EROSION CONTROL MANUAL

Overview

This manual provides technical guidance for temporary and permanent erosion prevention and sediment control to be used by site designers, developers, contractors and local government agencies during the construction process, before, during and after clearing, grubbing, grading and excavation. The Manual is split into 3 main sections:

Chapter 1 Local Jurisdiction Requirements
This chapter describes the erosion control, plan submittal and permit requirements.

Chapter 4 Section 1 - 7 — Erosion Prevention and Sediment Control
This chapter gives an overview of the environmental impacts created by erosion from construction sites. The chapter describes planning and implementation of Best Management Practices (BMPs) that can be used on a construction site.

Chapter 5 Section 2 — Construction Site Pollution Control
This chapter gives an overview of the environmental impacts created by pollution generated by construction site activities. The chapter describes planning and implementation activity controls that can be used on a construction site.

Last revised in 1994, this manual was originally developed in cooperation with the Unified Sewage Agency to address state-mandated erosion control requirements for the Tualatin River Basin. With this issuance it has been updated and revised to comply with the requirements of Portland's National Pollutant Discharge Elimination System (NPDES) Permit, Metro's Title 3 Stream and Floodplain Protection Plan, and the upcoming requirements of the Endangered Species Act. Details of the geographical areas in which the information in this handbook is enforced, permit applications, and review and enforcement information are available from the applicable local jurisdiction. Summaries of these elements are outlined in Chapter 1 of the manual.

It is intended that this manual and alternative methods requested for use in various jurisdictions, will be reviewed on an annual basis, with the Manual updated as needed.

Goal Statement

It is the intent of this manual to describe proactive practices that can be taken to prevent erosion, releases of sediment and other pollutants generated at a site of ground disturbance. Site planning and good site control are the best practices that can be used to prevent discharges from a development site of ground disturbance. This Manual is organized to emphasize measures to prevent erosion and control stormwater runoff, over practices designed to strictly control sediment.

MANUAL READER AND USER

From: City Staff

Subject: Errors and or Omissions

Through painstaking effort and numerious reviews, we believe that we have eliminated most of the errors in this manual. There are always those few that get by us, however. This is where you, the reader and user of this manual, can help us in this process, and with our efforts to have this manual error free. Should you discover an error, then you are encouraged to use this form. Please make a copy of this form, fill it out completely, and either fax it over to the City, or mail it to us.

This form can also be used for suggestions and recommendations for changes or to include new information in ths Manual. Please note that the intent of this Manual is to be generic in the sense that brand names are avoided if at all possible. This is not a forum for product endorsement or for an approved product list. You may have built a better mousetrap, but it is still a mousetrap, and will be called simply a mousetrap if the product is added to the Manual. This industry is very dynamic and always changing, sometimes the only way to stay on top of it is by receiving information from individuals and businesses like you. Thank you.

Errors in Manual:

Page Number: _____ Paragraph/Location: _____

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Identify error: _____

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Proposed correction: _____

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Your Name: _____ Business Name _____

Phone Number_____

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1 CITY OF PORTLAND REQUIREMENTS

Local Jurisdiction Erosion Control, Plan Submittal and Permit Requirements

City of Portland Requirements

The Erosion Control Manual is in accordance with the City of Portland's Title 10 Erosion and Sediment Control Regulations.

When is erosion control required? Erosion control is required on any ground disturbing activity happening as a result of using motorized equipment. An Erosion, Sediment and Pollution Control Plan (ESPCP) is required when doing permitted ground-disturbing activity such as a building, clearing, grading, public works or street opening permits. An ESPCP must be submitted with the permit application and must address the control of pollutants as identified in this manual.

EROSION, SEDIMENT AND POLLUTANT CONTROL (ESPC) PLAN SUBMITTAL REQUIREMENTS

Submittal requirements for erosion, sediment and pollution control plans for various types of construction projects are presented below. Planning Considerations are in Chapter 3 - Planning Best Management Practices.

> Approval of a erosion, sediment, and pollution control plan by the City of Portland does not relieve the applicant's responsibility to ensure that the approved erosion control best management practices are constructed and maintained to contain sediment and pollutants on the construction site.

Erosion control best management practices are required during all ground disturbing activity until permanent site ground covers are in place. Dirt and other landscaping materials delivery are not covered by Title 10, but may use many of the BMPs within this manual to control materials onsite. Delivery materials are required to comply with other sections of City code that prohibit discharge or deposition on streets or into sewers.

Certain base erosion control BMPs are required for construction sites at all times of the year. Also, additional cover or BMPs are required during the wet weather season (October 1 through April 30). All seed applications shall be **completed prior to September 1**, or shall employ additional erosion prevention BMPs.

Sites requiring a state Department of Environmental Quality 1200 C Permit, are encouraged to submit the same ESPC plan for the State construction site permit and the City development, building or street opening permit. The City of Portland does not administer the State 1200C Permit program, but does have limited sign off authority for discharged runoff.

Definitions & General Requirements

DEFINITIONS ➔ These definitions are copied from the City of Portland Title 10 code and are for words and terms used in this Manual.

ACCEPTED	Projects in the public right of way that the required plans have been reviewed by the Director and have been found to be in conformance with the Erosion and Sediment Control Regulations.
APPLICANT	The individual who applies for a permit.
APPROVAL or APPROVED	Determination by the Director that the provisions of this Title have been met.
BEDROCK	In-place solid rock.
BEST MANAGEMENT PRACTICE	(or BMP) A physical, chemical, structural or managerial practice that prevents, reduces, or treats contamination of water or which prevents or reduces soil erosion.
BUREAU	The Bureau of Environmental Services, the Office of Planning and Development Review, the Portland Office of Transportation and the Bureau of Waterworks.

CERTIFIED PROFESSIONAL in EROSION and SEDIMENT CONTROL or CPESC	A person who has been so determined by the Soil and Water Conservation Society and the International Erosion Control Association.
CONTRACT WORK	Capital improvement program or other City funded public works activities provided by an outside contractor in compliance with the City's Standard Construction Specifications and other applicable special standards.
DENUDED	Land that has had the natural vegetative cover or other cover removed leaving the soil exposed to the elements.
DEVELOPMENT	Any human induced change to improved or unimproved real estate, whether public or private, including but not limited to construction, installation, or expansion of a building or other structure, land division, street construction, drilling, and site alteration such as that due to, dredging, grading, paving, parking or storage improvements, excavating, filling or clearing.
DIRECTOR	Those persons specified in Section 10.10.030 or those persons' designees.
DRAINAGE CONTROL	The collection, conveyance and discharge of stormwater.
DUPLEX	A structure containing two dwelling units.
DWELLING	Any structure containing dwelling units.
ENVIRONMENTAL ZONE	Any location in a "c" or "p" overlay zone shown on Official Zoning Maps or described in Chapter 33.430 of the City of Portland Zoning Code.
EROSION	The wearing away of the ground surface as a result of the movement of gravity, wind, water or ice.
EROSION CONTROL MANUAL	The collection of administrative rules adopted by OPDR to implement the purpose and intent of this Title.
FINAL GRADE	The finished grade of the site which conforms to the approved plan.
GRADE	The vertical location of the ground surface.
GREENWAY	A Greenway Overlay Zone as determined by the City of Portland Zoning Code Title 33, Section 33.440.030.
GROUND DISTURBING ACTIVITY	Any activity that exposes soil through the use of motorized equipment. Permanent - ongoing areas of exposed soils or ground disturbance such as mining operations, farming gardening and sports fields. Temporary - short duration ground disturbance that occurs over a very limited time frame (less than 6 months between disturbances) such as construction, fill placement, landscape installation, and other vegetation clearing activities.
NUISANCE	(See Chapter 10.80.010 of this Title)
OWNER	The person whose name and address is listed as the owner of the property by the County Tax Assessor on the County Assessment and Taxation records.
PERMIT	An official document issued by the Director authorizing performance of a specified activity.
PERSON	Any individual, partnership, association or corporation.
PLAN	A graphic or schematic representation, with accompanying notes, schedules, specifications and other related documents.
POLLUTANT	Any substance which is prohibited or limited by the provisions of Chapter 17.39 of the City Code, released or discharged in conjunction with development.
RESPONSIBLE PARTY	The property owner or person authorized to act on the owner's behalf; or any person causing or contributing to a violation of this Title.
SEDIMENT	Mineral or organic matter deposited by as a result of erosion.

SITE	Any lot or parcel of land or contiguous combination where development occurs.
SLOPE	An inclined ground surface, the inclination of which is expressed as a ratio of horizontal distance to vertical distance.
SOIL	Naturally occurring surficial deposits overlaying bedrock.
STABILIZATION	The process of establishing an enduring soil cover of vegetation and/or mulch or other ground cover and may be in combination with installation of temporary or permanent structures. Stabilization shall reduce to the maximum extent practicable the erosion process and the resultant transport of sediment by wind, water or ice.
SPECIAL SITE	(See Section 10.30.030 of this Title)
STABILIZATION	The process of establishing an enduring soil cover of vegetation and/or mulch or other ground cover and may be in combination with installation of temporary or permanent structures. Stabilization shall reduce to the maximum extent practicable the erosion process and the resultant transport of sediment.
STORM DRAINAGE SYSTEM	Facilities by which stormwater runoff is collected and or conveyed, including but not limited to any roads with drainage systems, municipal streets, gutters, curbs, inlets, piped storm drains, culverts, pumping facilities, retention and detention basins, natural and constructed (or altered) drainage channels, reservoirs, and other drainage structures.
STORM EVENT	A storm that produces one-half inch of rain or more during a 24 hour time period.
STORMWATER	Water runoff, snowmelt runoff and surface runoff and drainage.
VISIBLE AND MEASURABLE	Deposits or tracking of mud, dirt, sediment or similar material exceeding one-half cubic foot in volume on public or private streets, adjacent property, or into the storm or surface water system, either by direct deposit, dropping, discharge or as a result of the action of erosion. Evidence of concentrated flows of water over bare soils; turbid or sediment laden flows; or evidence of on-site erosion such as rivulets on bare soil slopes, where the flow of water is not filtered or captured on the site. Earth slides, mud flows, earth sloughing, or other earth movement which leaves the property.
WATER BODY	Rivers, streams, sloughs, drainages including intermittent streams and seeps, ponds, lakes, aquifers, wetlands and coastal waters .
WATERCOURSE	A channel in which a flow of water occurs, either continuously or intermittently with some degree of regularity. Watercourses may be either natural or artificial.
WETLAND	An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and which under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include swamps, marshes, bogs and similar areas.

GENERAL REQUIREMENTS ➔ This Title applies to all ground disturbing activities whether or not a permit is required, unless such activities otherwise are exempted by Portland City Code. All non-permitted ground disturbing activities that are permanent or temporary in nature shall comply with this Title unless otherwise noted.

EXEMPTIONS ➔ Development or contract work which is subject to above may commence without complying with the requirements of this Title if the Director determines that there is a hazard posing imminent danger to life or property such as substantial fire hazards, risk of flood or other emergency. However, upon a determination by the Director that such hazard has passed, the provisions of this Title shall apply.

The Erosion, Sediment and Pollution Control Plan (ESPCP) shall provide for compliance with City of Portland Code section 10.30.020, Minimum Requirements outlined below:

PURPOSE ➔

- No visible and measurable sediment or pollutant shall exit the site, enter the public right of way or be deposited into any water body or storm drainage system.
- Depositing or washing soil into a water body or the storm drainage system is prohibited.
- Ground disturbing activities requiring a permit shall provide adequate public notification of the City's Erosion Control Complaint Hotline.

REQUIREMENTS AND STANDARDS ➔ In order to meet the purpose defined in Subsection A above, the responsible party shall:

- Install measures intended to keep soil on site or out of water bodies, storm drainage systems or the public right of way as the first step in any development. These measures shall be made functional prior to any upslope development taking place.
- Remove any soil that enters the public right of way.
- Protect stormwater inlets that are functioning during the course of the development by approved sediment control measures so that sediment-laden water cannot enter the inlets without first being filtered.
- Apply permanent or temporary soil stabilization to denuded development site areas in conformance with the following schedule:
  - Between October 1 and April 30, all denuded sites shall immediately be provided with either temporary or permanent soil stabilization.
  - Between May 1 and September 30, temporary erosion and sediment control measures to reduce dust and sediment transport shall be applied as soon as practicable, but in no case more than seven days after ground disturbing activity occurs.
  - Ground cover shall be installed on any portion of a site that is denuded for more than six months. Sports fields or playgrounds surrounded by vegetative cover or permanently installed curbing are exempt from this requirement.
  - Temporary measures shall be maintained until permanent measures are established.
  - Ground disturbing activity taking place between October 1 and April 30 for sites located in the Balch Creek and Northwest Hills subdistricts of the Skyline plan district is prohibited, and is not subject to administrative review per Section 10.40.040. (See Chapter 33.575 of the City of Portland Zoning Code.)
  - Permanent non-permitted ground disturbing activities may achieve compliance with the standards set out in subsections a-e above, with the installation and maintenance of approved permanent BMPs that meet the purpose of this Title.
- Plant replacement vegetative cover that does not include plants listed in either the Nuisance or the Prohibited Plant List, as set forth in the City of Portland Plant List. Agriculture, timber production or residential crop growing activities are exempted from this requirement.
- Secure or protect soil stockpiles throughout the project with temporary or permanent soil stabilization measures. The responsible party is accountable for the protection of all stockpiles on the site, and those transported from the site. Depositions of soil may be subject to additional regulations requiring permit, review or erosion and sediment control.
- Select BMPs from the Erosion Control Manual.
- Post signage on the site of the permitted ground disturbing activity that identifies the City's Erosion Control Complaint Hotline number or the responsible City project manager/inspector.

- Post a sign on the site that is clearly visible from the right-of-way. The sign shall be at least 18" by 18" and made of materials that shall withstand weather for the duration of the project. Lettering shall be at least 3" high and easily readable. Signs shall be color coded or otherwise marked to identify the appropriate enforcing bureau.
- Another visual notification method may be used if approved by the Director of the designated enforcing bureau.

ADDITIONAL REQUIREMENTS FOR SPECIAL SITES ➔ When the Director determines that special site conditions may prevent compliance with Section 10.30.020, the Director may require additional erosion, sediment and pollutant control measures.

- Special site conditions may include, but are not limited to, the following:
  - Slopes before development that are greater than 10 percent (1 Vertical:10 Horizontal).
  - Ground disturbance of a natural vegetative buffer within 50 feet of a wetland and or water body.
  - The development site is located entirely or partially within an Environmental Overlay Zone or Greenway Overlay Zone.
  - The development site or development phase will have ground disturbance at any one time of 10,000 square feet or more. Single family dwellings and duplex dwellings are exempt from this size limitation.
  - The development includes a Land division containing 10,000 square feet or more.
  - Project timing is such that ground disturbing activity will take place between October 1 and April 30.
- Additional requirements imposed by the Director to achieve compliance with Section 10.30.020 A may include, but are not limited to, the following:
  - Requiring drainage control in compliance with Titles 17 and 24, during all development phases.
  - Requiring that a State of Oregon registered professional engineer, other professional certified by the State of Oregon with experience or qualifications in preparing erosion control plans, or a registered CPESC prepare and/or implement the erosion and sediment control plan.
  - Prohibiting ground disturbing activities between October 1 and April 30.
  - Limiting the amount of denuded soil at any given time.
  - Requiring a bond, letter of credit or other guarantee.
- The Permittee or other responsible party shall be required to maintain the site and meet the following conditions:
  - The responsible party shall maintain all erosion, sediment and pollutant control measures, temporary and permanent, in proper functioning order.
  - The responsible party shall maintain, adjust, repair, and replace erosion, sediment and pollutant control measures within 24 hours following a storm event to ensure that the measures are functioning properly.
  - During active ground disturbing activity, the responsible party shall inspect erosion, sediment and pollutant control measures daily between October 1 and April 30. All inspections by a responsible party shall be noted in an inspection log indicating the date and time of the inspection. The inspection log shall be made available to the Director upon request.
  - All site public notification signs required by 10.30.020 shall be maintained to remain easily readable from the public right-of-way throughout the duration of the ground disturbing activity.

An Erosion, Sediment and Pollutant Control Plan (ESPCP) shall be required for any ground disturbing activity that currently requires a City of Portland building, public works or development permit. An ESPCP may also be required in response to a violation of the City's erosion control requirements. A Professional licensed Engineer with the State of Oregon may be required to prepare the plan in cases of special sites or in cases or major plan revision due to site violations.

The ESPCP shall provide the following:

- Indicate compliance with the minimum requirements set above.
- Show compliance with all special requirements mandated by the Director as set forth above.
- Identify any wetland or waterbody within 200 feet of the ground disturbing activity.
- Provide a simplified narrative description of existing land uses and proposed land use. Provide a copy of any applicable Land Use Review documents.
- Identify the type of soil or soils on the site using applicable Natural Resource Conservation Service soil classes (A, B, C, D) found in the applicable county soil survey.
- Provide clear delineation of area to be disturbed. Show existing and proposed ground contours. Provide drainage patterns for existing and final ground contours. In addition, provide drainage patterns for all intermediate contours throughout the length of the ground disturbing activity.
- Indicate the name and address of all responsible parties including the developer and property owner. Identify emergency contact and number.
- Provide a preliminary activity schedule (general construction schedule) including anticipated start and completion dates for all sequencing of ground disturbing activity, and the associated dates for erosion, sediment and pollution control BMPs. The activity schedule shall also indicate the time frame of installation, maintenance and removal of temporary BMPs. The applicant is responsible for notifying the City when site work will deviate from the preliminary schedule. The preliminary schedule can be modified through the designated site inspector as work on the site progresses.
- Identify application and maintenance for Best Management Practices (BMPs). Show location of all erosion, sediment and pollution control BMPs and their position in relation to ground disturbing activities.
- Identify scheduling for specific BMPs - identifying which BMPs are used for which phases of development. Also identify which BMPs, if any, are permanent controls.
- Provide a simplified site landscape plan indicating the types and amounts of vegetation to be used, and when and where it will be planted. This plan shall distinguish between temporary vegetative cover and permanent site landscaping.
- For all structural erosion, sediment and pollution control BMPs, provide a detail of installation methods including any sizing calculations (flow volumes, rates, etc.), or reference to BMP's outlined in this manual.
- When required by the Director, provide drainage calculations.

- The Director may require a pre-construction conference with the responsible party to review the erosion, sediment and pollution control requirements and procedures.
- The Director may deny a plan if it is determined that the plan either does not meet the requirements of Title 10 and the Erosion Control Manual or does not meet the intent of Title 10. Review of ESPCPs will look for the following BMP approval criteria:
  - Efforts to minimize area of disturbance.
  - Use of combination of BMP types - not just sediment controls. Good plans will include at least on type of BMP control for each variety of BMP group in the Manual - site entry, perimeter, stormwater, erosion prevention, etc.
  - Use of stabilized construction entrances away from the low points of sites. Use of multiple entrances for large sites.
  - A specific construction schedule.
  - Description of stormwater controls prior to storm sewer or infiltration system installation.
  - Description of vehicle storage, maintenance and fueling practices. Designated staging areas, if appropriate.
  - Designated and protected materials storage and stockpile areas.
  - Description of site inspection and maintenance requirements for all BMP's after any storm event.
- Approval of the ESPCP is for the minimum requirements outlined in the Erosion Control Manual based on anticipated site conditions and schedule. During the construction period, these measures shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment- laden water does not leave the site. Approval of a plan may be granted with or without restrictions. Restrictions on a plan may include, but shall not be limited to, the following:
  - That work only be conducted during a specified time of the year.
  - Approval of only a portion of the work.

2 INTRODUCTION

When discussing sediment related issues on any construction sites, Best Management Practices (BMPs) can be grouped into two broad categories:

EROSION PREVENTION is the use of practices designed to protect the surface of the soil from the force of rain, wind and other runoff so that they will not dislodge (erode) and be transported off the construction site as sediment. These practices include such things as establishing a vegetative cover, controlling stormwater runoff and/or providing protective covers for exposed soils.

SEDIMENT CONTROL is the use of practices that are designed to capture soil particles after they have been dislodged and become sediment, and attempt to retain the sediment on-site. These practices include such things as installing sediment fencing, sediment traps or ponds.

Both erosion prevention and sediment control have appropriate uses; however, erosion prevention BMPs are more effective in preventing soil particles from leaving the construction site than sediment control practices. Once soils are dislodged, they are very difficult to recover. It is the intention of this manual to emphasize careful planning and erosion prevention over after-the-fact sediment control. The applicant must demonstrate that all proposed ground-disturbing activities are necessary for the completion of the project. Undisturbed groundcover must be retained whenever possible. This emphasis is particularly important in the Pacific Northwest immediately before and during the rainy season, when it is difficult to establish vegetation, and the intense rains have high erosion potential.

EROSION PREVENTION & SEDIMENT CONTROL

Erosion occurs when rain or wind loosen soils from the soil surface. Rain generated runoff cuts rills and larger gullies into exposed soils to convey sediment laden flows. Wind erosion creates a more consistent, area-wide stripping of soils from the soil surface. Both types of erosive forces are capable of depositing large amounts of sediment, sometimes at great distances, away from the site of soil disturbance.

There are four main factors that influence erosion:

Soil erodibility

Can be determined by 4 main factors:
- Soil texture (particle size and gradation)
- Percentage of organic content
- Soil structure
- Soil permeability

Soils containing high percentages of fine sands and silts are usually the most erodible. Clay can help bind soils, but they are easily transported in stormwater runoff. Organic matter helps provide a more stable soil structure that allows for more infiltration and resists erosion. Well-drained soils, sands and gravels resist erosion most, because of their ability to infiltrate.

Vegetative cover

Provides the following benefits to controlling erosion:
- Shields soils surface from raindrop and wind erosion.
- Provides root systems which hold soil particles in place.
- Aides soil to absorb water
- Slows velocity of runoff
- Evapotransporates sub-surface water between rain storms.

Topography

Topography or size, shape and slope of a watershed can influence the amount and rate of stormwater runoff. High slope lengths and steep gradients increase the rate of runoff (creating a higher probability for erosion) and can limit abilities to establish and maintain vegetative cover.

Climate

Climate has an impact because it dictates the frequency, intensity and duration of rainfall. High volumes and velocities can detach and transport soil particles. Snow melt can also cause high erosion hazards by limiting infiltration, and generating soil uplift from freeze / thaw cycles.

Every year, tons of sediment are washed and blown from sites of ground disturbance into streams, rivers and lakes. The U.S. Environmental Protection Agency estimates approximately 600 million tons of soil erodes from U.S. construction sites alone each year (1993). As the Metro area continues to grow, our local waterways are being affected by ground disturbance, with the greatest sediment impacts occur during the land grubbing, clearing, grading and other excavation phases of development.

Sediment, resulting from disturbed soils, can move onto neighboring properties and streets or into drainage systems and other bodies of water. Excessive sediment has significant negative impacts on how the natural watershed runoff and soil conveyance system works. Under natural conditions, runoff moves through a watershed as groundwater through infiltration or as surface water by spreading across floodplains and migrating downstream through stable stream and waterway channels. In a natural watershed system, sediment, cobbles and gravel travel throughout the stream network creating deposition, scour and gravel areas that are important for fish habitat. The natural system survives by its ability to contain flows and balance sediment loads within the stream network.

Fish Impacts

Excessive sediment (especially silt) degrades riparian habitat impacting fish and other aquatic life. Streamflow, water temperature, channel bed substrate, riparian and instream cover, and dissolved materials are all the elements typically associated with instream fish habitat. All salmonids require:

- Access to and from spawning and rearing areas.
- Sufficient aquatic organisms for food.
- Cool, flowing waters free of pollutants and with high oxygen levels for rearing / incubation.
- Low sediment levels for visual feeding.
- Clean gravel substrate for reproduction.

Construction site sediments have higher negative impacts on fish species because they usually reach local waterways as silts and fines. These increased silts/fines loads within waterways result from fines in runoff generated from compacted soils and from sedimentation of larger particles within the stormwater conveyance system. Sediment resulting from naturals processes, is usually coarser than construction site silts. Natural sediments are essential to the development and maintenance of spawning gravels for salmonids. However, where sediment delivery, especially silts and other fines, exceeds natural background levels, the following negative impacts can occur:

- Migrating salmon will avoid or cease migration in waters with high sediment loads.
- Reduction of oxygen flow to developing embryos and entombment of emerging juveniles in their nests.
- Reduction of interstitial spaces in cobbles that juvenile salmonids use as winter cover.
- Reduction of pool volume, decreasing rearing habitat for juvenile and resting pools for migrating adults.
- Increase in the frequency of channel scour and fill events, creating increased channel width, raising of the channel bed, and decreasing stability of large woody debris.
- Abrasion and clogging of fish gills.
- Interference with the production and diversity of the bottom dwelling food supply (bugs and macroinvertebrates).

Left unchecked, excessive sediment can cover upland, instream and streamside habitat areas, raise streambeds, alter watercourses, reduce infiltration, and cover floodplains causing flooding. Excess sediment creates cloudy or turbid water conditions, interfering with recreational uses. Additionally, local governments and their tax payers must pay for removing sediment from streets, sewers, ditches, sumps and culverts, and for dredging sediment from harbors and navigation channels. Many of these costs could be largely avoided through implementation of adequate erosion control practices.

Recommended construction erosion prevention, sediment and pollution control BMPs are detailed in this chapter. The practices and BMPs outlined in this manual are recommended for use in the development of appropriate site erosion, sediment and pollution control plan (ESPCP) and permit submittals as outlined in Chapter 1 jurisdictional requirements. The site designer or site engineer is usually the person asked to develop the ESPCP. The ESPCP is similar to implementation documents with a detailed description of current site conditions, proposed changes, schedule for changes, and description of control activities. Many site designers / engineers already have experience developing construction management plans – which lay out when, what and by whom various development activities will occur. An ESPCP is very similar in nature – with a more specific content. See Section 3.1 Develop an Erosion, Sediment and Pollution Control Plan for more details of what to look for.

The applicant may desire to use the Natural Resource Conservation Service Universal Soil Loss Equation or Revised Universal Soil Loss Program for sizing of sediment control measures. See Appendix C.

The site owner/developer is responsible for seeing that erosion control BMPs are installed, maintained and working as designed. An approved ESPCP does not waive the owner/developer's responsibility for ensuring that approved / permitted erosion control is achieved. If an installed erosion control system does not adequately contain sediment on site, then the erosion BMPs must be field adjusted as necessary by the applicant, and as approved by the permitting jurisdiction.

Tables 1.1 through 1.3 are matrices presenting recommended erosion control BMPs for various site and construction types.

Table 1.1 is a matrix summarizing recommended erosion controls for single family residential and duplex construction activities on single lots of record. Table 1.2 summarizes recommended erosion control BMPs for larger construction sites including commercial, industrial and subdivision development and construction. Table 1.3 is a matrix presenting recommended erosion controls for small, linear utilities construction and ditches/swales.

Erosion control BMPs are divided into two categories:

Base BMPs which are required for construction sites at all times while there is disturbed, unstabilized ground surface on the site, and

Supplementary wet weather BMPs are required between October 1 and April 30 in addition to the base BMPs.

TABLE 1.1 EROSION CONTROL

Single Family/Duplex Residential Construction

	SITE SLOPE		STOCK PILES	DETAIL
	<2%	>2%		
Base Measure				
Gravel Construction Entrance	■	■		4.1A
Sediment Fence/barrier at toe of disturbed area or stockpile		■	■	4.2A, 4.2C, 4.3D
ALT: Sidewalk subgrade gravel barrier (site slopes to street at >5% grade)	●			4.2B
ALT: Undisturbed buffer at toe of disturbed areas (site slopes >10%)		●		4.2E
Wet Weather Measure				
6-mil plastic sheet cover			▲	4.4E
2-inch minimum mulch cover for raindrop splash			●	pg 4-58
4 to 6-inch minimum mulch cover for sediment control			▼	pg 4-58
Post Construction				
Reestablish ground cover or landscape prior to removing erosion measures	■	■		pg 4-55

KEY:
- ■ Base measure
- ● Alternate or additional base measure
- ◆ Optional base measure, can use as applicable
- ▲ Supplemental wet weather measure (Oct. 1 - April 30)
- ▼ Alternate or additional wet weather measure

TABLE 1.2 EROSION CONTROL

Commercial/Industrial/Subdivisiion Construction

	SITE SLOPE (%)						STOCK PILES	DETAIL
	<2	<10	<15	<20	<30	<50		>50%
Base Measure								
Gravel Construction Entrance	■	■	■	■	■	■		4.1A
Sediment Fence/barrier at toe of disturbed area or stockpile		■	■	■	■	■	■	4.2A, 4.2C, 4.3D
ALT: Undisturbed buffer at toe of disturbed areas		●						4.2E
Sediment fence installed on contours (spacing)		■	■	■	■	■	■	4.2A
Temporary interceptor dikes/swales around active work areas	◆	◆	◆	◆	◆	◆	◆	4.3A
Pipe slope draims	◆	◆	◆	◆	◆	◆	◆	4.3C
Wet Weather Measure								
Established grass		▲	▲	▲	▲	▲		pg 4-55
2-inch minimum straw mulch cover for splash		▼	▼	▼	▼		▼	pg 4-58
4 to 6-inch minimum mulch cover for sedimentation		▲	▲	▲	▲			pg 4-58
Erosion blankets with anchors		▼	▼	▼	▼	▼		4.4C, 4.4D
6-mil plastic sheet cover		▼	▼	▼	▼	▲	▼	4.4E
Sediment trap or pond		▼	▼	▼	▼	▼		4.4F, 4.4G
Post Construction								
Reestablish ground cover or landscape prior to removing erosion measures	■	■	■	■	■	■		pg 4-55

NOTE: If different areas of the site have considerably different slopes, the site may be divided up and erosion measures selected for each area from the appropriate column in the matrix.

TABLE 1.3 EROSION CONTROL

Utilities Construction and Stock piles / Ditches / Swales Protection

	UTIL CONST		STOCK PILES	DITCH/SWALES	DETA
	catch basin	ditch		Const/Prot	
Base Measure					
Sediment Fence/barrier at toe				■	4.1A
Check dams		■		■	4.2A-C, 4.3D
Storm drain inlet protection barrier	■				3.3
Wet Weather Measure					
Established grass				▲	pg 4-55
6-mil plastic sheet cover			▲		4.4E
2-inch minimum mulch cover for raindrop splash			▼	▼	pg 4-58
4 to 6-inch minimum mulch cover for sedimentation			▼	▼	pg 4-58
Erosion blankets with anchors			▼	▼	4.4C, 4.4D
Dewatering		▲			4.8A (5.1A)
Post Construction					
Reestablish ground cover or landscape prior to removing erosion measures	■	■		■	4.3A

3 PLANNING LEVEL BEST MANAGEMENT PRACTICES

3-1

DEVELOP AN EROSION, SEDIMENT & POLLUTANT CONTROL PLAN

Adequate site planning and development layout can allow significant impact avoidance for a development site. The following planning Best Management Practices (BMPs) can assist the site designers in creating a site layout and development plan that minimizes erosion from the site.

PURPOSE ➔ An Erosion, Sediment and Pollution Control Plan (ESPCP) is a detailed description or where, how and in what manner activities will be implemented on a site to control erosion and sediment migration. This plan is a central, specific component that uses the overall site development management plan as its base.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Any permitted ground disturbing activity.
- Required for some construction sites.
- Required as a result of a violation.

