed along the uphill side of v-ditch or other drainage structures.
- For flood flow protection, rows are installed perpendicular to flow in midbank areas.
- To treat wave erosion, rows are installed parallel to waves.
- On outer bends, and moist, seeping banks, fascines should be installed at an angle of 45 to 60 from horizontal, with the bud ends at the top, pointing upstream. On drier banks, and inner bends, fascines should be installed on contour.

Materials and Equipment

Fascines are made of brushy cuttings (stems that have leaves and twigs) of tree and shrub species capable of vegetative propagation, typically willow species. Plant material harvest and installation must be performed during its dormant season, late fall through early spring, or at other times of year if water is available. The cuttings should be long (3 ft (1 m) minimum), straight brushy branches up to 1 ½ inches (40 mm) in diameter. For optimum success, the fascines should be soaked for 24 hours or installed on the same day they are harvested and prepared (McCullah, 2002).

Construction / Installation

- Cuttings shall be tied together to form bundles, tapered at each end, 6-30 feet (2-10 m) in length, depending on site conditions or limitations in handling. The completed bundles should be 6-12 inches (152.4-304.8 mm) in diameter, with the growing tips and butt ends oriented in alternating directions (for fascines, ends oriented in the same direction).
- Stagger the cuttings in the bundles so that the tips are evenly distributed throughout the length of the bundle.
- Compress and tightly tie the bundle every 1 ft (30 cm) with rope or twine of sufficient strength and durability. Hemp, jute, cotton or other biodegradable rope may be used (McCullah, 2002).
- Installation progresses from the bottom to the top of the slope.
- Install bundles into trenches dug into the slope on contour.
- Spacing of contour trenches (fascines) is determined by soil type, potential for erosion and slope steepness. See Table 1 below for general spacing guidelines.
- The trench shall be shallow, about ½ the diameter of the fascine. The trench width will vary from 12-18 inches (0.30-0.45 m) depending on the slope angle, but should be at least 1 in (2.5 cm) wider than the bundle.

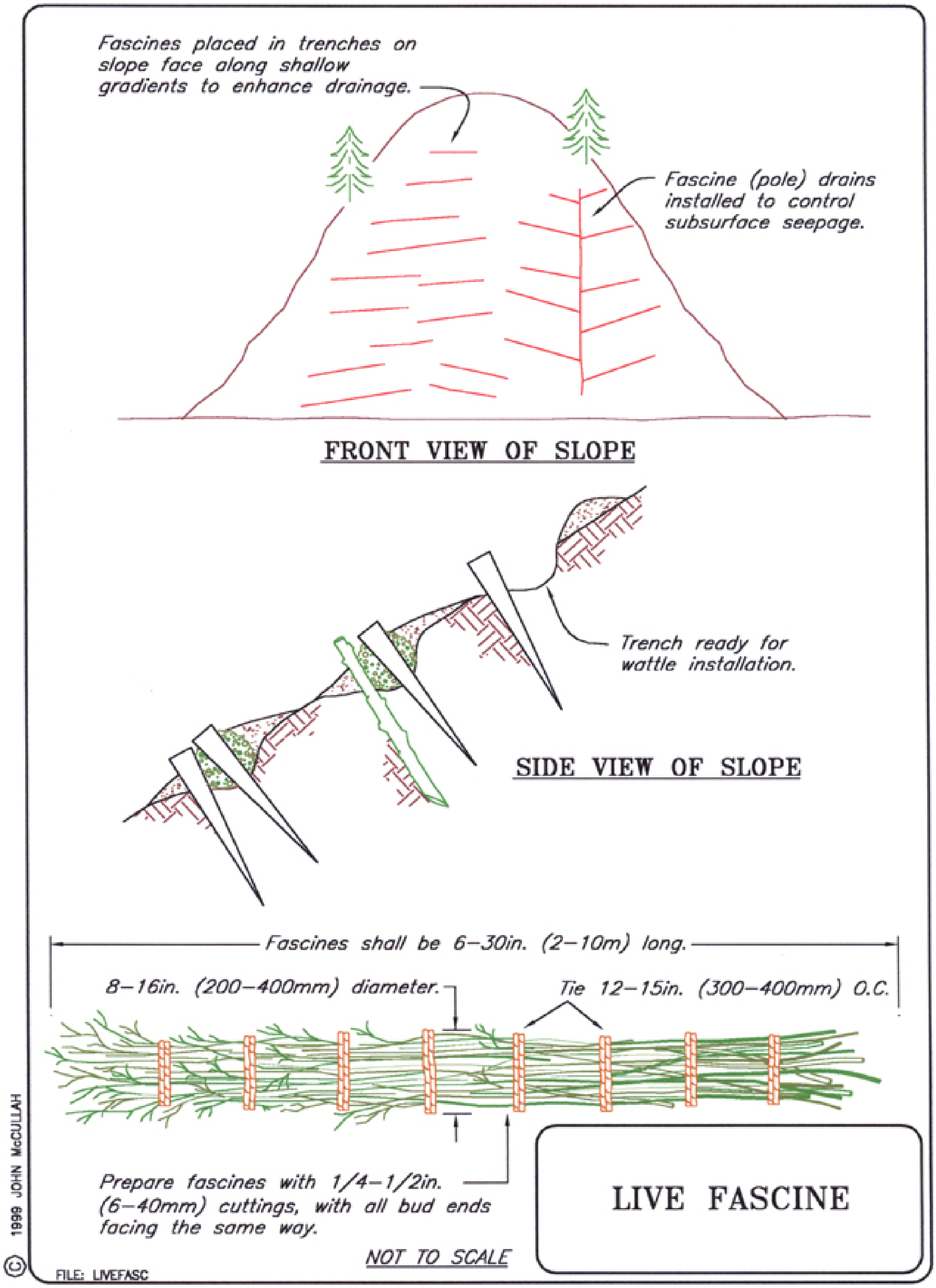

Fascines placed in trenches on slope face along shallow gradients to enhance drainage.
Fascine (pole) drains installed to control subsurface seepage.
FRONT VIEW OF SLOPE
Trench ready for wattle installation.
SIDE VIEW OF SLOPE
Fascines shall be 6–30in. (2–10m) long.
8–16in. (200–400mm) diameter.
Tie 12–15in. (300–400mm) O.C.
Prepare fascines with 1/4–1/2in. (6–40mm) cuttings, with all bud ends facing the same way.
NOT TO SCALE
LIVE FASCINE
© 1999 JOHN McCULLAH
FILE: LIVEFASC

Table 1: General Installation Guidelines

Slope (V:H)	Slope Length Between Fascines (ft (m))
1:1 to 1:1.5	3-4(0.9 – 1.2)
1:1.5 to 1:2	4-5 (1.2 – 1.5)
1:2 to 1:2.5	5-6 (1.5 – 1.8)
1:2.5 to 1:4	6-8 (1.8 – 2.4)
1:3.5 to 1:4	8-12 (2.4 – 3.7)
1:4.5 to 1:5	10-20 (3 – 6)

- In non-cohesive soils, the trench should be lined with a coir erosion control blanket or netting prior to installation of the fascine.
- Fascines shall be staked firmly in place with one row of construction stakes on the downhill side of the bundle, not more than 3 ft (1m) apart. A second row of stakes shall be placed through the fascines, near the ties, at not more than 5 feet (1.5 m) apart.
- Overlap the tapered ends of adjacent bundles at least 18 in (45 cm) so the overall thickness of the fascine is uniform.
- Two stakes shall be used at each bundle overlap, such that a stake may be driven between the last two ties of each bundle. Live stakes, if specified, are generally installed on the downslope side of the bundle.
- Drive the live stakes below and against the bundle between the previously installed construction stakes.
- Repeat the proceeding steps to the top of the slope, placing moist soil along the sides of the live bundles.
- When finished, all live stakes should be trimmed, such that a maximum of 3 in (7.5 cm) of stake protrudes above the bundle.
- Fascines should be keyed into the bank at least 3 ft (1 m) on both upstream and downstream ends (Sotir & Fischenich, 2001).
- Proper backfilling is essential to the successful rooting of the fascine.
- Backfill bundles with soil from the slope or trench above. The backfill shall be worked into the fascine interstices and compacted behind and below the bundle by walking on and working from its terrace.
- Seed and mulch the slope. Shallow slopes, generally 3:1 or flatter may be seeded and mulched by hand. Steeper slopes can have seed applied hydraulically and the mulch should be anchored with tackifier or other approved methods.

Inspection and Maintenance

Inspections should occur after each of the first few floods, and/or twice the first year, and at least once each year thereafter.

Common Reasons / Circumstances for Failure

Toe erosion and/or flanking can cause loss of the structure, if not combined with a toe protection in areas where shear stresses and velocities exceed limits for the soils underlying the structure. Flanking can be caused by insufficient keying-in of the structure.

BRUSH BOX EP-17

Brush boxes are toe wall or breast wall type retaining structures constructed with branch cuttings, wooden construction stakes, and wire.

Condition Where Practice Applies

Brush boxes are best if constructed on firm ground at the toe of a small slump or along the toe of an oversteepened stream bank. Brush boxes require minimal excavation and require fill behind them. Brush boxes are larger and stronger than wattles and are therefore more suitable for buttressing the base of a slope.

This brush box stabilized the toe of this slide even before the willow became established, and then vegetated the slide.

Materials

The ideal plant materials for brush boxes are those that:

1. Root easily.
2. Are long, straight and flexible.
3. Adapted to the site conditions.
4. Are in plentiful supply near the job site.

Willow (*Salix* spp) makes ideal cutting material. Some species of Coyotebrush (*Baccharis* spp), Dogwood (*Cornus* spp), and Cottonwood (*Populus* spp) also have very good rooting ability.

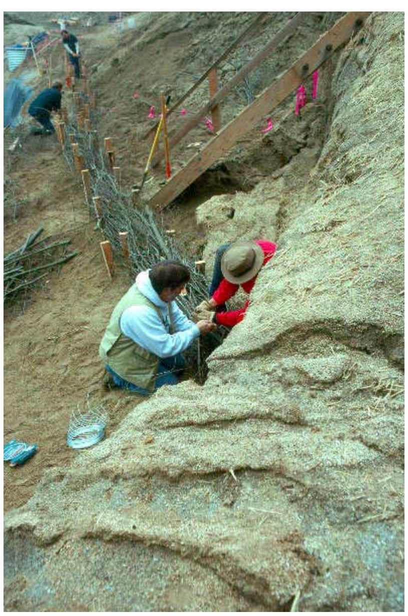
This brush box was made using mostly dead plant materials, and was intended to protect this eroding streambank and encourage siltation.

The cuttings should be very long, 6-12 ft (2-4 m) minimum, with straight branches up to 1 ½ inches (40 mm) in diameter. Trimmings of young suckers and some leafy branches may be included in the bundles to aid filtration. The number of stems varies with the size and kind of plant material. If willow or other rootable species are in short supply, non-rooting woody material may be used to partially fill the box (up to 50%).

Brush boxes require sturdy construction stakes, cut on a diagonal from vertical grained wood capable of being driven into the ground. Cut stakes at least 3 ft (1 m) long. Wire, usually 9 ga or heavier, is required to bind the tops of the stakes together.

Implementation

- Work shall start at the bottom of the slope. Perform any slope repairs, such as runoff diversions, prior to brush box installation.
- Dig a trench 12-18 inches (0.3-0.5 m) wide and approximately 12 inches (0.3 m) deep along the toe of the slump or stream bank.
- Drive construction stakes, 36-48 inches (0.9-1.2 m) long, into the soil adjacent to the trench wall across from each other, one on the downhill side of the trench and one on the uphill side of the trench. Repeat the procedure by driving pairs of stakes every 2 feet (0.6 m) along the length of the trench. Cut small notches into the stakes, approximately 3 inches (75 mm) from the top.



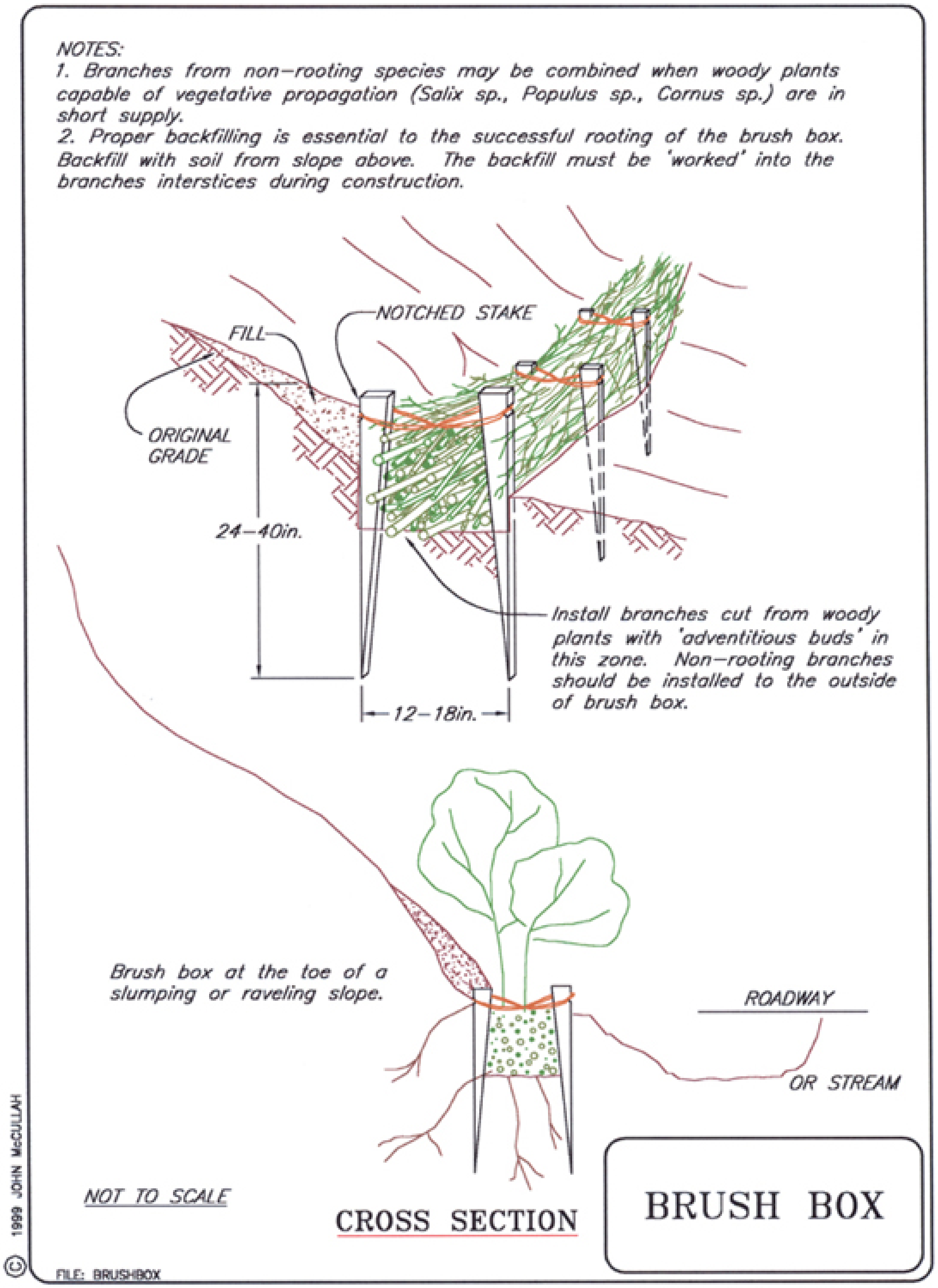
BRUSH BOX EP-17

These brush boxes were installed for landslide repair.
("Old Faithful" cut slope project, Hwy 299W, CA, 1992)

The same brush boxes in September of 2003

- Place the cuttings immediately after trenching to reduce desiccation of the soil. Cuttings shall be placed together between the stakes with the growing tips and butt ends oriented in alternating directions. Stagger the cuttings in the box so that the tips are evenly distributed throughout the length of the brush box.
- Compress the cuttings tightly between the stakes and tie the pair of stakes and cuttings together with a strong galvanized wire. Wrap the wire tightly around the stakes at the notches and twist the wire between the stakes to "cinch" the cuttings down. Drive the stakes further into the soil. This procedure will tighten the wires and compress the cuttings into the trench.
- Proper backfilling is essential to the successful rooting of the brush box. Backfill with soil graded from the slope above. Place moist soil along the sides of the live box. The backfill shall be worked into the cutting interstices during construction and compacted behind and below the bundle by walking on and working from brush box terrace.
- Repeat the proceeding steps to the top of the slope. The top of the brush box should be slightly visible when the installation is completed.

BRUSH BOX EP-17



FASCINES WITH SUBDRAINS EP-18

Conditions Where Practice Applies

The system can be considered for use in filled gully areas or tributary swales where groundwater is likely to collect and concentrate. Live fascines are intended to establish shrubs for biotechnical erosion control and are not removed at the end of construction.

Construction Specifications

Rows of fascines are installed on contour on a slope in the conventional manner. In addition, a subsurface drain, oriented downslope and perpendicular to the fascines, is placed in a trench beneath the rows of fascines to intercept and collect seepage. The subsurface drain consists of a perforated pipe wrapped in a geo-composite drainage medium placed at the bottom of a trench. The trench is backfilled with clean, coarse aggregate or gravel

The seepage collection trench is excavated first, and a perforated pipe wrapped in a composite geodrain is placed in the bottom of the trench. The trench is then backfilled with gravel or coarse aggregate. The fascines are installed over and across the trench and subsurface drain. Fascines are prepared and installed in the conventional manner. The geodrain is formed by first wrapping the perforated pipe in a three-dimensional open mat or matrix comprised of semi rigid polymeric fibers, e.g., Enkamat, followed by another wrap of filter fabric or filter cloth. The porous core of the geocomposite should face in towards the pipe, with the filter cloth backing facing outward. All drains should be constructed and installed with clean-out access tubes. The perforated pipe in the subdrain should have sufficient capacity to handle and transmit intercepted groundwater flow or seepage. Guidelines for computing the appropriate size can be determined from published nomographs. Normally, a 4 in (10 cm) diameter polymeric pipe should suffice.

After construction of the drain trench, the live fascines are installed over the trench in the normal manner. Other than the presence of a clean out tube in the treatment including subsurface drainage, both techniques have the same external appearance.

Materials and Equipment

- In addition to the live cuttings required for the fascines, additional materials are also required for manufacturing the drains, viz., perforated polymeric pipe, filter cloth, and a turf reinforcement mat, e.g., Enkamat™, for wrapping the pipe. Stakes must not be allowed to dry out. All cuttings should be soaked in water for 5-7 days (a minimum of 24 hours) and planted the same day they are removed from the water.

Construction / Installation

- The seepage collection trench is excavated first, and a perforated pipe wrapped in a composite geodrain is placed in the bottom of the trench.

- The trench is then backfilled with gravel or coarse aggregate.

- The fascines are installed on contour over and across the trench and subsurface drain. Row spacing guidelines for fascine installations are presented in Table 1.