The ultimate goal in erosion prevention is to limit the time and area of ground disturbance and establish permanent ground cover as quickly and thoroughly as possible.

DESIGN CRITERIA/SPECIFICATIONS ➔ Your ability to plan and sequence ground disturbance activities will yield many benefits, including: compliance with local regulations, effective erosion prevention and sediment control on site, pro-active solutions, less maintenance, stormwater quality enhancement, controlled construction costs and limitations on bad public relations or agency fines. Designs should:

- Prevent erosion – rather than control sediments. Your plan must minimize the amount of disturbed land area and avoid or minimize work on steep slopes and during wet weather (October 1 to April 30) as much as possible. Approval of your plan may require you to modify the size and timing of the proposed work area to avoid unnecessary ground clearing or periods of wet weather. By minimizing the area of disturbance and avoiding steep slopes and ground disturbance during the wet season, you can realize the following positive results:
  - Less chance of soil washing off the site and clogging streets and drainage systems and impacting the neighbor's properties.
  - The number, size and extent of erosion control BMPs required is minimized.
  - The costs of maintaining erosion control BMPs are reduced.
  - As much top soil as possible is retained on the site, making existing vegetation easier to preserve and permanent landscaping easier to establish.
- Design the project to fit natural topography, soils and drainage patterns. Use site characteristics to assist erosion control efforts.
- Control stormwater runoff flows. Concentrated stormwater flows are responsible for many ground disturbance site erosion control problems. Divert up-slope flows around or through the development site in systems that control volumes and flow rates. If flows must pass through the site of ground disturbance, use BMPs that keep velocities low and allow water to infiltrate.
- Select the right erosion control technique for your specific site, including slope and soil conditions. Use guidance provided in this manual and assistance from your local permitting authority or an experienced design professional.
- **Plan for rain!** Install and monitor your baseline BMPs and be prepared to place additional wet weather BMPs as needed.

- Keep sediments onsite! Although it is not the most desirable method of erosion control – control of sediments so they do not discharge offsite, is a vital component to any ESPCP.
- Design criteria and use of the USDA Natural Resource Conservation Service (NRCS) Revised Universal Soil Loss Equation for the purpose of sizing sediment traps or ponds and proposed new erosion prevention and sediment control, BMPs are described in Appendix C.
- Vegetation establishment is critical to erosion prevention and control. Success is often determined by plant survival. It is very difficult to establish healthy, stable vegetation on graded areas that are compacted, have a smooth hard surface or have all the topsoil removed. Moderately rough slope surfaces with uneven soil and rocks left in place may appear somewhat unconventional, but they will encourage water infiltration, decrease runoff velocity and speed up the plant establishment period. Rough loose soils aid the germination of seeds by providing cooler microclimates with more favorable growing conditions than hard flat surfaces. Limit seeding and planting to the growing season. Seed can rot over winter, which amounts to wasting money. Choose seed appropriate for the site, seasonal conditions and intended use.
- Because of particular site conditions or preferences, the applicant may desire in certain cases to use **different** erosion, sediment and pollutant control BMPs than are recommended in this manual. In such cases, the applicant must submit calculations or other supporting information used to determine the sizing and layout of the submitted erosion control plan to the director of the permitting agency. Check local jurisdictional requirements for appropriate alternative method review processes.
- See Appendix B for a list of uniform coding system symbols.

MAINTENANCE / REMOVAL GUIDANCE ➔ Review your ESPCP often. Delays, site conditions or other circumstances may significantly change you plan. Modify as needed.

Development of a Erosion, Sediment and Pollution Control Plan as Part of the Overall Site Development Plan

The following are recommended steps and check lists to use in the development and implementation of an acceptable site development plan that includes all elements of an ESPCP. This information will provide the necessary tools to gain jurisdictional approval of development activities for all types of construction sites and developments.

➔ **STEP 1:** IDENTIFY GENERAL SITE CHARACTERISTICS

EXISTING:
- topography/contours
- flow quantity and velocity of existing drainage patterns on and immediately up and downstream of site – including groundwater flows
- current drainage service available to the site
- soil quality and type – including soils susceptible to erosion
- wetlands and sensitive areas, creeks, and other identified natural areas

FUTURE:
- future site contours
- future site drainage system type and location
- future impervious areas and where they will drain
- future as-built runoff (flows and velocities)

After identifying site charactersitics - can you answer the following questions:

- ❑ How much stormwater runoff will be generated by this site?
- ❑ Where are the areas of steep slopes and problem soils that should be avoided or will need special care?

- ❑ Are there natural resources that require special permitting or protection?
- ❑ Are there vegetation areas that can be preserved as buffers strips?
- ❑ Is the groundwater table high enough to create the need for dewatering? If so at what phases or activities of development will dewatering be an issue?

➔ **STEP 2:** LAY OUT PRE-CONSTRUCTION PLAN AND FOUNDATION EROSION, SEDIMENT AND POLLUTANT CONTROL BMPS:

- Identify existing vegetation to use as buffers, especially on the downhill borders of the site.
- Identify limits of clearing and ground disturbance – describe how these areas will be marked.
- Determine construction activities, timing, sequence.
- Determine if ground disturbance will occur during wet season (October 1 through April 30).
- Determine if construction phasing is necessary.
- Identify development site entrances and exits and internal site roads and parking areas. Provide details for establishing gravel construction entrance and wheel wash (if used). Describe dust control measures.
- Identify where construction generated stormwater flows will go and if they will need treatment prior to discharge. Specify stormwater control BMPs.
- Select secure locations for stockpiling soils and other material.
- Describe perimeter control BMPs. Specify types of fabric or filter material.
- Identify erosion prevention BMPs to be used – and on what parts of the site. Will these choices vary upon what season they are implemented?
- Determine what permanent erosion prevention measures will be used (permanent landscaping, bio-engineering or armoring), if any.
- Specify plant varieties to be used for temporary or permanent erosion control. Describe any seed mixes, fertilizers or other soil ammendments and their application rates needed to establish vegetation.
- Provide for a controlled equipment repair, refueling and chemical storage area, if needed.
- Plan for wet weather BMPs including cover over all exposed soils.
- Describe BMPs for use during utility installation.
- Develop a schedule and procedures for inspections and maintenance of erosion control BMPs.
- Develop contingency BMP plans for possible failures of BMPs, including blow outs of sediment control structures like ponds or sediment fence. Identify emergency contact and phone number.
- Describe how administrative controls will be used. Describe methods for staff training on installation, maintenance and removal of BMPs.

After identifying basic site development charactersitics - can you answer the following questions:

- ❑ What is the intent of the ESPCP design (prevention or control)?
- ❑ What is the development schedule and will there be site phases? When and what BMPs will be used for each phase?
- ❑ Are there ESPCP details for BMP installation and maintenance? How will BMPs be removed? Will there be sufficient access after development to reach all temporary BMPs?

- ❑ Are any administrative controls (speed limit, designated areas for storage or disposal) going to be used? How will employees and/or sub-contractors be educated and encouraged to follow these controls?
- ❑ What BMP will control, convey and dispose of runoff before inlets are in place? Does the site need a sediment trap or pond? Where should it be located? Will the post-development stormwater management facility be used during construction? Are temporary swales and dikes going to be left for permanent conveyance of stormwater runoff?
- ❑ What perimeter controls will be used? When will they be installed?
- ❑ What erosion prevention soil covers will be used (i.e. mulch, grass, blankets)? Specify areas for each type.
- ❑ Where are stockpile areas? What method of cover will be used? Does the cover vary depending on season (i.e. grass for spring and summer, plastic sheeting for fall and winter)?
- ❑ Will construction vehicles be repaired or refueled onsite? If so where? Is it a controlled, designated, and isolated from contact with rainfall?

➔ **STEP 3:** BMPs DURING CONSTRUCTION :

- Install base erosion BMPs including sediment barriers, stabilized construction entrances, sediment traps and ponds, and other erosion control BMPs prior to any ground disturbing activity.
- Install fencing or other necessary BMPs around vegetation to be protected.
- Begin ground disturbing activity only after erosion prevention and sediment control BMPs are in place.
- Stockpile woody debris for chipping and use chips for on-site erosion control.
- Grading should immediately follow clearing so that ground cover can be established immediately.
- Heavy mulch or temporary vegetation should be used on land that will be exposed for any period of time – see local jurisdictional requirements.
- Protect the toe of soils stockpiles with sediment barriers and the surface of stockpiles with vegetative cover, mulch, blankets, plastic tarping or other approved material.
- Control all chemicals that are to be used or stored onsite. Specify a designated storage area.
- Limit vehicle maintenance, fueling and washing activities to designated, controlled areas.
- Properly dispose of all paint, concrete, and other construction debris wastes.
- Carry out inspections and maintenance procedures and for all erosion control BMPs taken – see guidance in later sections of this manual for each BMP.
- Assure good coordination between construction and utility crews by defining schedules and limitations. Instruct subcontractors to follow the master plan for stockpiling materials, parking and erosion control.

? After implementing site BMPs - can you answer the following questions:

- ❑ How often are BMPs inspected? Are those inspections logged? What changes have been made as a result of inspections?
- ❑ Is schedule correct? Have BMPs been adjusted to address alternative seasons of work caused by project delays?
- ❑ Are construction wastes appropriately collected and recycled or disposed of?
- ❑ Are inlets and streets cleaned periodically during the course of construction?
- ❑ Do employees and sub-contractors need refresher training about the site?

➔ **STEP 4:** POST DEVELOPMENT BMPs :

- After final grading, immediately install permanent vegetation according to the approved simplified landscaping plan.
- Ensure all disturbed surfaces have been permanently stabilized, including borrow pits and disposal areas before removing base erosion control BMPs.
- Clean sediment from basins, traps; inlets, post development stormwater management facilities, and street structures. Remove sediment from the site and reuse or dispose of appropriately.
- Remove temporary structures like sediment fences, removing sediments for reuse or disposal.

? After finishing development – can you answer the following questions:

- ❑ Has vegetative cover established? Does vegetation need water, nutrients or more aerobic soils?
- ❑ Have temporary site control BMPs been removed, especially perimeter controls?
- ❑ Have any permanent stormwater conveyance or treatment facilities been refurbished for post development use?

CONSTRUCTION SEQUENCING (for sites greater than 1 acre)

Scheduling of activities on the project site can be done in a manner that increases effectiveness of erosion control efforts. Sequencing of site activities requires the contractor to fully consider each erosion control need during the various phases / activities of the project. Time of year, weather anticipated during activity duration, and size of ground disturbance area must be considered.

PURPOSE ➔ To minimize on-site erosion and off-site sedimentation resulting from any ground-disturbing activities. Sequencing helps assure installation of erosion, sediment and pollution controls are in accordance with the minimum requirements of this Manual.

CONDITIONS WHERE PRACTICE APPLY ➔ All ground disturbance projects, especially those that will disturb more than one acre of land.

DESIGN CRITERIA/SPECIFICATIONS ➔ Project sequencing will likely differ from single family residential construction and large subdivision or commercial / industrial site construction. The goal is the same for both – an actual schedule for implementing various erosion prevention, sediment and pollution control BMPs. Development of the sequencing plan will have many of the same steps for any project (See checklist page 3-8).

DEVELOPING THE SEQUENCING PLAN ➔

- Analyze the site and the anticipated construction schedule for the various aspects of the site: clearing, grubbing, grading, utility, installation, and structural improvements and landscaping. Identify activities at high risk for soil movement by air or by water. Include consideration of time of year and amount of soils exposed.
- Identify the BMPs for the various elements of site development. Consider the controls needed before any drainage, road or other utilities are installed. Also consider material reuse, waste storage and disposal needs and issues. Your site's sequencing may dictate the order that tasks are conducted or demonstrate that additional storage areas are needed.
- Develop an outline that describes the various BMPs that are to be utilized, when and where they are to be utilized, and incorporate it into an Erosion Sediment and Pollution Control Plan (ESPCP). Include design and maintenance considerations and facility sizing calculations. Lay out a site schedule that outlines these various activities – noting on the plan what ESPC BMPs will occur at which location for each activity.

Suggested Site Sequencing:

SMALL SITE

less than or = to 1 acre
(one and two family residential, small public works or other activities)

Entry Control BMPs
- gravel drive
- curb ramp
- sidewalk cut

Perimeter Controls
- buffers
- sediment fence
- inlet protection

Drainage Controls
- diversion ditches
- pipe slope drains

Sediment Control Features
- barriers
- inlet protection

Foundation *ESC BMPs
- control of sidecasting
- dewatering
- cover

Stockpiling BMPs
- siting
- perimeter control
- cover

Backfill *ESC BMPs
- control of materials movement

Utility Tie-In Controls
- control of side casting
- specific stockpiles

Final Grading *ESC BMPs
- during process

Vegetation Cover
- control materials
- irrigation flows

Temporary *ESC BMPs
- removal schedule

LARGE SITE

larger than 1 acre
(subdivisions, commercial / industrial or other site doing large amounts of grading including large public works projects)

Limit of Clearing Activities
- designate vegetation protection areas

Perimeter Controls
- include stormwater collection conveyance systems if needed

Entry Control BMPs
- gravel drive
- curb ramp
- wheel wash

Clearing and Grubbing BMPs
- limit to area needed for public works and utilities

Stripping and Soil Stockpiling BMPs
- siting
- perimeter control
- cover

Rough Grading Controls
- limit to area needed for public works and utilities

Utility Installation Controls
- control of side casting and materials movement

Backfill / Bedding *ESC BMPs
- temporary vegetation and/or cover

Foundation *ESC BMPs
- control of sidecasting
- dewatering

Backfill *ESC BMPs
- control of materials movement

Final Grading *ESC BMPs
- during process

Vegetation Cover
- control materials and irrigation flows

Temporary *ESC BMPs
- removal schedule

* ESC – Erosion and Sediment Control

Note: Assumes routine inspection, maintenance, and replacement of BMPs as needed.

PURPOSE ➔ To strategically determine position of roads, building lots and other site features to minimize drainage and erosion related impacts. Good site design will provide enhanced erosion prevention and sediment and pollutant control beyond using any combination of products.

CONDITIONS WHERE PRACTICE APPLIES ➔ All development sites.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Mimic existing drainage patterns and vegetative cover. When possible, enhance existing drainage and site vegetation features and patterns to meet development needs. By minimizing alteration to flow patterns, inundations of building pad areas or utility trenches is minimized. By preserving existing site vegetation, erosion prevention is already in place for that portion of the site and there is no cost of relandscaping.
- Design structures on contour. By following natural contours, drainage and sediment migration are controlled by running infrastructure and other elements parallel to slope rather than perpendicular to the slope. Not only does designing on contour enhance sediment control within site structures, but also reduces the velocity of permanent drainage flows into the receiving system.
- Consider temporary control features for permanent site service. Temporary development drainage control and vegetative cover can potentially be used as permanent site features. If a swale is functioning during construction to divert flows and minimize flow velocity, it could serve the same purpose in the post development condition of the site. Planning to have permanent vegetation used for during construction erosion prevention, removes one ground disturbing activity from the overall site development (removal of temporary vegetation for replacement with permanent vegetation).

4 EROSION & SEDIMENT CONTROL BMPS

SITE ENTRY BMPs

Control of access to and from a site of ground disturbance can go a long way to controlling migration of sediments off the worksite. Site entry BMPs should be the first erosion measures installed at any site.

Gravel Construction Entrances

PURPOSE ➔ To minimize the amount of mud, dirt, rocks, etc, transported onto roads by motor vehicles or storm water runoff, by constructing a stabilized pad of gravel at entrances/exits to construction sites.

CONDITIONS WHERE PRACTICE APPLIES ➔ At any construction site where traffic will be leaving the site and moving directly onto public roads, other paved areas, or other approved access points.

DESIGN CRITERIA/SPECIFICATIONS ➔

- A gravel construction entrance should be the first site BMP installed after clearing. No removal of stripped material is allowed until after establishment of the gravel entrance.
- Material should be clean pit run or 3/4 inches-minus gravel (or larger, as needed).
- The gravel pad shall be at least 8 inches thick and 50 feet in length. Width shall be the full width of the vehicle ingress and egress area. (A 20-foot minimum pad length may be acceptable as approved for one and two family construction sites.) **See Detail Drawing 4.1 A.**
- Use subgrade reinforcement geotextile under gravel pads for all but construction of a one or two family residence on existing lots of record.

ADDITIONAL BMPS ➔

- An additional control measure is construction of gravel filter berms across on-site traffic wheel paths to capture and retain sediment. Berms shall be 1 foot high with 3:1 side slopes, constructed of 3/4 to 3-inch crushed rock with less than 5 percent fines. Berms must be inspected regularly and accumulated sediment removed with rock added or replaced as needed. Berms should be spaced as follows:
  - Every 300 feet on slopes less than 5 percent.
  - Every 200 feet on slopes between 5 and 10 percent.
  - Every 100 feet on slopes greater than 10 percent.
- If the gravel pad does not adequately remove dirt and mud from vehicle wheels such that mud and dirt tracking is evident off site, additional BMPs must be taken. Such BMPs may include washing off wheels before vehicles leave the site or other construction techniques/work operations modifications. Wheel washing should be done on the gravel pad or in an approved wheel wash structure located onsite, adjacent to and on the site interior side of the gravel pad.
- Wheel wash. Wheel wash structures shall be established on a relatively flat grade (1 percent) with a minimum 50 foot run out area after the wash. The wash itself shall be 18 inches deep with a constant minimum 12 inches deep water pool – maintain depth at all times. Wheel washes shall be constructed as shown in detail drawing (a layer of filter fabric, covered by 12 inches of compacted, crushed rock, and then covered by 12 inches of reinforced concrete -#5 rebar at 12 inches on center, both directions) or as designed by a licensed engineer. Wash water shall be drained through a sediment-trapping structure prior to leaving the construction site. See **Detail Drawing 4.1B** for details of a typical wheel wash structure.

MAINTENANCE ➔ The entrance shall be maintained in a condition that will prevent tracking or flow of mud onto public rights-of-way, or other hard impervious surface. This may require period top dressing with additional gravel, or rock, or the washing and reworking of the existing material as conditions demand. This shall include the repair and or cleanout of any structures used to trap sediment.

All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into the stormwater collection system must be removed, or cleaned up, immediately. The use of water trucks to remove this material will not be permitted under any circumstances.

REMOVAL ➔ When vehicles are no longer entering and exiting the site, the need for the construction entrance diminishes. The construction entrance may be permitted to be removed if construction activities have ceased, a permanent pad or surface has been established, light and heavy construction traffic has ceased or no longer has a need to enter the site, or another entrance has been established.
A construction entrance shall not be removed without the proper approval and authorization of an inspector. Once an entrance has been approved for removal, temporary or permanent ground cover shall be established within designated time frames.

NOTE: Construction entrance materials are such that they can easily be recycled, rewashed, reused, or have an alternate use and it is encouraged that they be so recycled, or reused.

PRIMARY PURPOSE ➔

- To contain sediments onsite.
- To provide access without the use of gravel ramp (wooden curb ramp).
- To prevent vehicles from tracking dirt onto improved roadways.

SHALL NOT BE USED ➔

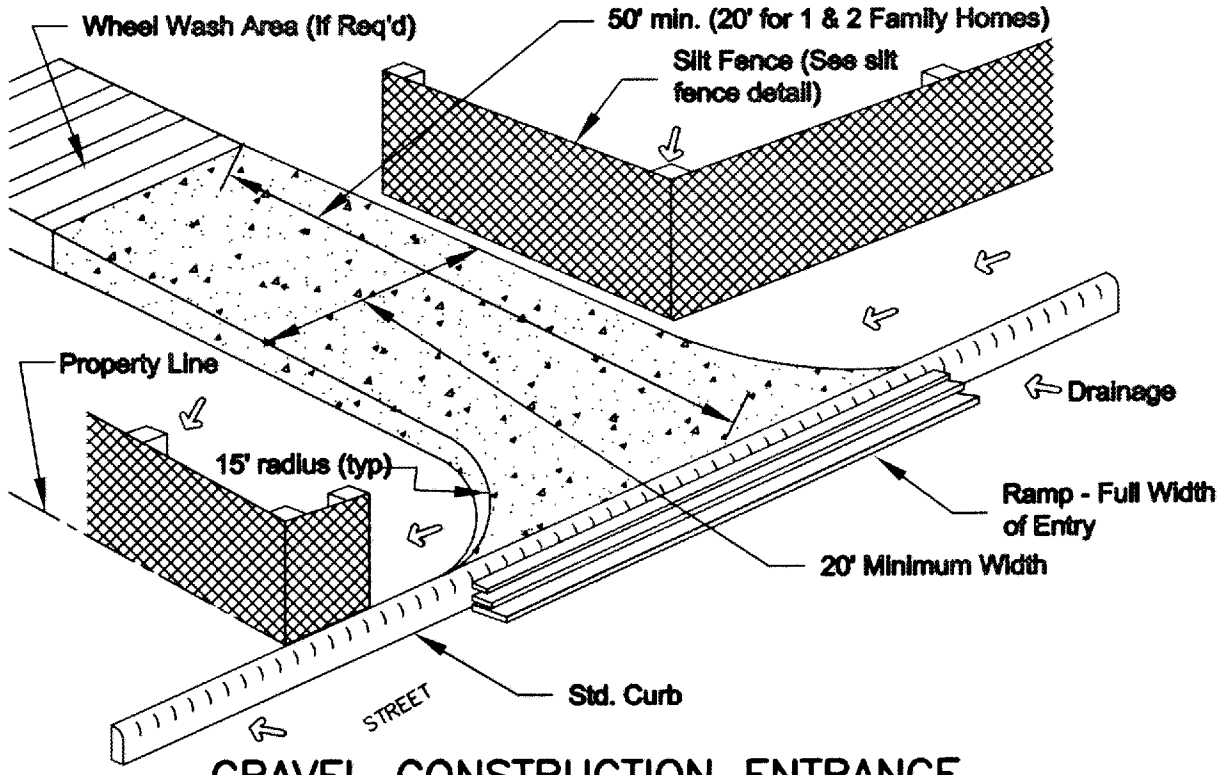
- When paved on-site access is available.
- Across streams and other drainage channels.

INSTALLATION TIPS ➔

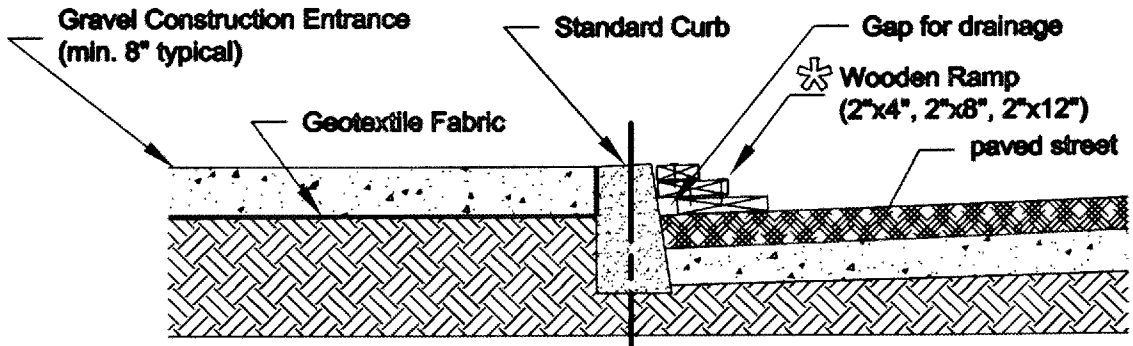
- Implement as first site BMP.
- Excavate to finish drive sub-grade so that fabric and gravel may remain permanently in place
- Remove contaminated material adequate to pave driveway.
- Locate entry on upslope side of lot if possible, to avoid concentrating and diverting runoff into the street.
- Consider use of multiple entries to access large or difficult sites.
- Add a wheel wash area as required (see Additional BMPs on page 4-2).

Signs of Failure

Symtoms	Cause	Solution
Tracking mud into the street	Gravels are contaminated or insufficient. Lack of proper maintenance.	Add additional gravel. Add a wheel wash facility. Physically remove surface mud from tires.
Dust generation	Lack of moisture on site roads. Friable soils onsite.	Add additional gravel or lengthen drive. Use a water truck to keep dust down. Control amount and type of spray to minimize erosion. Use a wetting agent on roadways (see Dust Control BMP).



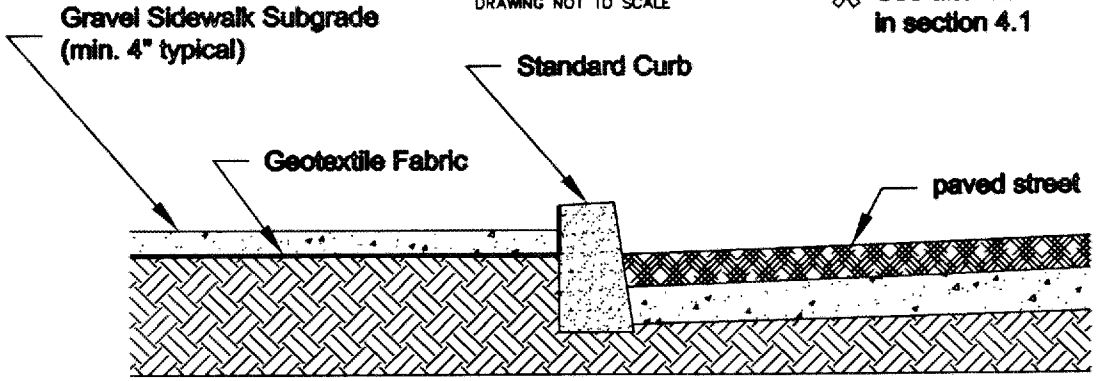
GRAVEL CONSTRUCTION ENTRANCE



CONSTRUCTION ENTRANCE ⟷ WOODEN CURB RAMP

DRAWING NOT TO SCALE

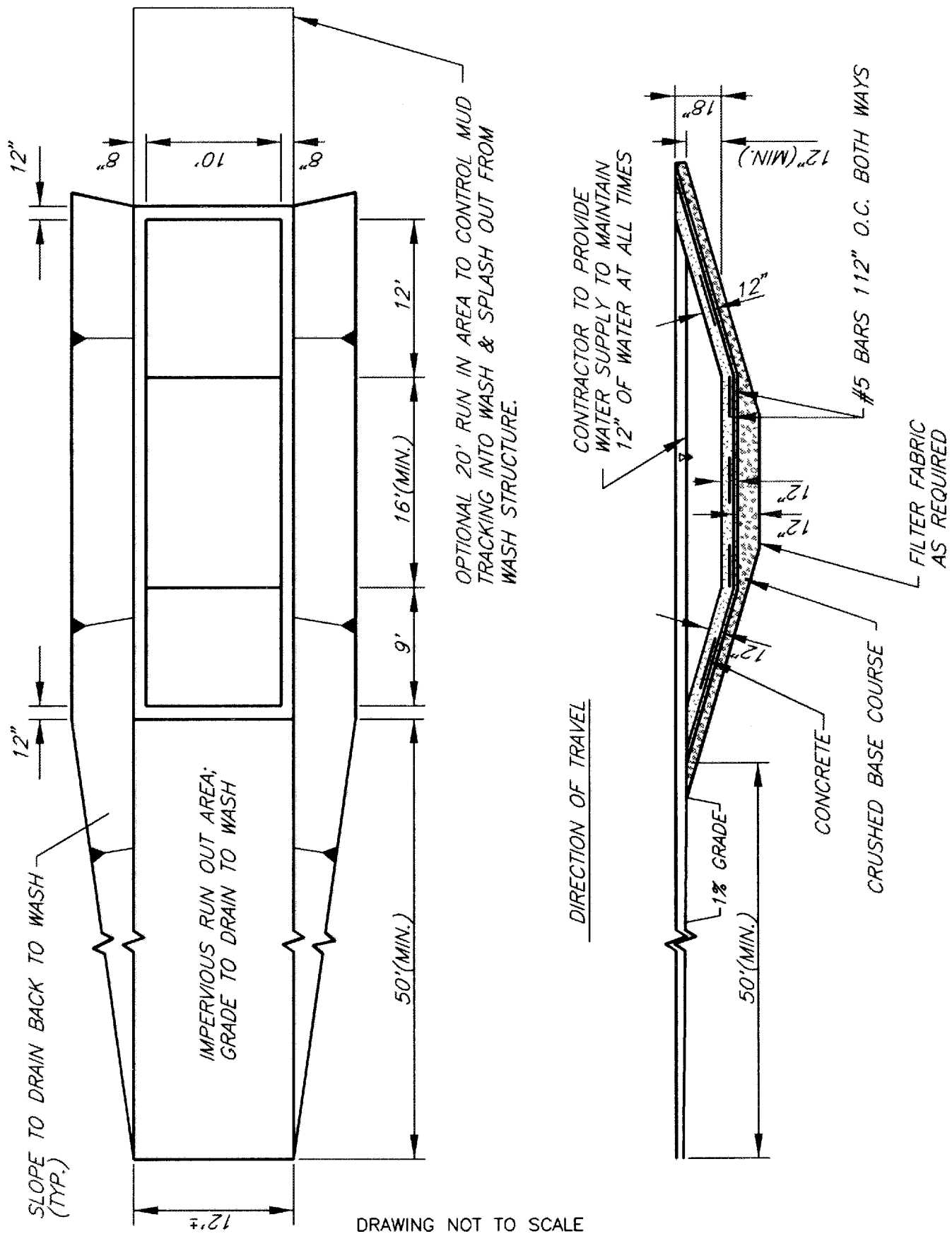
✻ See alternatives for wood in section 4.1



SIDEWALK SUB–GRADE

DRAWING NOT TO SCALE

Detail Drawing 4.1 B - Wheel Wash



DRAWING NOT TO SCALE

Wooden Curb Ramp

PURPOSE ➔ To provide ramp access to stabilized construction entrance without blocking flow or adding sediment to curb runoff.

CONDITIONS WHERE PRACTICE APPLIES ➔ Any area needing access from a paved surface to a gravel site entrance.

DESIGN CRITERIA/SPECIFICATIONS ➔

- No gravel or road base allowed.
- A wooden ramp shall be built from three or more planks of increasing size wood, offset to allow for drainage.
- Materials shall be untreated wood of 2x4 to 4x12 dimensions and shall be attached using nails, screws, adhesive or other approved fastening system.
- A minimum 2 inches gap for drainage shall be cut or left in the offset stack adjacent to the curb. Drainage should be routed through this opening.
- Larger, long-term projects may use hot mix asphalt ramps that will be removed when permanent drive installed. Cold asphalt is not allowed because of its lack of durability. Asphalt shall be poured for a minimum 2' gradual slope between curb and street level and have sanded connection joints. Adequate drainage conveyance controls are required.

MAINTENANCE REMOVAL GUIDANCE ➔

- Remove sediment and other debris when it begins to accumulate behind or upslope from the ramp.
- Inspect frequently to assure nails, screws or adhesives are in good working order. Replace any wood pieces that become cracked or damaged where they can no longer provide structural support.
- Remove wooden ramp after construction has ceased or when a permanent driveway has been installed.

See Detail Drawing 4.1A.

Perimeter control BMPs are the last protection before sediment enters the roadway, storm drains, or adjacent properties. Perimeter control BMPs can be the most visible and most vandalized BMPs used on a site of ground disturbance. Perimeter BMPs shall be installed before starting any site grading activities.

Sidewalk Subgrade Barrier

PURPOSE ➔ To minimize the transport of sediment from a construction site by using the sidewalk subgrade gravel as a temporary trap for sediment-laden runoff.

CONDITIONS WHERE PRACTICE APPLIES ➔ One and two family residential construction sites, where the site slopes to a street with planned but unconstructed sidewalks, and site slopes are less than 5 percent.

DESIGN CRITERIA/SPECIFICATIONS ➔

- See Detail Drawing 4.1 A for specifications.
- Excavate a minimum of 8 inches behind existing curbing. Line with a geotextile fabric. Backfill with a minimum of 4 inches of gravel, leaving a 4 inches capture depth behind the curb.
- Sidewalk subgrade gravel must be in place during the entire construction period, from the time of initial site clearing/grading through establishment of permanent site cover. If the sidewalk concrete is to be poured prior to establishment of permanent site cover, approved sediment barriers must be installed prior to pouring concrete.

MAINTENANCE REMOVAL GUIDANCE ➔

- Remove sediment when it accumulates within 2 inches of the top of the curbing. All materials spilled, dropped, washed, or tracked from vehicles onto roadways or into the stormwater collection system must be removed, or cleaned up, immediately. The use of water trucks to remove this material will not be permitted under any circumstances.
- Replace gravel when surface voids in gravel are visible. This may require period top dressing with additional gravel, or rock, or the washing and reworking of the existing material as conditions demand.
- If the sidewalk subgrade gravel does not provide an effective filter and sediment is leaving the construction site, additional BMPs must be applied. These may include replacement of gravel or installation of sediment barriers.
- Subgrade gravel may not meet the local jurisdiction's specifications for sidewalk concrete placement if too much sediment has infiltrated the rock. The permittee must therefore weigh the benefits of eliminating sediment barriers versus the possibility that the subgrade gravel may be rejected by the local jurisdiction.

PRIMARY PURPOSE ➔

- To contain sediments onsite.

SHALL NOT BE USED ➔

- By itself on slopes >5 percent.
- In areas of high runoff volume.

INSTALLATION TIPS ➔

- Evacuate to finish sub-grade so that fabric and gravel may remain permanently in place. Remove contaminated material adequate to pave driveway.
- Use with sediment fence at the back of the curb or at property line.
- Use mulch or gravel behind curb.
- For cross slopes >5 percent add winged sections to sediment fence behind curb.
- Add winged sediment fence sections at property corners.

Signs of Failure

Symtoms	Cause	Solution
Sediment in Road.	Sediment has overtopped sub-grade capture area. Lack of proper maintenance. Concentrated stormwater flow from above subgrade area.	Remove sediment buildup. Mulch or prevent erosion from contributing areas. Pipe away concentrated stormwater flows. Use a spreader to disperse concentrated flows evenly across site.

Temporary Sediment Control (Silt) Fences

4-2

PURPOSE ➔ To minimize the transport of sediment from a construction site by providing a temporary physical barrier to sediment movement and reducing runoff velocities.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Down slope of disturbed areas where runoff occurs as sheet runoff.
- At the toe of soil stock piles.
- At intervals along the contours of large disturbed areas.
- At grade breaks exceeding 20 percent up to 50 percent only (see matrices).

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- Sediment fences shall not be installed across streams.
- Sediment fences are most effective for trapping granular / coarse materials and should not be relied on to reduce turbidity.

DESIGN CRITERIA/SPECIFICATIONS ➔

- See Detail Drawing 4.2 A for details.
- A trench shall be cut along slope contours and around stockpiles for sediment fence installation. Filter fabric fence shall have a minimum vertical burial of 6 inches. All excavated material from filter fabric fence installation shall be firmly redeposited along the entire trenched area on the uphill side of and against the fence.
- Standard or heavy-duty filter fabric fence shall have manufactured stitched loops for 2 inches x 2 inches post installation. Stitched loops shall be installed on the uphill side of the sloped area, with posts spaced a maximum of 6 feet apart.
- Where practical, the filter fabric shall be purchased in a continuous roll to the length of the barrier to avoid use of joints. When joints are necessary, 2 inches x 2 inches posts shall be interlocked with each other and be attached securely together. (See Detail Drawing 4.2 A)
- Maximum sheet or overland flow path length to sediment fences: 100 linear feet for greater than 2:1 slopes, and 50 feet for 2:1 slopes. The size of the drainage area is no more than 1/4 acre for each 100 lineal feet of fence. Ends of fence lines shall be angled upslope in an arcing fashion. Wings may need to be added for long lines running downslope to allow for slowing of surface flows. Sediment fences also can be used in multiple rows to provide enhanced efficiency. Spacing of rows is dependent on the slope of the site.
- The physical integrity of all materials shall be sufficient to meet the requirements of their intended use and withstand normal wear and tear. Selection of filter fabric tensile and bursting strength depends on the slope characteristics. The use of standard or heavy-duty filter fabric that retains 85 percent of the soil by weight shall meet design standards. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 degrees F to 120 degrees F. Selection shall be based on standard engineering principles for design.
- Sediment fences may also be used in combination with chain link, haybales, fiber rolls and bio-filter bags for additional structural support and / or sedimentation effectiveness. Chain link fencing shall be placed directly behind temporary sediment fence for additional structural control. Haybales maybe used in front of sediment fence for sedimentation or behind sediment fence for structural improvement. Bio-filter bags, fiber rolls or coarse mulch are most effective in front of sediment fence, either adjacent to or upslope within 3 feet of the sediment fence.

MAINTENANCE / REMOVAL GUIDANCE ➔

- Sediment fences shall be inspected by applicant/contractor immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs, relocations or additions shall be made immediately.
- At no time shall more than one foot depth of sediment be allowed to accumulate behind a sediment fence. Sediment should be removed or regraded onto slopes, and the sediment fences repaired and reestablished as needed.
- Fences shall be removed only when upslope areas are permanently stabilized. This may require a post construction completion visit to remove fencing.

PRIMARY PURPOSE ➔

- To divert or provide a barrier to surface flows and slow flows coming off a project.
- To contain sediments onsite.
- Limited capacity to filter sediment from flows.

SHALL NOT BE USED ➔

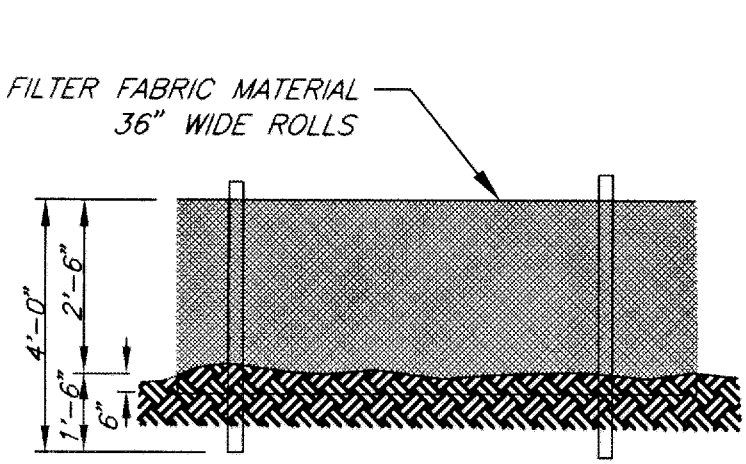
- Sediment fence should never be used on steeper than 2:1 slopes.
- Across streams and other drainage channels.

INSTALLATION TIPS ➔

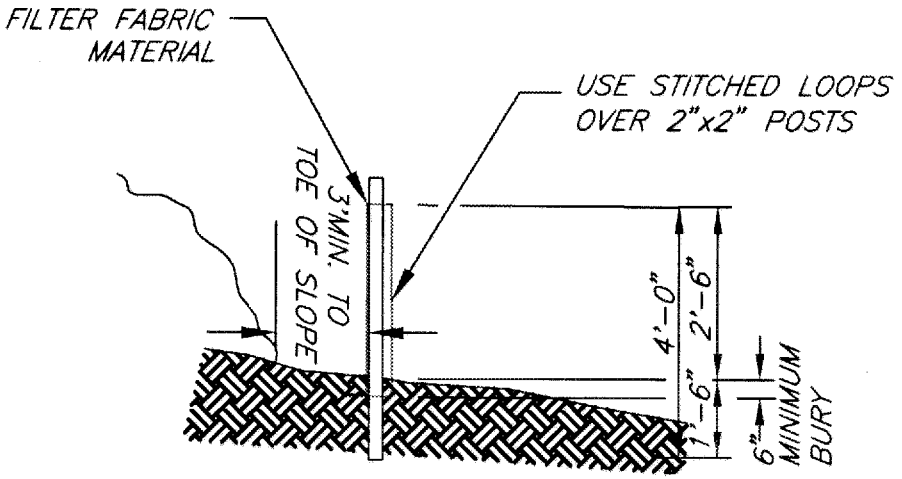
- Dig trench and backfill at least 6 inches on top of fabric. Compact soil well. Do not lay the bottom fabric flap on the ground surface and pile soil onto it.
- Install sediment fence on horizontal contours. Do not install fence down the slope, unless needed as a wing arm or to divert flow (see top view detail)
- Place mulch, fiber rolls or bio-filter bags along the upslope side of the sediment fence to provide additional sediment capture. This practice will keep sediment from reducing the porosity of the fence fabric

Signs of Failure

Symtoms	Cause	Solution
Concentrated runoff from under the fabric of the fence.	The bottom flap is not properly buried. Fence not installed on contour. Concentrated stormwater flow from above subgrade area.	Reinstall on contour with bottom fabric in trench and compact soil ontop of the fabric. Evaluate and redirect concentrated flows.
Sediment fence is tipping over.	Stakes not penetrating subgrade. Stake pockets are downslope, fence falls as stake pocket fails.	Reinstall correctly or add additional layer of sediment fencing or install additional staking.
Excessive sediment buildup.	Lack of timely maintenance. Spacing of fencing is too great – too long or steep of slope. Groundcover treatments inadequate. Improper installation – too much concentrated runoff at common points.	Clean out sediment from behind fence. Add addition fencing lines (see detail). Add groundcover, mulch, tackifier or other erosion prevention products upslope. Add winged sections to help divert and control flow.

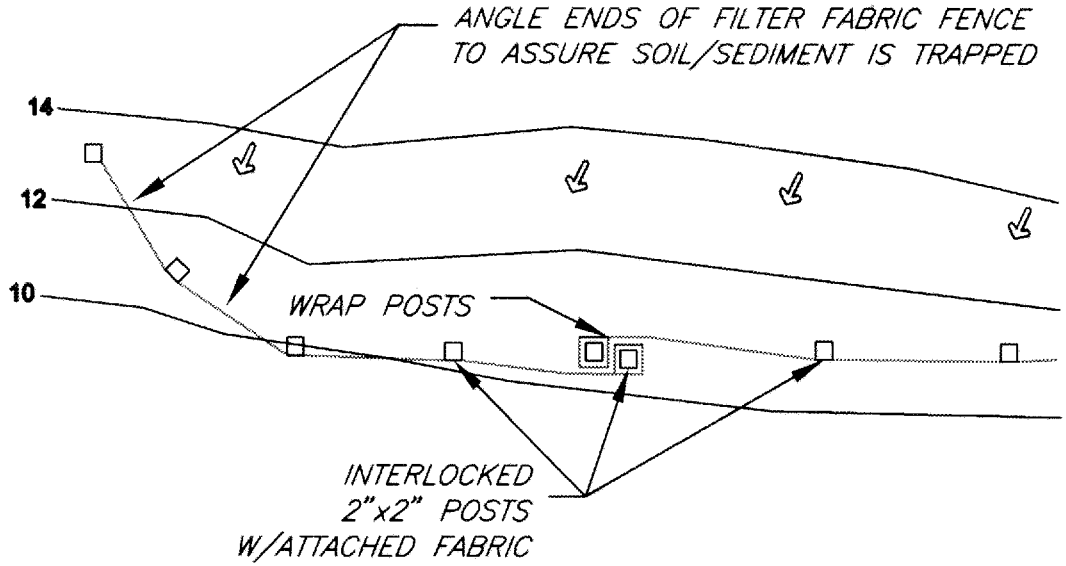


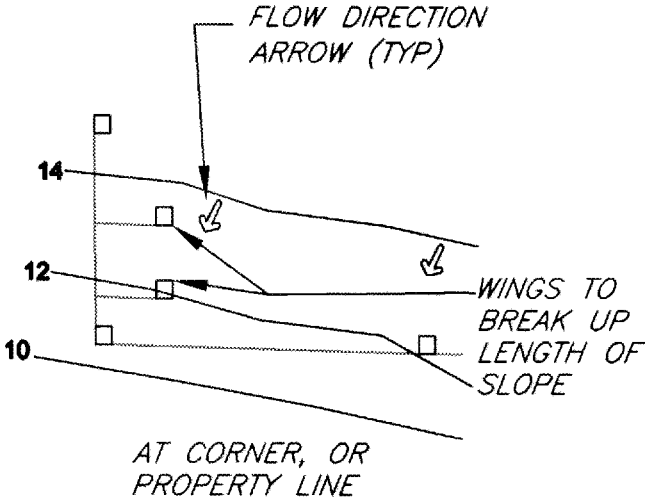
SIDE VIEW



SIDE VIEW

DRAWING NOT TO SCALE





TOP VIEW

Bio-Filter Bags and Fiber Rolls

4-2

DEFINITION ➔ Bio-filter Bags are plastic mesh bags of various sizes filled with a variety of organic and in-organic materials designed to filter and detain flows and sediment. The most common fill material is bark chips. Fiber rolls are circular, dense, vegetated fiber tubes that act to detain sediments and runoff flows. Fiber rolls are commonly made of rice and coconut fibers, and can provide a planting medium for plug or potted plants.

PURPOSE ➔ To minimize the transport of sediment from a construction site by providing a temporary physical barrier to sediment and reducing runoff velocities.

CONDITIONS WHERE PRACTICE APPLIES ➔

- At toe of soil stockpiles or slopes.
- On the up or down slope side of a sediment fence line.
- As a perimeter control BMP.
- As a check dam in newly constructed or existing drainage ditches and/or swales.
- For catch basin protection.
- As flow control, by splitting up slope length on slopes

DESIGN CRITERIA/SPECIFICATIONS ➔

- See **Detail Drawing 4.2 B** for details of installation recommendations.
- Bio-filter bags fill material shall be clean 100 percent recycled wood product waste. Size of bag can vary but generally are 18 to 20 inches long and weigh approximately 45 pounds. The bag is usually made of 1/2 inch plastic mesh.
- Fiber rolls are bio-degradable and comprised of weed free vegetated materials.
- Stakes shall be installed as shown in the notes on **Detail Drawings 4.2 B-D**.

MAINTENANCE REMOVAL GUIDANCE ➔

- At no time shall more than a six inches depth of sediment be allowed to accumulate behind Bio-filter bags or Fiber rolls. Sediment should be removed or regraded onto the slope, or new lines of barriers installed uphill of sediment-laden barriers.
- Once the upslope area is stabilized, Bio-filter bags shall be removed or reused onsite. Fiber rolls may be left onsite as a semi-permanent, bio-degradable landscape feature. Bio-filter bags fill material can be incorporated as mulch after completion of site work if approved by the jurisdiction. Removal may necessitate a post construction site visit. The bags shall be disposed of at a local recycling or solid waste disposal facility.

PRIMARY PURPOSE ➔

- To contain sediments onsite.
- To slow surface water flow coming off a project.

SHALL NOT BE USED ➔

- In high flow areas.

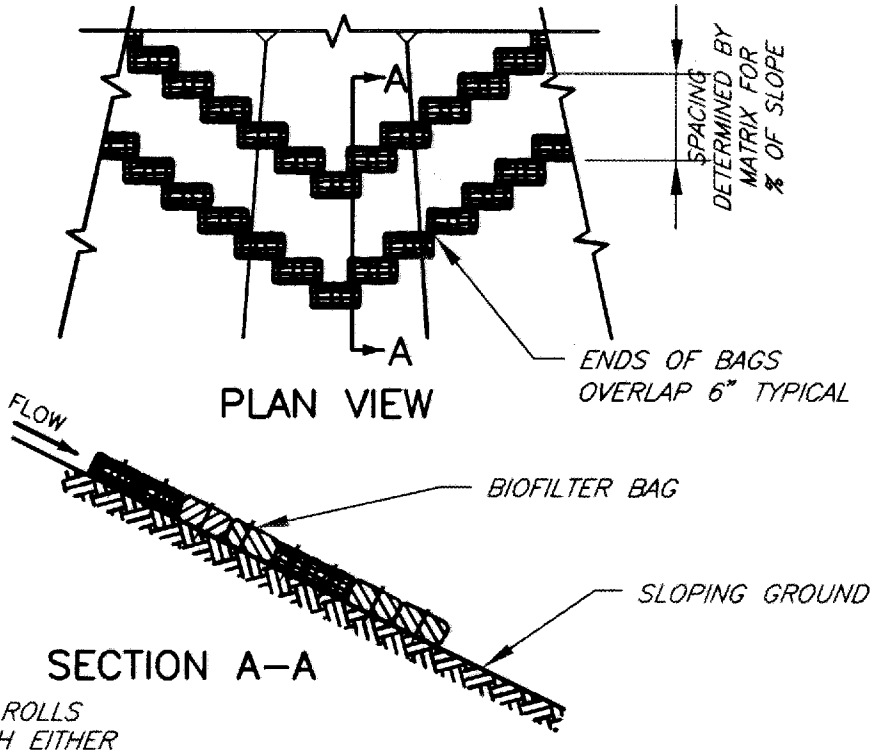
INSTALLATION TIPS ➔

- Use Bio-filter bags or Fiber rolls in front of or behind sediment fence to provide added support to the toe of the fence.
- Maintenance is critical. Remove sediment build up , replace or add additional Bio-filter bags or Fiber rolls when 1/3 of capacity is full.
- Check remaining capacity often since high flows can limit performance and damage bags or rolls.
- Best used in low exposure / low sediment load areas.
- Check placement and performance often to avoid impacts from vehicle damage and/or vandalism.
- For Bio-filter bags assure that no gaps exist under or between bags that could bypass flows. Bags shall be overlapped whenever possible.

Signs of Failure

Symtoms	Cause	Solution
Concentrated runoff or sediment flows are coming around or under bags or rolls.	Insufficient materials. Insufficient stake down during installation.	Add additional materials and align to contain flows. Reinstall with proper staking and entrenchment.
Sediment is overwhelming bags or rolls.	Lack of upslope BMPs. Inadequate maintenance.	Add erosion prevention or other sediment control BMPs. Clean sediment from behind bags or rolls.

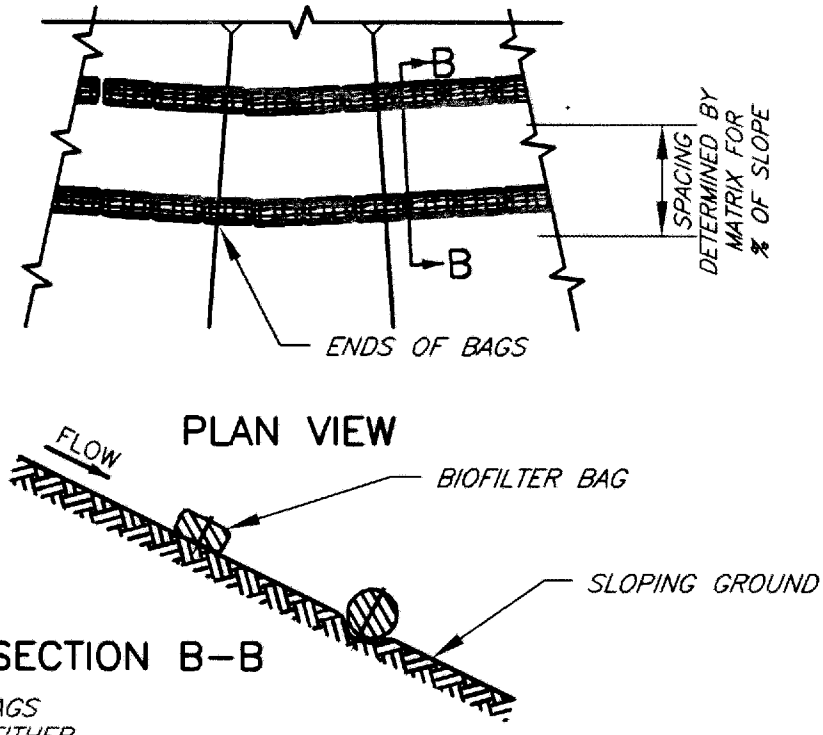
Detail Drawing 4.2 B - Slope Installation Bio-filter Bags & Fiber Rolls



NOTE:
STAKING OF BAGS OR ROLLS MAY BE REQUIRED WITH EITHER METHOD. USING (2) 1"x 2" WOOD STAKES OR APPROVED EQUAL PER BAG OR ROLL.

ALTERNATE #2

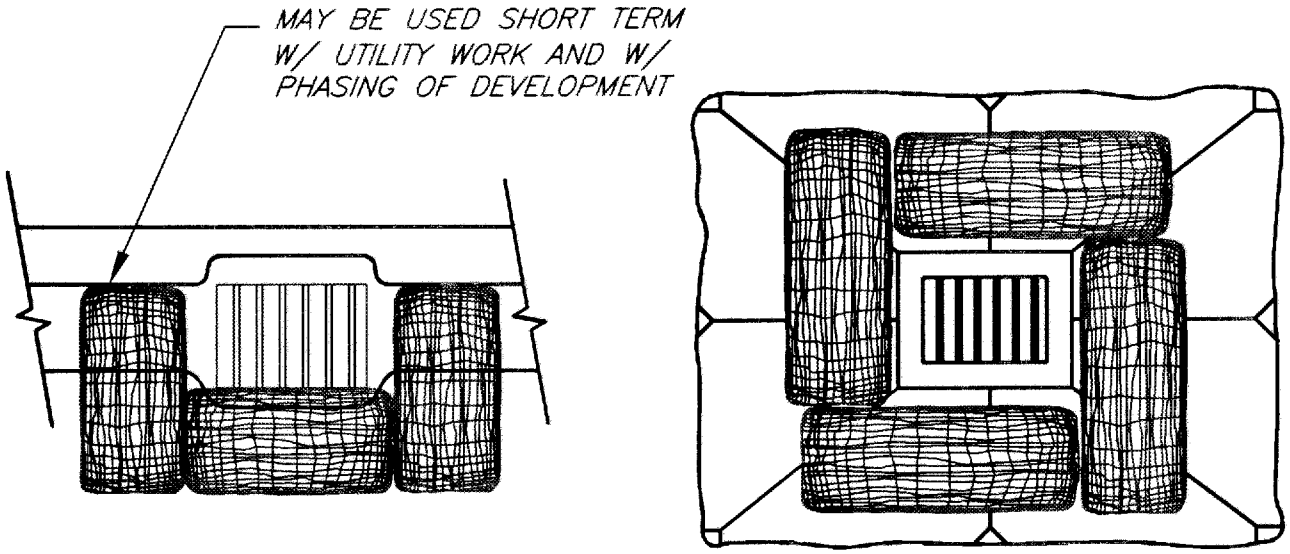
DRAWING NOT TO SCALE



NOTE:
STAKING OF ROLLS OR BAGS MAY BE REQUIRED WITH EITHER METHOD. USING (2) 1"x 2" WOOD STAKES OR APPROVED EQUAL PER ROLL OR BAG.

ALTERNATE #1

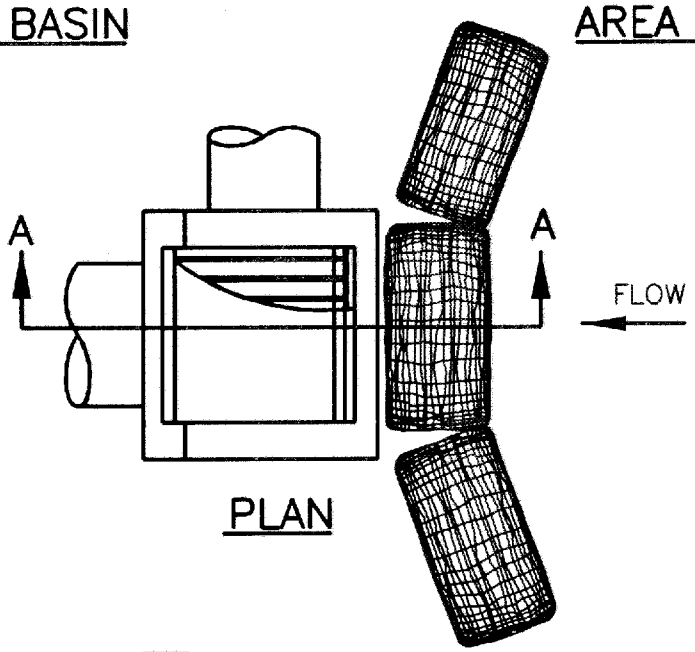
DRAWING NOT TO SCALE



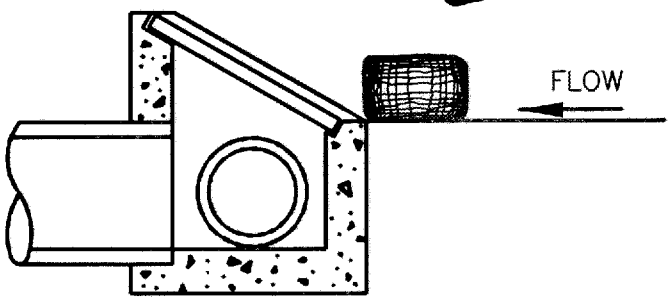
CATCH BASIN

AREA DRAIN

MAXIMUM
3 MONTH
USE



PLAN

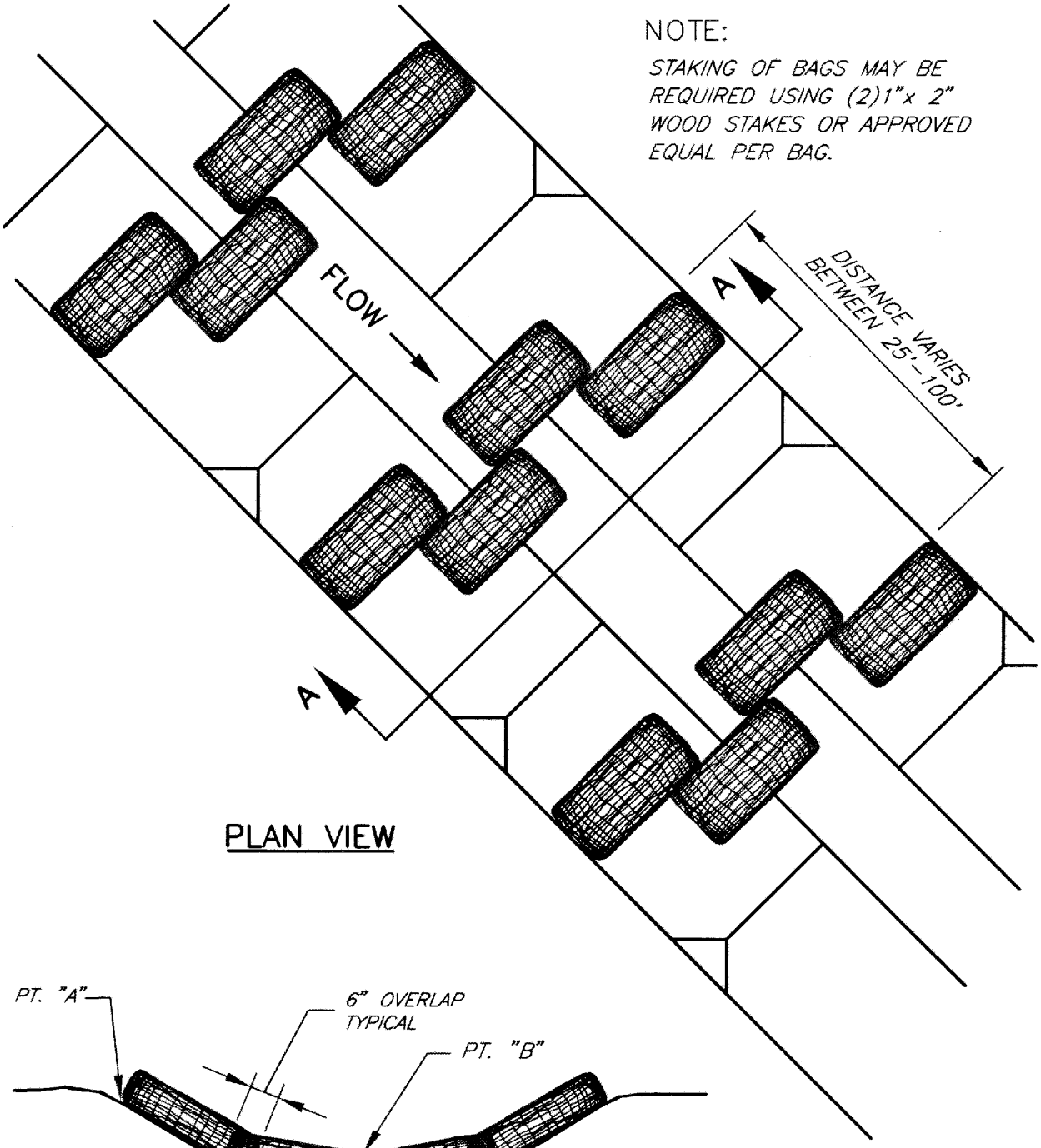


SECTION A–A

DITCH INLET

DRAWING NOT TO SCALE

Detail Drawing 4.2 D - Bio-filter Bag Ditches and Swales



PLAN VIEW

NOTE:
PT. 'A' MUST BE 6" MIN. HIGHER THAN PT. 'B'

SECTION A–A

DRAWING NOT TO SCALE

Undisturbed Vegetated Buffers

DEFINITION ➔ Undisturbed buffers are swaths of preserved or established vegetation that act as perimeter controls for a project site. The rooted vegetation holds soils; acts as a wind break and filters runoff that may leave the site. Vegetation should be at least 1 inch in height and provide 80 percent ground coverage.

PURPOSE ➔ To minimize soil movement off-site by wind or surface runoff. May act as an alternate, or in certain cases, a supplemental measure, to sediment barriers or sediment fence.

CONDITIONS WHERE PRACTICE APPLIES ➔

An undisturbed buffer may be used as approved as an alternate to a sediment barrier at the toe of the site slopes if the buffer meets the following criteria:

- The buffer is an undisturbed grassy area or covered with other approved dense vegetation,
- the buffer is downhill and in the drainage path of the construction/disturbed area,
- there are no concentrated flows from the disturbed site entering the buffer,
- the buffer area is owned by the applicant or approved for such use in writing by the owner.

DESIGN CRITERIA/SPECIFICATIONS ➔

Before creating a temporary site control buffer, consider placement of permanent site vegetation. There may be an opportunity to install permanent site vegetation areas during construction to act as temporary sediment control BMPs.