Table 1. Recommended Spacing for Live Fascines on Slopes

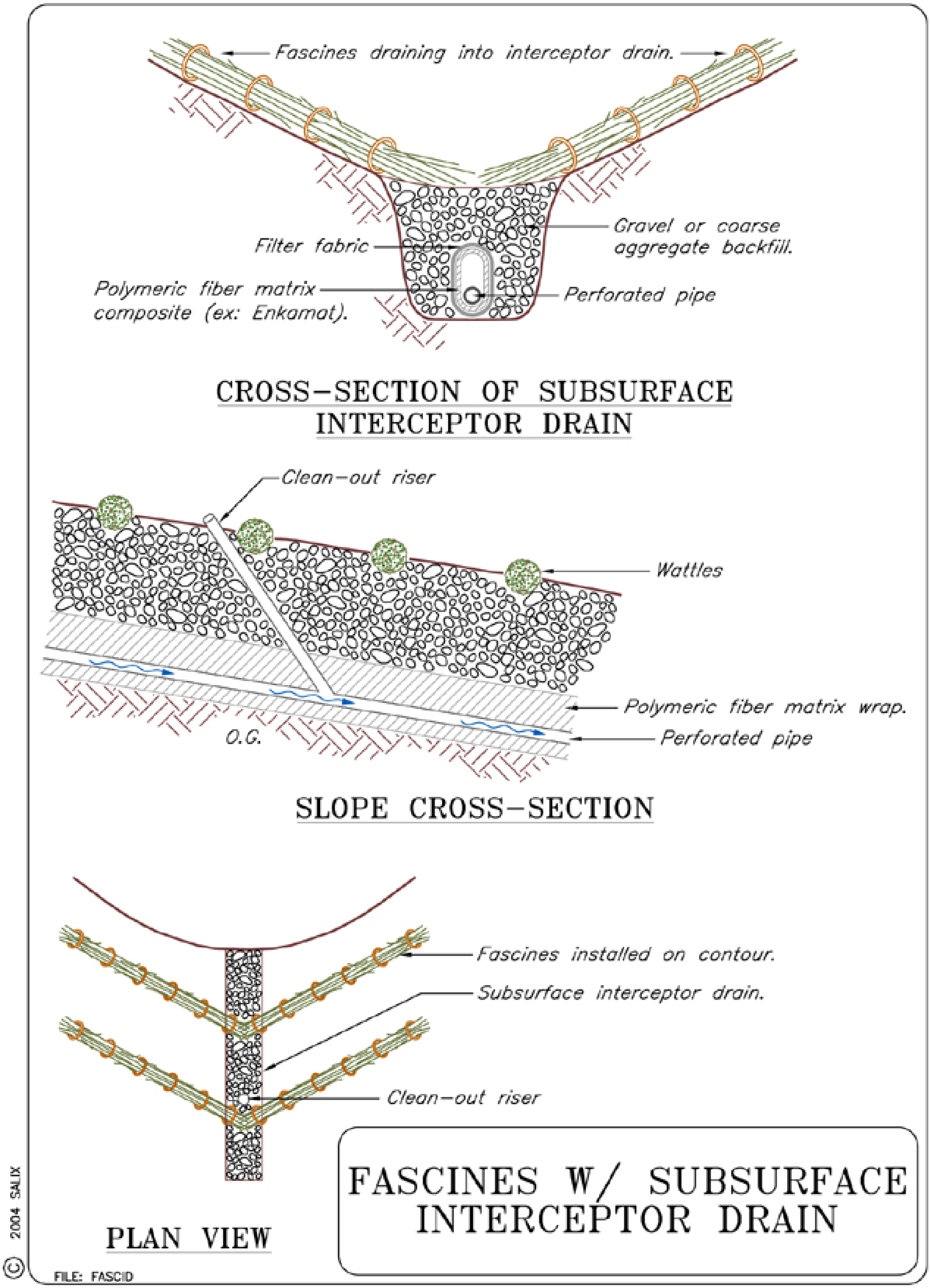
Slope Steepness (V:H)	Slope Distance Between Fascine Rows ft (m)	
	On Contour	**On Angle**
1:1 to 1:1.5	3-4 (0.9 – 1.2)	2-3 (0.6 – 0.9)
1:1.5 to 1:2	4-5 (1.2 – 1.5)	3-5 (0.9 – 1.5)
1:2 to 1:2.5	5-6 (1.5 – 1.8)	3-5 (0.9 – 1.5)
1:2.5 to 1:3	6-8 (1.8 – 2.4)	4-5 (1.2 – 1.5)
1:3.5 to 1:4	8-9 (2.4 – 2.7)	5-7 (1.5 – 2.1)
1:4.5 to 1:5	9-10 (2.7 – 3.0)	6-8 (1.8 – 2.4)

Inspection and Maintenance

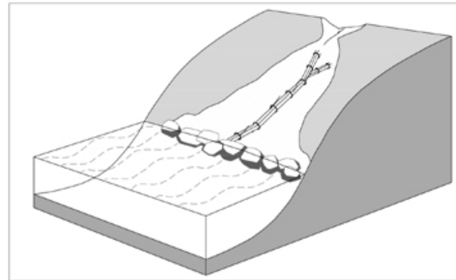
- The exit end of the subsurface drain should be checked periodically to insure that water is flowing out of the drain.
- The subsurface drain pipe should be flushed via the clean-out access tube as-needed if inspection indicates that the drain may be clogged. Flushed materials typically consist of excess groundwater and should be disposed of properly based on site specific conditions and local requirements.

Common Reasons / Circumstances for Failure

The most common reasons for failure are improper design of the interceptor drain placed at the bottom of the axial trench. The perforated pipe should be correctly sized and wrapped with a suitable geodrain composite that excludes fines but that lets water through. Failure to inspect and flush the drain via the clean-out access tube as needed can lead to prolonged clogging and poor performance.


Fascines draining into interceptor drain.
Gravel or coarse aggregate backfill.
Filter fabric
Polymeric fiber matrix composite (ex: Enkamat).
Perforated pipe
CROSS-SECTION OF SUBSURFACE INTERCEPTOR DRAIN
Clean-out riser
Wattles
Polymeric fiber matrix wrap.
Perforated pipe
O.G.
SLOPE CROSS-SECTION
Fascines installed on contour.
Subsurface interceptor drain.
Clean-out riser
PLAN VIEW
FASCINES W/ SUBSURFACE INTERCEPTOR DRAIN
© 2004 SALIX
FILE: FASCID

LIVE POLE DRAINS EP-19



Live pole drains are drainage systems composed of bundles of live willow (*Salix* spp) branches (live fascines or willow wattles) placed in areas where excess soil moisture results in soil instability. They are intended to drain excess water away from an unstable bank.

Conditions Where Practice Applies

Live pole drains are most applicable on streambanks and slopes where excessive soil moisture is causing piping, erosion, or slumping gullies. Live pole drains tend to be used most frequently on outer bends.

Construction Specifications

When designing a project, one must decide whether to use willow wattles or live fascines. Both are constructed of the same size poles, and in the same manner, with the exception of the orientation of the cuttings. Fascines have all the cuttings oriented one way (all butt ends together), while wattles are composed of poles oriented in both directions.

The use of live fascines will facilitate rooting, as cuttings grow best when the tips are pointed uphill. The use of willow wattles, on the other hand, will provide more efficient drainage, as half of the tapering tips are pointed downward, but rooting success will likely be lower. Therefore, one must decide whether the goal of the project is drainage or plant establishment.

Materials and Equipment

Live Pole Drains are essentially willow wattles or fascines constructed with longer than usual poles, with many of the branches left on, and staked with live willow stakes, construction stakes, or a combination of the two. Stakes must not be allowed to dry out. All cuttings should be soaked in water for 5-7 days (a minimum of 24 hours) and planted the same day they are removed from the water.

Construction / Installation

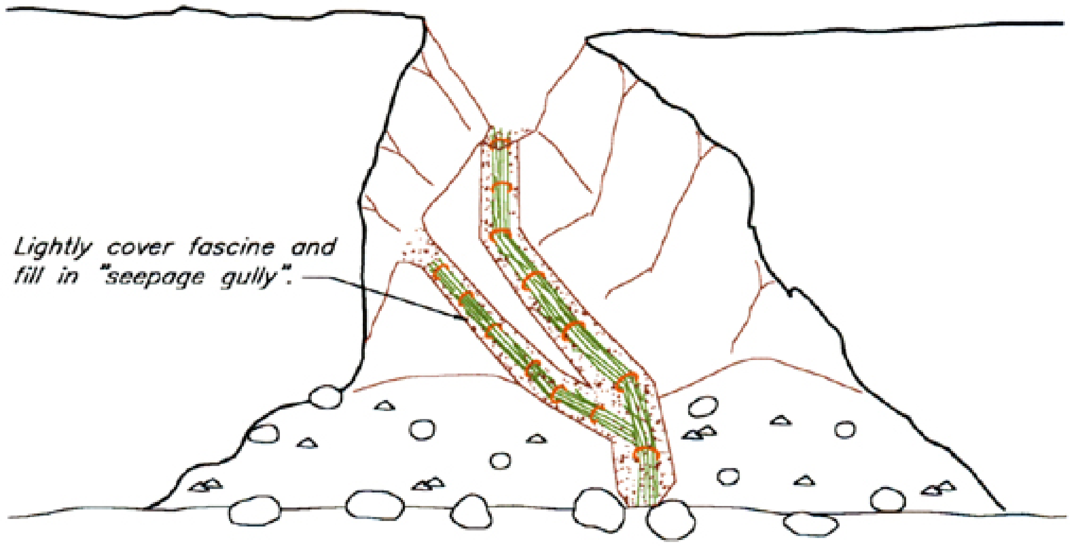
- Place the wattles or fascines in an excavated trench or existing drainage gully in an area of seepage, such that they intercept and control excess moisture on the bank.
- Key the bundles into each other by jamming the ends together firmly and stake into place with live or inert stakes at 3-6 ft (1-2 m) intervals (Sloan, 2001).
- Stakes should be placed near rope ties and in transitional areas for additional support.

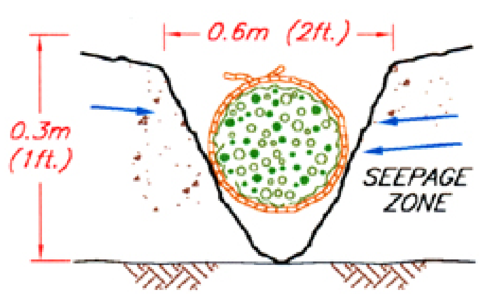
Inspection and Maintenance

Regular inspection and maintenance of wattle installations should be conducted, particularly during the first year, and repairs should be made promptly. Any stakes that loosen because of saturation of the slope or frost action should be re-installed. Rills and gullies around or under wattles should be repaired using Brushlayers and Live Gully Fill Repair as necessary. All temporary and permanent erosion and sediment control practices should be maintained and repaired to assure continued performance of their intended function.

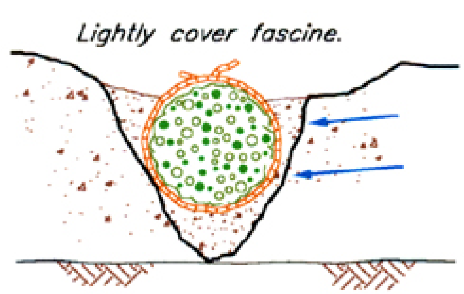
Common Reasons / Circumstances for Failure

Using a subsurface drainage technique, e.g., Live Pole Drains, when a surface runoff control measure is necessary.





Excavate a shallow trench or utilize existing "seepage gully" (small<2ft.^{2}).



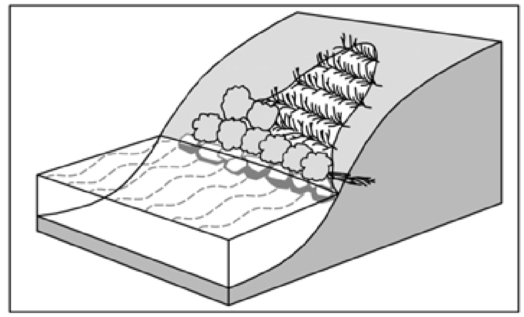
Place bundle of cuttings (fascine) in the trench and lightly backfill with native material.

NOTES:
1. Live pole drain is a biotechnical technique which drains excess moisture from the bank and provides an initial cover of woody vegetation.
2. The cuttings used to form the fascines are intended to sprout and grow while the excess moisture continues to drain from the lower end.

LIVE POLE DRAIN

FILE: LIVE POLE DRAIN

Construction Specifications:



In general, gully repair consists of a combination of techniques for stabilizing eroding intermittent or ephemeral channels. These repair techniques taken together include grading, installing drainage and fill, live cuttings, and surface erosion control. Live Gully Fill Repair consists of alternating layers of live branch cuttings and compacted soil. This reinforced fill can be used to repair small gullies. The method is similar to branch packing (a method for filling small holes and depressions in a slope) but is more suitable for filling and repairing elongated voids in a slope, such as gullies. Gully treatment must include correcting or eliminating the initial cause of the gully as well as the gully itself. Accordingly, consideration should be given to diverting excessive or concentrated runoff away from the gully head area. Gullies are likely to have side gullies that require treatment; however, priority should be given to the main channel.

Conditions Where Practice Applies

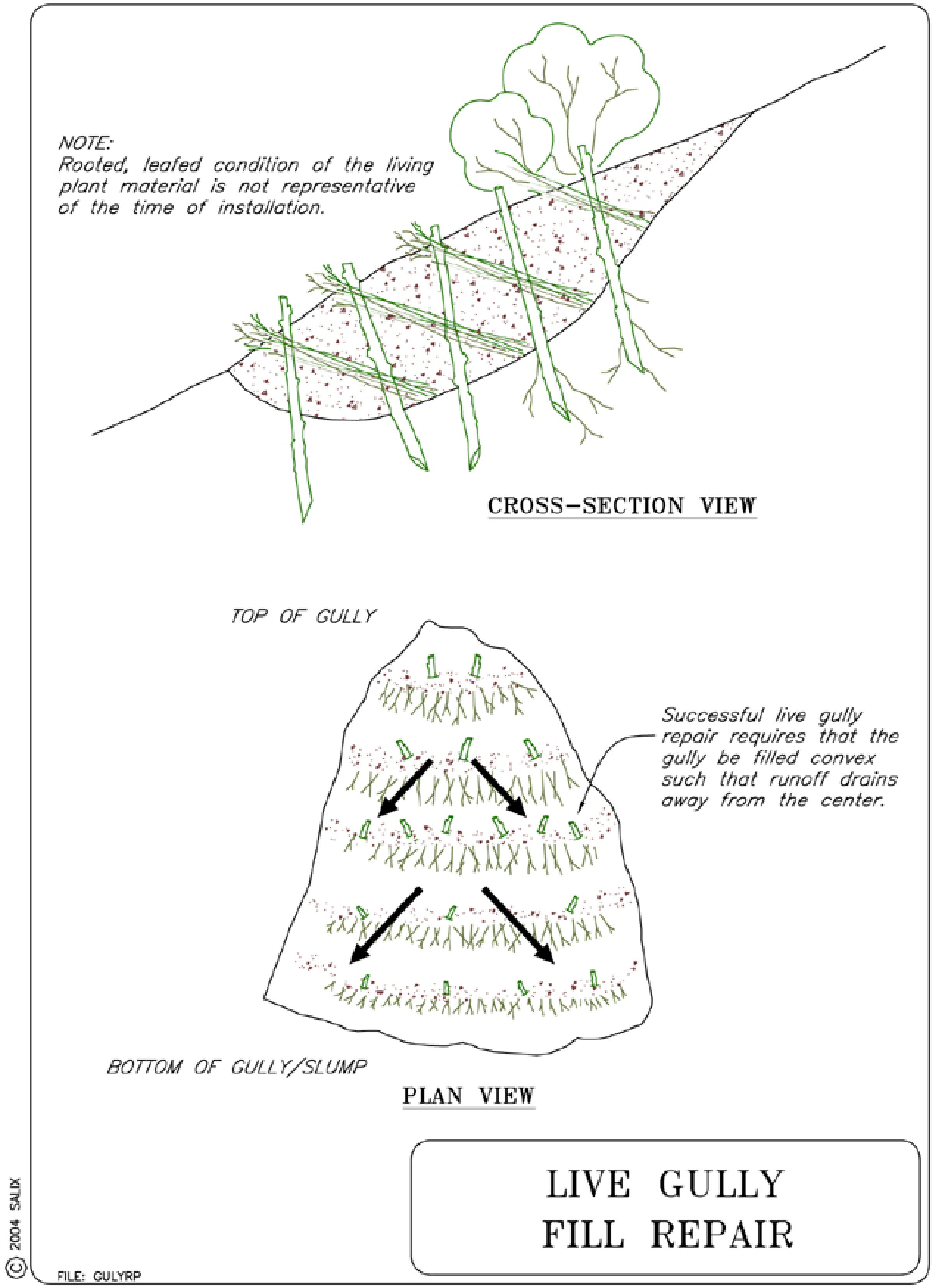
- Live Gully Fill Repair is useful for gullies ranging in depth from about 1 to 6 ft (0.3 to 2 m) deep to 30 ft (10 m) long.
- This repair technique should only be used in channels with intermittent flows. The erosion processes at work in the incised channel, or "gully," must be correctly identified and understood to make a successful repair.

Design Guidelines / Typical Drawings

- This technique is used to fill small gullies in natural slopes and streambanks.
- Fill placed in the channel should consist of graded and well drained soil.
- Imbedded branches and their secondary roots will reinforce the backfill used to repair the gully and protect it against future washout and scour.
- A subsurface drain may be required if significant amounts of seepage or groundwater enters the gully at its head.
- Surface runoff entering the gully at its head should be intercepted and diverted away from the area.

Materials and Equipment

- Graded and well drained soil for use as fill material.
- Live branch cuttings ranging from 1/2 to 2 inches in diameter.
- The branches should be long enough to touch the undisturbed soil at the bottom (back) of the gully and to protrude slightly beyond the rebuilt slope face.


NOTE:
Rooted, leafed condition of the living plant material is not representative of the time of installation.
CROSS-SECTION VIEW
TOP OF GULLY
Successful live gully repair requires that the gully be filled convex such that runoff drains away from the center.
BOTTOM OF GULLY/SLUMP
PLAN VIEW
LIVE GULLY
FILL REPAIR
© 2004 SALIX
FILE: GULYRP

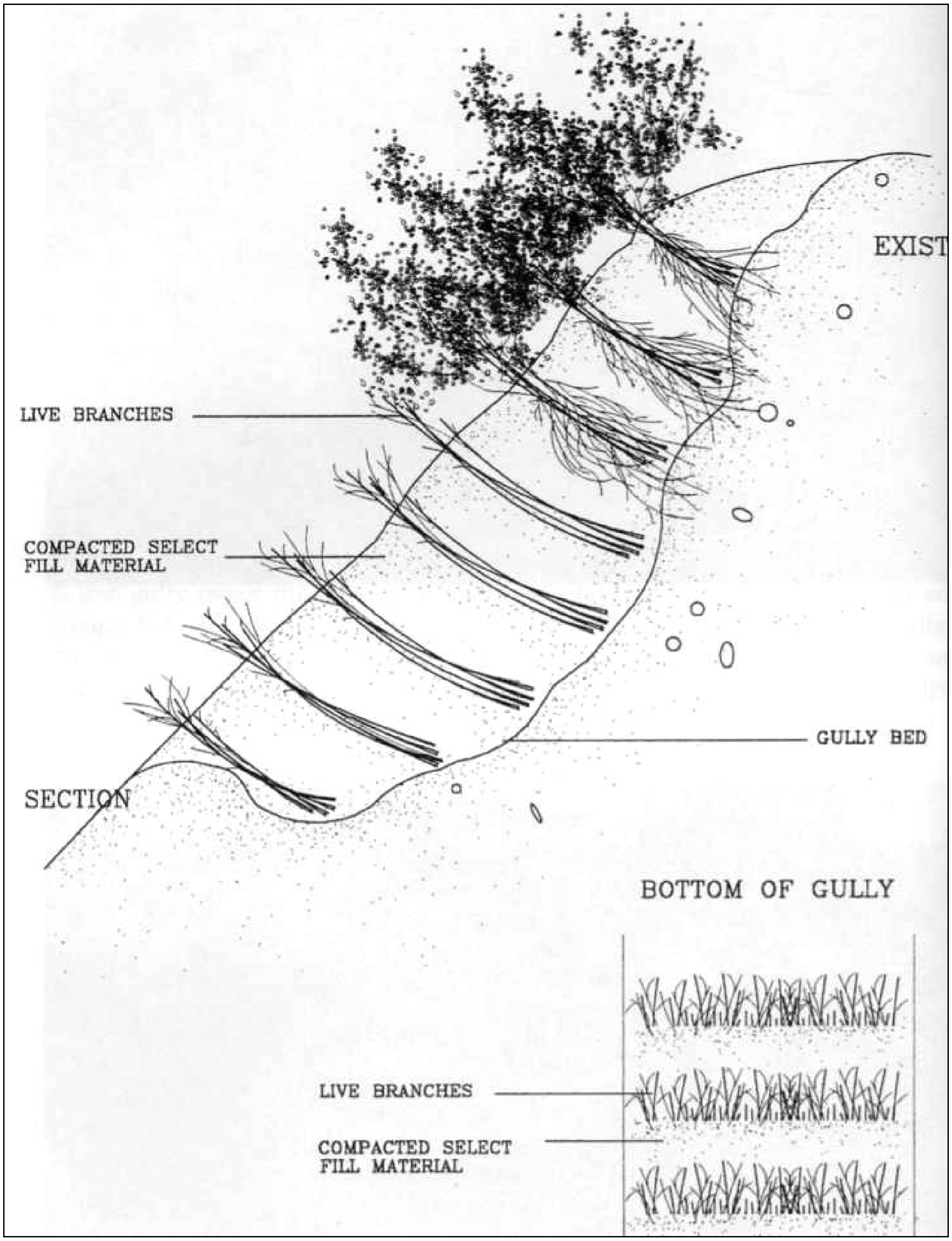


Figure 1. Schematic drawing of established live gully fill repair.

Construction / Installation

Live gully fill repair begins at the lowest point in the gully and proceeds upward. The live branches are inserted between successive lifts of lightly compacted soil. The following guidelines and procedures are recommended when installing a live gully fill repair system:

- Starting at the lowest point of the slope, place a 3- to 4-inch thick layer of branches at the lowest end of the gully and approximately perpendicular to the gully bottom (see Figure 1).
- Cover with a 6- to 8-inch thick layer of fill soil and compact

- Place the live branches in a crisscross fashion. Orient the growing tips toward the slope face with the basal ends lower than the growing tips.
- Follow each layer of branches with a layer of soil; work and compact the soil to ensure intimate contact with the branches and to eliminate large voids in the fill.

Inspection and Maintenance

- Periodically check on stability of gully fill, particularly during the initial vegetative establishment period.
- Check for wet spots or seeps in fill which indicate subsurface seepage problems. Examine surface of fill for evidence of runoff erosion such as rills.
- Make sure that runoff is diverted away from fill during initial stages.

Common Reasons / Circumstances for Failure

The main reason for failure of a Live Gully Fill Repair is saturation and washout of the earthen fill. Prevention of this outcome requires that seepage and runoff be excluded as much as possible from the fill area.

SODDING – EP-21

Sodding is the placement of permanent grass cover that has been was grown elsewhere and brought to the site. Sodding involves the placement of "sheets" of pre-established grass. Sodding provides immediate stabilization to an area by covering the soil surface with pre-established sheets of grass, thereby protecting the soil from erosion, enhancing infiltration, filtering sediment and other pollutants, and slowing runoff velocities.

Sodding is appropriate for areas that contained turf or grasses before construction; any graded or cleared area that might erode; and areas where a permanent, long lived plant cover is needed immediately. Sodding may be used in vegetative buffer zones, stream banks, grassed dikes, swales, slopes, outlets, level spreaders, and filter strips and is particularly effective on flood plains, areas adjacent to wetlands or other sensitive water bodies, and on steep, unstable slopes. Natural revegetation may be more appropriate for areas not prone to erosion that have an available seed source.

Construction Specifications:

- Sod should be protected with tarps or other protective covers during delivery and should not be allowed to dry out between harvesting and placement.
- All weeds and debris should be removed before cultivation of the area to be planted and properly disposed.
- After cultivation, installation of irrigation systems, and rough grading are completed, areas to be planted with sod should be fine graded and rolled. Topsoil may be needed in areas where the soil textures are inadequate. Areas to be planted with sod should be smooth and uniform before placing sod. Areas to be planted with sod adjacent to sidewalks, concrete headers, header boards, and other paved border and surface areas should be 1.5 in ± 0.25 in (38 mm ± 6 mm) below the top grade of such facilities after fine grading, rolling, and settlement of the soil. Sod should be placed so that ends of adjacent strips of sod are staggered at least 24 in (600 mm). All edges and ends of sod should be placed firmly against adjacent sod and against sidewalks, concrete headers, header boards, and other paved borders and surfaced areas.
- After placement of the sod, the entire sodded area should be lightly rolled to eliminate air pockets and ensure close contact with the soil. After rolling, the sodded areas should be watered so the soil is moistened to a minimum depth of 4 in (100 mm). Sod should not be allowed to dry out, planted during very hot or wet weather, or placed on slopes that are greater than 3:1:3 (H:V:H) if they are to be mowed.
- If irregular or uneven areas appear before or during the plant establishment period, such areas should be restored to a smooth and even appearance.
- The turf (sod) should be allowed to grow to 3 in (75 mm) high. When the turf reaches this height, it should be mowed to a height of 1 in (25 mm) or as recommended by the grower of the sod. All turf edges—including edges adjacent to sidewalks, concrete headers, header boards, and other paved borders and surfaced areas—should be trimmed to uniform edge not extending beyond the edge of turf or such facilities.
- Mowed and trimmed growth should be removed and disposed of outside the project. Trimming should be repeated whenever the height of the turf exceeds 1 in (25 mm).
- Sod should be healthy and, field grown, containing thatch not more than 0.5 in (13 mm) thick. The age of the sod should be between 8 and 16 months old. The sod should be free from disease, weeds, insects, and undesirable types of grasses and clovers and grown in accordance with any applicable agricultural requirements. Soil upon which the sod has been was grown should contain less than 50 percent silt and clay. Sod should be machine cut at a uniform soil thickness of 0.625 in ±0.25 in (16 mm ± 6 mm), excluding top growth and thatch.
- A certificate of compliance for the sod should be furnished to the contractor.

Inspection and Maintenance

- Inspect sod installations weekly and after significant storm events, until the turf is established.
- Maintenance should consist of mowing, weeding, and ensuring that the irrigation system is operating properly and as designed to sustain growth.

APPENDIX F

SEDIMENT CONTROL BMPS

SEDIMENT FENCE – SC-1

Construction Specifications:

Local municipality requirements should be checked to determine if local requirements differ from this BMP with respect to specific types of sediment fence allowed and methods of installation.

<u>Prefabricated Sediment Fence</u>

Prefabricated fence fabric shall consist of material approved by its manufacturer for use in sediment fence applications and shall include pre-fabricated pockets for stake installation. Select standard duty or heavy duty prefabricated sediment fence based on criteria shown below:

Standard Duty Sediment Fence

- Slope of area draining to fence is 4H:1V or less - Use is generally limited to less than five months
- Area draining to fence produces moderate sediment loads
- Use prefabricated standard duty sediment fence.
- Layout in accordance with typical layout - Install in accordance with attached detail.

Heavy Duty Sediment Fence

- Slope of area draining to fence is 1H:1V or less
- Use generally limited to eight months. Longer periods may require fabric replacement
- Area draining to fence produces moderate sediment loads
- Use prefabricated heavy duty sediment fence. Heavy duty sediment fences typically have the following physical characteristics:
  - Fence fabric has greater tensile strength than other fabric types available from manufacturer
  - Fence fabric has a greater permittivity than other fabric types available from manufacturer
  - Fence fabric may be reinforced with a backing or additional support to increase fabric strength
  - Posts may be spaced closer together than other pre- manufactured sediment fence types available from manufacturer.
- Layout in accordance with attached typical layout.
- Install in accordance with attached standard details.

Installation

- Install sediment fence along a level contour, with the last 6 ft of fence turned up slope. Except for the ends, the difference in elevation between the highest and lowest point along the top of the sediment fence shall not exceed one-third the fence height.
- Generally, should be used in conjunction with erosion source controls up slope to provide effective control.

Minimum BMP standards that apply to Prefabricated Sediment Fence are provided on the attached details.

Common Reasons/Circumstances for Failure

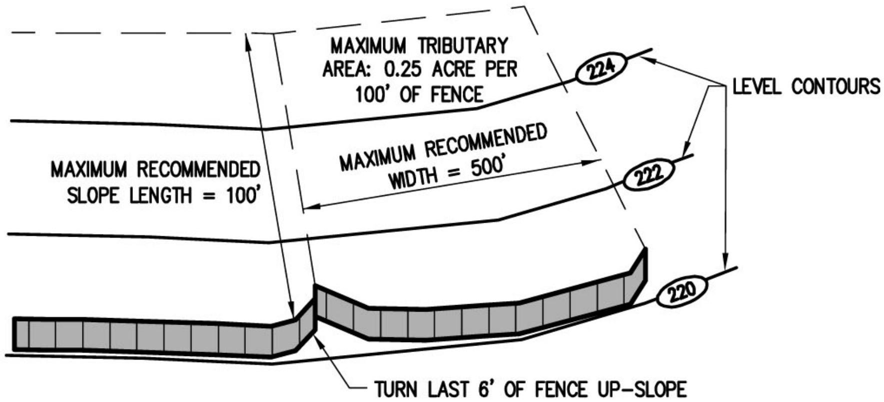
- The most common reasons for sediment fence failure are due to improper installation and poor maintenance. In particular, the toe must be securely trenched into the slope and accumulated sediment should be removed when accumulation reaches 1/3 of the fence height.

Inspection and Maintenance:

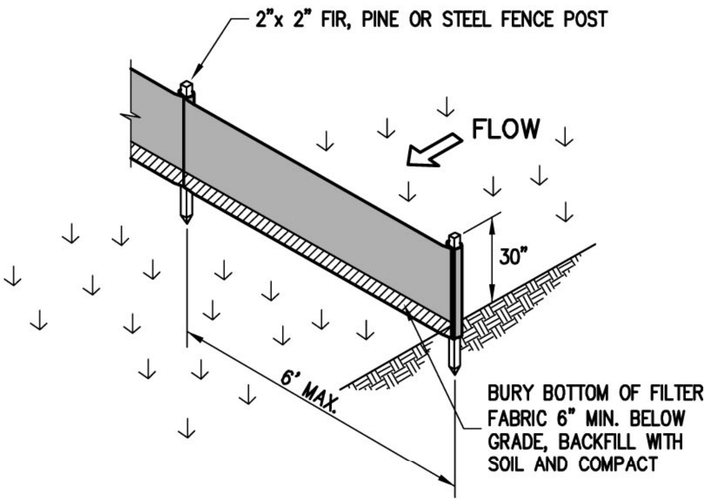
- Repair undercut sediment fences.

- Repair or replace split, torn, slumping, or weathered fabric.
- Inspect sediment fence before, during, and after storm events.
- Any required repairs shall be performed as soon as possible.
- Remove sediment when accumulation reaches 1/3rd the fence height.
- The removed sediment shall be incorporated in the project, disposed of properly, or appropriately stabilized with vegetation.
- Remove sediment fence when no longer needed and upslope area has been stabilized. Fill and compact post holes and anchorage trench, remove sediment accumulation, and grade fence alignment to blend with adjacent ground.

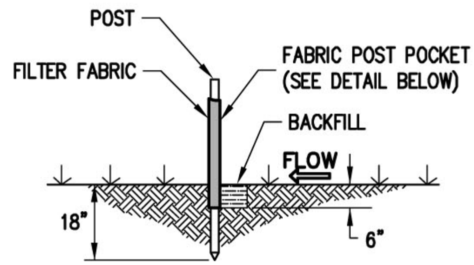
SEDIMENT FENCE – SC-1



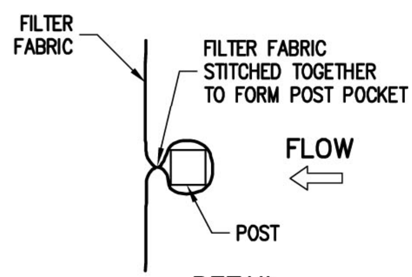
TYPICAL PREFABRICATED SEDIMENT FENCE LAYOUT



TYPICAL PREFABRICATED SEDIMENT FENCE LAYOUT



SECTION
MINIMUM INSTALLATION



DETAIL
FABRIC POST POCKET

NOTES:

1.) INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN NECESSARY.

2.) REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.

3.) SEDIMENT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.

4.) STITCHED POCKETS TO BE INSTALLED ON UPHILL SIDE OF SLOPE.

Construction Specifications:

Sand bag barriers are intended to block and divert flow. They are not intended to be used as filtration devices.

Materials

- Sand bag Material: Sand bag shall be polypropylene, polyethylene or polyamide woven fabric, minimum unit weight four ounces per square yard (135 g/m^2), mullen burst strength exceeding 300 psi (2,070 kPa) in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not acceptable since it rots and deteriorates easily.
- Sand bag Size: Each sand-filled bag shall have a length of 18 in (450 mm), width of 12 in (300 mm), thickness of 3 in (75 mm), and mass of approximately 33 lb. (15 kg). Bag dimensions are nominal, and may vary based on locally available materials. Alternative bag sizes shall be submitted to the engineer for approval prior to deployment.
- Fill Material: All sand bag fill material shall be non-cohesive, Class 1 or Class 2 permeable material free from clay and deleterious material, conforming to the provisions in Caltrans Standard Specifications Section 68-1.025 "Permeable Material". The requirements for the Durability Index and Sand Equivalent do not apply. Fill material is subject to approval by the engineer.
- Only use sandbag barriers when diverting runoff or run-on.

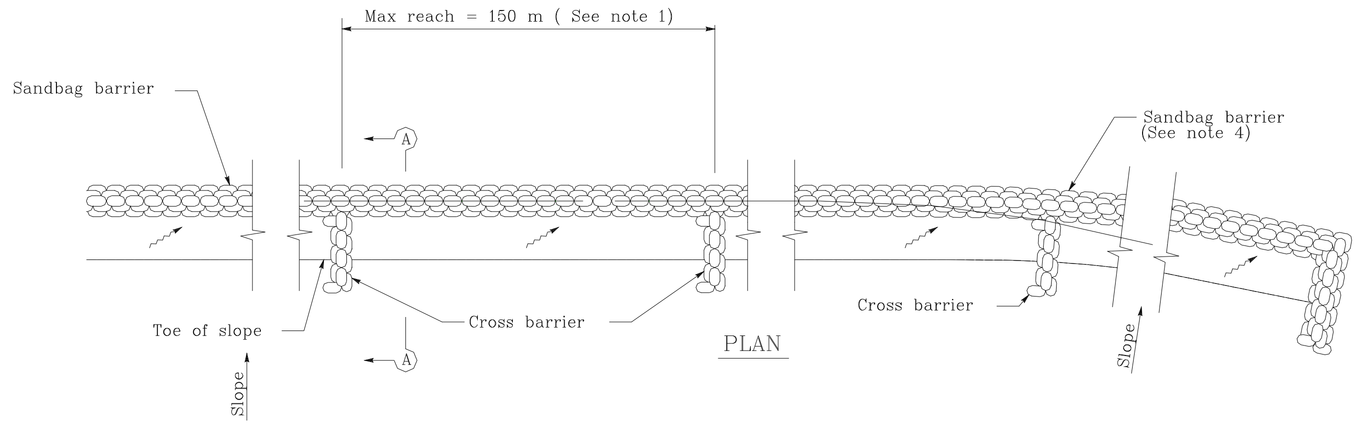
Installation

- Install along a level contour.
- Turn ends of sand bag row up slope to prevent flow around the ends.
- Generally, sand bag barriers shall be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.
- Construct sand bag barriers with a set-back of at least 3 ft (1m) from the toe of a slope. Where it is determined to be not practical due to specific site conditions, the sand bag barrier may be constructed at the toe of the slope, but shall be constructed as far from the toe of the slope as practicable.

Minimum BMP standards are provided on the following details.

Inspection and Maintenance:

- Inspect sand bag barriers before, during, and after each rainfall event, and weekly throughout the rainy season.
- Reshape or replace sand bags as needed.
- Repair washouts or other damages as needed.
- Inspect sand bag barriers for sediment accumulations and remove sediment when accumulation reaches 1/3rd the barrier height. Removed sediment shall be incorporated in the project at locations designated by the engineer or shall be disposed of properly.
- Remove sand bags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilized the area.



TEMPORARY LINEAR SEDIMENT BARRIER (TYPE SANDBAG)

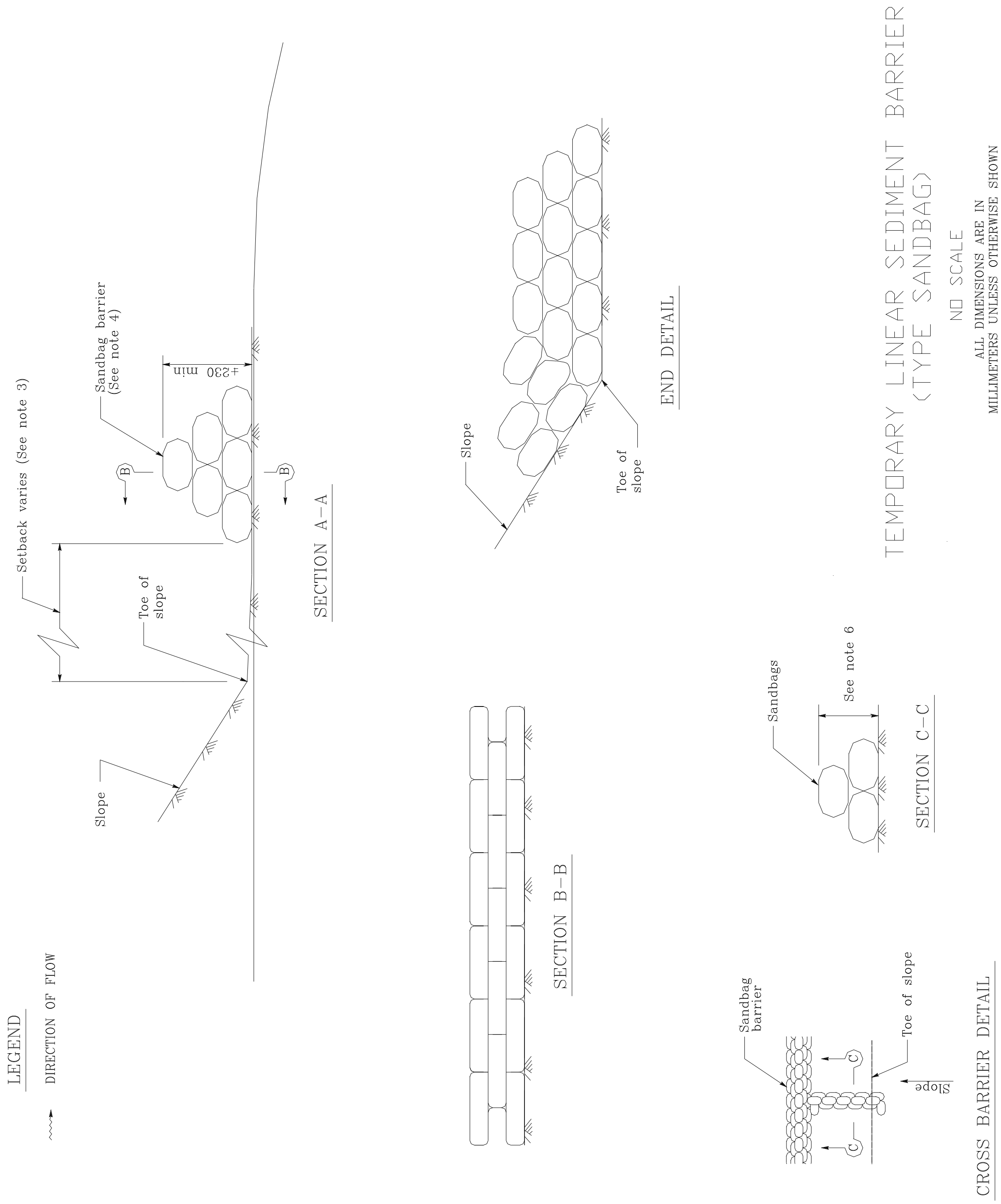
TEMPORARY LINEAR SEDIMENT BARRIER
(TYPE SANDBAG)

NO SCALE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

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 150 m.
2. Place sandbags tightly.
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a 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.