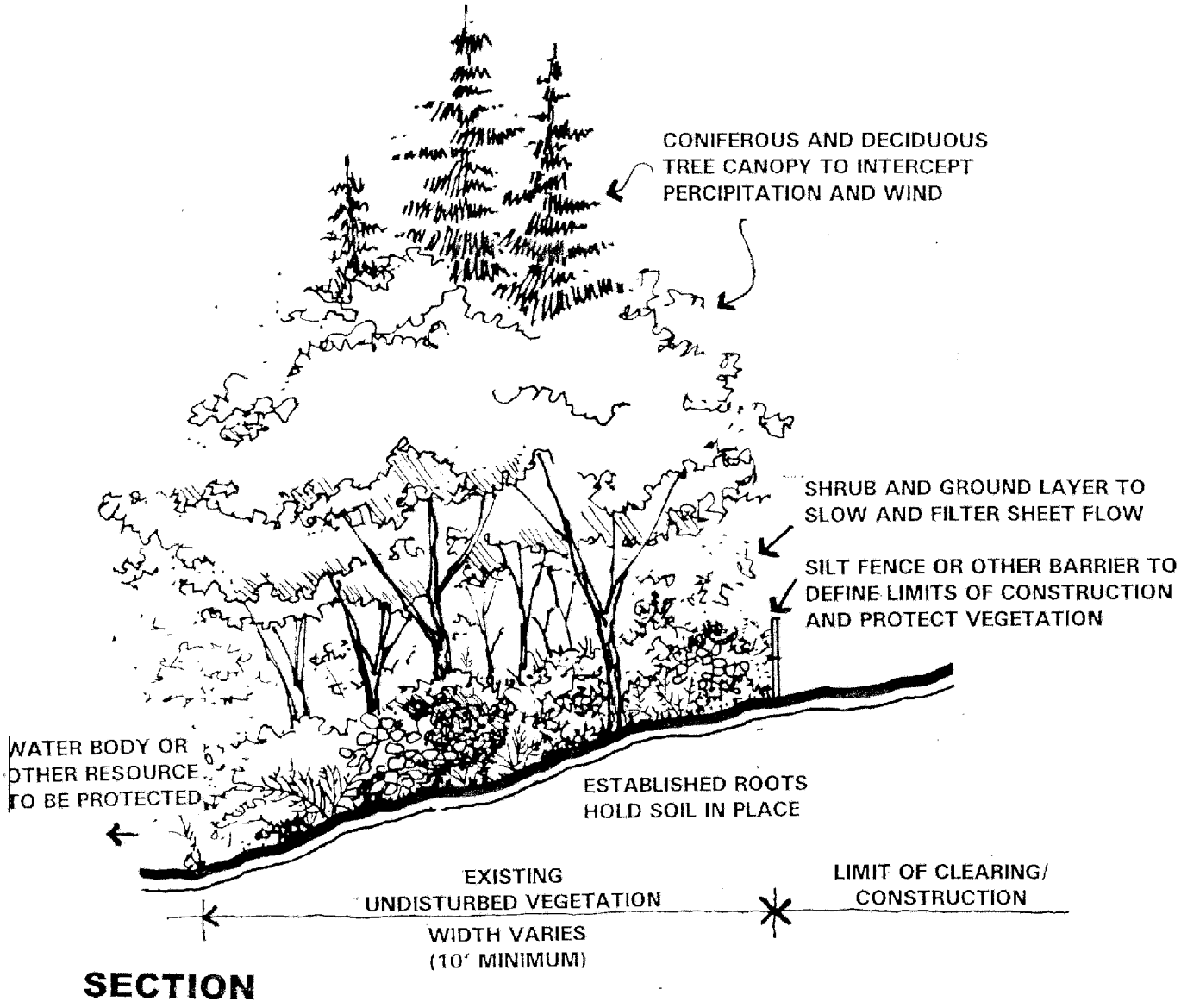
- For preservation buffers, designate areas of no disturbance. Clearly mark these areas with flags, fencing or other visible method. Assure all site workers understand the meaning and use of these areas.
- Buffers are best created by or preserved as native, high root mass, dense foliage vegetation. Blackberries do not make good erosion control buffers. Buffers are sized according to the table below:

BUFFER WIDTH REQUIREMENTS

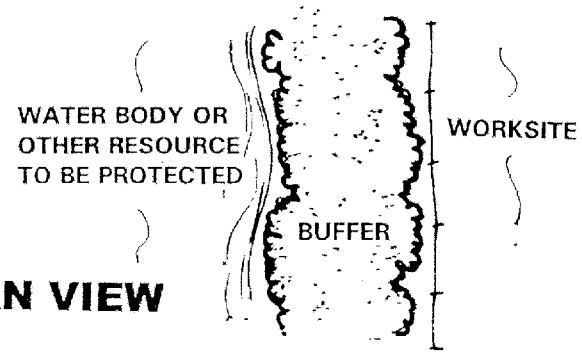
Site Location	Minimum Buffer Width
Infill / Flat site (less than 10%) slope.	10'
Adjacent to waterways or other natural resources.	Per Environmental or Buffer Protection Zone Regulations or 50' whichever is greater.
Steep slopes (more than 10%).	10' + 2 (% of slope).

MAINTENANCE REMOVAL GUIDANCE ➔

- Inspect buffers for concentrated storm flow damage after any major storm event. Repair any rills and re-establish adequate flow spacing across the buffer area.
- Assure survival of the buffer vegetation. Replace and/or add additional plants if necessary to fill in any voids.



SECTION



PLAN VIEW

DRAWING NOT TO SCALE

Storm Drain Inlet Protection

PURPOSE ➔ To minimize sediment entering storm drain systems prior to permanent stabilization of disturbed areas.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Where interior site or adjacent storm drain systems are operational before permanent stabilization of the disturbed drainage area.
- Adjacent to and immediately downhill of utility type construction in existing paved areas with catch basin drainage.
- In public right-of-way areas for use during approved flushing operations.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Design criteria and specifications for four recommended alternative methods of storm drain inlet protection are presented on **Detail Drawings 4.3 F and G.**
- Berms may be required to direct drainage to flow through the filters and prevent bypassing of the inlets.
- All gravels shall be no larger than 1 1/2 inches rock and shall be larger than any mesh opening. Wire mesh shall be no greater than 1/2 inch opening size. Rock minus mixture is allowed if fines are kept to a minimum. Washing of gravels in an appropriate location should be considered. Gravels shall be bermed in a manner to allow 6 inches of detention behind the gravel berms.
- Wrapped grates shall have fabric ends secured under the grate in such a manner as to not allow the grate to lift and flows to by pass. This protection technique is only allowed for short term use (less than 24 hours) and for small flow protection, i.e. control of saw cutting runoff.
- Bio-filter bags are not allowed for inlet protection use for more than three months.

NOTE: Straw bales shall not be used for catch basin protection.

MAINTENANCE REMOVAL GUIDANCE ➔

- At no time will more than a six inches of sediment be allowed to accumulate against storm drain inlet protection BMPs. Sediment must be removed and inlet protection BMPs restored as needed to maintain their sediment trapping and filtering capability.
- All facilities are removed after all construction is complete. Inlet protection should be the last BMPs removed from the site.
- Catchbasins are cleared of any sediment or debris that bypassed filter during site development.

PRIMARY PURPOSE ➔

- To act as a secondary perimeter, sediment control measure.

SHALL NOT BE USED ➔

- Alone without other site control BMPs.
- In high traffic or high flow areas.

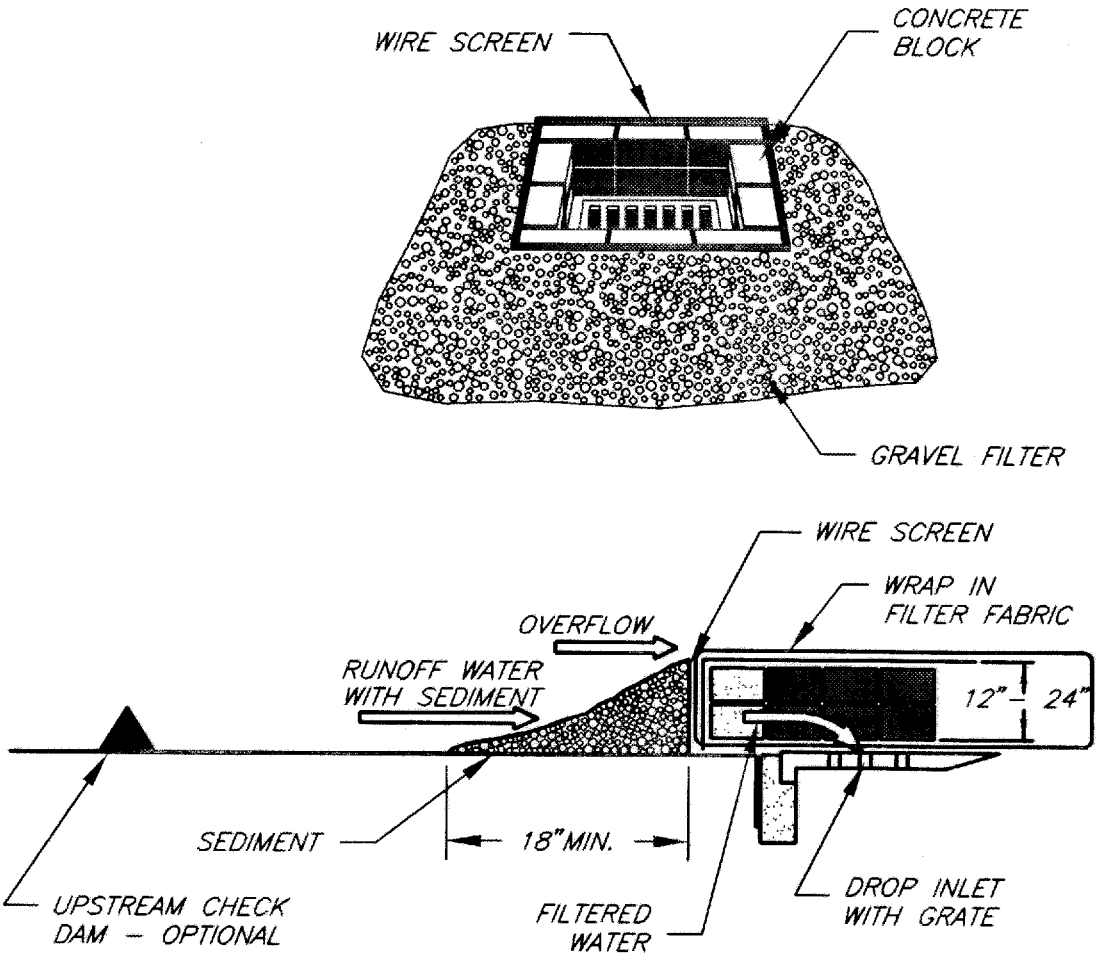
  NOTE: Inlet Inserts may be preferable to these BMPs.

INSTALLATION TIPS ➔

- For field inlets using sediment fence protection (4.2 F - top), use multiple rows of fencing to provide for enhanced protection from construction vehicles.
- Assure overlap joints in sediment fence fabric pieces are appropriately welded or wrapped.
- Consider use of check-dams in the gutter drainage area up slope of inlet devices to enhance sediment removal.
- For block inlet barriers (4.2 F - bottom) and wire mesh barriers (4.2 G) flag or otherwise mark block or gravel edges for easy identification under submerged conditions.
- Wrap blocks used for barrier with filter fabric before applying gravel to enhance filtration.

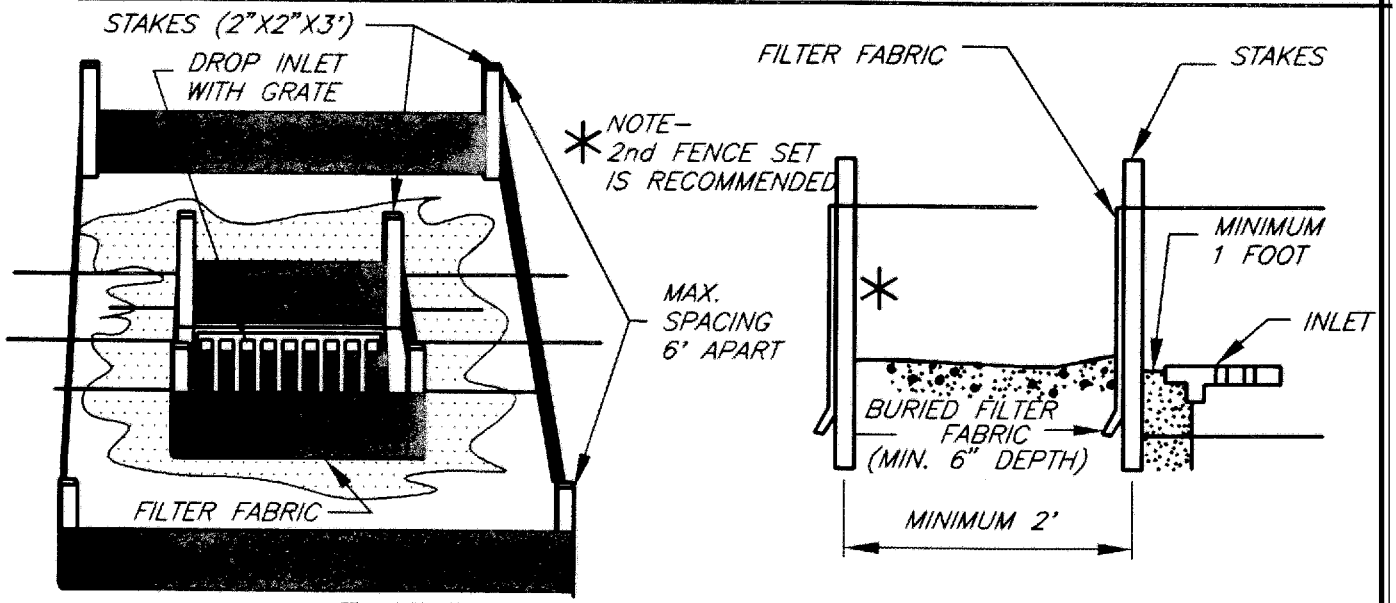
Signs of Failure

Symtoms	Cause	Solution
System not filtering.	Fabrics or gravel have become clogged.	Remove and replace filter materials. If materials can be cleaned for reuse – then use. Provide additional upslope erosion prevention or sediment control features.
Gravel has moved.	System is impacted by traffic flows. Runoff has too high a flow rate or flow volume.	Flag or redirect construction traffic away from inlet. Provide upslope check dams or other flow control and energy dissipaters.



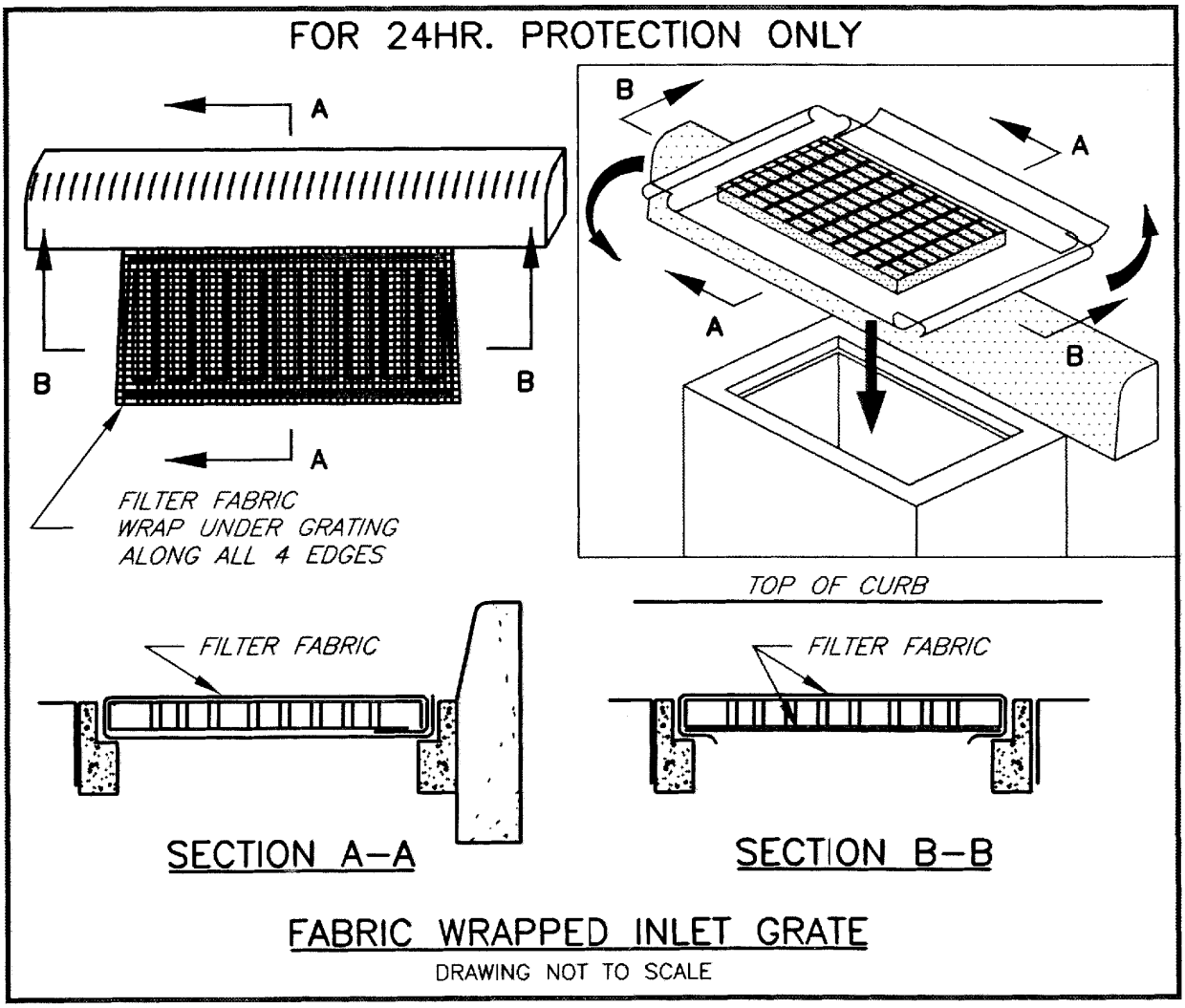
BLOCK & GRAVEL INLET BARRIER

DRAWING NOT TO SCALE



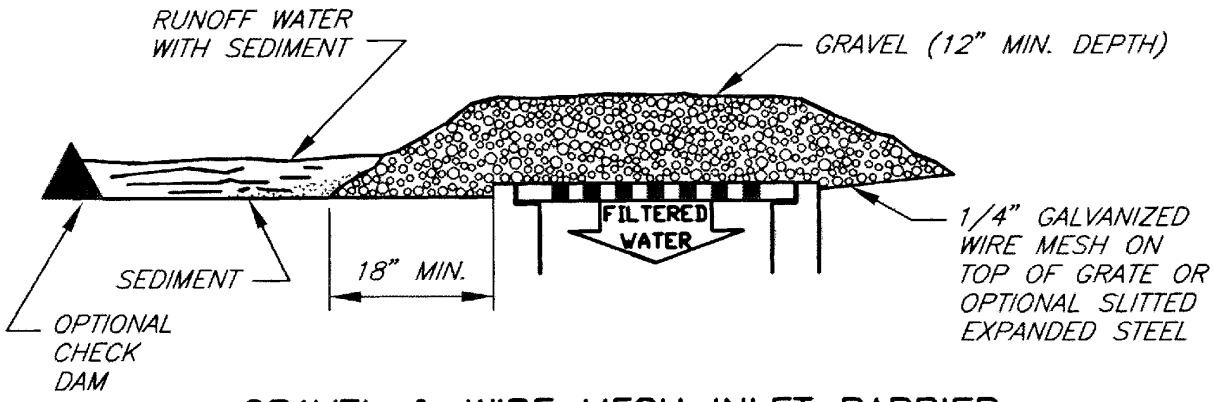
FILTER FABRIC INLET BARRIER (BEST FOR FIELD INLETS)

DRAWING NOT TO SCALE



FABRIC WRAPPED INLET GRATE

DRAWING NOT TO SCALE



GRAVEL & WIRE MESH INLET BARRIER

DRAWING NOT TO SCALE

Inlet Inserts

DEFINITION ➔ Inlet inserts are a series of devices designed to trap and/or filter construction and stormwater flows leaving a site. Inserts can include bags, racks, baskets and other materials that hang down into a catchbasin or inlet. Inserts are made from filter fabric, wire mesh, metal plates, various types of plastic products and combinations of these and other materials. Some inserts are even biodegradable.

PURPOSE ➔ To trap and/or filter sediment and other materials from site runoff and to prevent clogging of catchbasins and inlets.

CONDITIONS WHERE PRACTICE APPLIES ➔

Any field or street inlet or catchbasin that may receive construction related site runoff.

NOTE: These devices require additional upslope BMPs to be effective.

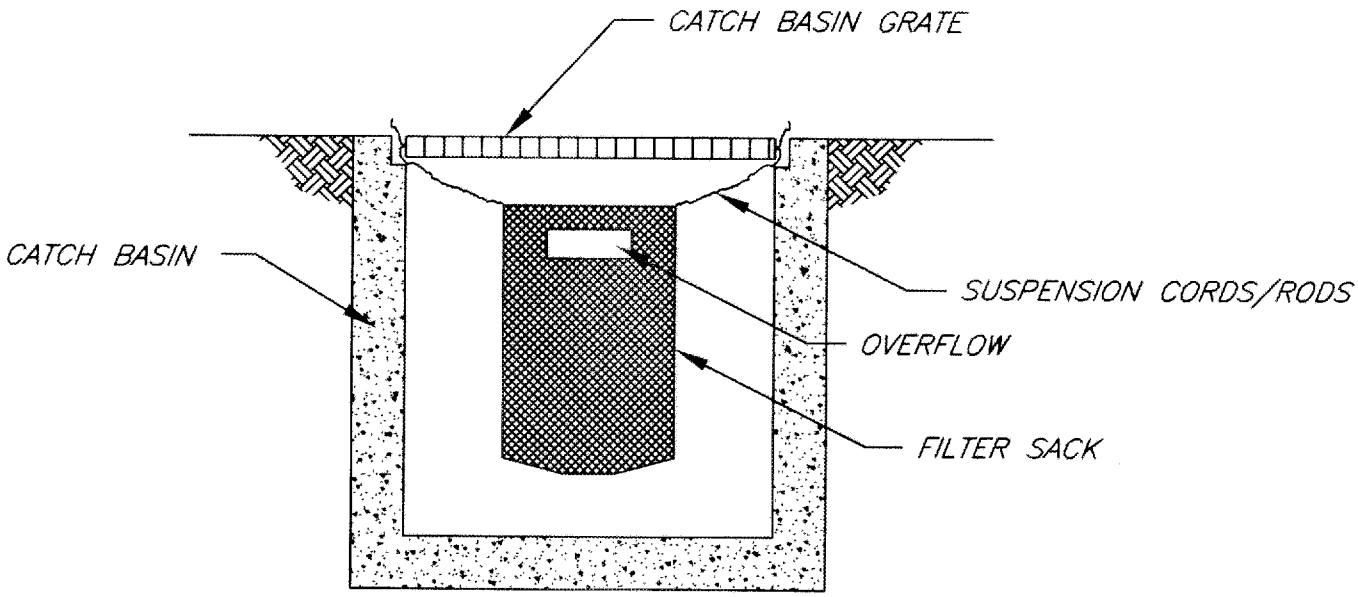
DESIGN CRITERIA/SPECIFICATIONS ➔

Devices shall be installed as per the manufacturer's instruction meeting the following criteria:

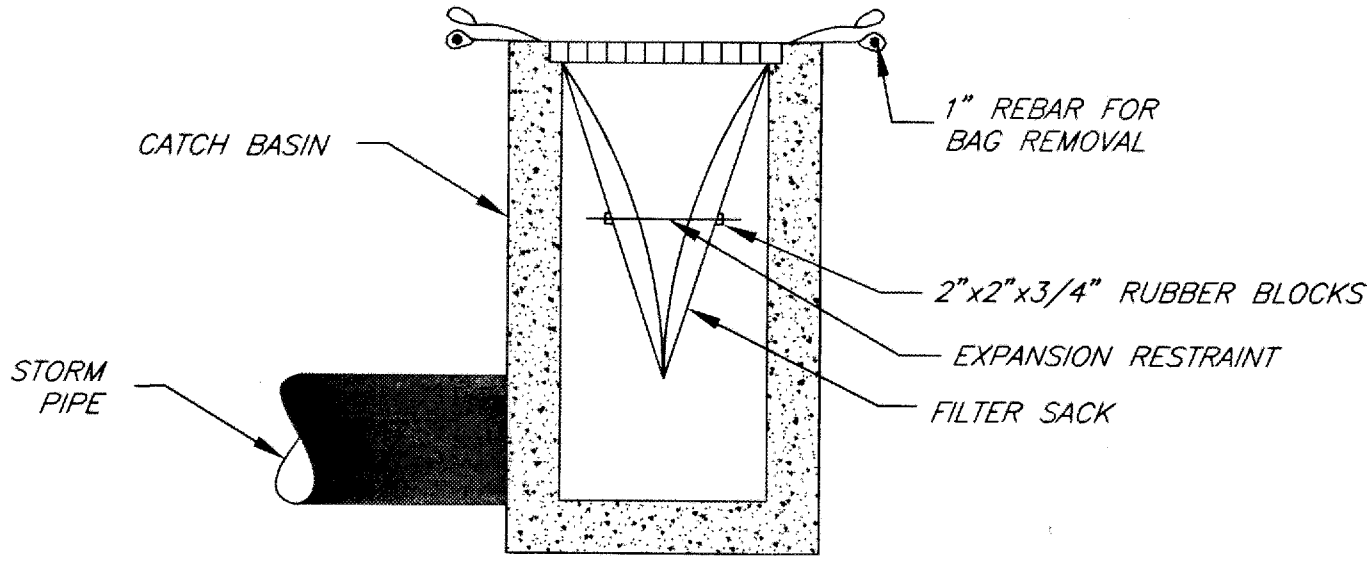
- Devices shall be installed as a point protection or in series as a perimeter sediment control BMP prior to any site grading activity.
- Installation shall not block flows from filtering into the inlet or catchbasin.
- Fabrics or other materials shall be sized to handle projected site runoff and sediment load flows.
- Devices shall be installed without protruding parts that could be a traffic, worker or pedestrian hazard.
- Retrieval edges, cords, bars, chains or other mechanisms shall be flagged or marked for retrieval under submerged conditions.

MAINTENANCE REMOVAL GUIDANCE ➔

- Inlet devices shall be inspected after every major rainstorm. During dry weather, devices shall be inspected every 2-3 weeks.
- Like other sediment control devices, inserts shall be maintained when sediment consumes 1/3 of actual device storage area or design storage capacity.
- Replacement shall be per manufacturer's instructions or when device no longer drains. At no time shall devices be punctured or otherwise modified to bypass.
- Unless cleaned for reuse as a permanent site control or cleaned and left to biodegrade, all devices shall be removed after construction is completed (or after permanent vegetation is established).



INSERT SACK
FRONT VIEW



INSERT SACK
SIDE VIEW

NOTE:
RECESSED CURB INLET MUST BE BLOCKED WHEN USING FIILTER FABRIC INLET SACKS.
SIZE OF FILTER FABRIC INLET SACK TO BE DETERMINED BY MANUFACTURER.

DRAWING NOT TO SCALE

Stormwater control is a vital element to prevent erosion. The following BMPs describe methods to convey, divert, treat and otherwise control stormwater flow rates and volumes. Stormwater control BMP sizing can be complex, and runoff volumes and rates difficult to predict. It is recommended that a licensed design engineer be consulted on all stormwater control designs.

Interceptor Dikes and Swales

PURPOSE ➔ To intercept and/or divert storm runoff from onsite and offsite drainage areas. To convey runoff from above unprotected slopes or a disturbed site and direct it to a sediment trap, pond or other approved stabilized outlet. Dikes and swales may be installed as permanent site drainage control features, while providing conveyance of temporary development flows.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Diversion of drainage around or away from work areas.
- Where the volume and velocity of runoff from disturbed slopes is erosive and must be reduced or redirected. When an interceptor dike or swale is placed above a disturbed slope, it collects and conveys flows away from the slope reducing the volume of water reaching the disturbed area.
- Interceptor dikes and swales can be used to direct site runoff to a sediment trap or pond, if applicable.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Flows shall be estimated for the drainage areas to be collected and/or conveyed by the dike or swale.
- Multiple dikes and swales may be needed to convey flows. Dikes and swales have the following horizontal spacing on slopes:

SLOPE SPACING

Slopes	Dike/Swale spacing (feet)
Less than 5%	300
5 – 10%	200
10 – 25%	100
25 – 50%	50

- Maximum grade of interceptor swales shall be 5 percent, and provide positive drainage to outlet. Erosion protection materials shall be used on exposed soils prior to receiving flows and shall be specified in submittal plans. Such cover may include grass, rock or erosion blankets.
- Grades for drainage parallel to interceptor dikes shall be between 0.5 and 1.0 percent with a maximum flow velocity of 2 FPS (Feet Per Second).

- Intercepted runoff must be directed to a stabilized area such as a pond, trap or other holding area. This diversion shall be designed in such a manner that no erosion occurs from the movement of the additional water volume and flow rate.
- The upslope side of interceptor dikes shall provide positive drainage to the dike outlet. Provide energy dissipation BMPs as necessary to minimize erosion at dike outlet.
- Minimize construction traffic over dikes and swales. When unavoidable, provide for underdrains to ensure diverted water does not cross traffic areas.
- See Detail Drawing 4.3 A for details.

MAINTENANCE REMOVAL GUIDANCE ➔

- Inspect after every major rainstorm for side, bottom, inlet and outlet scour.
- Remove sediment and other debris when 1/3 of conveyance or design storage capacity is met.
- Temporary dikes and swales shall be graded out at the completion of construction, when permanent vegetation has been established.
- Permanent stormwater management dikes and swales may be used to control during construction runoff flows, but must be refurbished prior to site close out.

PRIMARY PURPOSE ➔

- To convey flows away from work areas or exposed slopes.
- To collect flows from work areas and convey them to a stabilized facility.

  NOTE: These systems may be designed to provide permanent stormwater management pollution and flow control and temporary construction flow management.

4-3

SHALL NOT BE USED ➔

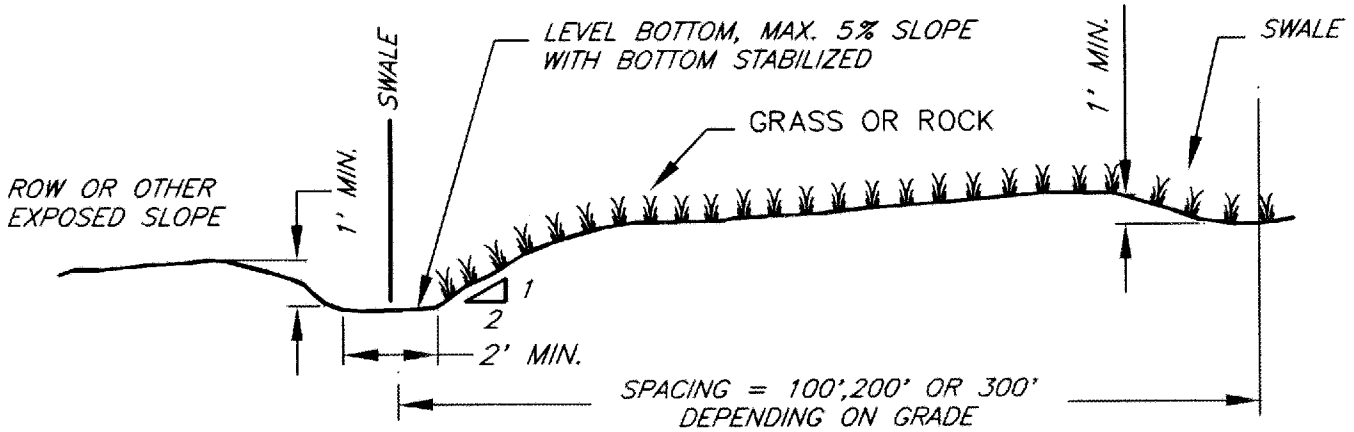
- On slopes > 5 percent.