TEMPORARY LINEAR SEDIMENT BARRIER
(TYPE SANDBAG)
NO SCALE
ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
LEGEND
DIRECTION OF FLOW
Slope
Toe of slope
Setback varies (See note 3)
Sandbag barrier (See note 4)
230 min
B
SECTION A-A
SECTION B-B
Slope
Toe of slope
END DETAIL
Sandbags
See note 6
SECTION C-C
Sandbag barrier
Toe of slope
Slope
C
CROSS BARRIER DETAIL

Construction Specifications:

Unlike sand bag barriers that divert flow, gravel bag berms are intended to intercept and filter sediment-laden storm water runoff from disturbed areas, retaining the sediment and releasing the water.

Materials

- Bag Material: Bags shall be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight four ounces per square yard (135 g/m^2), mullen burst strength exceeding 300 psi (2,070 kPa) in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- Bag Size: Each gravel-filled bag shall have a length of 18 in (450 mm), width of 12 in (300 mm), thickness of 3 in (75 mm), and mass of approximately 33 lb (15 kg). Bag dimensions are nominal, and may vary based on locally available materials. Alternative bag sizes shall be submitted to the engineer for approval prior to deployment.
- Fill Material: Gravel shall be between 0.4 and 0.8 inch (10 mm and 20 mm) in diameter, and shall be clean and free from clay balls, organic matter, and other deleterious materials. The opening of gravel-filled bags shall be between 28 and 48 lb (13 kg and 22 kg) in mass. Fill material is subject to approval by the engineer.

Installation

- When used as a linear control for sediment removal:
  - Install along a level contour.
  - Turn ends of gravel bag row up slope to prevent flow around the ends.
  - Generally, gravel bag barriers shall be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.
- When used for concentrated flows:
  - Stack gravel bags to required height using a pyramid approach.
  - Upper rows of gravel bags shall overlap joints in lower rows.
- Construct gravel bag barriers with a set-back of at least 1m from the toe of a slope. Where it is determined to be not practicable due to specific site conditions, the gravel bag barrier may be constructed at the toe of the slope, but shall be constructed as far from the toe of the slope as practicable.
- A certificate of compliance for the gravel and bags shall be provided.

Inspection and Maintenance:

- Inspect gravel bag berms before, during, and after each rain event, and weekly throughout the rainy season. More frequent inspections may be required by local municipalities.
- Reshape or replace gravel bags as needed.
- Repair washouts or other damages as needed.
- Inspect gravel bag berms for sediment accumulations and remove sediments when accumulation reaches 1/3rd of the berm height. Removed sediment shall be incorporated in the project.
- Remove gravel bag berms when no longer needed. Remove sediment accumulations and clean, re-grade, and stabilize the area.

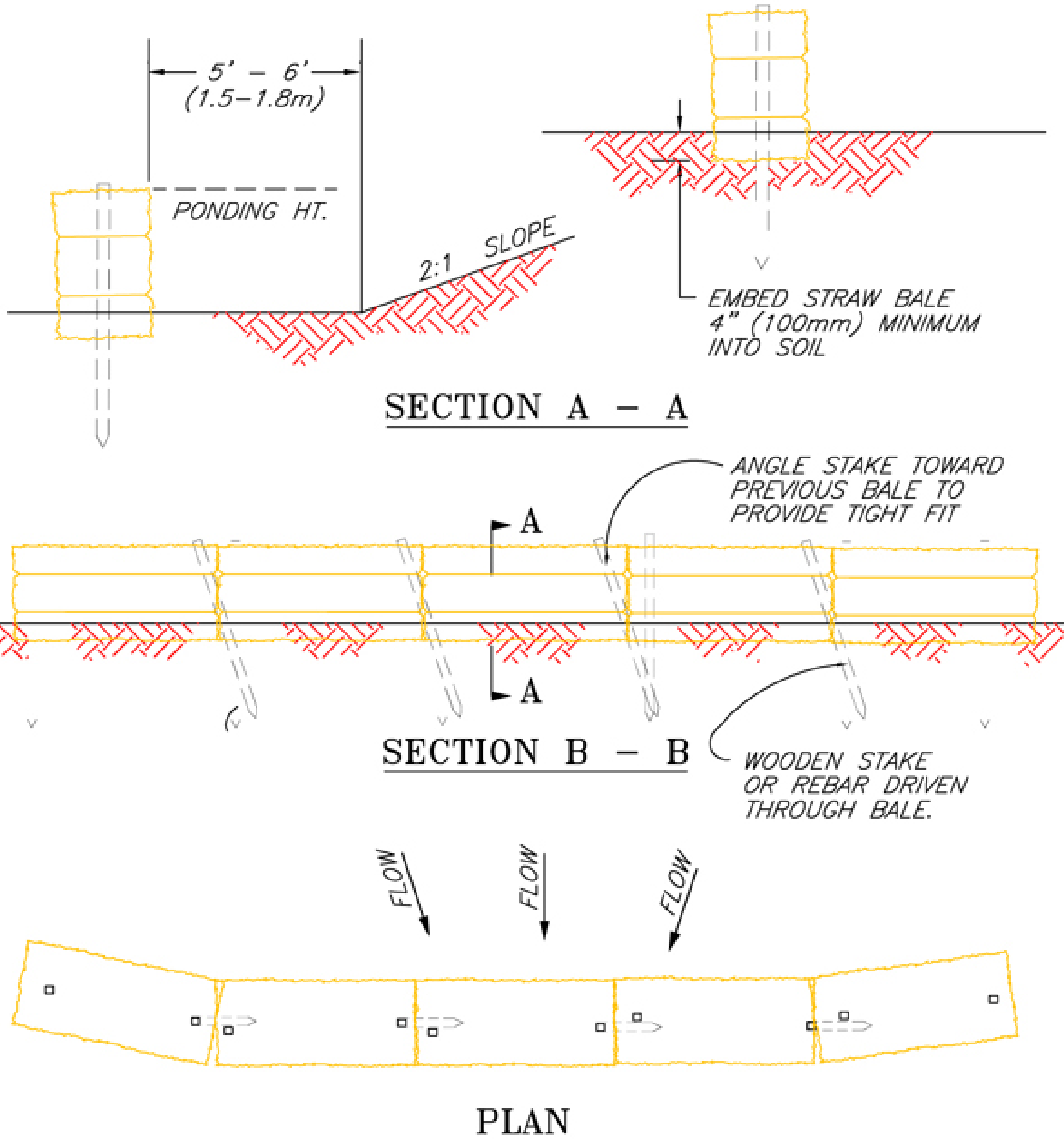
Construction Specifications:

- Some local municipalities may only allow the use of straw bale dikes on an emergency basis; local requirements should be reviewed and followed.
- The bales shall be placed on the slope contour at the base of the slope or around the perimeter of the construction site. If the dike is constructed at the toe of a slope, place it 5-6 feet (1.5-1.8 m) away from the slope if possible.
- Do not construct the dike more than one bale high.
- Bales shall be placed in a row with the ends tightly abutting.
- Each bale shall be embedded in the soil a minimum of 4 inches (101 mm). Use straw, rocks, or filter fabric to fill any gaps between the bales and tamp the backfill material to prevent erosion under or around the bales.
- If the bales are wire bound, they should be oriented so the bindings are around the sides rather than along the top and bottom. Wire bindings that are placed in contact with the soil soon disintegrate and may allow the bale to fall apart.
- The bales shall be securely anchored in place by two wooden stakes or rebar driven through the bales. The first stake in each bale shall be driven toward the previously laid bale to force the bales tightly together. Drive the stakes at least 18 inches (0.5 m) into the ground.
- The straw bales do not need to be anchored if the bales are used on a relatively flat construction area with slope lengths less than 100 feet and the straw bale dike is inspected regularly. The trapped sediment should be removed when required, and repairs made promptly. The bales also do not need to be anchored if they are to be removed and replaced daily to facilitate construction.

Minimum BMP standards are provided on the following detail.

Inspection and Maintenance:

- The straw bale dikes shall be inspected before, during, and after each rain event.
- Straw bales should be replaced if they have decomposed.
- In wet areas, bales may require replacement every 6 to 9 weeks during the rainy season.
- Repairs and/or replacement shall be made promptly. Replacement bales shall be in good condition, not previously exposed to weather.
- Remove sediment behind the barrier when it reaches a depth of 6 inches (0.2 m).
- Remove the straw bales when the upslope areas have been permanently stabilized.
- Sediment shall be removed and deposited in an area that will not contribute sediment offsite.



NOTES:

1. THE STRAW BALES SHALL BE PLACED ON SLOPE CONTOUR.
2. BALES TO BE PLACED IN A ROW WITH THE ENDS TIGHTLY ABUTTING.
3. KEY IN BALES TO PREVENT EROSION OR FLOW UNDER BALES.

STRAW BALE DIKE

FILE: STRWDIKE

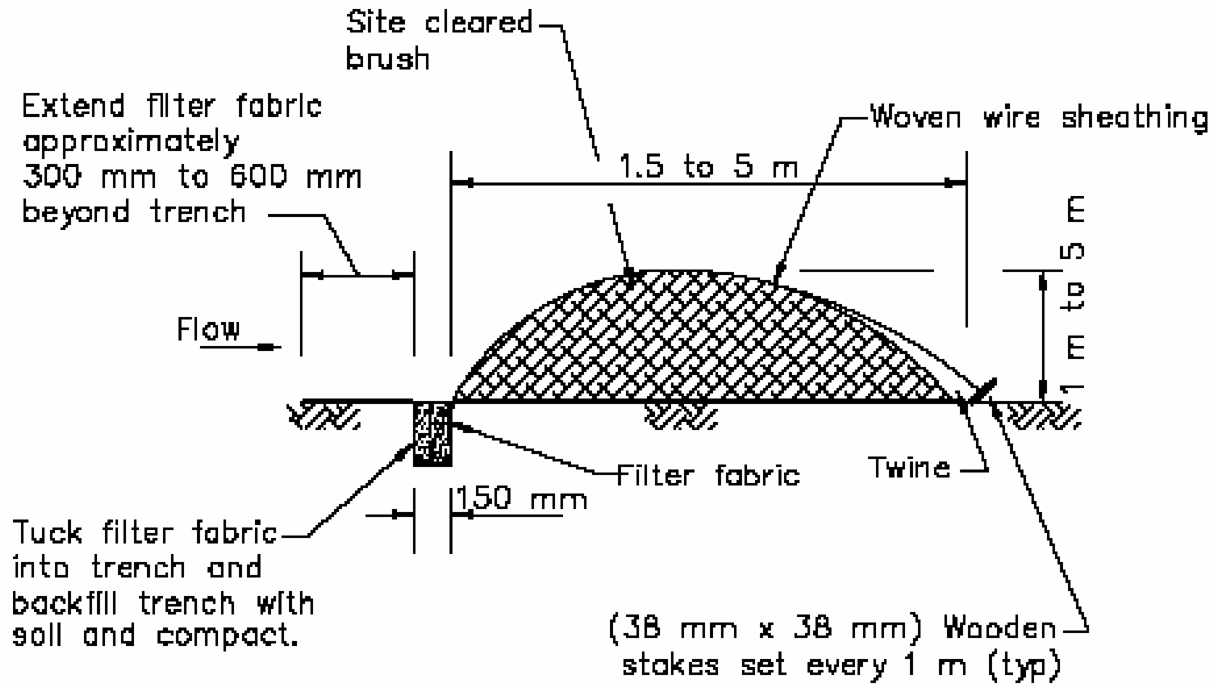
Rock or brush filters are temporary barriers composed of brush, wrapped in filter cloth and secured in place, or rock anchored in place. They are intended to intercept and filter sediment-laden storm water runoff from disturbed area, retaining the sediment and releasing water as sheet flow, at a reduced velocity. Note: filters require sufficient space for ponded water; are not effective for diverting runoff since filters allow to slowly seep through; and rock filter berms may difficult to remove when construction is complete.

Construction Specifications:

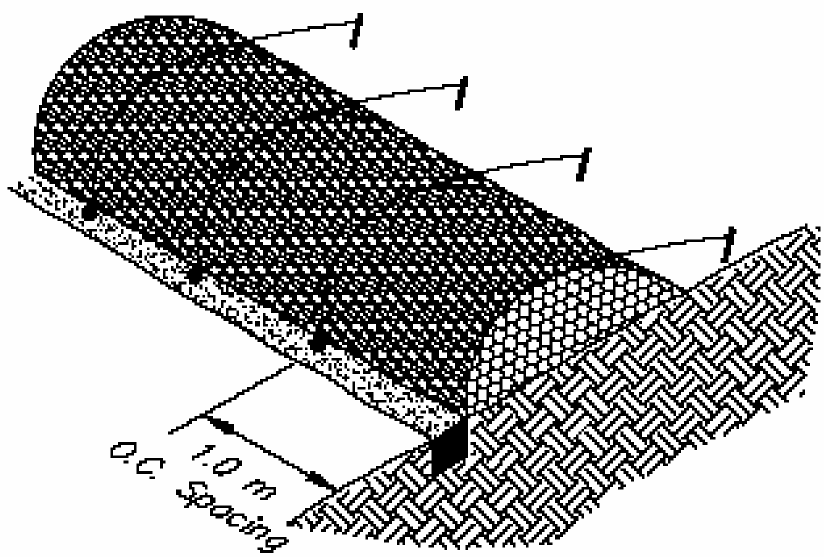
- Use for contributing drainage areas less than or equal to 5 ac (2 ha).
- Use along the perimeter of disturbed areas; near the toe of slopes which may be subject to flow and rill erosion; around temporary spoil areas; along streams and channels; and across mildly sloped construction roads (rock filter berms, only).
- Brush and rock filters shall be installed on a level contour.
- Provide adequate areas upstream of filter to accommodate ponding.
- Brush shall consist of site-cleared brush, or alternative material approved by engineer.
- Stakes: 1.5 in x 1.5 in (38 mm x 38 mm) wooden stake, or metal stake with equal holding capabilities.
- Rock: open-graded rock, 0.75 in (19 mm) to 3 in (75 mm) to 5 in (125 mm) for concentrated flow applications.
- Woven wire sheathing: 1 in (25 mm) diameter, hexagonal mesh, galvanized 20 gauge (used with rock filters in areas of concentrated flow).
- In construction traffic areas, maximum rock berm heights shall be 12 in (300 mm). Multiple berms should be constructed every 300 ft (90 m) on slopes less than 5:100 (V:H) (5%), every 200 ft (60 m) on slopes between 5:100 (V:H) (5%) and 10:100(V:H) (10%), and every 100 ft (30 m) on slopes greater than 10:100 (V:H) (10%).

Inspection and Maintenance:

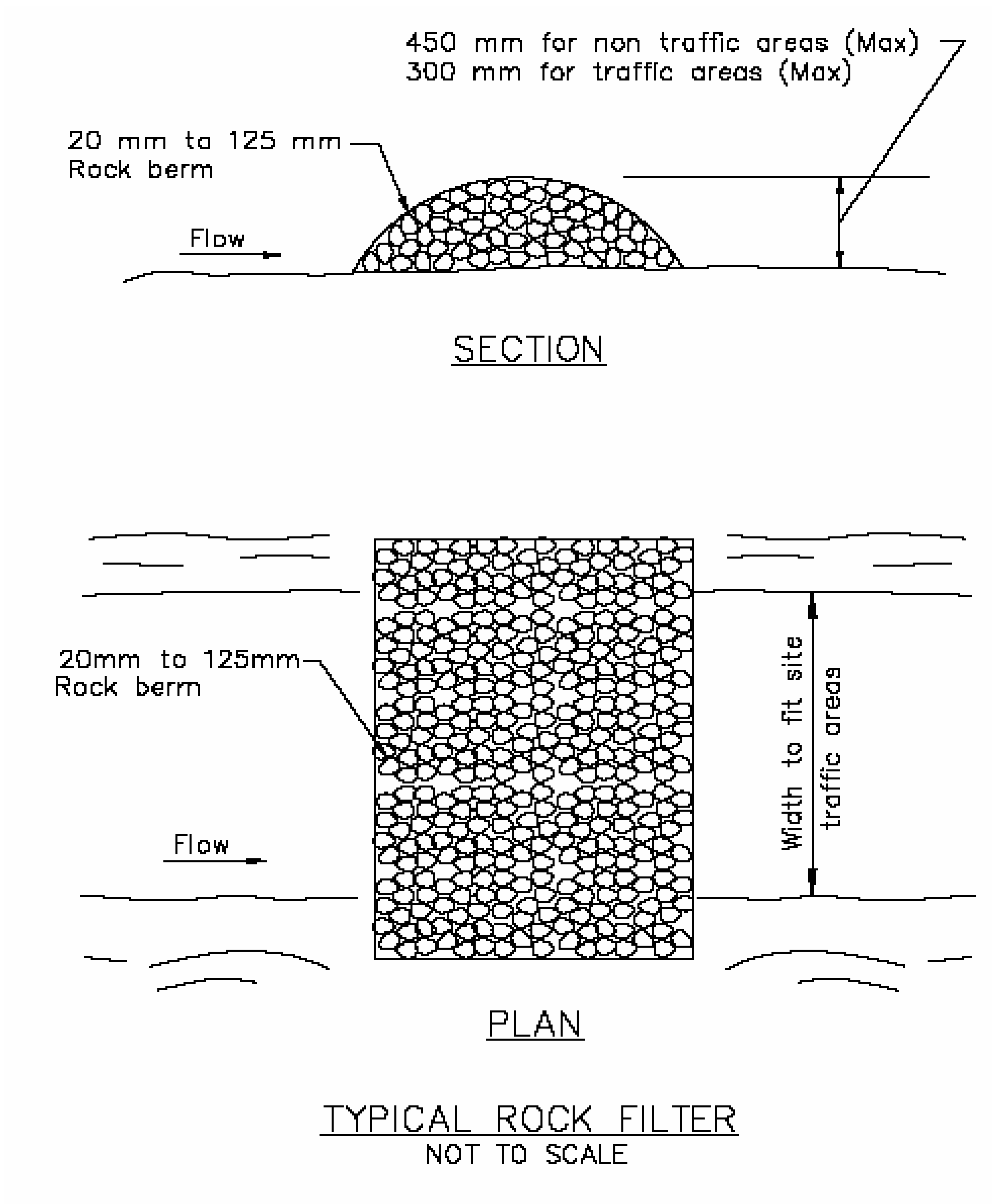
- Inspect berms before and after each significant rain event, and weekly throughout the rainy season.
- Reshape berms as needed and replace lost or dislodged rock, brush and/or filter fabric.
- Inspect for sediment accumulation, remove sediments when depth reaches 1/3 of the berm height or 12 in (300 mm), whichever occurs first.
- Filter berms should be removed upon completion of construction activities.



SECTION



TYPICAL BRUSH FILTER
NOT TO SCALE


450 mm for non traffic areas (Max)
300 mm for traffic areas (Max)
20 mm to 125 mm
Rock berm
Flow
SECTION
20mm to 125mm
Rock berm
Flow
Width to fit site
traffic areas
PLAN
TYPICAL ROCK FILTER
NOT TO SCALE

Construction Specifications

A compost filter berm is a trapezoidal berm applied by a blower and a compost sock is compost material encased in mesh to form a tube/roll. Both techniques intercept sheet flow and pond runoff, allowing sediment to fall out of suspension, and often filtering sediment as well. Compost berms and socks provide an environmentally-sensitive and cost-effective alternative to sediment fence.

Advantages

- Compost berms and compost socks made from biodegradable mesh sometimes offer a better solution than sediment fence and other sediment control methods, because compost does not require any special trenching, construction, or removal, unlike straw bales, sediment fence or coir rolls. This makes the technique very cost-effective.
- Compost is organic, biodegradable, renewable, and can be left onsite. This is particularly important below embankments near streams, as re-entry to remove or maintain the berm can cause additional disturbance. Sediment fence has to be disposed of in landfills and is often left abandoned on jobsites.
- Compost does not leach nutrients. Field tests in Connecticut have shown that run-off from compost treated sites has very low soluble salts, and all metals and nutrients are well within pollution leaching limits.
- Compost berms can be easily and quickly fixed should something happen to them in the course of construction. Compost socks withstand heavy machinery, but frequent disturbance can decrease the effectiveness of the sock.
- Mechanical compost spreaders for compost berms are commercially available and are widely used in the Pacific Northwest.
- When properly made, compost is full of nutrients and micro-organisms that stimulate turf and increase resistance to diseases. Compost binds heavy metals and can break down hydrocarbons into carbon, salts and other innocuous compounds.

Design Considerations

Compost filter berms and socks should be used at the base of slopes 2:1 or less. There are many types of compost, all with different properties, so it is best to determine what application the compost is being used for. For compost berms and socks, compost should have the following specifications:

- Compost needs to be stable and mature.
- Particle size: Compost should consist of both large and small pieces for maximum filtration. Finer grades (screened through 3/8-1/2") are better for vegetation establishment, long term plant nutrients, and increased infiltration rates. The coarser grades (screened 2-3") are better for increased filtration, and are less likely to be disturbed by rainfall and runoff. For berms, the ratio of coarse and fine material should be 1:1. No particle should be greater than 3".
- The recommended moisture content ranges from 20-50%. Compost that is too dry is harder to apply, while that which is too wet is heavier and harder to transport. In drier areas, use compost with a higher moisture content; in wet areas, use the drier compost, as it will absorb water.
- Organic matter content: The percentage of carbon based materials in finished compost should range between 40-70%. However, Texas DOT specifies no less than 70%.
- The pH should be between 5.0 and 8.5.
- Nitrogen Content: 0.5-2.0%.
- Compost should have a minimum of soluble salts, as these can inhibit vegetation establishment. These levels should be between 4.0 and 6.0 mmhos/cm.
- Compost must be weed and pesticide free, with manmade materials comprising less than 1%.

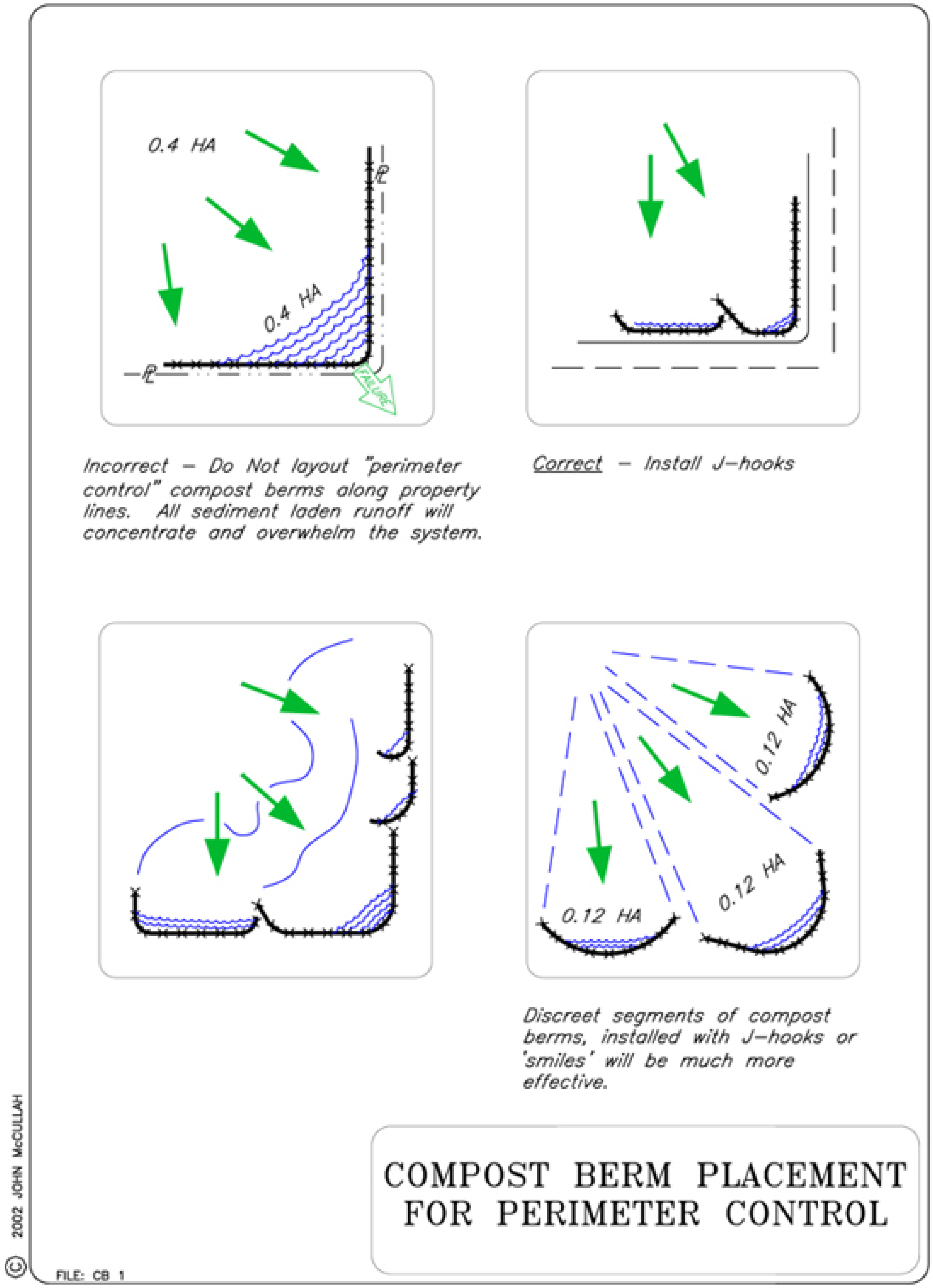
Construction Specifications

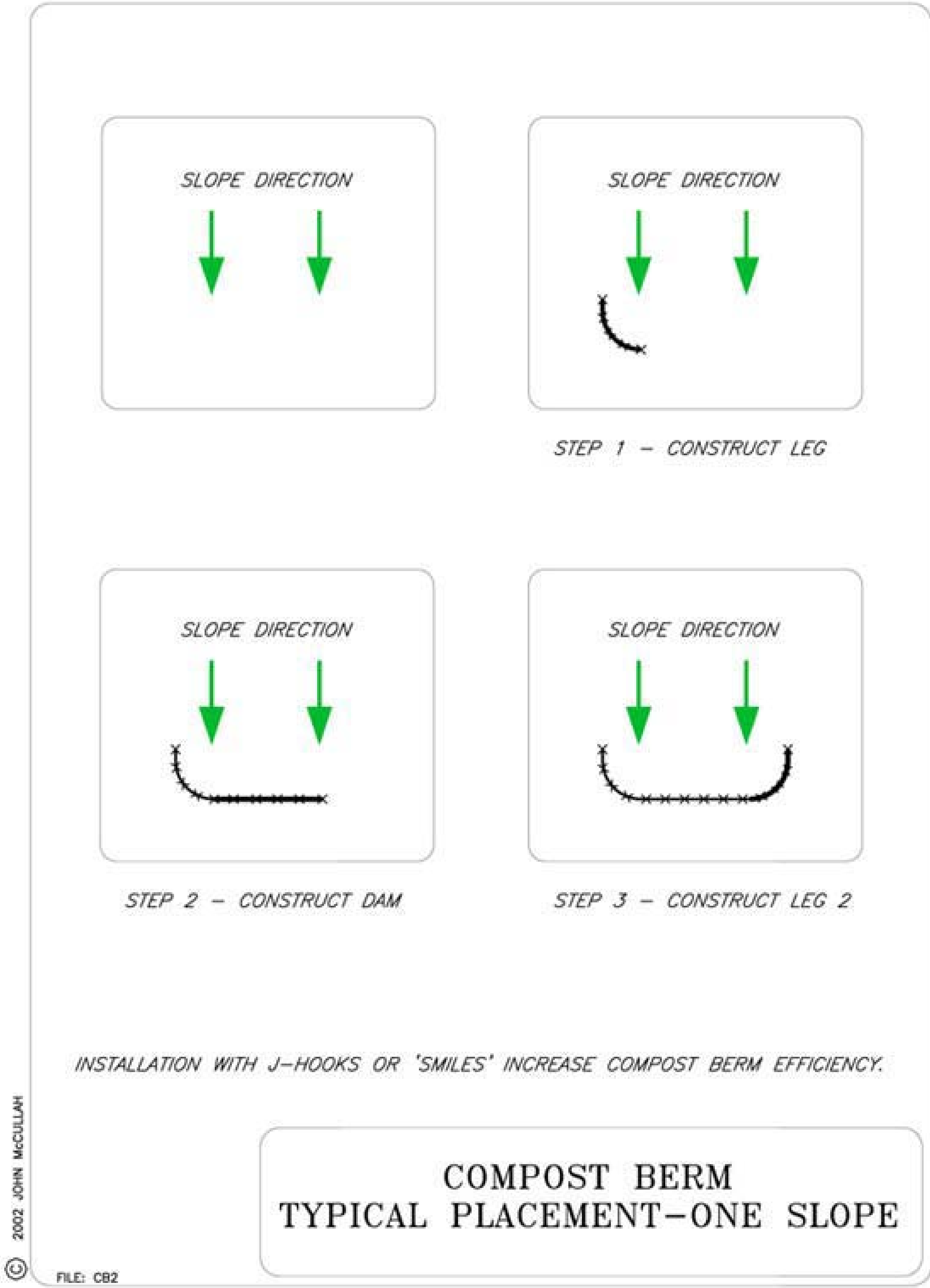
- For compost berms on slopes of 3:1 or less, install a compost berm 1-2 ft high and 2-4 ft wide at the base. For maximum filtration properties, install berm in a trapezoidal shape, with a 4-6 ft base, and a 2-3 ft wide top. Larger berms should be used for steeper slopes. The basic rule of thumb is that the base should be twice the height of the berm.
- Typically, compost socks can handle the same water flow or slightly more than sediment fence. However, the installation technique is especially important for them to work effectively. For most applications, standard sediment fence is replaced with 12" compost socks.
    - When placed on level contours sheet flow of water should be perpendicular to the compost sock at impact and un-concentrated.
    - Place compost socks at a 5' or greater distance away from the toe of slopes to maximize space available for sediment deposition.
    - In order to prevent water flowing around the ends of compost socks, point the ends upslope to place them at a higher elevation.

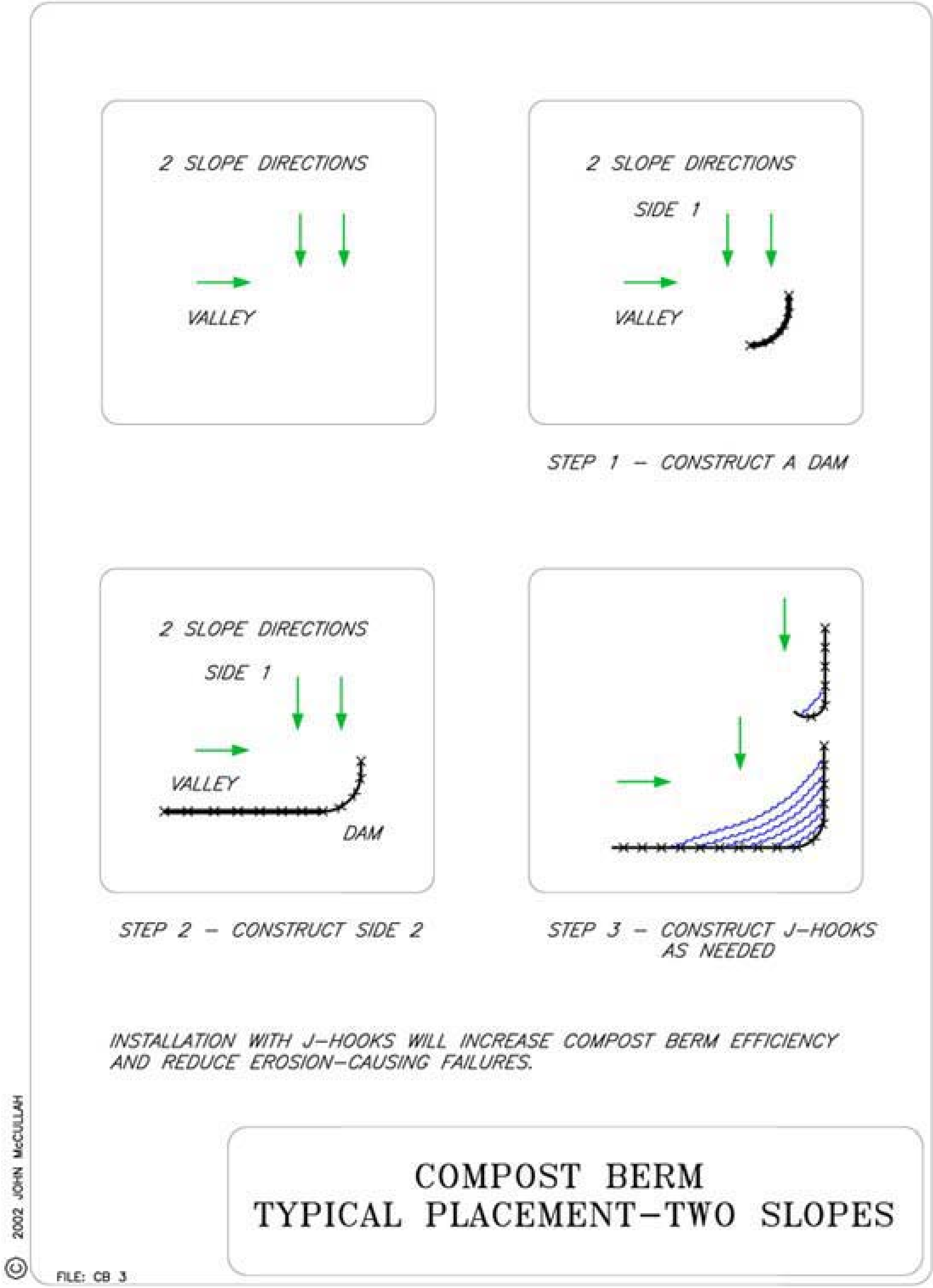
- Compost Berms and Socks can be placed around the perimeter of affected areas, if the area is flat or the perimeter is on contour. Berms and socks should be placed using 'smiles' and j-hooks. Do not place berms and socks where they cannot pond water.
- For steeper slopes, an additional berm or sock can be constructed on the top of the slope.
- Compost berms and socks can be seeded during application. However, field tests indicate that it is best to have only a thin layer of compost over the seed in compost berms. Slopes seeded with 2- 4" of compost over the seed had less vegetation establishment than slopes with less compost over the seed.
- Do not use compost berms and socks in areas of concentrated flow, as they are intended to control and filter sheet flow only.
- Tackifiers may be applied to berms if needed to enhance performance.

Inspection and Maintenance

- Compost berms and socks shall be inspected after each storm event and reapplied if necessary.
- Sediment retained by the berm or sock shall be removed when it has reached 1/3 of the exposed height of the berm. Alternatively, the sediment and berm or sock can be stabilized with vegetation at the end of construction.
- Berms can be left onsite and seeded, or spread out in place as a soil enhancement.


0.4 HA
0.4 HA
℄
℄
FAILURE
Incorrect – Do Not layout "perimeter control" compost berms along property lines. All sediment laden runoff will concentrate and overwhelm the system.
Correct – Install J–hooks
0.12 HA
0.12 HA
0.12 HA
Discreet segments of compost berms, installed with J–hooks or 'smiles' will be much more effective.
COMPOST BERM PLACEMENT FOR PERIMETER CONTROL
© 2002 JOHN McCULLAH
FILE: CB 1


SLOPE DIRECTION
SLOPE DIRECTION
STEP 1 – CONSTRUCT LEG
SLOPE DIRECTION
SLOPE DIRECTION
STEP 2 – CONSTRUCT DAM
STEP 3 – CONSTRUCT LEG 2
INSTALLATION WITH J–HOOKS OR 'SMILES' INCREASE COMPOST BERM EFFICIENCY.
COMPOST BERM
TYPICAL PLACEMENT–ONE SLOPE
© 2002 JOHN McCULLAH
FILE: CB2


2 SLOPE DIRECTIONS
VALLEY
2 SLOPE DIRECTIONS
SIDE 1
VALLEY
STEP 1 – CONSTRUCT A DAM
2 SLOPE DIRECTIONS
SIDE 1
VALLEY
DAM
STEP 2 – CONSTRUCT SIDE 2
STEP 3 – CONSTRUCT J–HOOKS AS NEEDED
INSTALLATION WITH J–HOOKS WILL INCREASE COMPOST BERM EFFICIENCY AND REDUCE EROSION–CAUSING FAILURES.
COMPOST BERM
TYPICAL PLACEMENT–TWO SLOPES
© 2002 JOHN McCULLAH
FILE: CB 3

Construction Specifications

Fiber rolls are manufactured from biodegradable fibers (such as weed-free rice straw) that are wrapped in photo degradable netting. They range from approximately 8 to 20 inches in diameter by 25-30 feet (8-9 m) long. Rolls are placed and staked along the contour of newly constructed or disturbed slopes, in shallow trenches. Fiber rolls reduce slope length, and are intended to capture and keep sediment on the slopes. Fiber rolls are useful to temporarily stabilize slopes by reducing soil creep, and sheet and rill erosion until permanent vegetation can be established. Fiber rolls can catch soil that is moved down the slope by the freeze/thaw processes. Organic matter and seeds are trapped behind the rolls, which provide a stable medium for germination. Rolls trap topsoil and retain moisture from rainfall, which aids in growth of seedlings planted upslope of the rolls.

Design Considerations:

- Sites appropriate for fiber rolls are:
    - Slopes susceptible to sheet and rill erosion.
    - Slopes producing dry ravel.
    - Slopes susceptible to freeze/thaw activity.
    - Slopes difficult to vegetate because of soil movement.
- Fiber rolls are not intended for use in concentrated flow situations.
- It is imperative, especially on steeper slopes, that a sufficiently deep trench is constructed in which to place the roll. Without the trench, the roll will not function properly, runoff will scour underneath it, and trees or shrubs planted behind the roll will not have a stable environment in which to become established.
- Fiber rolls last an average of two years, depending on the fiber and mesh used in manufacturing. This is an important factor to consider when planning how long the slope will need to be mechanically stabilized.
- Fiber rolls can be staked with live stakes if site conditions warrant. The moisture retained by the fiber roll will encourage cutting establishment.

Advantages

- Fiber rolls are a relatively low-cost solution to sheet and rill erosion problems.
- They can replace sediment fences or straw bales on steep slopes.
- Rolls are a short-term solution to help establish native vegetation.
- Rolls store moisture for vegetation planted immediately upslope.
- Plastic netting will eventually photo-degrade, eliminating the need for retrieval of materials after the fiber or straw has broken down.

- The fibers become incorporated into the soil with time, adding organic material to the soil and retaining moisture for vegetation.