NSTALLATION TIPS ➔

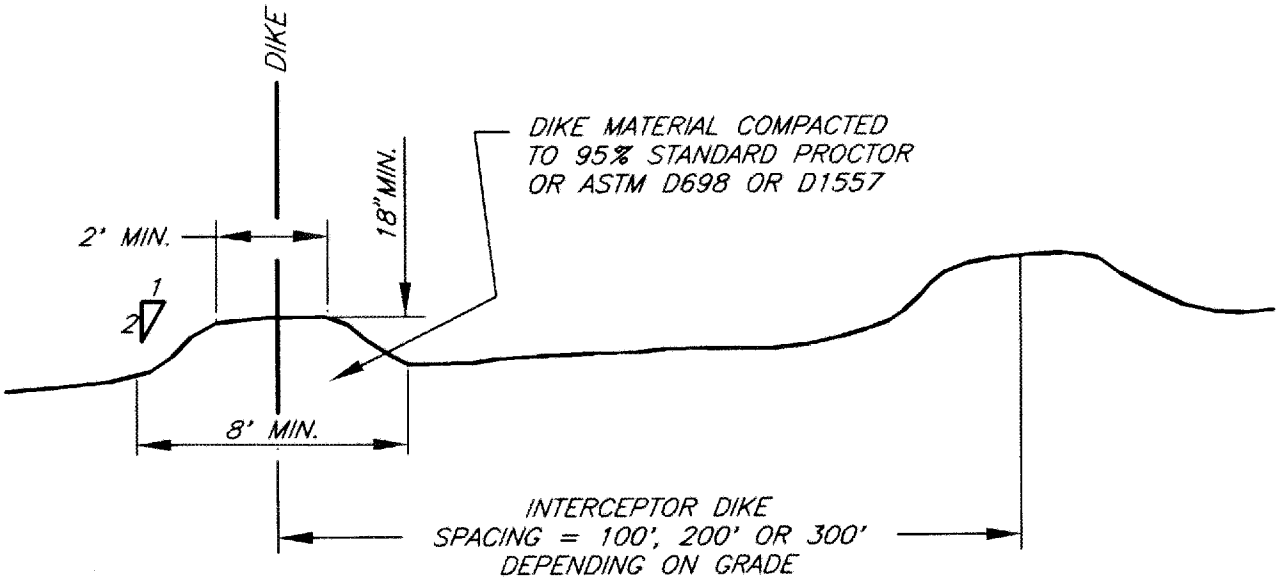
- Consider installing dike or swale as a permanent water quality or conveyance feature for post development runoff control.
- Establish dike or swale layout early in site design and development process.
- Site swales and dikes on terraces of steep slopes and on contour. Allow enough room in the terrace for maintenance access.
- Visibly mark locations of dikes and swales to help protect from construction traffic.
- Use check dams or other BMPs to control flow rate within dikes and swales. Assure these controls are designed to avoid blow out.

Signs of Failure

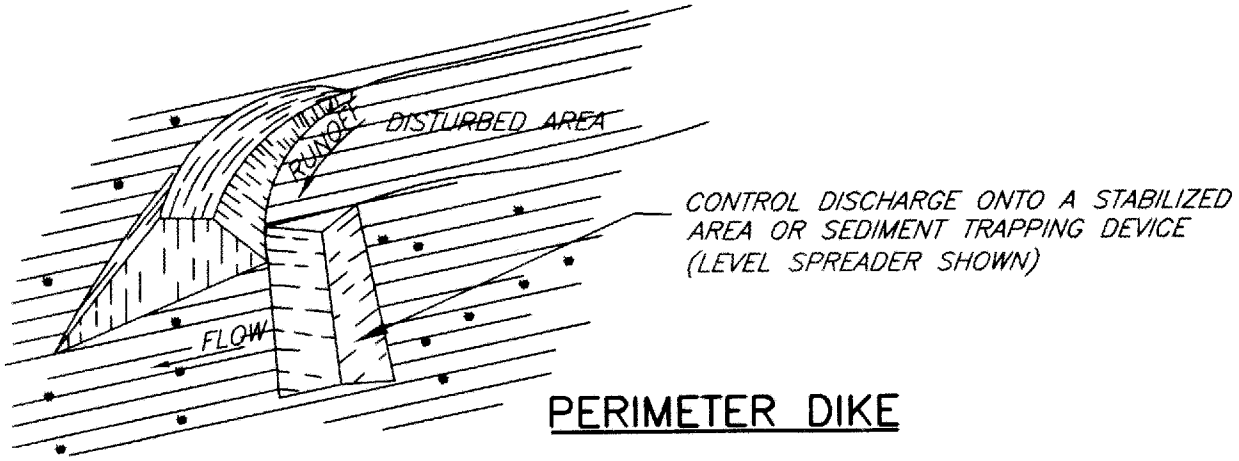
Symtoms	Cause	Solution
Erosion from dike or swale.	Flows are flushing sediments out of system. Flows are eroding dikes or swales themselves.	Install additional check dams or energy dissipaters. Add additional vegetative, blanket or armoring cover to sides and bottom of swale or dike.



INTERCEPTOR SWALE



TEMPORARY INTERCEPTOR DIKES



PERIMETER DIKE

DRAWING NOT TO SCALE

Check Dams

PURPOSE ➔ To reduce the velocity of concentrated flows in swales, dikes or ditches. Check dams reduce erosion and provide for sedimentation of suspended soil particles and other site pollutants. Check dams should not be used as permanent installations unless sufficiently keyed into side slopes.

4-3

CONDITIONS WHERE PRACTICE APPLIES ➔

- In existing or disturbed ditches, dikes and swales to reduce velocities and erosion.
- In interior site ditches, dikes or swales conveying runoff from disturbed areas BMPs.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- Check dams are not allowed in streams unless permitted by a state of federal resource protection agency.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Check dams shall be constructed of rock, fiber logs or tree logs. Check dams may also be constructed of straw bales or other materials as approved.
- Construct a 1-foot deep trench immediately upstream of check dams for storage of settled sediment.
- Provide a 6 inch spill over section within the center of the check dam.
- Check dams should be designed to have an armored scour pool on the downstream side of the check dam. The armoring shall be at least 2 inches thick and be half the width of the dam on the downslope side.
- Check dams shall be spaced such that the toe of the upstream dam is at the same elevation as the top of the next downstream dam.
- Rock check dams shall be constructed of 4 to 6 inches gabion rock. The rock must be placed by hand or mechanical placement in a manner that completely covers the width of the ditch or swale. Ensure that the center of the dam is lower than the edges by at least 6 inches.
- Log check dams shall be constructed of 4 to 6 inch diameter logs (See **Detail Drawings 4.3 B**). The logs shall be embedded into the bottom channel at least 18 inches. Logs shall be keyed into side slopes at least 18 inches. Log check dams for higher velocity (> 2 FPS) channels shall be designed by a licensed engineer.
- See **Detail Drawing 4.3 B** for details.

MAINTENANCE REMOVAL GUIDANCE ➔

- Check dams shall be checked for sediment accumulation after each major rainfall. Sediment shall be removed upon filling 1/3 of trapping capacity.
- Temporary erosion and sediment control check dams shall be removed when drainage is diverted to the permanent conveyance system or prior to construction site closeout. In no situation shall the same check dam remain in place without significant rehabilitation for a period of over 2 years.

PRIMARY PURPOSE ➔

- To reduce velocities in a ditch, dike or swale.
- To provide sedimentation behind the dam for development site flows.

SHALL NOT BE USED ➔

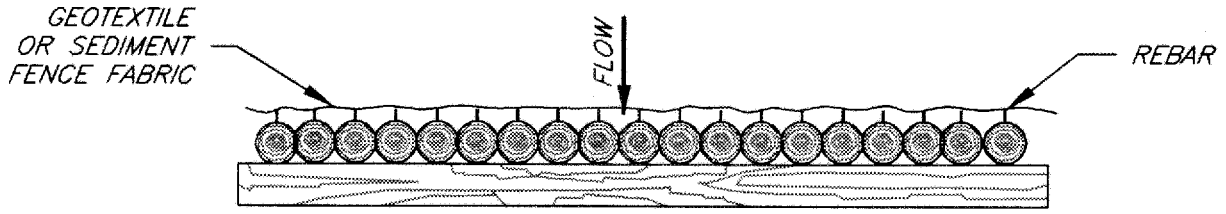
- Across natural channels (unless authorized/permitted).
- On slopes > 30 percent.

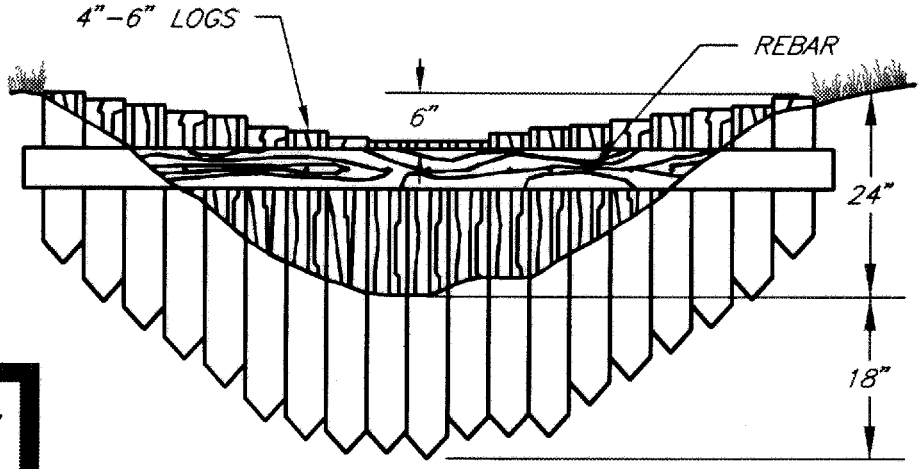
INSTALLATION TIPS ➔

- Assure check dams are adequately keyed into side slopes to withstand flows and prevent washout at ends.
- Assure materials make adequate contact with or are imbedded in the channel bottom.
- Consider using materials found locally on the site or that can be reused for another site purpose (i.e. mulch).
- Line log check dams with filter fabric on the upstream side to enhance filtration.
- Inspect and maintain check dams often.

Signs of Failure

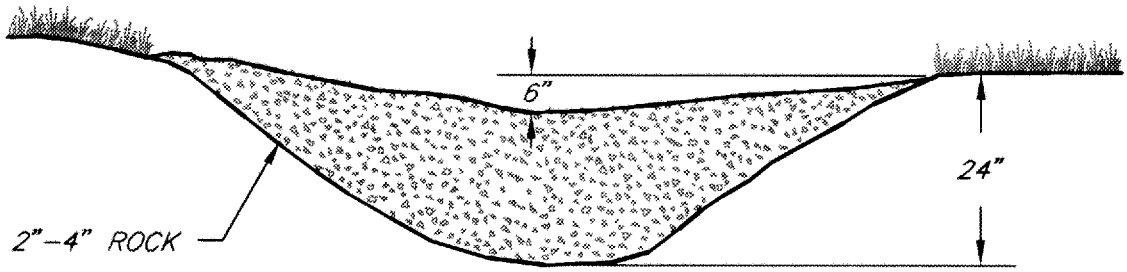
Symtoms	Cause	Solution
Check dam has blown out or material is displaced.	Materials not adequately anchored. Insufficient number or too much space between check dams.	Replace materials with adequate anchoring. Install additional or maintain upstream check dams.
Erosion is released from system.	Upstream check dams at or over capacity for sedimentation. Flows are scouring channel sides or bottom.	Maintain check dams. Add additional check dams or other energy dissipaters. Add soil protection BMPs like vegetation, blankets or armoring.



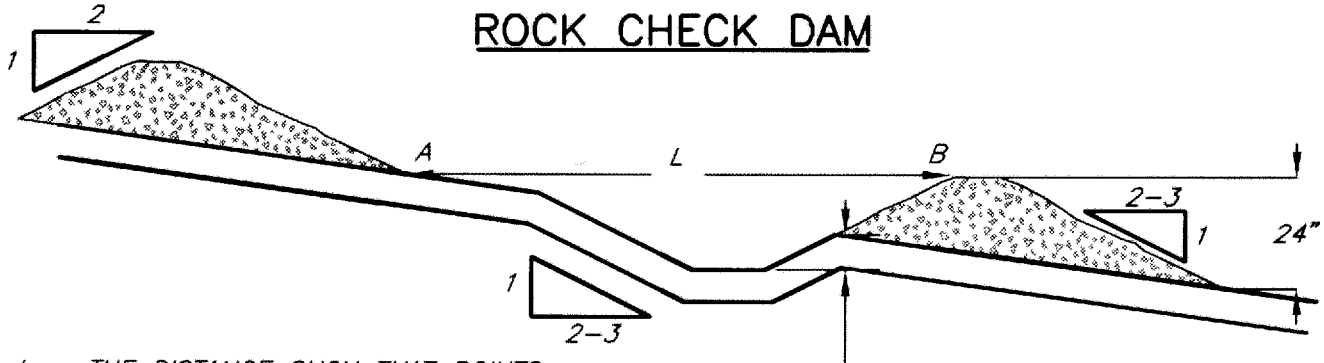


MAINTAIN 6" SPILLOVER

LOG CHECK DAM



ROCK CHECK DAM



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

SPACING BETWEEN CHECK DAMS

DRAWING NOT TO SCALE

Pipe Slope Drain

DEFINITION ➔ Pipe slope drains are temporary conduits, usually of flexible piping, that are placed from the top of the slope to the bottom of the slope to contain and convey runoff without coming in contact with bare slope soils causing erosion.

PURPOSE ➔ To convey concentrated runoff down steep slopes without causing erosion or saturating slide-prone soils.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Where concentrated runoff must be conveyed down a slope or around a work area to prevent erosion.
- To be combined with interceptor dikes or swales, to convey stormwater from entire drainage area above a slope to the base of the slope.

DESIGN CRITERIA/SPECIFICATIONS ➔ Proper installation, pipe sizing and entry flow control are key to pipe slope drain success. Failure of this facility usually results in severe erosion.

- The collection and conveyance system shall be designed to handle site runoff generated from a 10-year, 24 hour peak flow event. In general minimum recommendations for pipe sizing are as specified in the table below:

RECOMMENDED SLOPE DRAIN SIZE

Max. Drainage Area/Pipe (acres)	Pipe Diameter (inches)
0 – 0.5	12
0.5 – 0.75	15
0.75 – 1.0 *	18

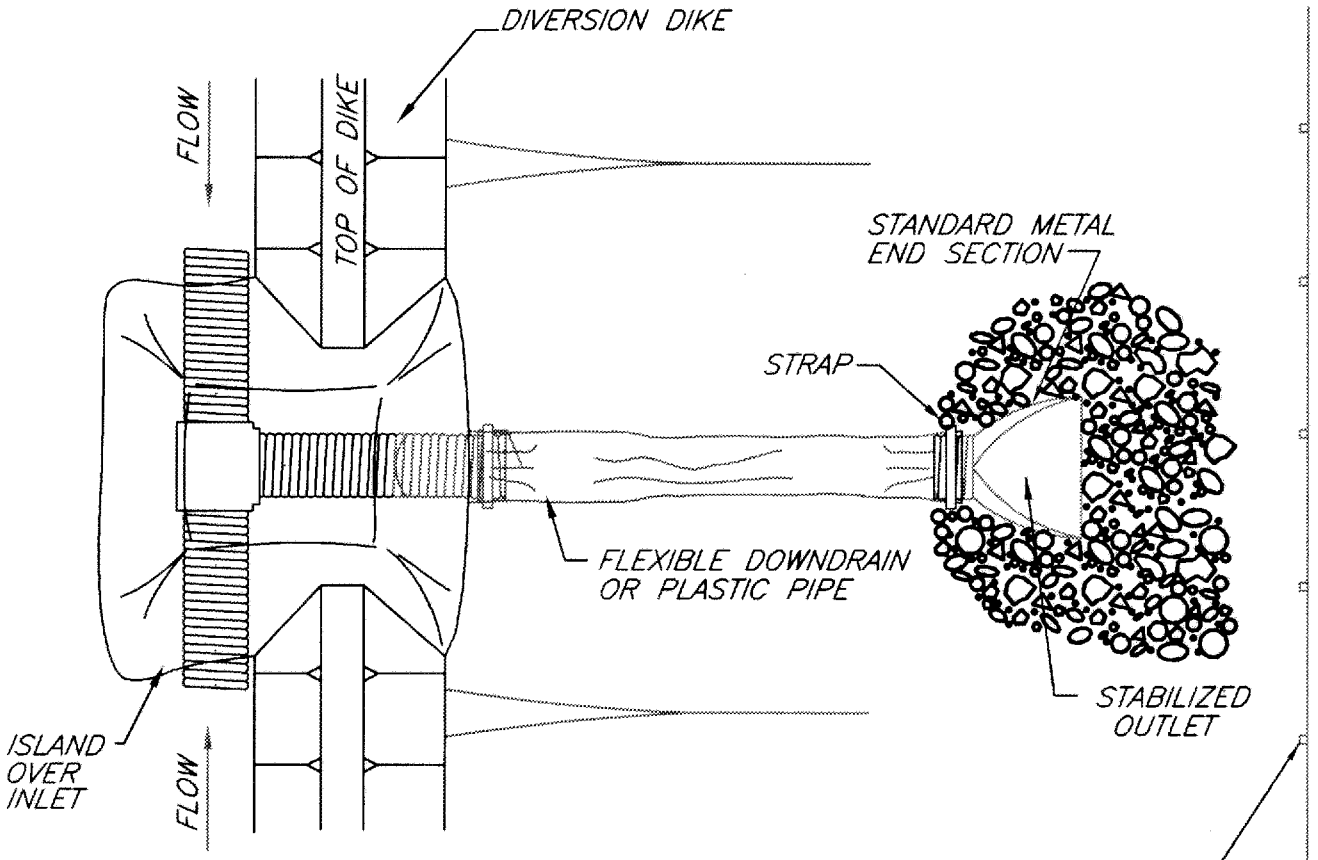
*Engineered system required for acreage of 1.0 and larger. The above numbers are recommendations only, they may or may not be applicable to your site. There are many factors that affect pipe slope drains that need to be considered. The City accepts no responsibility for the un-engineered use of these facilities should they be used and fail to meet other requirements of this Manual and the City Code.

- Pipe slope drains shall be constructed from heavy-duty flexible materials such as non-perforated, corrugated plastic pipe or specifically designed flexible tubing.
- Pipe slope drains shall be placed directly on the ground, or buried under the surface. The soil around and under the pipe entrance shall be thoroughly compacted to prevent undercutting. In addition, exposed soils shall be vegetated to prevent gully erosion from occurring beneath the pipe.
- The inlet / entrance to the pipe shall be a standard flared end section metal toe plate or approved equal. This plate shall be sized to fit flows and pipe opening (6 inches is minimum). The slope of the pipe entrance shall be at least 3 percent and oriented at an angle to collect flows.
- Interceptor dikes, swales, berms or sediment barriers shall be used to collect and direct runoff into a slope drain. The height of any dike, berm or barrier shall be at least 1 foot higher at all points than the top of the inlet pipe.
- All pipe sections shall be watertight and anchored with hold –down grommets and/or stakes with cross wire straps. Anchors shall be placed at intervals not to exceed 10 feet.
- Pipe slope drains shall discharge into approved stormwater management facilities. The area below the outlet must be stabilized with armoring, a planned scour hole, a row of sediment fence for potential blow outs or other approved facility.

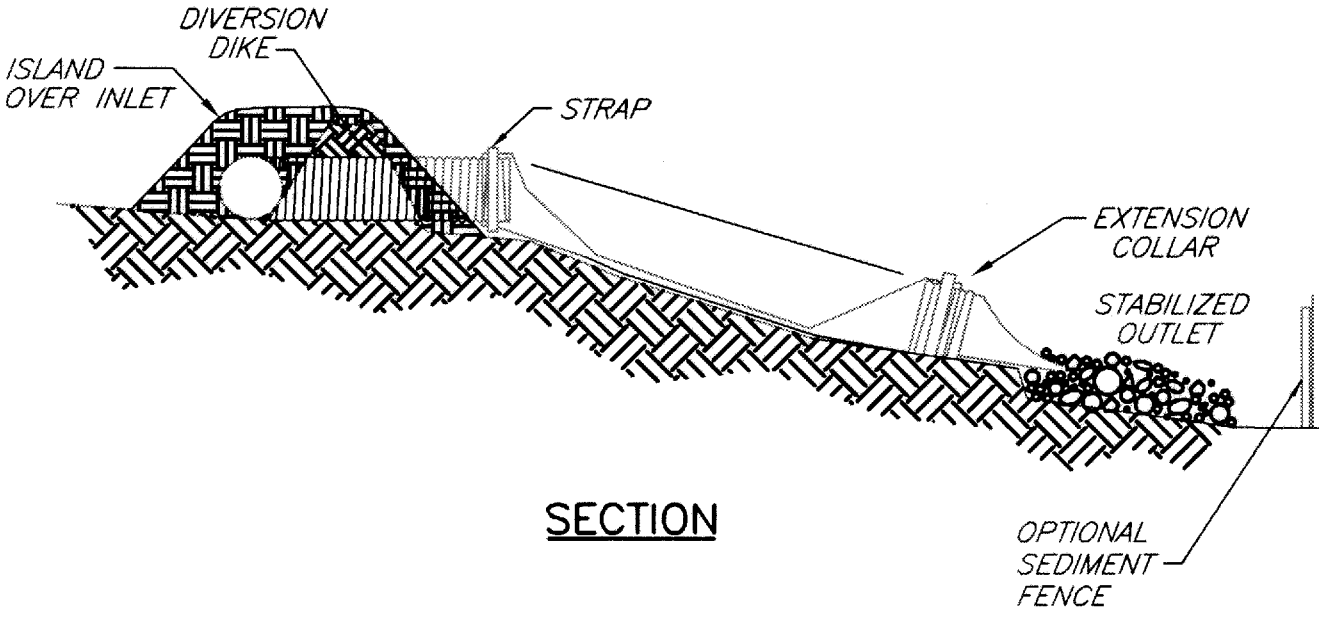
- If the pipe slope drain is conveying sediment-laden water, BMPs to trap the sediment in the runoff must be used before the water is conveyed off-site.
- See **Detail Drawing 4.3 C** for details.

MAINTENANCE REMOVAL GUIDANCE ➔

- Check inlet and outlet points regularly, especially after major storms. The inlet should be free of undercutting, and no water should be going around the pipe inlet. If erosion problems exist anywhere along the slope drain, any holes, rills or gullies shall be filled with soil, compacted and protected as necessary with appropriate materials such as erosion control blankets or rock.
- Temporary pipe slope drains shall be removed only after slopes have been stabilized, a permanent collection and conveyance system has been established or when the conveyance of runoff down the slope is no longer needed.



PLAN VIEW



SECTION

DRAWING NOT TO SCALE

Stormwater Barriers

DEFINITION ➔ Stormwater Barriers are a group of portable materials including hay bales, foam triangles, plastic dams, rock sack berms and other materials meant to impound stormwater and sediment laden flows. These systems are many times manmade, can be modular and therefore replaced by sections, and may have sediment settling abilities. Some systems are also designed to dissipate flows.

4-3

PURPOSE ➔ To block or divert stormwater or erosional flows from entering or exiting a site.

CONDITIONS WHERE PRACTICE APPLIES ➔

- As a dam for flows going offsite.
- Emergency flow diversion or flow blockage.
- Some products can be used to develop settling basins.
- Some products can act as inlet protection.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- Stormwater Barriers shall not be used in newly constructed, or existing ditches, swales, streams, and creeks.
- Straw bales shall not be considered as a means of filtering sediment and can be used alone only in emergencies. Straw bales shall not be used for catch basin protection, except in emergencies.

DESIGN CRITERIA/SPECIFICATIONS ➔

- For manufactured products, install as per manufacturer's instruction's.
- For barriers with aprons, sink the first 4 inches of the apron on the upslope / upstream side into a trench and backfill.
- Determine if additional energy dissipaters are needed to control discharges.
- Straw bales shall be standard 40 to 60-pound rectangular bales of grass hay or seed straw. Straw bales shall be keyed into existing ground 2 to 4 inches.
- Stakes shall be wood of size as shown on **Detail Drawing 4.3 D** and driven through bales and into ground to a minimum depth of 12 inches.

MAINTENANCE REMOVAL GUIDANCE ➔

- At no time shall more than 1/3 design depth of sediment be allowed to accumulate behind stormwater barriers. Sediment should be removed or regraded into the slope, or new lines of barriers installed upstream of sediment- laden barriers.
- Once the upslope area is stabilized, stormwater barriers shall be removed for disposal or reuse. Straw bales and other organic barriers may be reused onsite. Straw and other organics can be incorporated as mulch after completion of site work if approved by the jurisdiction. Removal may necessitate a post construction site visit.

PRIMARY PURPOSE ➔

- Temporary impoundment of stormwater or erosion laden flows.
- Straw bales - for emergency sediment control or flow diversion.

SHALL NOT BE USED ➔

- In streams and other drainage channels.
- Straw bales - without other upland or other perimeter control BMPs.

INSTALLATION TIPS ➔

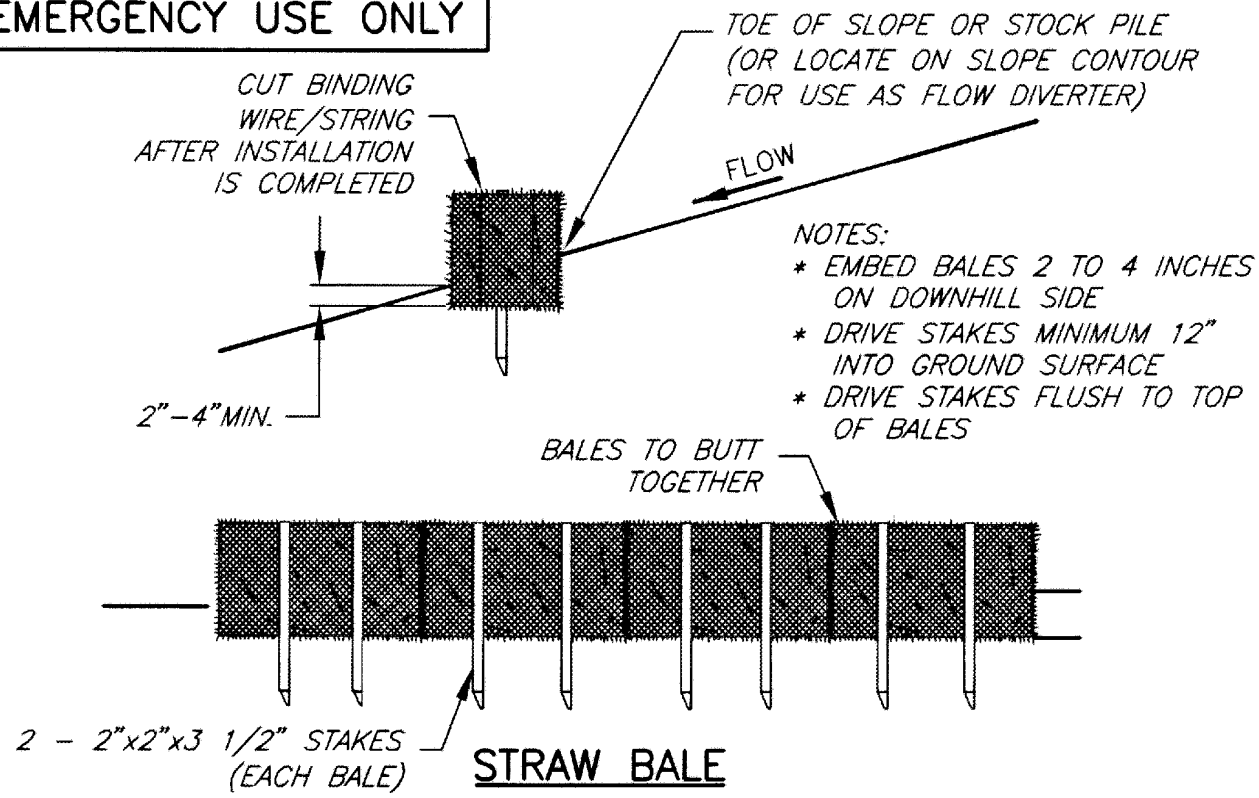
- Install per manufacturer specifications.
- Some may be good for use on impervious surfaces.
- Maintenance is critical. Empty, replace or add additional BMPs when 1/3 of capacity behind barrier is full.
- Check flow rates often since high flows can limit performance and damage the barrier.
- Check placement and performance often to avoid impacts from flows and/or vandalism.

NOTE: More permanent sediment control (ponds, traps) and flow diversion structures (temporary swales) are preferred choices for long term projects.