Disadvantages

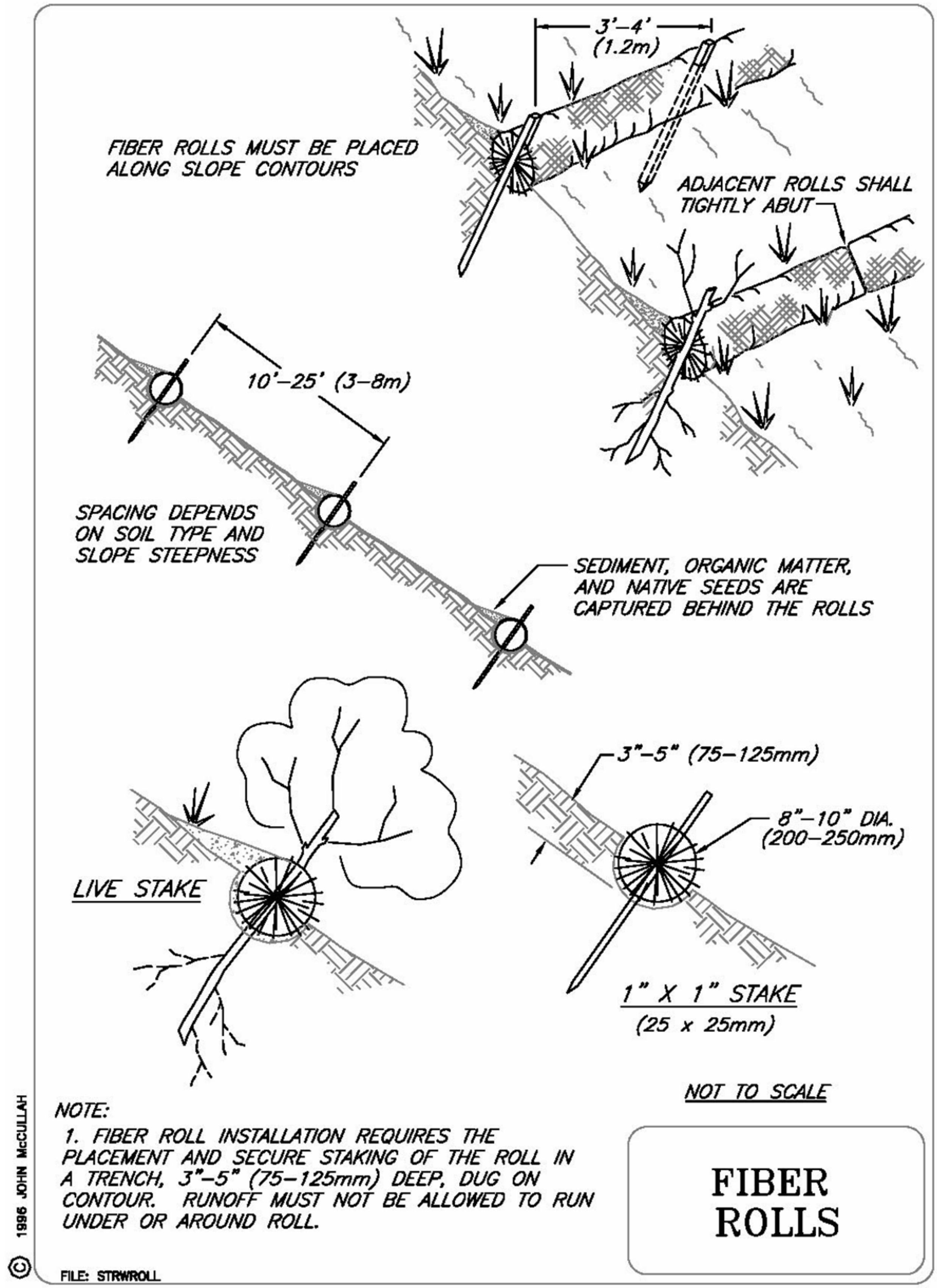
- Rolls only function for one or two seasons.
- Pilot holes through the rolls must be pre-driven with a metal rod.
- If not installed properly with a sufficient trench, rolls may fail during the first rain event.
- Fiber rolls may require maintenance to ensure that the stakes are holding and the rolls are still in contact with the soil. This is especially true on steep slopes in sandy soil.

Installation

- Prepare the slope before the installation procedure is started.
- Shallow gullies should be smoothed as work progresses.
- Dig small trenches across the slope on contour, to place rolls in. The trench should be deep enough to accommodate half the thickness of the roll. When the soil is loose and uncompacted, the trench should be deep enough to bury the roll 1/3 of its thickness because the ground will settle.
- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- Construct trenches at contour intervals 25-30 feet (8-10 m) apart depending on the steepness of the slope. The steeper the slope, the closer together the trenches should be.
- Lay the roll along the trenches fitting it snugly against the soil. Make sure no gaps exist between the soil and the straw wattle.
- Use a straight bar to drive holes through the roll and into the soil for the willow or wooden stakes.
- Drive the stake through the prepared hole, and into the soil. Leave only 1 or 2 inches (25 or 51 mm) of the stake exposed above roll.
- Install stakes at least every 4 feet (1.2 m) apart along the length of the wattle. Additional stakes may be driven on the downslope side of the trenches on highly erosive or very steep slopes.

Inspection and Maintenance

- Inspect the rolls and the slopes after rain events and at the frequencies required by local municipalities. Make sure the rolls are in contact with the soil.
- Repair any rills or gullies promptly.
- Reseed or replant vegetation if necessary until the slope is stabilized.


3'–4'
(1.2m)
FIBER ROLLS MUST BE PLACED
ALONG SLOPE CONTOURS
ADJACENT ROLLS SHALL
TIGHTLY ABUT
10'–25' (3–8m)
SPACING DEPENDS
ON SOIL TYPE AND
SLOPE STEEPNESS
SEDIMENT, ORGANIC MATTER,
AND NATIVE SEEDS ARE
CAPTURED BEHIND THE ROLLS
3"–5" (75–125mm)
8"–10" DIA.
(200–250mm)
LIVE STAKE
1" X 1" STAKE
(25 x 25mm)
NOT TO SCALE
NOTE:
1. FIBER ROLL INSTALLATION REQUIRES THE PLACEMENT AND SECURE STAKING OF THE ROLL IN A TRENCH, 3"–5" (75–125mm) DEEP, DUG ON CONTOUR. RUNOFF MUST NOT BE ALLOWED TO RUN UNDER OR AROUND ROLL.
FIBER
ROLLS
© 1996 JOHN McCULLAH
FILE: STRWROLL

Construction Specifications:

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

Methods and Installation

- DI Protection Type 1 - Filter Fabric Fence - The filter fabric fence (Type 1) protection is illustrated on Page 3. Similar to constructing a sediment fence. See BMP SC-1, "Sediment 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.
- DI Protection Type 2 - Excavated Drop Inlet Sediment Trap - The excavated drop inlet sediment trap (Type 2) is illustrated in Page 4. Similar to constructing a temporary sediment fence, See BMP SC-1, "Sediment Fence." Size excavated trap to provide a minimum storage capacity calculated at the rate of 67 yd^3/ac (130 m^3/ha) of drainage area.
- DI Protection Type 3 – Gravel bag - The gravel bag barrier (Type 3) is illustrated in Page 5. Flow from a severe storm shall 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 BMP SC-3, "Gravel Bag Berm." Gravel bags shall be used due to their high permeability.
- DI Protection Type 4 –Fiber Rolls – Fiber roll (Type 4) is placed around the inlet and keyed and anchored to the surface similar to SC-7 ("Fiber Rolls") installation. Fiber rolls are intended for use as inlet protection where the area around the inlet is unpaved and the fiber roll can be secured to the surface. On impervious surfaces use weighted or gravel-filled fiber rolls in the same configuration as specified above or as specified by the manufacturer. Type 4 DI protection functions similarly to Types 1 and 2.

Minimum BMP standards are provided on the following details. The DI Protection (Types 1-4) as illustrated was not designed to significantly inhibit flow and cause flooding. If flooding problems occur, modify the existing BMP to alleviate flooding. Do not remove the BMP and allow sediment-laden water to discharge to the storm drain.

Alternative methods may be substituted for the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices based on review and approval by DEQ or the local agency as submitted in the project ESCP. Typical installation details for Siltsack™ inserts and biofilter bags are included with this BMP.

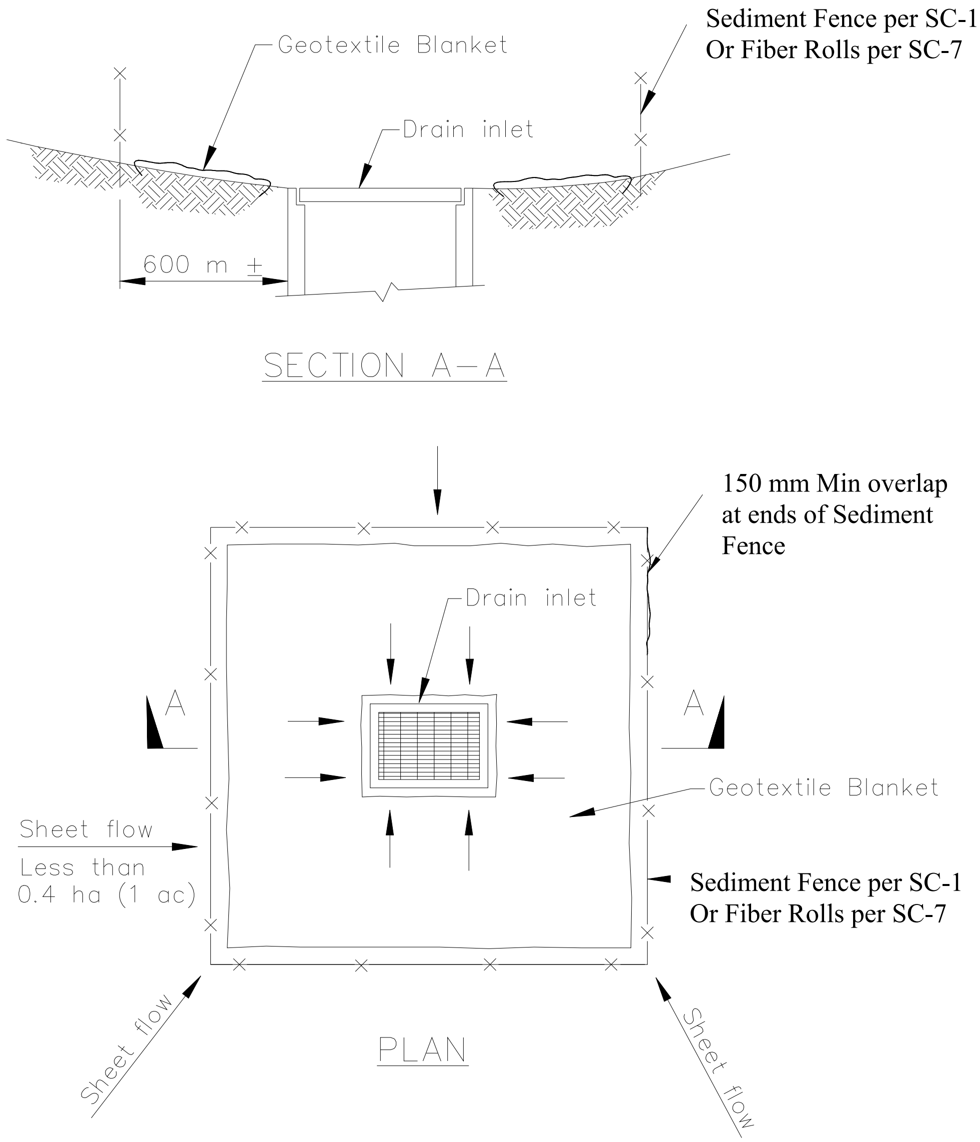
Inspection and Maintenance:

General

- Inspect all inlet protection devices before and after every rain event, and at the frequencies recommended by local municipalities. During extended rain events, inspect inlet protection devices at least once every 24 hours.
- Inspect the storm drain inlet after severe storms in the rainy season to check for bypassed material.
- Remove all inlet protection devices after the site is stabilized, or when the inlet protection is no longer needed.
    - Bring the disturbed area to final grade and smooth and compact it. Appropriately stabilize all bare areas around the inlet.
    - Clean and re-grade 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.

Requirements by Method

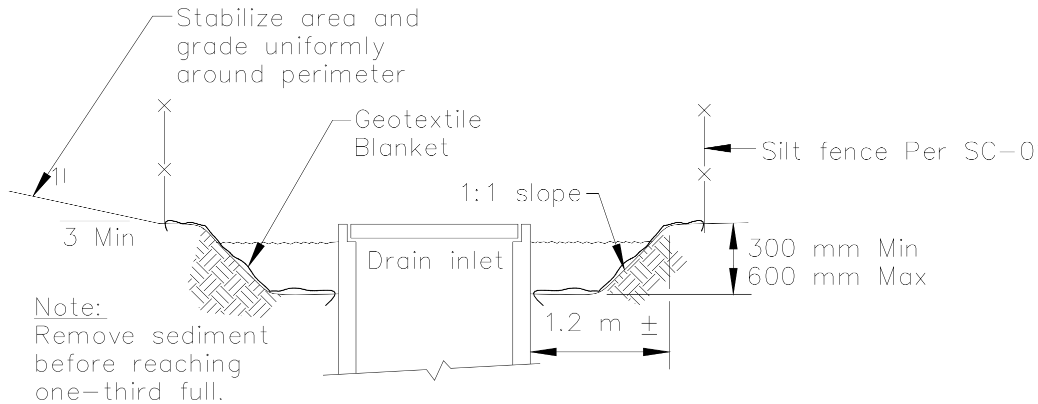
- Type 1 - Filter Fabric Fence
  - This method shall be used for drain inlets requiring protection in areas where finished grade is established and erosion control seeding has been applied or is pending.
  - Make sure the stakes are securely driven in the ground and are structurally sound (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.
  - Replace or clean the fabric when the fabric becomes clogged with sediment. Make sure the fabric does not have any holes or tears. Repair or replace fabric as needed.
  - At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height. Removed sediment shall be incorporated in the project or disposed of properly.
- Type 2 – Excavated Drop Inlet Sediment Trap
  - This method may be used for drain inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas are subject to grading.
  - Remove sediment from basin when the volume of the basin has been reduced by one-half.
- Type 3 - Gravel Bag Barrier
  - This method may be used for drain inlets surrounded by asphalt concrete (AC) or paved surfaces.
  - Inspect bags for holes, gashes, and snags.
  - Check gravel bags for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier. Removed sediment shall be incorporated in the project or disposed of properly
- Type 4 Fiber Rolls
  - This method may be used for drain inlets requiring protection in areas that have been cleared and grubbed, and where exposed soil areas subject to grading.
  - Use weighted or gravel-filled fiber rolls on impervious surfaces. Check that fiber rolls are in good contact with the surface without gaps or preferential flow paths.
  - Check fiber roll for proper arrangement and displacement. Remove the sediment behind the barrier when it reaches one-third the height of the barrier. Removed sediment shall be incorporated in the project or disposed of properly.



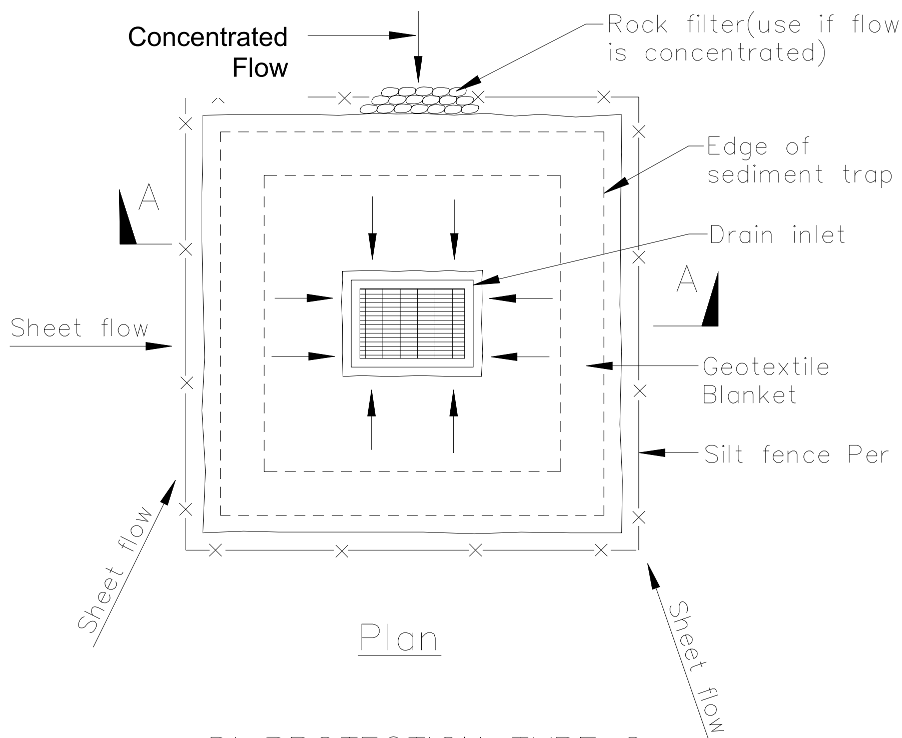
DI PROTECTION TYPE 1 AND TYPE 4
Not to scale

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.



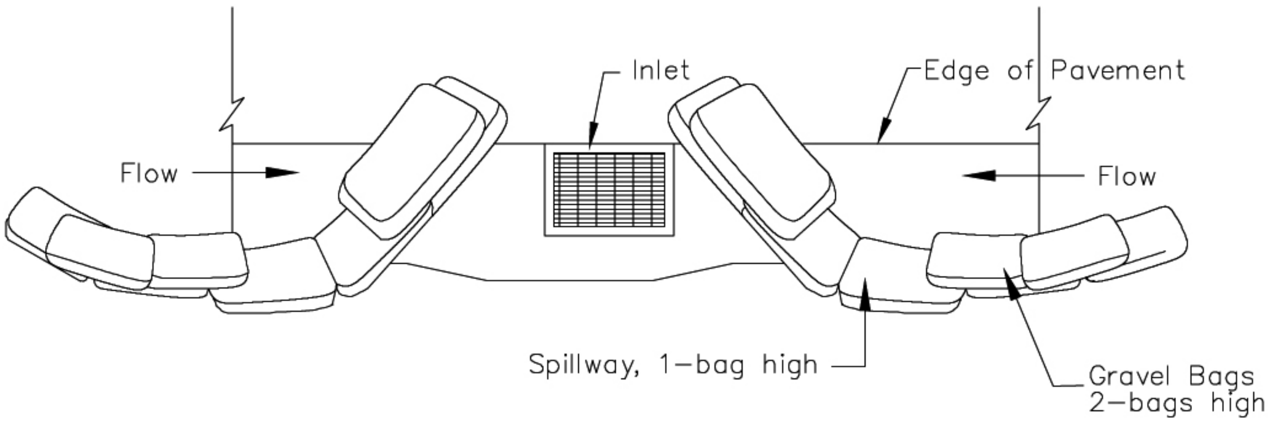
Section A–A



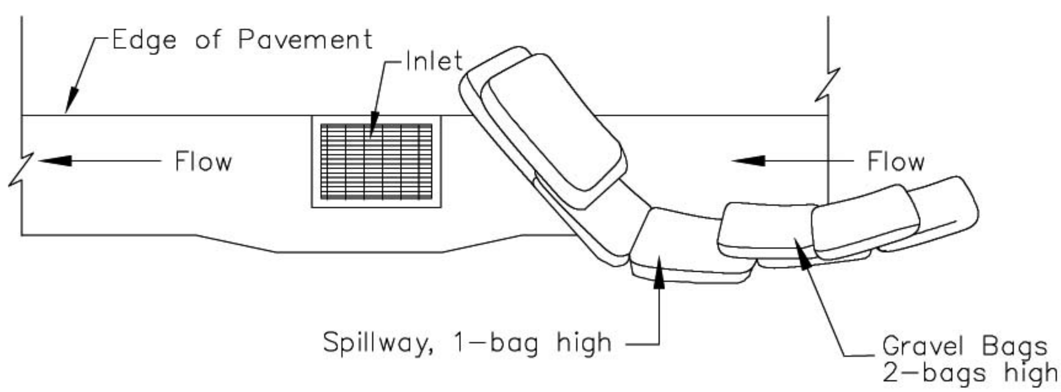
Plan

DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape 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.