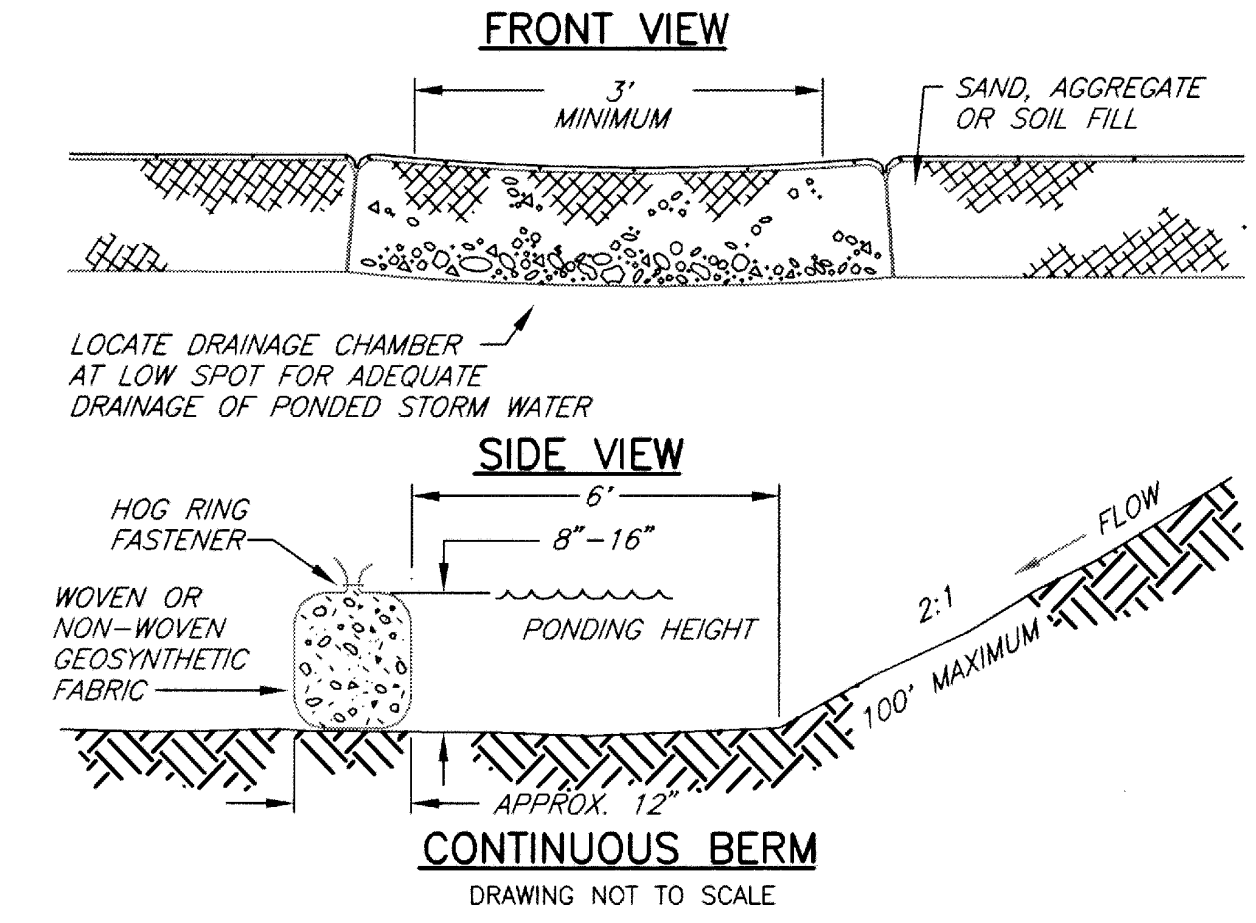
Signs of Failure

Symtoms	Cause	Solution
Concentrated runoff or sediment flows are coming around or under BMP.	Insufficient materials. Insufficient stake down during installation.	Add additional materials and align to contrain flows. Reinstall with proper staking and inset.
Sediment is overwhelming BMP	Lack of upslope BMPs. Inadequate maintenance.	Add erosion prevention or other sediment control BMPs. Clean sediment from behind bags or rolls.

EMERGENCY USE ONLY

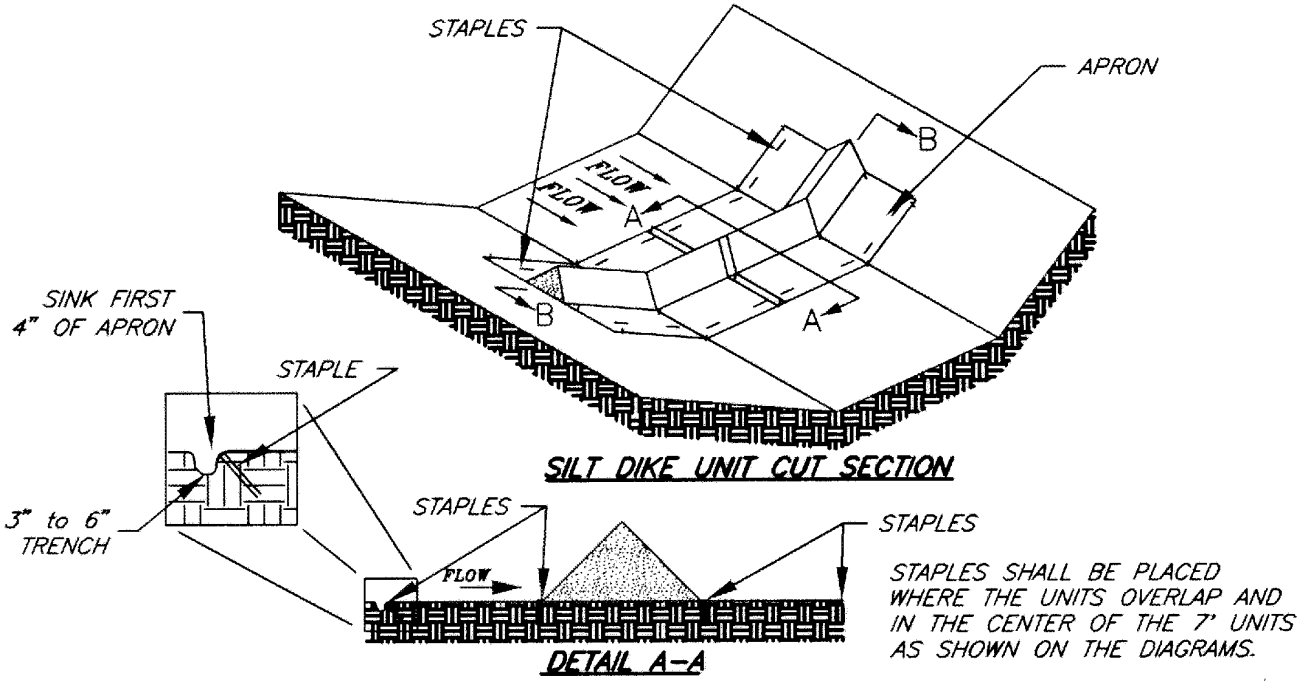


STRAW BALE



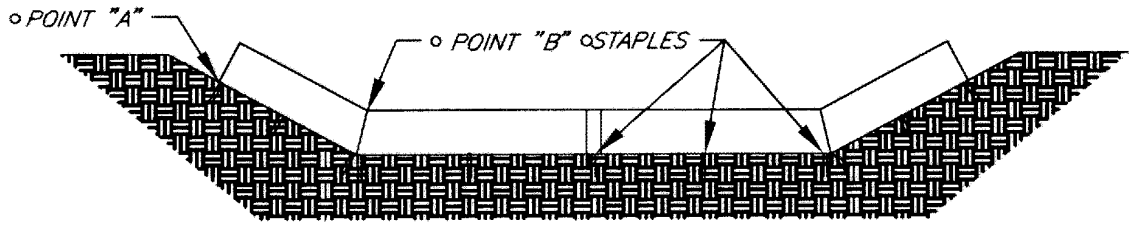
CONTINUOUS BERM

DRAWING NOT TO SCALE



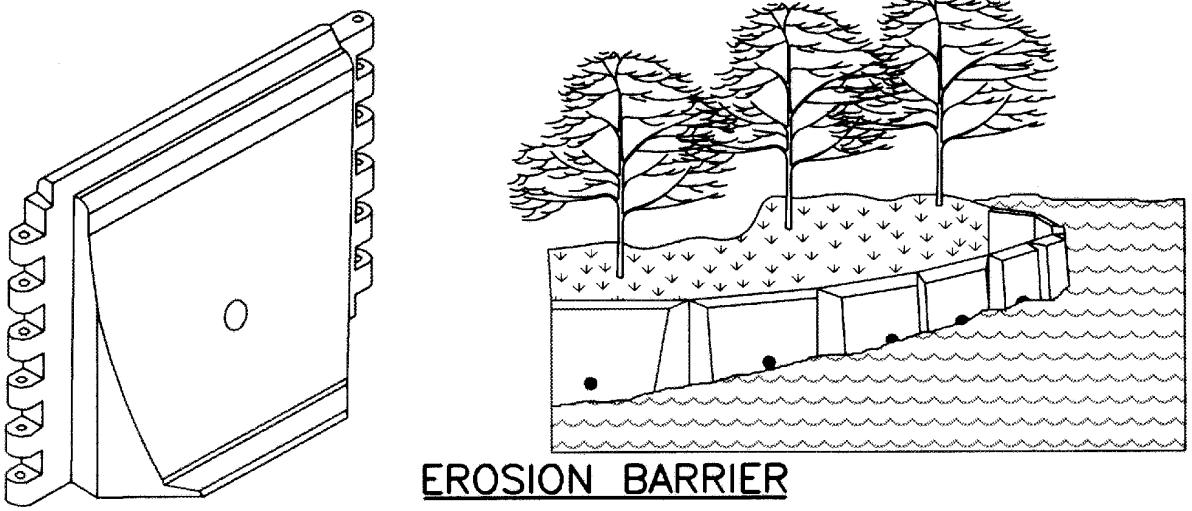
SILT DIKE UNIT CUT SECTION

DETAIL A-A



DIKE SECTION DETAIL B-B

TRIANGULAR SILT DIKE INSTALLATION FOR ROADWAY DITCH OR DRAINAGE DITCH



EROSION BARRIER

DRAWING NOT TO SCALE

Sediment Traps and Ponds

PURPOSE ➔ To collect and store sediment eroded from exposed ground surfaces disturbed during site development. Designers are encouraged to consider if ponds created to control sediment and other pollutants during site development could be used to manage post development stormwater runoff.

NOTE: Given the NW climate and clay soils, most sediment traps and ponds when used by themselves will not meet "clear water" discharge standards. It is recommended that a licensed Oregon Professional Engineer be used to design pond and trap systems.

4-3

CONDITIONS WHERE PRACTICE APPLIES ➔

- Downhill of areas with exposed soils.
- Sediment Traps: Each trap shall have a tributary drainage area limited to 3 acres or less (but not including one and two family residences constructed individually, on existing lots of record), and slopes of less than 50 percent.
- Sediment Ponds: Each pond shall have a tributary drainage area of 10 acres or less and slopes of less than 50 percent.

Multiple traps or ponds may be needed to control sediments from leaving the site.

DESIGN CRITERIA/SPECIFICATIONS ➔ Because of site and soil variability, traps and ponds must be designed to meet specific site conditions. Facility size, configuration and flow limits vary based on particle size and settleability of site soils. In general, these facilities should be designed with adequate holding time to settle fine soils. Designers are encouraged to use multi-cell systems.

Temporary interceptor dikes or swales may be constructed to divert runoff to sediment traps or ponds.

SITING ➔ The designer should consider sediment control needs during design – especially the need for sediment traps and ponds. In general these facilities should:

- Be located off line from any natural site drainages.
- Be located at the end of a site drainage control structure.
- Be located on the lowest portion of the site.
- Have no groundwater flows that could limit facility effectiveness.
- Have stabilized inlet, outlet and side slope structures capable of withstanding predicted flows prior to the facility receiving flow.
- Have depth markers within sediment basin to easily measure sediment deposits after water settling.
- Have a drainage system that dewaters the pond within 24 hours for maintenance.
- Have adequate access for maintenance procedures.
- Be demarcated or otherwise flagged or fenced to protect the pond from construction vehicles.

The designer is also encouraged to consider use of any post development stormwater management facilities for stormwater control and/or partial sediment control during the site's development phase. Post development stormwater management facilities are **not sufficient** to handle flows during the site construction phase. They may be used for polishing of flows, but not for primary stormwater and sediment control.

INLETS / OUTLETS ➔ All inlet and outlet structures shall be adequately stabilized for predicted flows. The designer is encouraged to use armoring or erosion control blankets rated to withstand predicted flows. All inlet and oulet structures shall be completely stabilized prior to receiving any site flows. See post-development stormwater design manuals of your local jurisdiction for more guidance on inlet and outlet structures.

- The designer is encouraged to use a floating skimmer or a perforated riser with a gravel jacket, or their equivalent, to further filter outlet discharge from the trap or pond.
- Pond and trap discharges shall be at least 1 foot below the spillway.

SEDIMENT TRAPS ➔ The sediment trap may be formed completely by excavation or by construction of a compacted embankment. It shall have a sediment storage depth not to exceed 1.5 feet, topped by a maximum 2 foot deep settlement zone. Sediment trap side slopes shall be 3:1 or flatter. The outlet of the trap should be a weir/spillway, providing a minimum 1 foot overflow depth between the spillway and embankment.

A turbidity curtain, fabric wrapped outlet or similar filter must be constructed to filter runoff from the trap prior to discharge from the construction site.

- Calculate the required sediment storage volume using the USDA Natural Resources Conservation Service Universal Soil Loss Equation or Revised Universal Soil Loss Program as described in Appendix C and assume a minimum one year sediment accumulation period for design purposes. For the purposes of this calculation assume one cubic foot of sediment weighs 100 lbs.
- Determine the bottom surface area of the sediment trap using the calculated sediment volume and the maximum 1.5 foot depth and 3:1 side slope requirements.
- Determine the total trap dimensions by adding an additional 2 feet of depth for settling volume (before overtopping of spillway) above the sediment storage volume, while not exceeding 3:1 side slopes. Consider using free board within the spillway design to trap additional sediment.
- A 3:1 ratio of trap length to width is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. Residence time will be soils dependent and should be sufficient to allow for adequate settling. A good rule of thumb is 36 hours of residence time within the system.
- See Detail Drawing 4.3 F for details.

SEDIMENT PONDS ➔ A sediment pond may be formed by partial excavation and/or by construction of a compacted embankment. It may have one or more inflow points carrying polluted runoff. Baffles to spread the flow, giving it longer residence time, throughout the pond should be included. A securely anchored riser pipe is the recommended principal discharge mechanism, with an emergency overflow spillway. The riser pipe should be perforated and covered with filter fabric and gravel "cone" for filtration; or solid with a l inch diameter dewatering hole and perforated drain pipe. Outlet protection shall be provided to reduce erosion at the pipe outlet. A turbidity curtain, fabric wrapped outlet or similar filter must be constructed to filter runoff from the pond prior to discharge from the construction site.

- The sediment pond shall have a sediment storage depth no greater than 3 feet, topped by a 2-foot (minimum) to 4-foot (maximum) deep settlement zone and an additional 1 foot minimum of freeboard. The pond side slopes shall be 3:1 or flatter. Fencing of the facility may be required.
- The sediment storage volume is determined in the same manner as mentioned above for sediment traps.
- The pond riser pipe and outlet pipe shall be sized to carry the 10-year design storm or shall meet the sizing criteria otherwise required by the local jurisdiction
- A 3:1 ratio between the pond length and width is desirable. Length is defined as the average distance from the inlet to the outlet of the trap. Use baffles in the pond to help prevent short-circuiting and to increase the effective pond length where site conditions prohibit constructing a pond with a direct 3:1 length to width ratio.
- See Detail Drawing 4.3 G for details.

MAINTENANCE REMOVAL GUIDANCE ➔ Traps and ponds shall remain in place until an adequate portion of the site is stabilized or adequately protected by other erosion prevention and sediment control BMP's. If the applicant wishes to remove these facilities prior to complete site stabilization, the permitting authority shall determine when and under what conditions these traps and ponds may be removed.

PRIMARY PURPOSE ➔

- To control sediment laden flows leaving the site.

SHALL NOT BE USED ➔

- Alone without upslope clean stormwater diversion and erosion prevention BMPs.

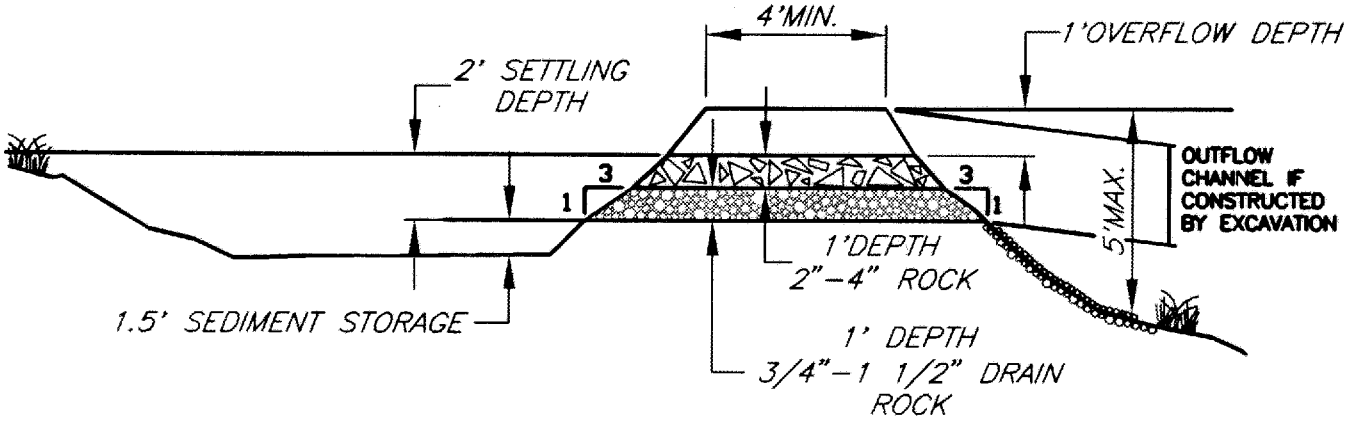
4-3

INSTALLATION TIPS ➔

- Construct the pond at the bottom of the drainage, sited on well-compacted and stabilized soils.
- Assure inlet and outlet structures are adequately designed for predicted flows.
- Do not route all stormwater through pond. Segregate and divert clean stormwater to approved receiving system.
- Consider using post development stormwater management facilities as polishing facilities after the sediment pond or trap.

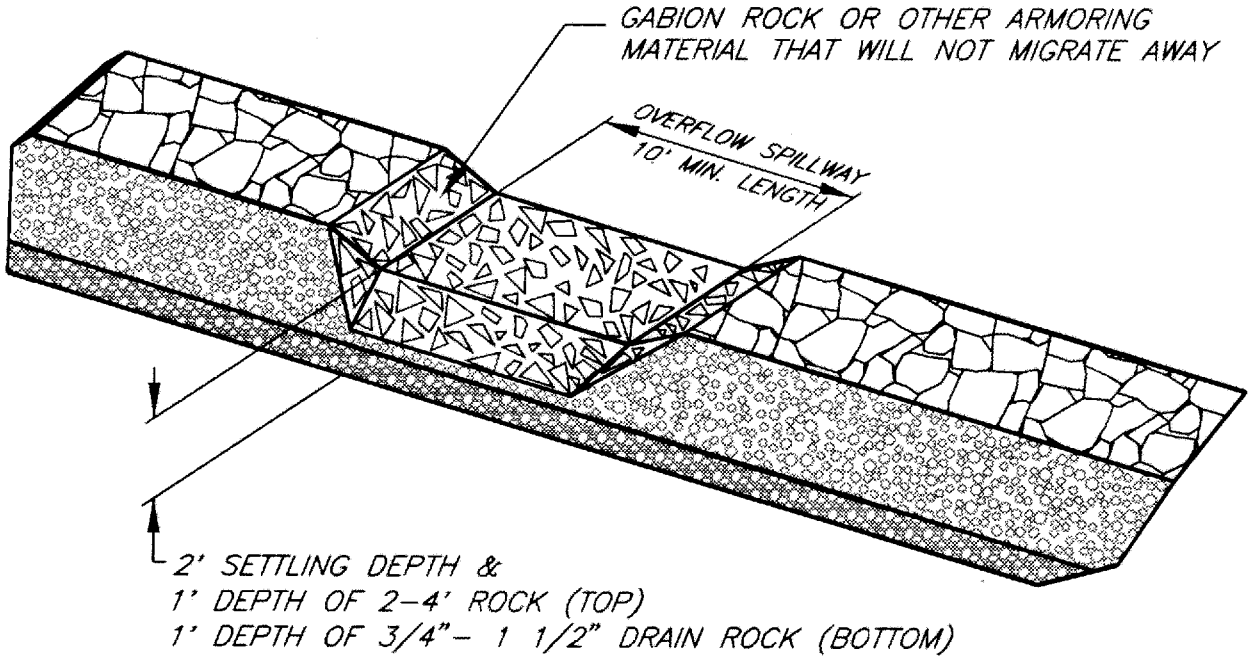
Signs of Failure

Symtoms	Cause	Solution
Muddy water exits pond	Upstream erosion prevention controls are insufficient. Residence time is insufficient. Outlet system does not adequately filter flows	Provide additional erosion prevention BMPs. Recalculated sizing design, and upsize facility if needed. Alter outlet or cover with filter fabric to help filter flows
Pond is overflowing	Outlet is plugged Clean flows are running into facility Facilities are inadequately sized	Maintain system Divert any clean stormwater flows around work site and facility, to approved receiving system. Review sizing criteria – upsize facility if needed.



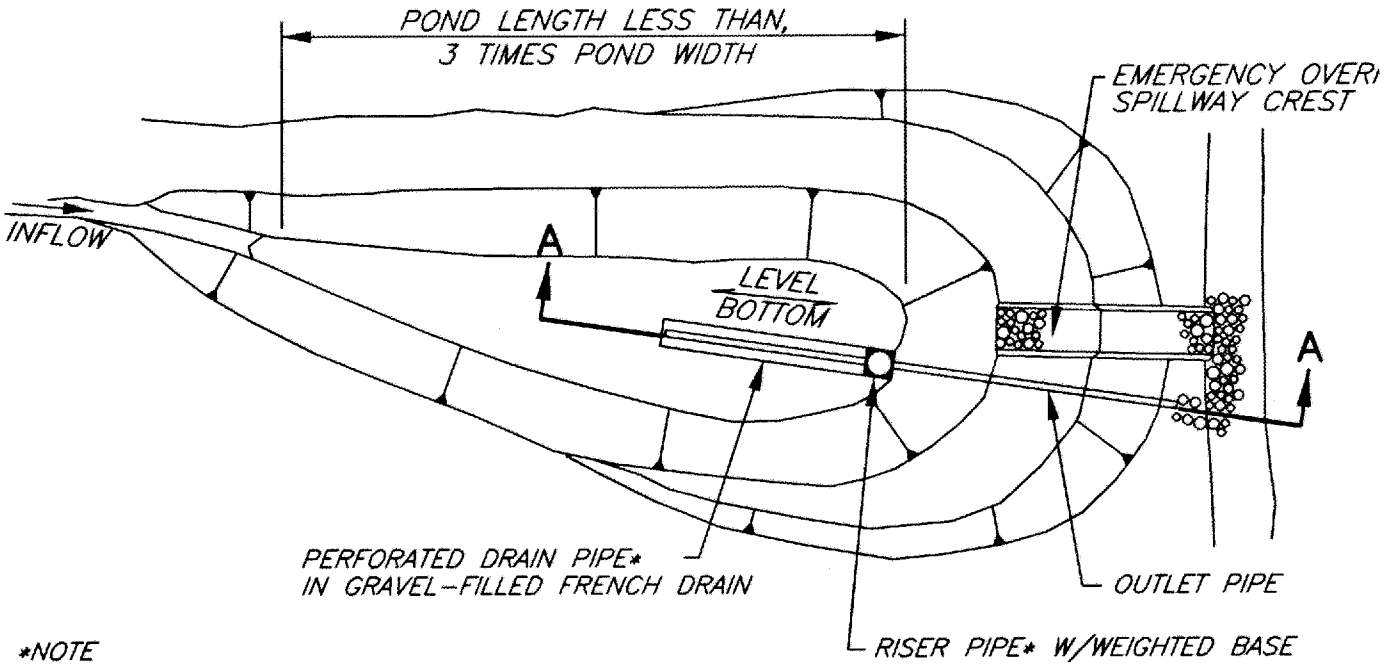
CROSS SECTION

NOTE: MAY BE CONSTRUCTED BY EXCAVATION OR BY BUILDING A BERM.

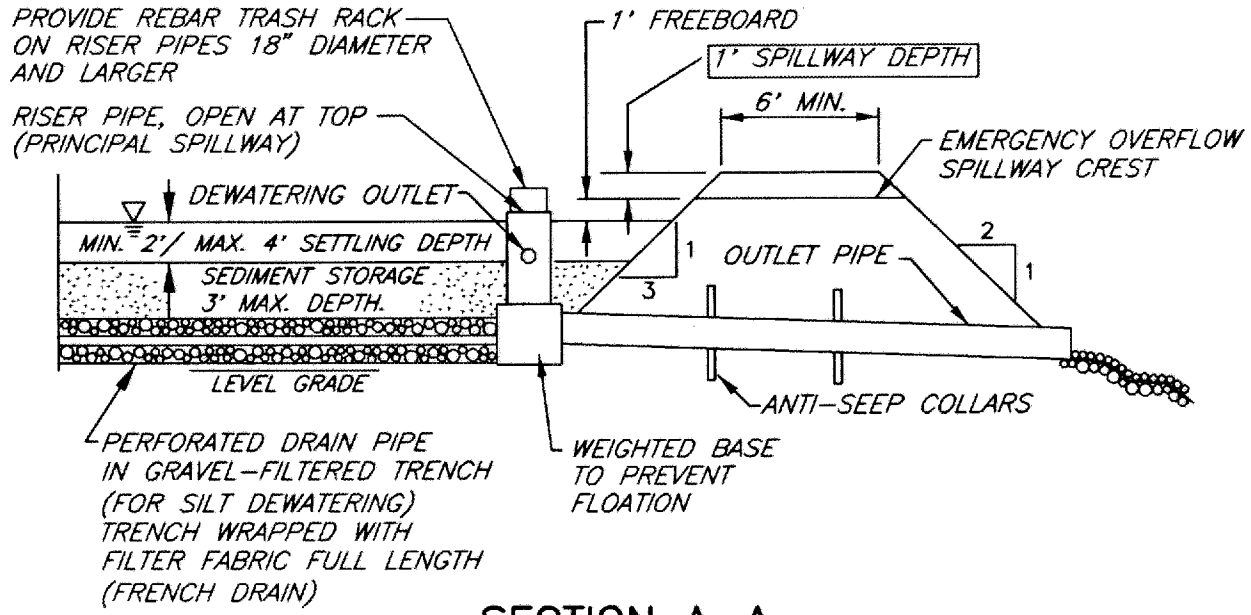


SEDIMENT TRAP OUTLET

DRAWING NOT TO SCALE



*NOTE
SEDIMENT DEWATERING MAY BE ACCOMPLISHED WITH PERFORATED DRAIN PIPE IN TRENCH AS SHOWN OR WITH A PERFORATED RISER COVERED WITH FILTER FABRIC AND GRAVEL "CONE".



SECTION A-A

DRAWING NOT TO SCALE

Erosion prevention BMPs can be the simplest and most effective measures you can take to retain sediments on your site. The following BMPs protect exposed soil surfaces from rain generated splash erosion and can help slow flows across a site of ground disturbance. All sites should incorporate at least one type of erosion prevention measure when exposed to a ground disturbing activity.

Surface Roughening

PURPOSE ➔ To aid in the establishment of vegetative cover, prevent erosion, and allow for infiltration and sedimentation by reducing runoff velocity.

CONDITIONS WHERE PRACTICE APPLIES ➔

- All slopes steeper than 4:1 and greater than 5 vertical feet.
- Any bare soil needing at least some erosion prevention BMPs.

DESIGN CRITERIA/SPECIFICATIONS ➔

There are different methods for roughening the soil surface, and the selection of an appropriate method depends on the type of slope and the desired temporary or permanent slope vegetative treatment. The major consideration when using this BMP is to develop grooves or furrows that lie perpendicular to (across) the slope. Other factors to consider are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling. The following criteria are for disturbed areas, where existing vegetation has been removed.

- All vegetation sites require some surface roughening; stair step, grooving, furrowing or tracking.
- Areas that will be mowed (slopes less than 3:1) may have small furrows parallel to contour left by disking, harrowing, raking, or other grooves (across the slope) left by seed planting machinery operated on the contour. Areas that will not be treated with permanent vegetation that requires mowing, may be stair-step graded, grooved or left rough after filling.
- Slopes steeper than 2:1 should be stair-stepped with benches. Stair-step grading is also particularly appropriate in soils containing large amounts of rock. Each step catches material that sloughs from above, and provides a level site to convey or detain drainage or establish vegetation. Stairs should be wide enough to work with standard earth moving or maintenance equipment (12 feet minimum with no more than 15 percent slope). Heights will be slope specific but should not exceed 3 feet with out appropriate soils analysis or retaining structure support.
- Excessive compaction of soils during grubbing should be avoided. Tracking can compact soils, reducing infiltration. Tracking with a bulldozer is the least preferred method of roughening, but is better than not roughening at all. Tracking should be done up and down the slope to leave track tread indentations across the slope
- Roughened soil surfaces should be seeded and mulched as quickly as possible. If conditions are not appropriate for seeding, then the area should at a minimum be mulched or covered with an erosion control blanket.

MAINTENANCE REMOVAL GUIDANCE ➔

- Roughened areas without other cover shall be inspected after every rainstorm. If grooves or stairs fill in leaving less than 1/3 of the original groove or stair depth, then the sediment shall be removed and the site re roughened if necessary.
- Roughening is a permanent site feature.

PRIMARY PURPOSE ➔

- Reduce runoff velocity and allow for infiltration.
- Sediment trapping.
- Support the establishment of vegetative cover.

SHALL NOT BE USED ➔

- On sites with slide or safety hazards - use the discretion of the contractor or other site professional.

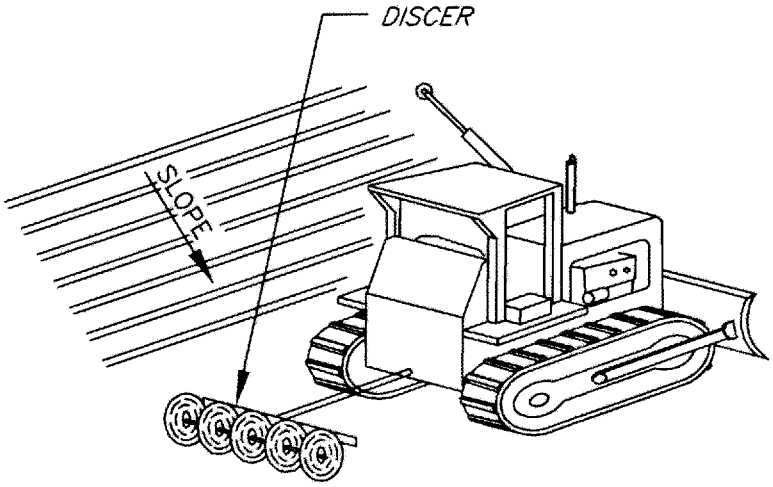
INSTALLATION TIPS ➔

- Track up and down slopes so tread furrows are perpendicular to the slope (see drawing).
- Use proper equipment for installation of furrows.
- Cut furrows a minimum of 1 inches in depth.
- Avoid excessive compaction of soils.
- Control concentrated flows to slope. Divert flows away from the top of the slope.
- Tracking with bulldozer treads is the minimal acceptable practice. Other roughening forms (i.e. discing, benching, and terracing) are more effective.
- Seed and ground covers shall be in place as soon as possible and shall provide adequate cover prior to the beginning of the wet season.

Companion BMPs - mulching, vegetative cover, tackifier, and plastic sheeting.