TYPICAL PROTECTION FOR INLET WITH OPPOSING FLOW DIRECTIONS

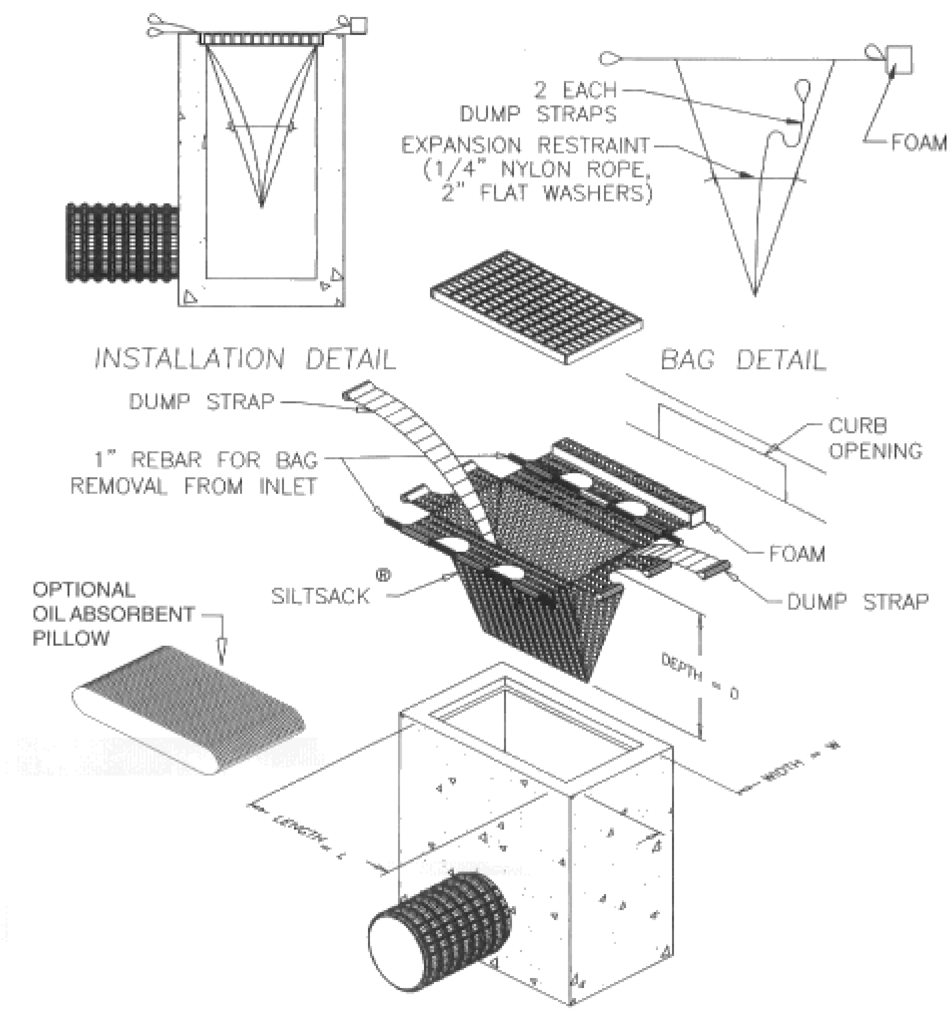


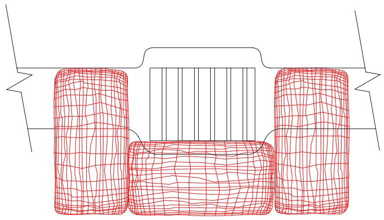
TYPICAL PROTECTION FOR INLET WITH SINGLE FLOW DIRECTION

NOTES:

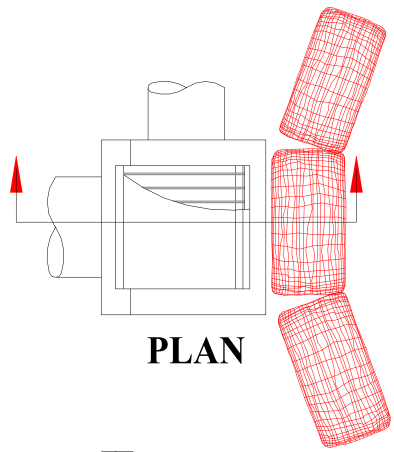
1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

Typical Siltsack® Construction

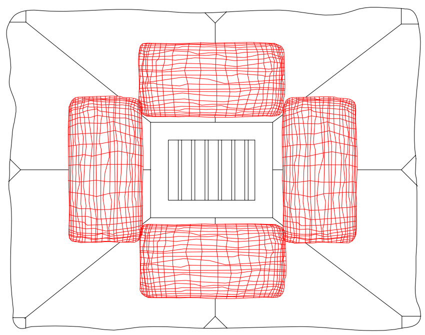




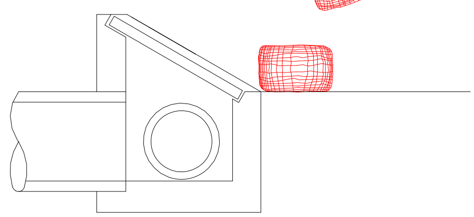
CATCH BASIN



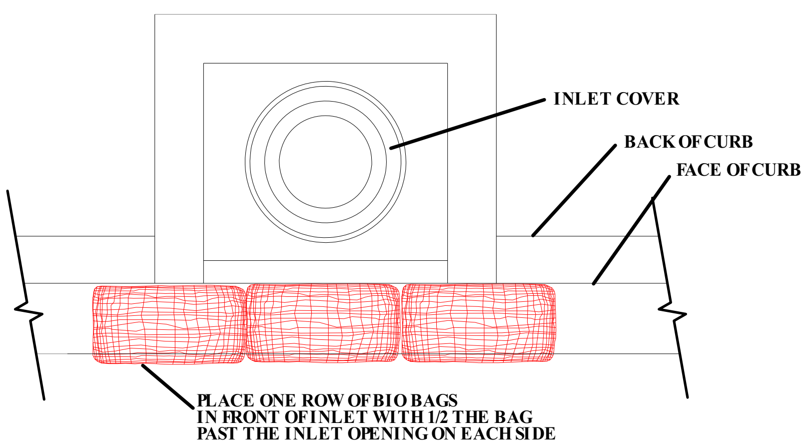
PLAN



AREA DRAIN



DITCH INLET



CURB INLET CATCH BASIN
BIO BAG INLET PROTECTION

NTS

Construction Specifications:

A sediment basin is a temporary basin with a controlled release structure, formed by excavating or constructing an earthen embankment across a waterway or low drainage area. Sediment basins may be placed where sediment laden storm water may enter a storm drain or watercourse, and around and/or up-slope from storm drain inlet protection measures. The sediment basin shall follow one of the four design options summarized below:

1. A sediment basin designed pursuant to local ordinance provided that the design efficiency is as protective, or more protective of water quality than Option No. 3.
2. A sediment basin designed with a minimum capacity of 3,600 cubic feet of storage per acre of disturbed land in a watershed equivalent to or more efficient than Option No. 3.
3. A sediment basin designed using the following equation:

   $(V) = 1.2Q/Vs_{ED}$ where:

   V = settling zone volume,

   Q = flow rate based on peak discharge from a specified design storm (where Q = CiA; see Section 2.4), and

   Vs_{ED} = settling velocity of the design soil particle.
4. A basin designed using an equivalent surface area design equation, equivalent to or more efficient than Option No. 3.

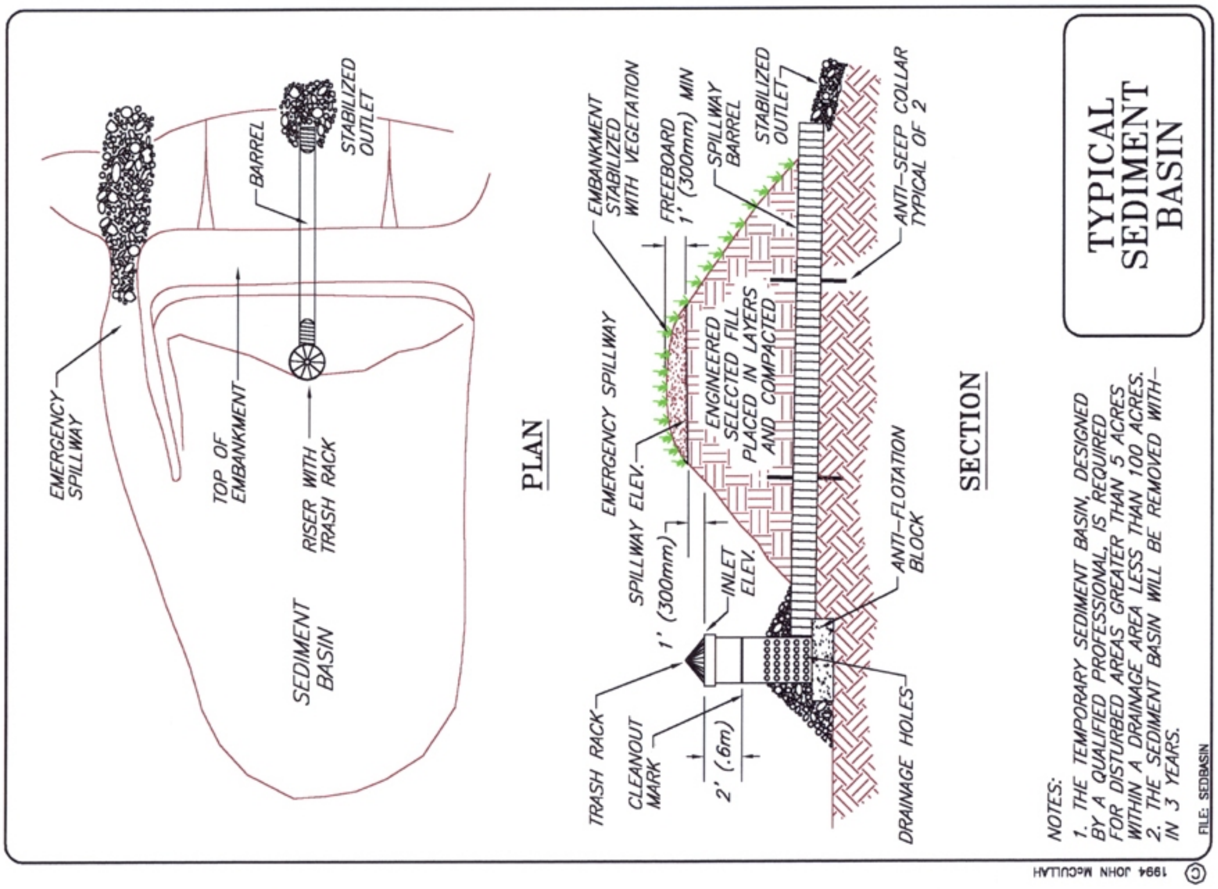
- In accordance with the requirements of the NPDES 1200-C General Permit, all sediment basins must be designed by a professional engineer licensed in Oregon.
- Construct the basin by excavating or building an embankment before any clearing or grading work begins.
- Areas under the embankment and any structural works shall be cleared, grubbed and stripped of any vegetation and rootmat as shown on the grading plan.
- In order to facilitate cleanout and restoration, the basin area shall be cleared, grubbed and stripped of any vegetation.
- A cut-off trench shall be excavated along the centerline of the earth fill embankments. The minimum depth shall be 2 feet (0.6 m). The cut-off trench shall extend up both abutments to the spillway elevation.
- Fill material for the embankment shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks or other objectionable material, and sufficiently moist for compaction.
- Fill material shall be placed in 6 inch (0.2 m) lifts, continuous layers over the entire length of the fill. Compaction shall be obtained by routing the hauling equipment over the fill so that the entire surface of each layer of the fill is traversed by at least one wheel or tread track of the equipment, or by the use of a compactor.
- The embankment should be constructed to an elevation of 10 percent higher than the design height to allow for settlement if compacting is achieved with hauling equipment. If compactors are used for compacting, the overbuild may be reduced to not less than 5 percent. The basin shall have means for dewatering within 7 days following a storm event.
- The principal spillway riser shall be securely attached to the discharge pipe by welding all around. All connections shall be watertight. A trash rack shall be installed on the top of the riser to prevent clogging of the discharge pipe.

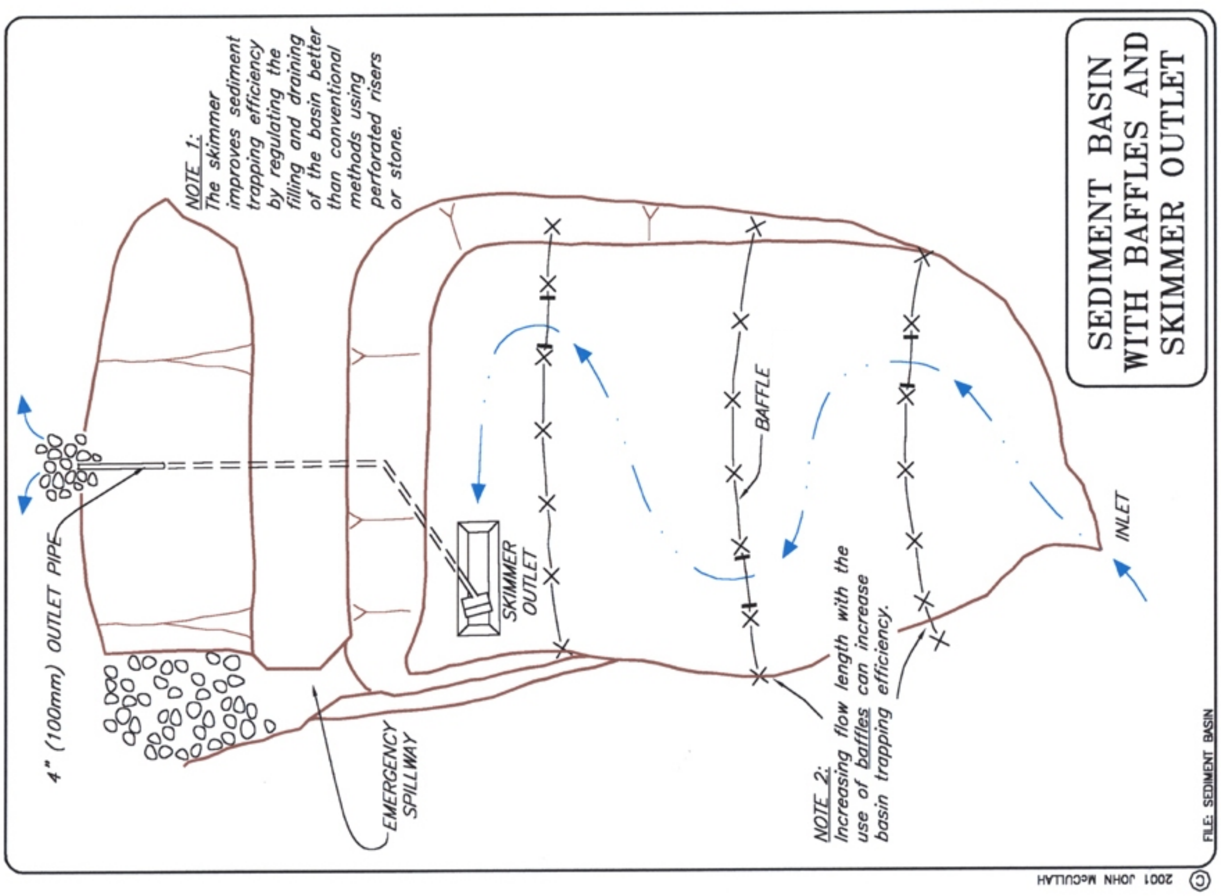
- The pipe and riser shall be placed on a firm, smooth soil foundation. The connection between the riser and the riser base shall be watertight. Pervious materials such as sand, gravel or crushed stone shall not be used as backfill around the pipe or anti-seep collars.
- The fill material around the pipe spillway shall be placed in 4-inch (101 mm) layers and compacted under the shoulders and around the pipe to at least the same density as the adjacent embankment. A minimum of 2 feet (0.6 m) of compacted backfill shall be placed over the pipe spillway before crossing it with construction equipment.
- Steel base plates shall have at least 2 1/2 feet (0.8 m) of compacted earth, stone or gravel over them to prevent flotation.
- The emergency spillway shall not be installed in fill. Elevations, design width, and entrance and exit channel slopes are critical to the successful operation of the emergency spillway.
- If used, baffles shall be constructed of 4 inch (101 mm) by 4 inch (101 mm) posts and of 4 foot (1.2 m) by 8 foot (2.4 m) - 1/2inch (12.7 mm) exterior plywood. The posts shall be set at least 3 feet (0.9 m) into the ground, no further apart than 8 feet (2.4 m) center to center, and shall reach a height 6 inches (0.2 m) below the riser crest elevation. Alternatively, earthen berms, metal sheeting, or other methods may be used as approved by DEQ or the local agency in the project ESCP.
- The embankment and emergency spillway shall be stabilized with vegetation immediately following construction. The outflow shall be provided with outlet protection to prevent erosion and scour of the embankment and channel.
- Construction operations shall be carried out in such a manner that erosion and water pollution will be minimized.
- Local and state requirements shall be met concerning fencing and signs warning the public of hazards of soft sediment and floodwater.

Minimum BMP standards are provided on the following details.

Inspection and Maintenance:

- Inspect before during, and after each rain event.
- All damages caused by soil erosion or construction equipment shall be repaired before the end of each working day.
- Remove sediment when the sediment storage zone is half full. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.
- When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankment and resulting sediment deposit shall be leveled or otherwise disposed of in accordance with the approved erosion and sediment control plan.


TYPICAL SEDIMENT BASIN
PLAN
SEDIMENT BASIN
RISER WITH TRASH RACK
TOP OF EMBANKMENT
EMERGENCY SPILLWAY
BARREL
STABILIZED OUTLET
SECTION
TRASH RACK
CLEANOUT MARK
2' (.6m)
1' (300mm)
SPILLWAY ELEV.
INLET ELEV.
EMERGENCY SPILLWAY
EMBANKMENT STABILIZED WITH VEGETATION
FREEBOARD 1' (300mm) MIN
SPILLWAY BARREL
STABILIZED OUTLET
ENGINEERED SELECTED FILL PLACED IN LAYERS AND COMPACTED
DRAINAGE HOLES
ANTI-FLOTATION BLOCK
ANTI-SEEP COLLAR TYPICAL OF 2
NOTES:
1. THE TEMPORARY SEDIMENT BASIN, DESIGNED BY A QUALIFIED PROFESSIONAL, IS REQUIRED FOR DISTURBED AREAS GREATER THAN 5 ACRES WITHIN A DRAINAGE AREA LESS THAN 100 ACRES.
2. THE SEDIMENT BASIN WILL BE REMOVED WITHIN 3 YEARS.
FILE: SEDBASIN
© 1994 JOHN McCULLAH


SEDIMENT BASIN WITH BAFFLES AND SKIMMER OUTLET
4" (100mm) OUTLET PIPE
EMERGENCY SPILLWAY
SKIMMER OUTLET
BAFFLE
INLET
NOTE 1: The skimmer improves sediment trapping efficiency by regulating the filling and draining of the basin better than conventional methods using perforated risers or stone.
NOTE 2: Increasing flow length with the use of baffles can increase basin trapping efficiency.
FILE: SEDIMENT BASIN
© 2001 JOHN McCULLAH

ENTRANCE / EXIT TRACKING CONTROLS – SC-10

Tracking controls reduce offsite tracking of sediment and other pollutants by providing a stabilized entrance at defined construction site entrances and exits and/or providing methods to clean-up sediment or other materials to prevent them from entering a storm drain by sweeping or vacuuming.

Construction Specifications:

- Stabilize entrances should be implemented on a project-by-project basis in addition to other BMPs.
- Sweeping or vacuuming should be implemented when sediment is tracked from the project site onto public or private paved roads, typically at points of site exit.
- Use stabilized entrances and/or sweeping at construction sites:
  - Where dirt or mud is tracked onto public roads;
  - Adjacent to water bodies;
  - Where poor soils are encountered, such as soils containing clay;
  - Where dust is a problem during dry weather conditions.