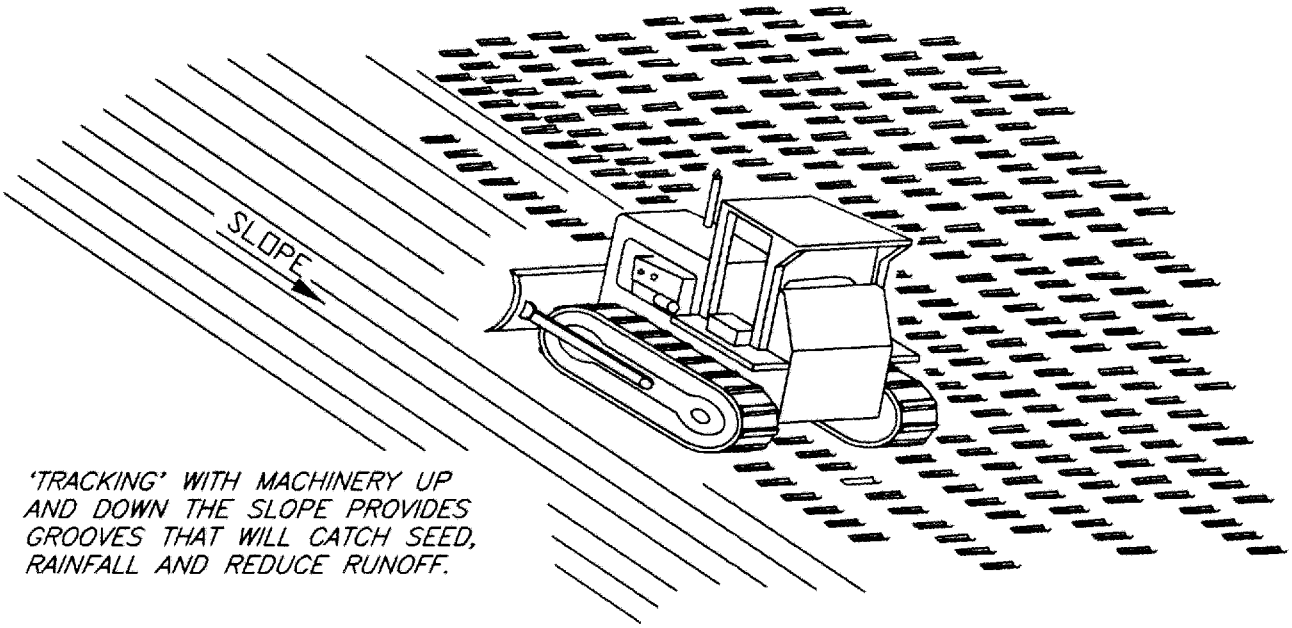
Signs of Failure

Symtoms	Cause	Solution
Bare Soil in Wet Season.	Lack of adequate cover.	Mulch or appropriately cover to prevent rainfall contact.
Rill Erosion.	Lack of penetration of furrows. Mulch migrated.	Regrade and recover.
Slope Failure.	Concentration of runoff from top of slope. Groundwater emergence. Unstable soils. Over compaction of soils.	Provide adequate collection and conveyance system - i.e. pipe slope drain. Install trench drain to collect and infiltrate drainage. Remove and replace fill slope.



NOTE:

GROOVE BY CUTTING SERRATIONS ALONG THE CONTOUR. IRREGULARITIES IN THE SOIL SURFACE CATCH RAINWATER, SEED, MULCH AND FERTILIZER.

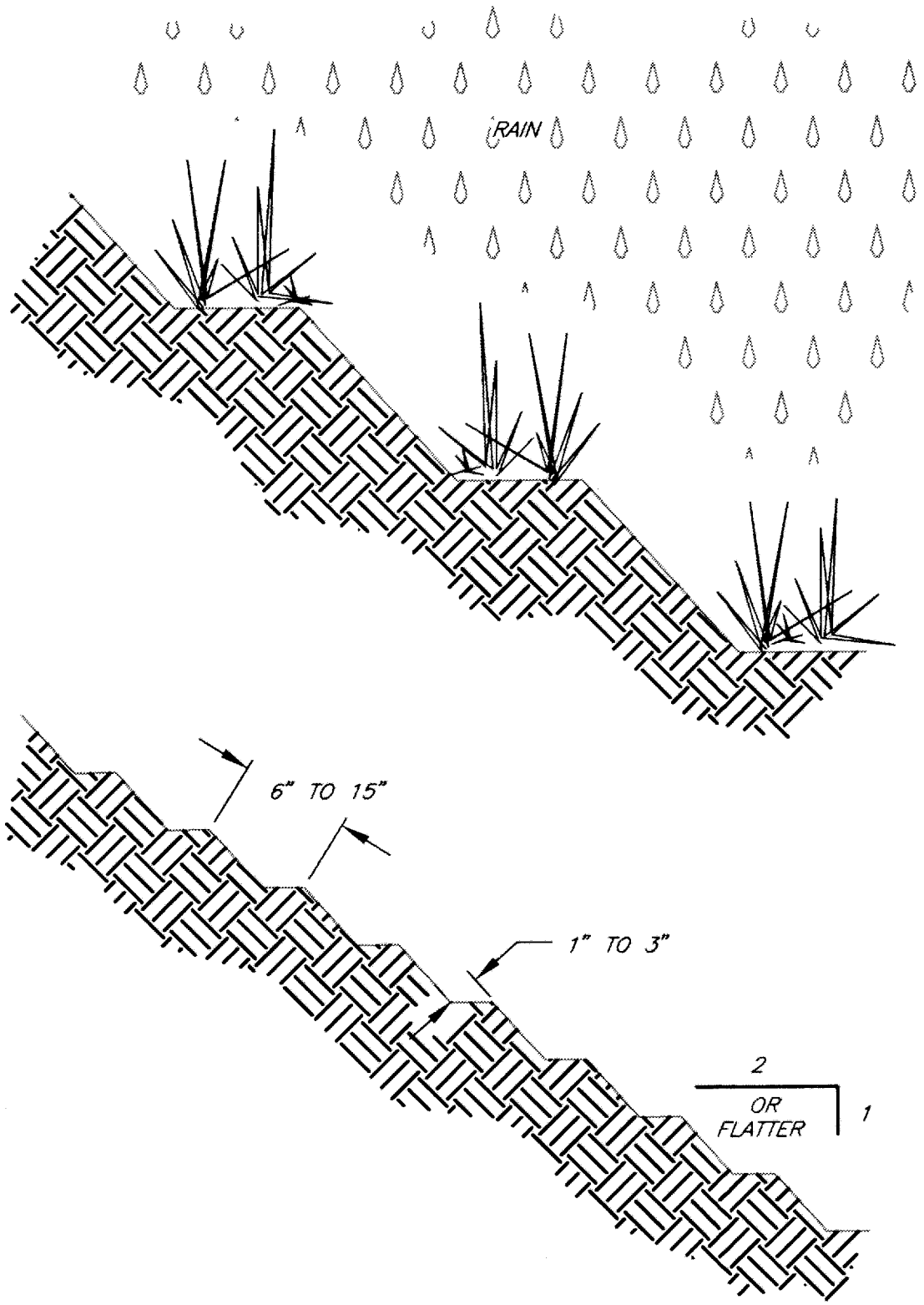


'TRACKING' WITH MACHINERY UP AND DOWN THE SLOPE PROVIDES GROOVES THAT WILL CATCH SEED, RAINFALL AND REDUCE RUNOFF.

TRACKING

DRAWING NOT TO SCALE

Detail Drawing 4.4 B - Grooved or Serrated Slope



DRAWING NOT TO SCALE

Temporary Grasses and Permanent Vegetative Cover

PURPOSE ➔ To minimize erosion and sedimentation by stabilizing exposed soils with vegetation and mulching.

NOTE: Temporary establishment may differ from permanent vegetated cover (the best erosion prevention technique) which uses many of the same design and implementation principles as set out below.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Ground surfaces likely to be exposed during the wet season (October 1 through April 30) or surfaces likely to be exposed for more than 3 weeks during dry season.
- Areas that will not be subjected to heavy wear or are not working soils piles used by on-going construction traffic.
- Exposed ground surfaces at end of construction period (permanent cover must be established prior to removal of any erosion control BMPs).
- Temporary or permanent stabilization of new or disturbed ditches, ponds, trenches, dikes or swales

DESIGN CRITERIA/SPECIFICATIONS ➔

Temporary Erosion Control Grasses

- All vegetation sites require some surface roughening: stair step, grooving, furrowing or tracking.
- Temporary grass cover BMPs must be fully established by October 1 or other cover BMPs (mulch, blankets, etc.) will have to be implemented until adequate grass coverage is achieved. To establish an adequate grass stand for controlling erosion by October 1, it is recommended that seeding and mulching occur by September 1. (see Chapter 1 for required jurisdiction specific planting date).
- Soil Preparation - Topsoil should be prepared according to landscape plans, if available, or recommendations of grass seed supplier.
- Seeding - Recommended erosion control grass seed mixes are as specified below. Similar mixes designed to achieve erosion control may be substituted if approved by jurisdiction. In general, use of quick growing, sterile grasses and grains in mixture with permanent vegetative cover is recommended to achieve quick cover of exposed soils. The designer or contractor are encouraged to use mixes of native grasses that can be incorporated into a permanent vegetative cover.

  - Dwarf Grass Mix (low height, low maintenance):
    Dwarf Perennial Ryegrass, 80 percent by seed count
    Creeping Red Fescue, 20 percent by seed count
    Application rate: 100 pounds minimum per acre
  - Standard Height Grass Mix
    Annual Ryegrass, 40 percent by seed count
    Turf-type Fescue, 60 percent by seed count
    Application rate: 100 pounds minimum per acre

  Seed supplies should be selected from local sources who grow local genetic strains, when possible. These supplies will usually contain fewer weed species that could be noxious or invasive to the local environment.

RECOMMENDED NATIVE GRASS SPECIES

Tall Grasses	Common Name	Shade Tolerance	Seeding Rate (lbs/acre)	Commercially Available
Wetter Areas				
Agrostis exarata	Spike Bentgrass		10	•
Beckmannia syzigachne	Sloughgrass		40	•
Glyceria elata	Mannagrass	++	30	
Glyceria occidentalis	Western mannagrass	+	30	•
Hordeum brachyantherum	Meadow barley		30	•
Leersia oryzoides	Rice cutgrass	+	30	
Drier Areas				
Bromus sitchensis (including sp. carinatus)	Sitka brome	+	40	•
Bromus vulgaris	Columbia brome	++	50	
Elymus glaucus	Blue wildrye	+	40	•
Festuca californica	California fescue		40	
Trisetum canescens			50	
Factuca Subulata		+	50	

Tall Grasses	Common Name	Shade Tolerance	Seeding Rate (lbs/acre)	Commercially Available
Wetter Areas				
Alopecurus geniculatus	Water foxtail		30	
Deschampsia caespitosa	Tufted hairgrass		10	•
Deschampsia elongata	Slender hairgrass	+	10	
Drier Areas				
Danthonia california	California oatgrass		40	
Festuca occidentalis	Western fescue	+	40	
Melica geyeri	Oniongrass	++	20	
Melica subulata	Oniongrass	++	20	
Stipa occidentalis	Stipa		40	
Koeleria Cristata	Junegrass		30	

NOTE: Native Grasses may have different maintenance requirements and susceptibilities to horticultural chemical use.

- Seed may be applied in 3 differing methods:
  1. Broadcast – by hand or machine, seed is scattered on the soil surface. Mostly used for smaller areas.
  2. Hydroseeded – applied as a mixture of water, seed, and sometimes fertilizers or mulch, this mixture is sprayed onto exposed soils. Best for sites over 5,000 sq. feet in size.
  3. Drilled – seed is tracked down by equipment to inject seeds into exposed soils. Best for sites greater than 2 acres.
- Fertilization for grass seed only as needed or as specified in accordance with supplier's recommendations. Development areas within 50 feet of water bodies and wetlands must use a non-phosphorus fertilizer.
- Mulch shall be spread uniformly immediately following seeding. Mulch shall be applied at double the hydroseed application requirement (4000 lb./acre). Anchor mulch on steeper slopes (greater than 3:1) by working in by hand or with equipment (rollers, cleat tracks, etc).
- Hydromulch shall be applied with grass seed at a rate of 2000 lb./acre or as specified by supplier. On slopes steeper than 10 percent (10:1), hydroseed and mulch shall be applied with a bonding agent (tackifier). Application rate and methodology to be in accordance with seed supplier recommendations.

- Use netting and anchors, as needed. For disturbed areas on slopes, and in ditches/swales, erosion control blankets, biodegradable netting or jute is desirable and may be used instead of bonding agents to provide a stable area for seeding. Netting should be anchored in accordance with manufacturer's recommendations.
- Watering - Seeding shall be supplied with adequate moisture to establish grass. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Water application rates should be controlled to provide adequate moisture without causing runoff.
- Re-seeding - Areas which fail to establish grass cover adequate to prevent erosion shall be re-seeded as soon as such areas are identified, and all appropriate BMPs taken to establish adequate cover.
- Weed Control - Specify whether mechanical, hand removal, biological or chemical methods will be used. Minimize chemical use as a last resort if possible. Assure the selected weed control regime adequately protects your selected seed mix.

MAINTENANCE REMOVAL GUIDANCE ➔

- At the end of site development, approved permanent site landscaping or establishment of a healthy stand of grass (or alternative vegetation as approved) must occur prior to removal of site erosion prevention BMPs.

Mulch

DEFINITION ➔ Mulch is a name given to a group of organic and inorganic (natural or synthetic) materials that are spread on the soil surface to prevent movement of soil by wind and rain. Mulches; protect exposed soil surfaces from the force of falling rain, slow downslope flows, increase heat and moisture content for seeding and other vegetation, and when adequately anchored, can provide slope stabilization.

PURPOSE ➔ To minimize erosion by providing a protective cover over disturbed, bare or reseeded soils. Also is best used to enhance success of seeding/revegetation. Minimal thickness protects soils from splash erosion while thicker layers are effective for additional sediment control.

CONDITIONS WHERE PRACTICE APPLIES ➔

- As a cover on ground surfaces and stockpiles exposed during the wet season (October 1 through April 30).
- As a mulch to enhance vegetation establishment in areas that have been seeded.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- On slopes steeper than manufacturer or supplier guidelines.
- No organic mulches shall be used on streams or water quality / quantity facility banks below high water line.

DESIGN CRITERIA/SPECIFICATIONS ➔

- All materials shall be loose, designated a certified grass seed strain, and free of significant sediment loads.
- Mulches shall be spread uniformly throughout the entire area and integrated into the top layer of soil – if appropriate.
- Mulches are most effective when anchored. Anchoring can include punching materials into the soil, mixing mulches with tackifier products, or covering with adequately anchored netting or blankets. Otherwise thick layers of mulch can migrate off-site.
- Organic mulches must be stabilized in place by hand, machine punched into the soil, sprayed with a tacking agent, or covered with an erosion blanket or other netting.
- Mulches shall be applied at the rates specified in the following Mulch Comparison Matrix.

MAINTENANCE REMOVAL GUIDANCE ➔

- Additional mulch applications shall be made when the current mulch layer has migrated or is no longer uniform depth.
- Mulches may be left in place permanently - either as part of the final landscaping plan or integrated into the topsoil as a soil amendment.

MULCH APPLICATION RATES AND NOTES

Mulch Material/Quality Standards	Min. Application Rate Per 1000 ft	Per Acre	Depth of Application	Considerations
Straw (or Hay) Air dried Free from seeds and coarse material.	90-100 lbs. (2-3 bales)	2-2 1/2 tons (80-130 bales)	2 in. for splash control 4-6 in. for sedimentation	May be windblown or moved by flows - needs to be anchored
Compost Well composted Free of coarse foreign matter (plastics, metals, etc.) Size dependent on use.	6-9 yds. (2-3 cy)	265-400 yds (80-120 cy)	2 in. for splash control 4-6 in. for sedimentation	Coarser grades from more erosion prone areas. Finer grades may be windblown. All grades good for landscaping and as a soil amendment. Durability dependent on grade and type of compost.
Wood Chips Green or air-dried Free of coarse material	3-9 yds. (1-3 cy) 185-275 lbs	130-400 yds (40-120 cy) 4-6 tons	1-3 in. for splash control 4-6 in. for sedimentation	Durable, but subject to movement on >6% slopes. Add 12 lbs. organic compost or nitrogen fertilizer per ton chips. Not for use in fine turf areas. Apply with mulch blower, chip handler or by hand.
Bark Chips/Shredded Bark Green or air-dried Free of coarse material	3-6 yds. (1-2 cy)	150-280 yds (50-70 cy)	1-3 in. for splash control 4-6 in. for sedimentation	Durable, but subject to movement on >6% slopes. Add 12 lbs. organic compost or nitrogen fertilizer per ton chips. Not for use in fine turf areas. Apply with mulch blower, chip handler or by hand.
Wood or Cellulose Fiber Dyed visible color Should contain no growth inhibiting factors	35-50 lbs.	1500-2000 lbs	n/a	Apply with hydroseeder or with hydroseed. Second application in different direction to avoid shadowing. Double application rate, in two layers, on critical areas. Use tackifier as recommended by manufacturer. Do not use in hot/dry weather. Packaged in 50 lb. bags
Crushed Rock 1-1/2 inch fractured face Clean, with less than 10% fines.	12 tons	410 tons	1-2 inch	Use of landscape rock in permanent landscape areas

PRIMARY PURPOSE ➔

- To prevent erosion from exposed soils.

SHALL NOT BE USED ➔

- On slopes steeper than manufacturer's recommendation.
- No organic mulches on stream or water quality/quantity facility banks below high water line.

INSTALLATION TIPS ➔

- Complete required grading and roughen underlying surface (see pages 4-48 through 53) prior to application of mulches.
- Use in conjunction with a perimeter sediment control barrier.
- Disc, punch, or use other approved anchoring method to bind mulches to the soil.
- Assure minimum 2 inches uniform across entire site.

Signs of Failure

Symtoms	Cause	Solution
Soil migration off site.	Mulch has gone bare or is no longer at least 2 inches uniform thickness.	Clean up migrated soil. Add more mulch. Disc or punch in. Repair rills or gullies. Recover with alternative material - i.e. blanket, tackifier, plastic sheeting or other approved BMP.

Erosion Blankets

DEFINITION ➔ Erosion control blankets are mats comprised of organic fibers or inorganic materials held by synthetic or biodegradable netting. Most blankets are rolled products, but some may be sprayed onto exposed soils.

PURPOSE ➔ To provide immediate protection and physical stabilization of disturbed soils. Typically used when vegetative cover cannot be achieved due to soils, time of year or where slopes are too steep for mulch or other erosion prevention BMPs. Can be used to enhance success of seeding, planting and/or sod application.

CONDITIONS WHERE PRACTICE APPLIES ➔

- As channel stabilization against concentrated runoff flows (with adequate approval and permits for active waterways).
- On areas of steep slopes (greater than 50 percent) and areas of moderate slopes that are prone to erosion.
- As a cover on ground surfaces exposed during the wet season (October 1 through April 30).
- As supplemental aid to seed and/or mulch treatment on slopes or in ditches or swales.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- No blanket product shall be installed outside of manufacturer specifications.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Erosion blankets may be used on level areas and on slopes up to 1:1. Where soil is highly erodible, netting shall only be used in conjunction with organic mulch such as straw or wood fiber. The blanket must be applied so that it is in complete contact with the soil; if it is not, erosion will occur beneath it. Erosion blankets shall be securely anchored to the slope in accordance with manufacturer's recommendations.
- Consider installing fiber rolls or other barriers at various locations on the slope to minimize full slope length flows.
- Deformed plastic filament matting may be used for stream velocity protection and other special applications when approved by the jurisdiction.
- Provide additional seed over and under mat installations to enhance vegetative cover growth.

MAINTENANCE REMOVAL GUIDANCE ➔

- Erosion control blankets and mats are usually permanent installations.

PRIMARY PURPOSE ➔

- To prevent erosion from exposed soils in channels on slopes, or as a wet weather measure.

SHALL NOT BE USED ➔

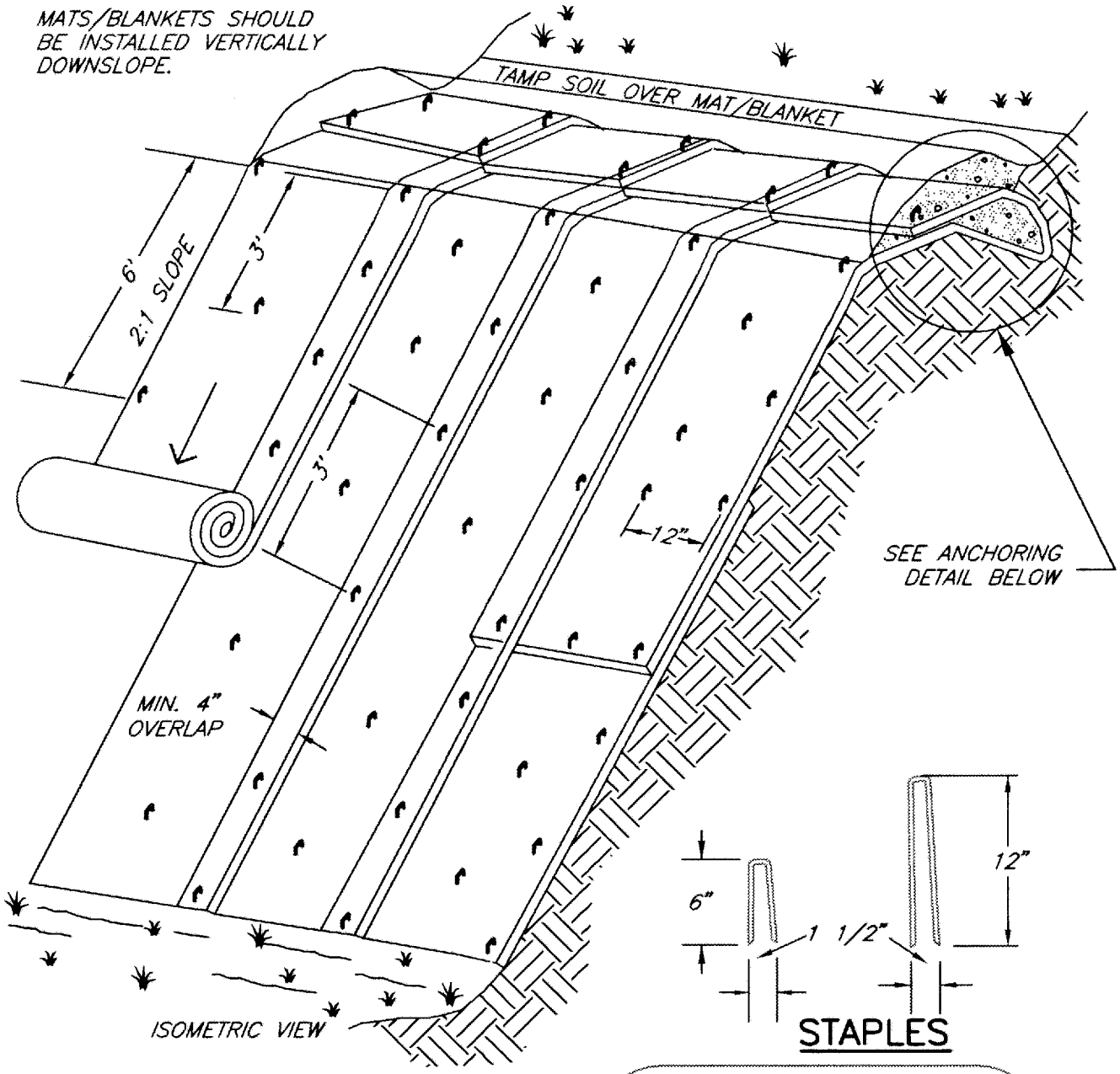
- On slopes steeper than manufacturer's recommendation.
- On rough surface projects where there is not good contact with the ground.

INSTALLATION TIPS ➔

- Best used for slopes over 2:1 down to 4:1.
- Allow adequate material for overlaps and trenching.
- Install horizontally across slopes, with overlap of upper blanket over lower blanket.
- Organic and/or thicker materials will provide enhanced protection of soils.

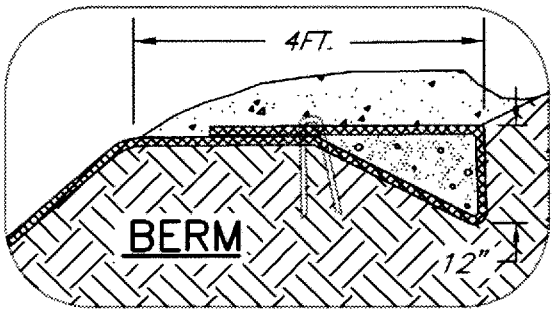
Signs of Failure

Symtoms	Cause	Solution
Blanket moved or deformed.	Improperly or inadequately staked. Joints not properly overlapped or secure. Concentrated flows are directed into joint or weakly stapled areas.	After adequately repairing erosional damage under blanket: Adjust and reanchor blanket. Control or reduce upstream flows.
Slope creep / undermining.	Blanket not making good contact with soils. Flows directed under blanket edge. Groundwater or slope failure issue.	After adequately repairing erosional damage under blanket: Add additional stakes to have blanket conform to contours of soils. Assure edges are anchored under incoming flows (in trench, under outfall, etc.). Have Geotech check slope stability.
Erosion occurred.	Flows too high for type of blanket used. Blanket not secured.	After adequately repairing erosional damage under blanket: Choose blanket rated to withstand site flows. Re-anchor blanket.



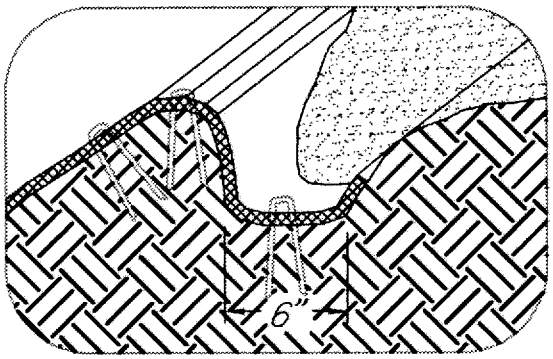
TYPICAL SLOPE SOIL STABLIZATION

STAPLES

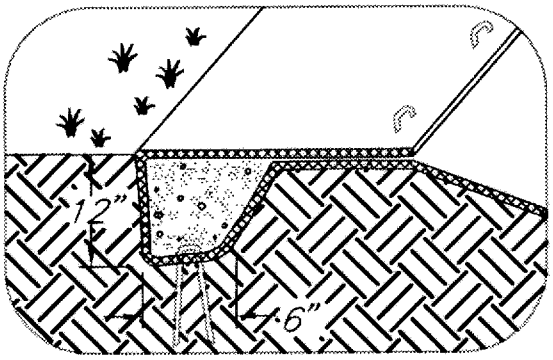


ANCHORING DETAIL

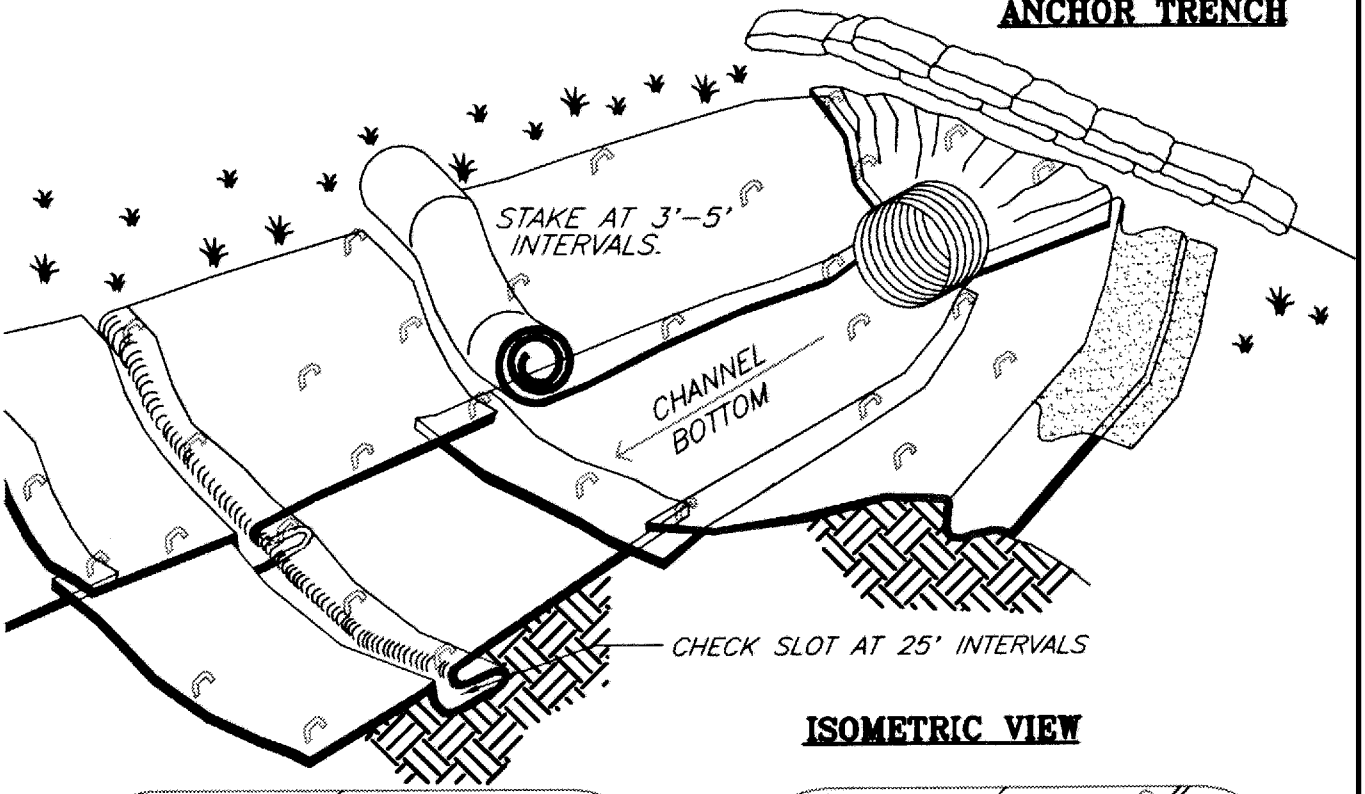
NOT TO SCALE



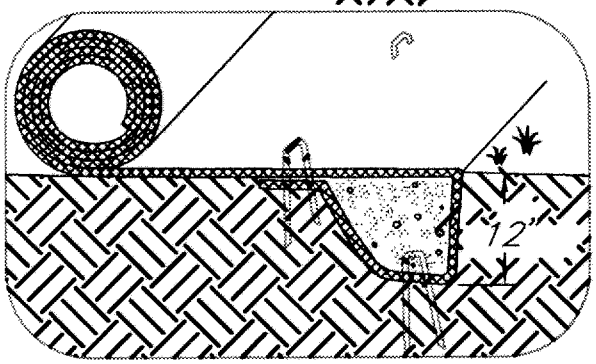
LONGITUDINAL ANCHOR TRENCH



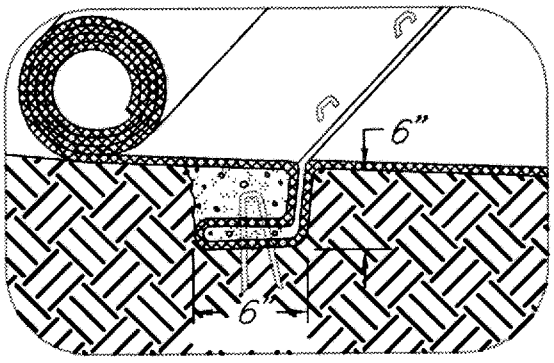
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH



ISOMETRIC VIEW



INITIAL CHANNEL ANCHOR TRENCH



INTERMITTENT CHECK SLOT

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

DRAWING NOT TO SCALE

Plastic Sheet Covering

PURPOSE ➔ To provide immediate erosion protection, usually for small areas, where vegetative cover cannot be achieved due to soil conditions, steep slopes or time of year. To provide temporary erosion protection on soils, spoils, and other erodible stockpiles.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Disturbed areas which require immediate erosion protection.
- On steep slopes (greater than 2;1) and areas of moderate slopes that are prone to erosion.
- On disturbed ground surfaces and stockpiles exposed during wet weather season (November 1 through April 30).