Stabilized Construction Entrances

- Limit the points of entrance/exit to the construction site by designating combination or single purpose entrances and exits. Require all employees, subcontractors and others to use them. Limit speed of vehicles to control dust. Clearly mark entrances and exits with appropriate signage.
- Locate construction entrances and exits to limit sediment leaving the site and to provide for maximum utility by all construction vehicles. Avoid entrances which have steep grades and entrances at curves in public roads.
- Grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions.
- Use of constructed or constructed/manufactured steel plates with ribs (e.g., shaker / rumble plates or corrugated steel plates) for entrance/exit access is allowable (See below).
- The aggregate size for construction of the pad shall be 3-6 inch (76-152 mm) stone. Place the gravel to the specific grade and dimensions shown on the plans, and smooth it.
- The thickness of the pad shall not be less than 8 inches (203 mm). Use geotextile fabric, if necessary, to improve stability of the foundation in locations subject to seepage or high water table.
- The width of the pad shall not be less than the full width of all points of ingress or egress and in any case shall not be less than 12 feet (3.6 m) wide.
- The length of the pad is as required, but not less than 50 feet (15.2 m).
- All sediment spilled, dropped, washed or tracked onto public rights-of-way shall be removed as soon as possible by hand sweeping or mechanized sweeper. Washing of sediment from the public right-of-way shall be prohibited.
- Provide drainage to carry water to a sediment trap or other suitable outlet.
- When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public rights-of-way (see SC-11, Entrance / Exit Tire Wash).
- All sediment shall be reduced or prevented from entering any storm drain, ditch or watercourse through use of sediment fence, gravel bags, sediment barriers, or other approved methods.

Minimum BMP standards are provided on the following detail.

Entrance with Shaker Plates

- Incorporate with a stabilized construction entrance/exit.
- Construct on level ground when possible, on a pad of coarse aggregate, greater than 3 inches (76 mm) and smaller than 6 inches (150 mm). A geotextile fabric shall be placed below the aggregate.
- Install constructed or manufactured steel plates with ribs (e.g., rumble plates or corrugated steel plates) at the entrance/exit in addition to the aggregate.
- Steel shaker plates shall be designed and constructed/manufactured for anticipated traffic loads.

Street Sweeping and Vacuum Sweeping

- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed as needed. Manual sweeping is appropriate for small jobs.
- For larger projects, it is preferred to use mechanical broom or vacuum sweepers that collect and contain removed sediment and material.

If not mixed with debris or trash, incorporate the removed sediment back into the project or depose of it at an approved disposal site.

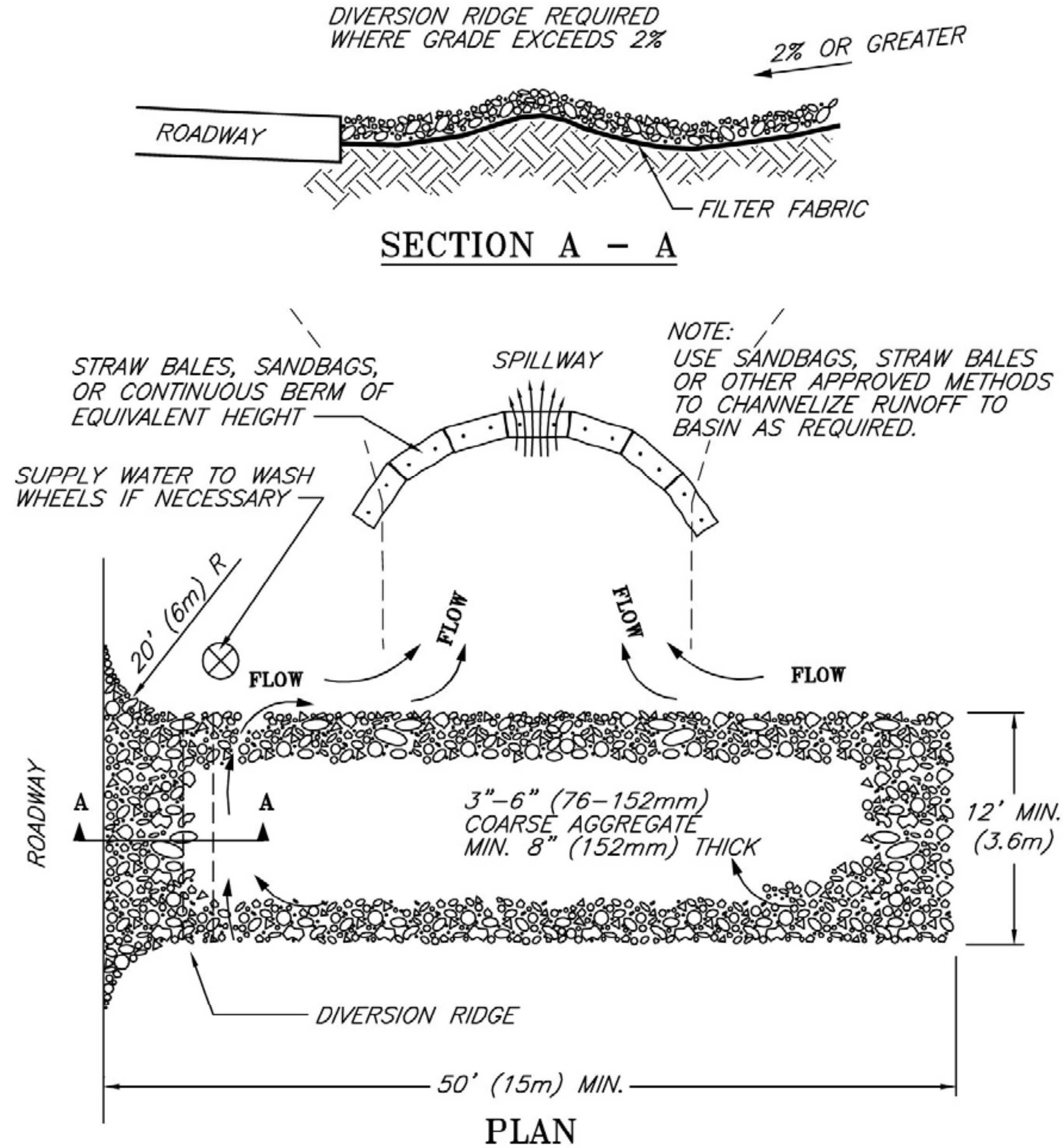
Inspection and Maintenance:

Stabilized Construction Entrance

- Inspect routinely for damage and assess effectiveness. Repair if access is clogged with sediment.
- Where tracking has occurred on roadways sweeping should be conducted the same day. Preferably water should not be used to wash sediment off the streets. If water is used, it should be captured preventing sediment-laden water from running off the site.
- Keep all temporary roadway ditches clear.
- The entrance shall be maintained in a condition that will reduce or prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand, and repair and/or maintenance of any measures used to trap sediment.
- Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. Replace gravel material when surface voids are visible.
- After each rainfall, inspect all gravel construction entrances and clean it out as necessary.
- As soon as possible remove all objectionable materials spilled, washed, or tracked onto public roadways. Remove all sediment deposited on paved roadways immediately.

Street Sweeping and Vacuuming

- Inspect entrance and exit points daily and sweep tracked sediment as needed.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- After sweeping is finished, properly dispose of sweeper wastes.



NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT–OF–WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEAN OUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT–OF–WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.

TEMPORARY GRAVEL CONSTRUCTION ENTRANCE/EXIT

FILE: ENTRANCE

Construction Specifications:

- Incorporate with a stabilized construction entrance/exit. See BMP SC-10, "Entrance / Exit Tracking Controls."

Manual/Hose Tire Wash

- Construct on level ground when possible, on a pad of coarse aggregate, greater than 3 inches (75 mm) and smaller than 6 inches (150 mm). A geotextile fabric shall be placed below the aggregate.
- Tire wash shall be designed and constructed/manufactured for anticipated traffic loads.
- Provide a drainage conveyance that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch shall be of sufficient grade, width, and depth to carry the wash runoff.
- Require that all employees, subcontractors, and others that leave the site with mud-caked tires and/or under-carriages use the wash facility.

Temporary Drive-Through Tire Wash

- Minimum dimensions: 40 feet by 12 feet by 1.5 feet (length, width, and sump depth; 12.2 m by 3.7 m by 0.46 m). The minimum length includes ingress and egress from the sump.
- The aggregate size for construction of the pad shall be 4-6 inch (101-152 mm) stone. Place the gravel to the specific grade and dimensions shown on the plans, and smooth it.
- The thickness of the pad shall not be less than 8 inches (203 mm). Use geotextile fabric under the gravel to improve stability of the foundation.
- Alternatively, install a 3 in. asphalt lift over a stable roadway base with the same dimensions identified above.
- The run out pad should extend 50 feet (15.2 m) past the egress ramp and drain back into the sump or to a suitable collection and treatment facility.
- Install fencing, as necessary, to manage vehicle traffic.

Minimum BMP standards are provided on the following illustrations.

Inspection and Maintenance:

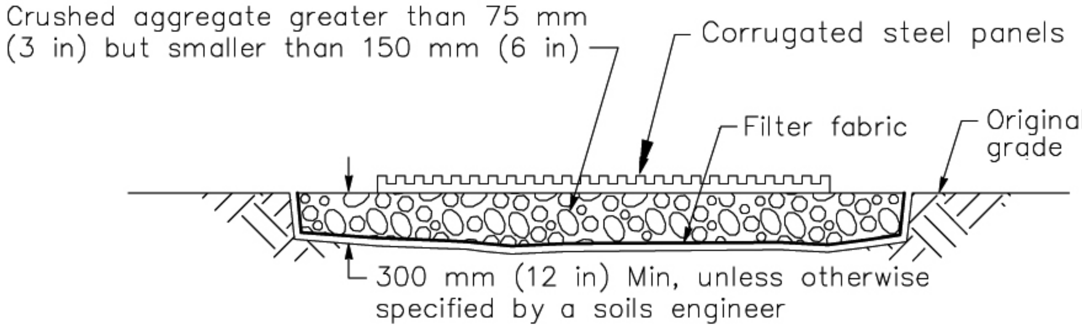
Manual/Hose Tire Wash

- Remove accumulated sediment in tire wash and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

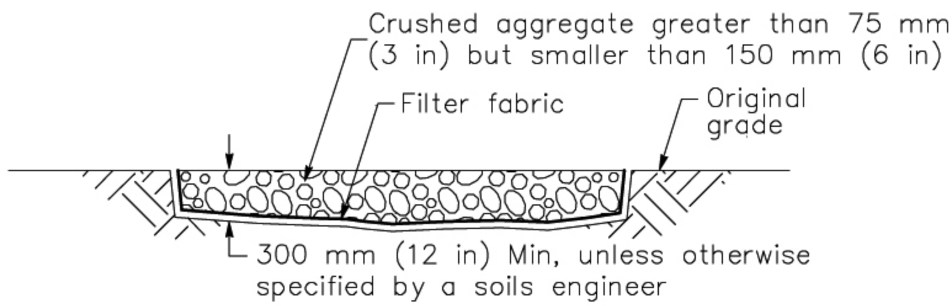
Temporary Drive-Through Tire Wash

- Inspect routinely to assess the water levels within the sump, the depth of accumulated sediment, and identify any areas that require maintenance.
- Remove accumulated sediment from the tire wash facility to maintain tire wash sump depth. Sediment may be pumped, piped or vacuumed to a suitable collection and treatment facility.
- Clean or replace rock when clogged with sediment and re-grade as needed.
- Maintain the run-out pad as necessary to prevent sediment accumulation.
- Immediately remove any rock that is carried from the pad to the roadway.
- Ensure that wash water drainage, collection and treatment system is functioning.

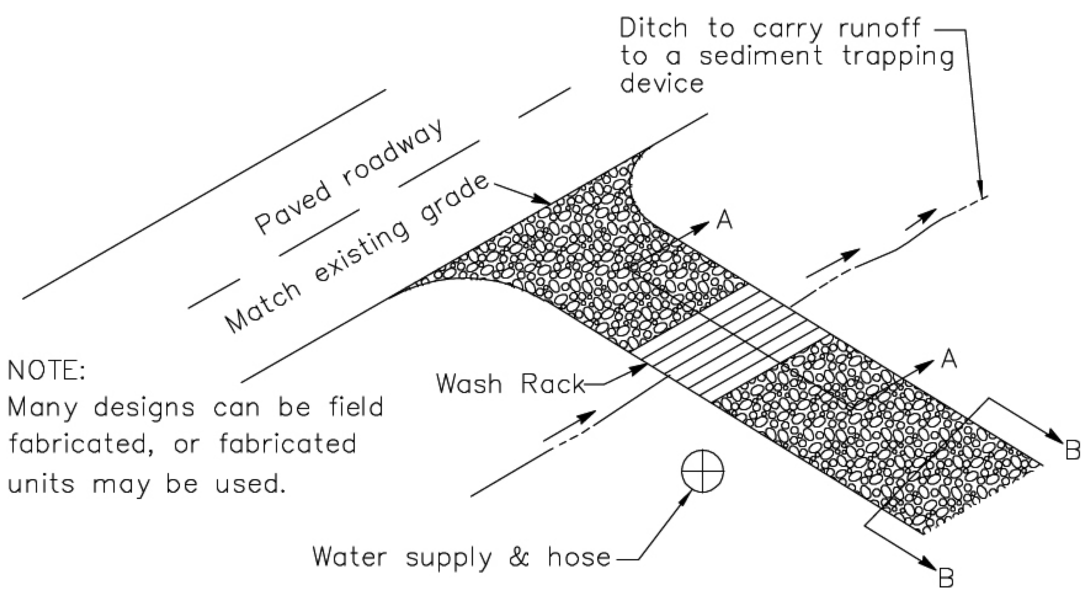
ENTRANCE / EXIT TIRE WASH – SC-11



SECTION A–A
NOT TO SCALE

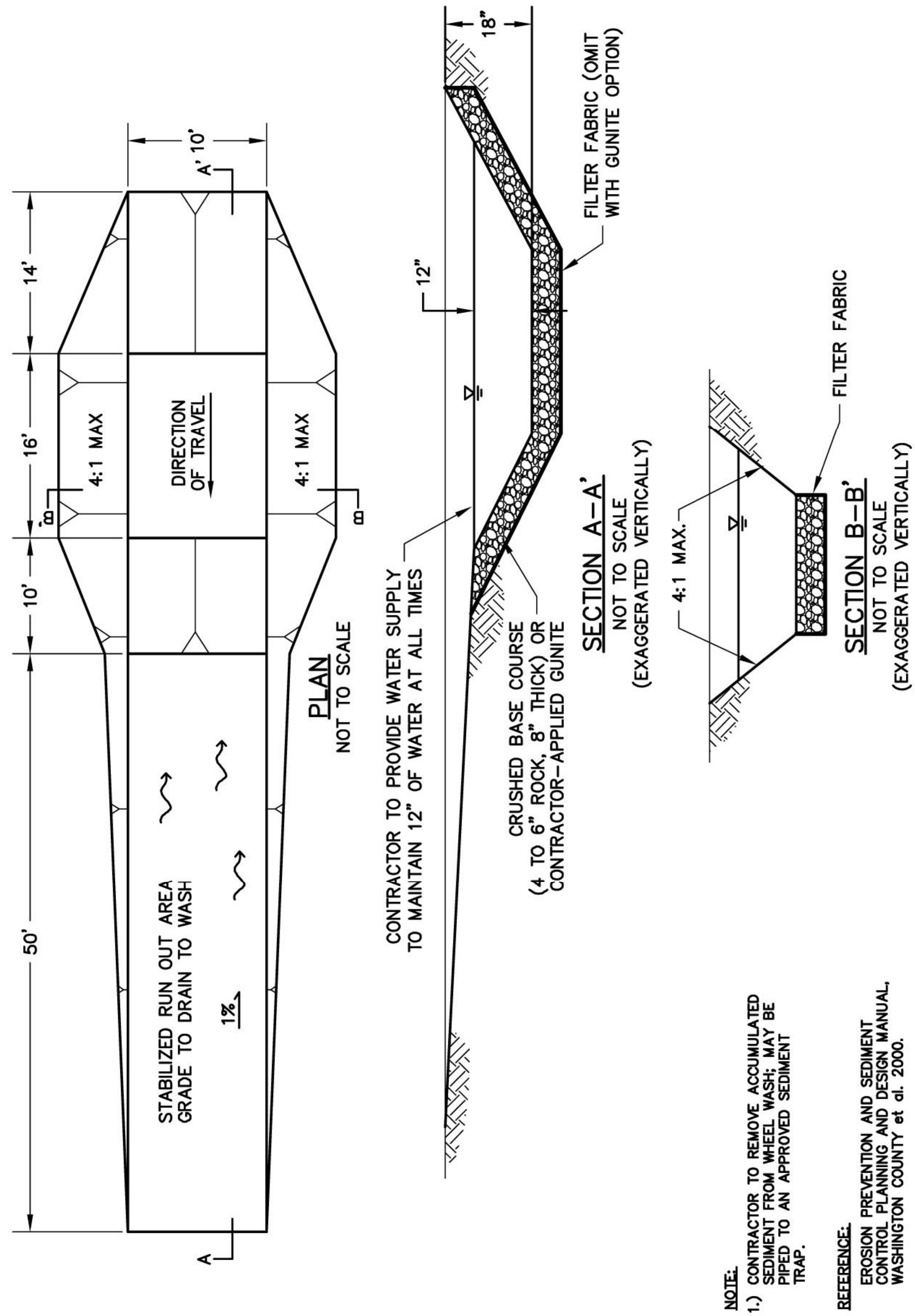


SECTION B–B
NTS



TYPICAL TIRE WASH
NOT TO SCALE

MANUAL / HOSE TIRE WASH



TEMPORARY DRIVE THROUGH TIRE WASH

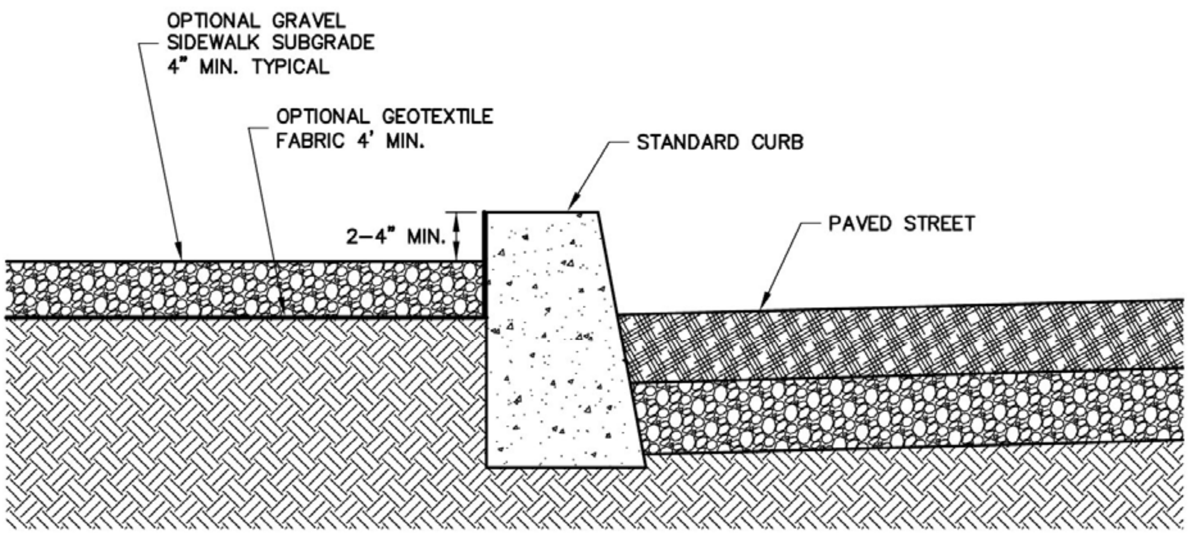
UNDERCUT LOTS – SC-12

Construction Specifications:

- Cut back soil from curb 2” – 4” deep to form a temporary sediment trap.
- Extend cut back a distance of 3’ – 4’ from curb, or the width of the parkway or sidewalk.

Inspection and Maintenance:

- Allow ponded water to infiltrate, evaporate, or pump out in accordance with BMP NS-1, “Dewatering and Ponded Water Management.”
- Remove accumulated sediment in sediment trap to maintain system capacity.
- Inspect routinely and maintain as needed.



SECTION UNDERCUT LOT
NOT TO SCALE