DESIGN CRITERIA/SPECIFICATIONS ➔

- Plastic sheeting shall be polyethylene (any color is acceptable) and have a minimum thickness of 6 mil.
- Covering shall be installed either overlapping side to side or top to bottom. Sheeting shall be maintained tightly in place by using: staples, stakes, sandbags, 12 inches diameter rock, cinder blocks or other rough surface materials with substantial weight.
- Sheeting should be applied as a continuos sheet whenever possible. All seams shall be taped, appropriately welded or weighted down for the full length and there shall be at least a 12-inch overlap of all seams. For seams parallel to the slope contour, the uphill sheet shall overlap the downhill sheet. For seams crossing up and down slope, sheet shall be laid so that the top sheet faces away from any prevailing wind. No runoff is allowed to run under the plastic covering.
- Collection trenches shall be placed at the top and around the base of any stockpile or other area using sheeting. The top trench shall direct waters away from the sheeting to an appropriate collection and conveyance system (i.e. pipe slope drains or swales). The trench may be designed and used to assist in conveyance as well as anchoring. The bottom trench shall be sized and stabilized to adequately route and control flows from the sheeting surface. Drainage from areas covered by plastic sheeting shall be controlled such that no discharge occurs directly onto uncontrolled, disturbed areas of the development site.

MAINTENANCE REMOVAL GUIDANCE ➔

- Plastic sheeting should be visually inspected every two weeks and after every storm for tears or weak points.

PRIMARY PURPOSE ➔

- Protect soils from contact with storm water.

SHALL NOT BE USED ➔

- As a first choice for erosion prevention cover. Erosion control blankets, mulch or seeding is preferred.

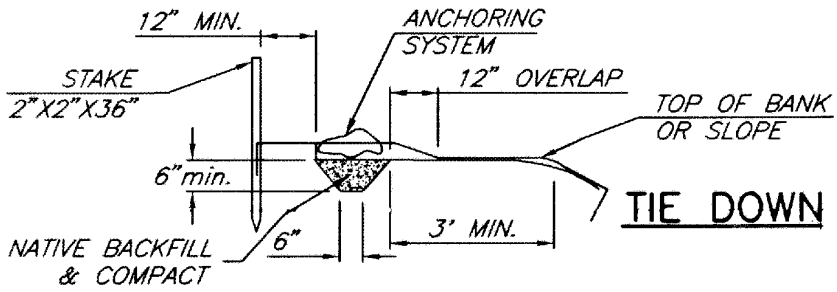
INSTALLATION TIPS ➔

- Apply in a continuous sheet covering pile.
- Secure edges tightly. Inspect weights frequently to assure plastic stays in place.
- Maintain and adequately size drainage trenches to carry flows generated by the plastic.
- Check seams and material condition often.
- Soils under plastic may go anaerobic – killing various organisms that make soil healthy. Consider grass cover to hold soils and improve soil health.

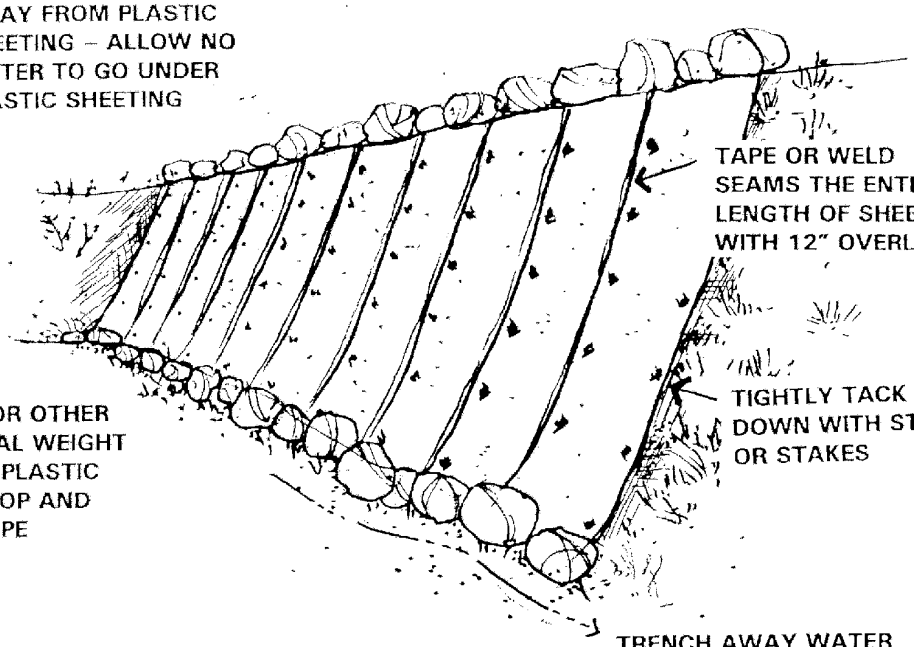
NOTE: mulching, vegetative cover, tackifier, blankets are preferred BMPs

Signs of Failure

Symtoms	Cause	Solution
Seams split / fabric tear.	Too much weight strain. Inadequate overlap or weld. Wind shear.	Adjust plastic layers and anchoring, choosing more and lighter anchoring materials. Weld seams appropriately. Cover with duct tape or additional plastic.
Fabric blown off / bare soils.	Wind shear.	Replace plastic and add extra anchoring.



TRENCH AND DIVERT WATER TO A CONTROLLED AND STABILIZED ROUTE AWAY FROM PLASTIC SHEETING – ALLOW NO WATER TO GO UNDER PLASTIC SHEETING



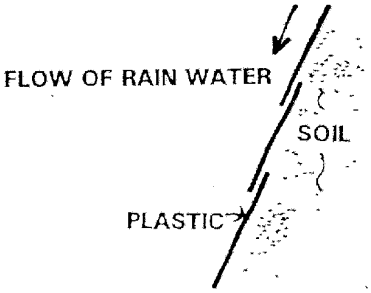
TAPE OR WELD SEAMS THE ENTIRE LENGTH OF SHEET WITH 12" OVERLAP

TIGHTLY TACK DOWN DOWN WITH STAPLES OR STAKES

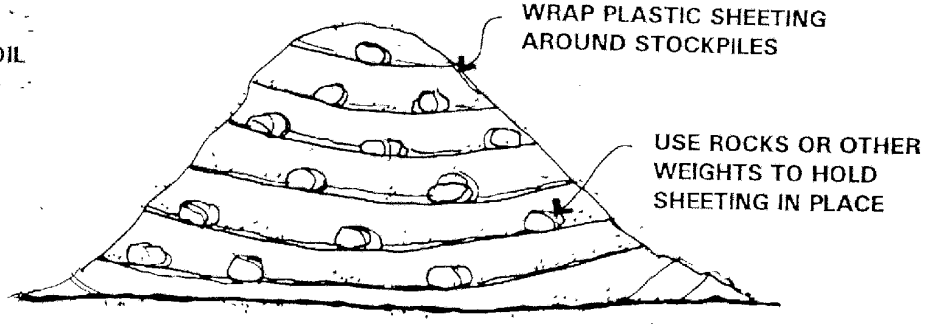
USE ROCK OR OTHER SUBSTANTIAL WEIGHT TO SECURE PLASTIC SHEET AT TOP AND TOE OF SLOPE

TRENCH AWAY WATER RUNNING OFF PLASTIC

STEEP SLOPES



START AT THE BOTTOM OF THE STOCKPILE AND OVERLAP SHEETING AS WRAPING GOES UP



WRAP PLASTIC SHEETING AROUND STOCKPILES

USE ROCKS OR OTHER WEIGHTS TO HOLD SHEETING IN PLACE

DRAWING NOT TO SCALE

Dust Control

PURPOSE ➔ To minimize wind erosion of bare soils.

CONDITIONS WHERE PRACTICE APPLIES ➔

Bare soils exposed to wind, especially unpaved roads, stockpiles and soil tracked onto paved roads or other impervious surfaces.

DESIGN CRITERIA/SPECIFICATIONS ➔

Dust is formed when bare soils come into contact with the wind. The following BMPs are ordered to emphasize prevention and then move to stricter controls:

- Administrative Control Methods. These methods concentrate on preventative controls such as: traffic restrictions / speed limits; reducing work activities with increasing wind speeds; enclosing bulk soil; and enclosing soil movement operations.
- Structural and Mechanical Control Methods. These methods concentrate on actions taken to reduce exposure during site work operations. Options include:
  - tilling soil into big clumps with fewer fines that are easily moved by air;
  - installing or maintaining vegetative or structural barriers, including preservation of perimeter trees (especially on the windward side of the site);
  - street sweeping of paved surfaces to remove tracked soil;
  - application of mulches to exposed soils;
  - and use of plastic sheeting for dust control on stockpiles.
- Water: Water is the wetting agent of choice to be used on soils to resist wind erosion. Assure that spray types and flow volumes and rate do not cause soil wash off.
- Chemical Control Methods. When other methods fail, the site may require application of dust control / wetting agents. Options include tackifier mixtures to bind soil or application of other binding agents (see table below):

BINDING AGENTS FOR DUST CONTROL

Agent (agent : Water)	Dilution Ratio	Nozzle type	Application Rate (gallons per acre)
Latex Emulsion	12.5 : 1	Fine Spray	235
Resin in Water	4 : 1	Fine Spray	300
Acrylic Emulsion (traffic)	3.5 : 1	Coarse Spray	350
Acrylic Emulsion (non-traffic)	7 : 1	Coarse Spray	450
Anionic Asphalt Emulsion	7 : 1	Coarse Spray	1,200

Amoring BMPs are included in this manual for the instances when using structures or hardscape materials are the only measures that will withstand high site flows (i.e., outfall discharge points, landslide areas). Other measures should be used when possible, like bioengineering, sod installation, or use of erosion control blankets that are rated to withstand flows. Many of these armoring systems can be installed with a large vegetative component that will provide additional environmental and erosion control benefits. Armoring BMPs are usually permanent measures.

Reinforced Soil Retaining Systems

DEFINITION ➔ Reinforced soil retaining systems are a mixture of permanent BMPs including hinged block, grid containment and articulated armoring systems. These products are usually pre-formed structural systems that are laid atop soils and then backfilled with a variety of materials – usually concrete, soil, sand or planted with vegetation. While they can be more expensive than other treatments, ease of installation and permanency can make these systems desirable.

PURPOSE ➔ To provide erosion protection and stabilization for slopes, and on rare occasions streambanks. Best used under high flow or unstable soil conditions.

CONDITIONS WHERE PRACTICE APPLIES ➔

- High flow channel stabilization or outfall armoring projects.

NOTE: Bioengineering techniques should be used in environmental and buffer zone areas and are preferred for low flow waterway conditions.

DESIGN CRITERIA/SPECIFICATIONS ➔

Use of these systems in drainages and other waterways may be prohibited. Bio-engineering techniques are the preferred alternative in bank and waterway projects because of their ability to provide upland habitat for animals and instream habitat for salmonids. In sensitive areas, it may be preferable to retain larger setbacks from the stream to avoid the need to armor banks and allow for natural channel migration. Use of these systems within a waterway or drainage area will likely require a variety of permits from state and federal natural resource protection agencies (Oregon Department of Fish and Wildlife, Oregon Department of State Lands, US Corp of Engineers, National Marine Fisheries Service, etc.)

- All materials should be installed per manufacturer's guidance and shall be designed by an licensed professional when required by the permitting authority. In general a licensed professional should be consulted for high flow, steep slope, or poor soil conditions.
- Follow the general installation principles below unless manufacturers instructions specify a different installation method:
  - Excavate the application area to a depth to assure that the reinforced soil retaining system will be flush with, or slightly lower than, adjacent terrain. The exposed surface shall be leveled and free of minor obstructions such as stones and debris. Major obstructions can be left in place, with materials established around them. Soils shall be compacted or removed as necessary.

- Lay panels or sheets on exposed surface. Use appropriate pins, hinges, staples, hog rings, or overlapping suggested by the manufacturer. Trench in top, bottom or sides of panel or sheets as specified by the manufacturer.
- Anchor reinforced soil retaining systems as per manufacturer's instructions. Anchoring shall at least occur along slope crests, upstream system edges, steep areas and areas likely to experience the highest turbulence from nearby surface water systems.
- Fill systems with material of choice – as rated for the system selected. Consider using some element of vegetative cover to enhance aesthetics and provide habitat.

MAINTENANCE REMOVAL GUIDANCE ➔

- Reinforced soil retaining systems are primarily used as permanent site features. All systems shall be maintained as installed for the life of the BMP. System repair typically consists of additional anchoring or refilling of sections on an as needed basis.

PRIMARY PURPOSE ➔

- To provide permanent slope stabilization or armoring.
- To protect high flow system channels or outfall locations.

NOTE: bioengineering techniques are preferred for low flow, waterway sites.

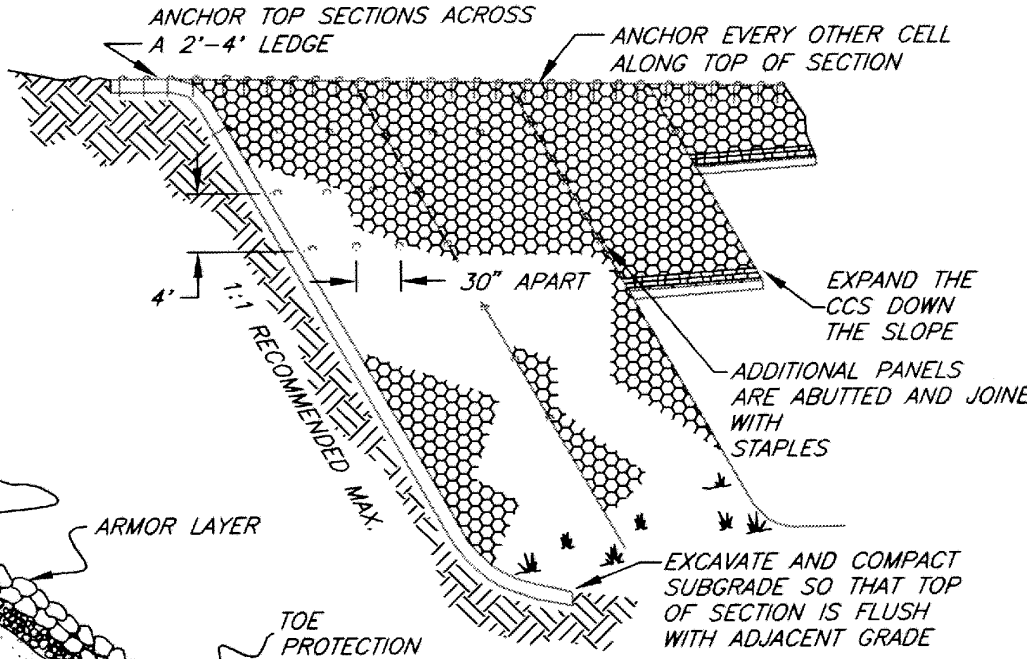
INSTALLATION TIPS ➔

- Make sure there is a good foundation with adequately compacted soils.
- Adequately anchor – especially on slope crests, upstream edges and other areas with steep slopes or high velocity flows.
- Consider overseeding or otherwise planting systems to enhance appearance and performance.

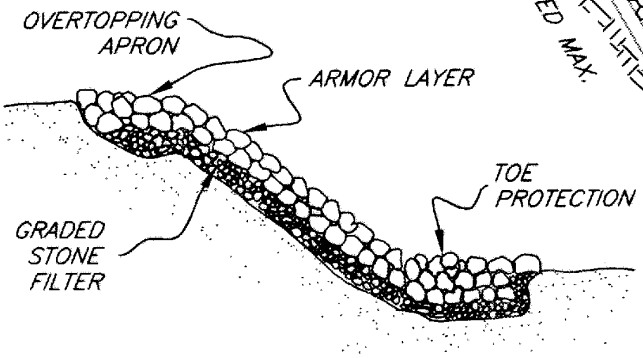
Signs of Failure

Symtoms	Cause	Solution
System is broken or otherwise compromised.	Flow is too intense. Materials are weak.	Revisit flow calculations. Add additional material supports or fill support materials. Overseed or over plant with vegetation to help hold in fill material.
System has slid or been displaced.	Foundation was insufficiently compacted, and the slope slipped. System was not adequately anchored.	Reestablish slope, compact and reinstall system. Replace and add additional anchors to system.
Erosion occurred.	Flows too high for type of system used. Flows are undermining system. Fill materials are missing.	After adequately repairing erosional damage under or within system: Choose system rated to withstand site flows. Replace and/or reanchor system. Add additional fill as necessary. Overseed or otherwise vegetate system to hold fill material.

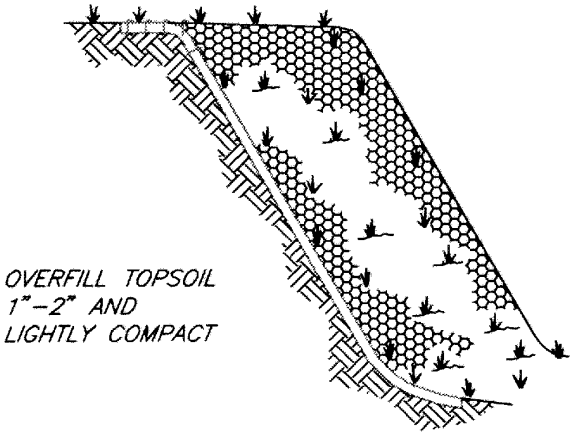
NOTES:
1. THE CELLS SHALL BE ANCHORED SECURELY TO PREVENT DISPLACE- MENT AND DEFORMATION OF PANELS WHEN BACKFILLING.
2. INFILL FROM CREST OF THE SLOPE TO TOE TO PREVENT DISPLACEMENT. LIMIT DROP HEIGHT TO 3'.



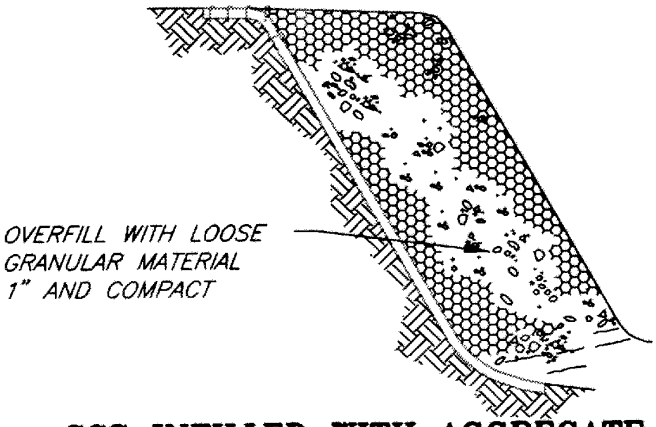
CELLULAR CONFINEMENT



TYPICAL ROCK REVERTMENT



CCS INFILLED WITH TOPSOIL AND VEGETATED WITH GRASS



CCS INFILLED WITH AGGREGATE

DRAWING NOT TO SCALE

Gabions

DEFINITION ➔ Gabions are wire mesh baskets or bags used for semi-permanent or permanent slope protection and stabilization. These rock filled devices are pervious, semi flexible building blocks that can be used as retaining walls of for structure to support all types of vegetation, especially live stakes. In addition gabions and sack gabions can be used as check dams for water conveyance systems.

PURPOSE ➔ To provide erosion protection and stabilization for slopes. They can also be used as energy disappaitors to slow flow and provide sedimentation.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Slope stabilization and retaining wall projects.

NOTE: Bioengineering techniques should be used in environmental and buffer zone areas and are preferred for low flow waterway conditions.

4-5

DESIGN CRITERIA/SPECIFICATIONS ➔

Use of these systems in drainages and other waterways may be prohibited. Bio-engineering techniques are the preferred alternative in bank and waterway projects because of their ability to provide upland habitat for animals and instream habitat for salmonids. In sensitive areas, it may be preferable to retain larger setbacks from the stream to avoid the need to armor banks and allow for natural channel migration. Use of these systems within a waterway or drainage area will likely require a variety of permits from state and federal natural resource protection agencies (Oregon Department of Fish and Wildlife, Oregon Department of State Lands, US Corp of Engineers, National Marine Fisheries Service, etc.)

- Gabions can come as boxy baskets, thinner mattresses, or as sacks. Each type is typically constructed of 3 1/4 by 4 1/2 inch opening, double twisted or welded, hexagonal zinc wire mesh. Gabions are typically filled with 5 to 7 inches or 5 to 9 inches gabion rock. Alternative mesh opening sizes are available. Some gabions can also come with a PVC coating to protect from zinc flaking or rusting off gabions. Gabions can use 1/3 the thickness of a rip-rap layer to provide the same protection.

Follow the general installation principles below unless manufacturers instructions specify a different installation method:

NOTE: PVC or other approved coating will be required for gabion used near streams, stormwater management facilities or other waterbodies.

- Unfold and assemble gabion into proper dimension by tying edges with lacing wire or other approved fasteners. Include proper installation of mid-height form wires as appropriate (form wires may also be added during filling).
- Excavate the location for gabion use. Key any basket or mattress at least 1 to 2 feet into the foundation area and side slopes of the work area or streambank. Follow manufacturer's instructions.
- Place empty gabions into excavated area, stretching gabions as needed for proper alignment or connection. Tightly tie gabions together on the side as needed.
- Fill gabions, tying form wires as needed. When basket or mattress is full, tie lid shut. If additional layers are used, new gabions shall be secured to the underlying gabion layer.

MAINTENANCE REMOVAL GUIDANCE ➔

Gabions, outside of sack gabions, are primarily used as permanent site features. All gabions shall be maintained as installed for the life of the BMP. Gabion repair typically consists of tying holes closed in the mesh structure when needed.

PRIMARY PURPOSE ➔

- To provide permanent slope stabilization or armoring.
- To act as a check dam providing energy dissipation and sedimentation.

SHALL NOT BE USED ➔

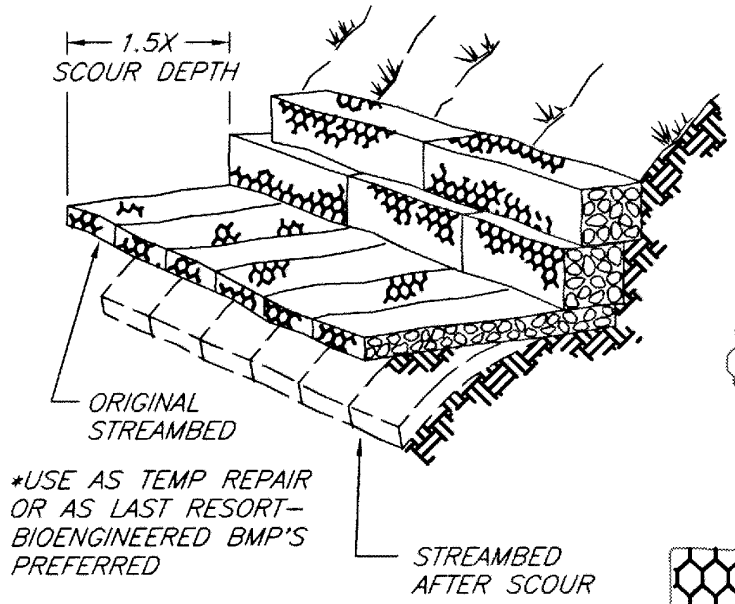
- In streams, stormwater facilities and other waterbodies when bioenineering techniques are applicable. If used, they must be coated with PVC or other appropriate material.

INSTALLATION TIPS ➔

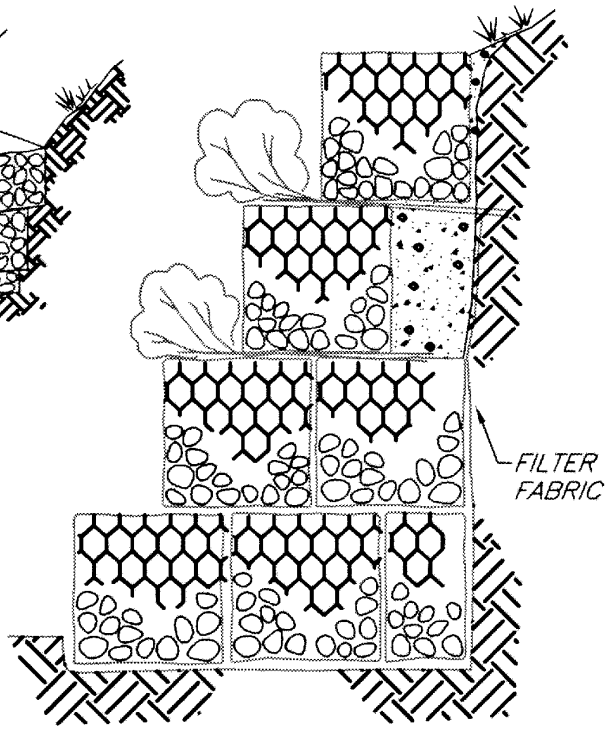
- Make sure there is a good foundation. Consider use of a gravel base course, especially where used as retaining wall systems.
- Adequately key in to foundation and side slopes, at least 1 to 2 feet or as per manufacturers or engineer's instructions.
- Consider overseeding or otherwise plant gabions to enhance appearance and performance.

Signs of Failure

Symtoms	Cause	Solution
Gabion wires are broken.	Flow is too intense. Mesh is weak.	Revisit flow calculations. Add additional wire supports or ties to mesh. Overseed or over plant with vegetation to help hold in rock.
Gabion has displaced.	Foundation was insufficient. Gabion was not adequately keyed into side slopes. Wire ties have broken or are missing.	Re-intrench gabion into foundation or key into side slopes. Add additional wire supports or ties to mesh.

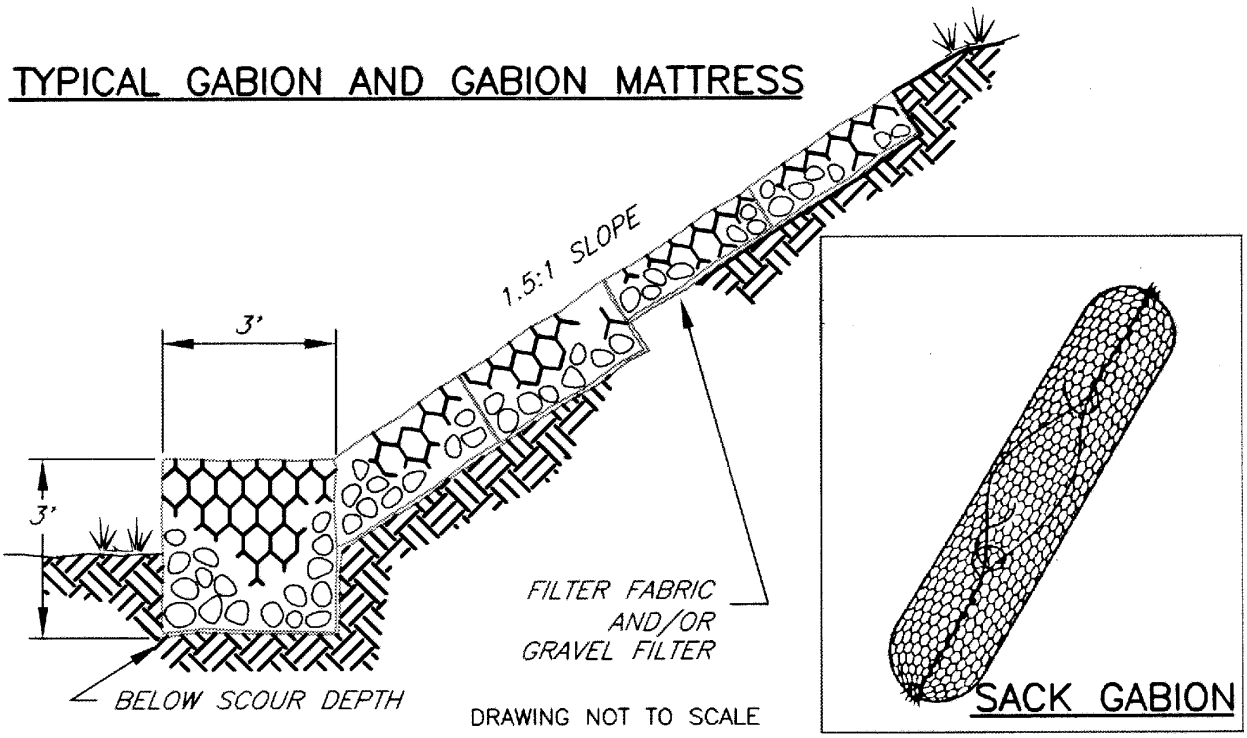


TYPICAL GABION APRON



TYPICAL VEGETATED ROCK GABION

TYPICAL GABION AND GABION MATTRESS



Soil bioengineering BMPs are the ideal measures for use in streambanks and on other upland slope areas. Bioengineering uses vegetative materials to provide structural support to banks and flow reduction across banks. Soil bioengineering BMPs are usually permanent measures.

Live Stakes

DEFINITION ➔ Live stakes are stakes of woody plant materials that are capable of rooting with relative ease (i.e. willow). Theses cuttings are cut to length, tamped into the ground, and then grow into mature shrubs that will, over time, hold and provide a protective cover for the soil surface.

PURPOSE ➔ To act as an effective, inexpensive system for securing natural geotextiles such as jute mesh, coir or other blanket surface treatment; growing into mature shrubs that, over time, will serve to stabilize the soils and restore the riparian zone habitats. Live stakes offer no immediate erosion control.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Streambanks restoration or construction projects.
- Simple, shallow slope stabilization projects.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Grade slopes to appropriate slope – preferably 2H to 1V or flatter, especially when soils are less cohesive or lenses of sands and gravels exist.
- Use fresh, healthy, straight, and live wood that is at least 1 year old, with side branches removed, and bark intact. They must be taken from species that root easily from cuttings, such as willow or other native species approved by the local jurisdiction.
- Prepare cuttings 1/2 to 2 inch diameter, 2 to 3 feet in length. Cut the basal (butt) ends cleanly at an angle to facilitate easy insertion into the soil. Cut the top square or blunt for tamping.
- Keep cuttings fresh and moist after they have been prepared into appropriate lengths. It is suggested that they are soaked 24 hours prior to installation.
- Tamp the cuttings into the ground at right angles to the slope and angled downstream. Tamp cuttings into the ground carefully for approximately 4/5 of their length. 2 to 5 bud scars should remain above the ground surface. Remove any additional length above ground. Place stakes in a random configuration from 2 to 5 feet apart, to prevent gullies from forming and to produce a more natural effect in the revegetation area.

MAINTENANCE REMOVAL GUIDANCE ➔

- Live stakes are permanent vegetative measures. Assure plant survival by providing adequate water, nutrients and aerobic soils conditions. Replace any dead vegetation.

PRIMARY PURPOSE ➔

- To secure streambanks or slope erosion prevention materials.
- To provide long term permanent streambank or slope cover.
- To provide quick, inexpensive and easily installed permanent vegetative cover on simple areas.

SHALL NOT BE USED ➔

- By itself for immediate erosion control protection or soil reinforcement.

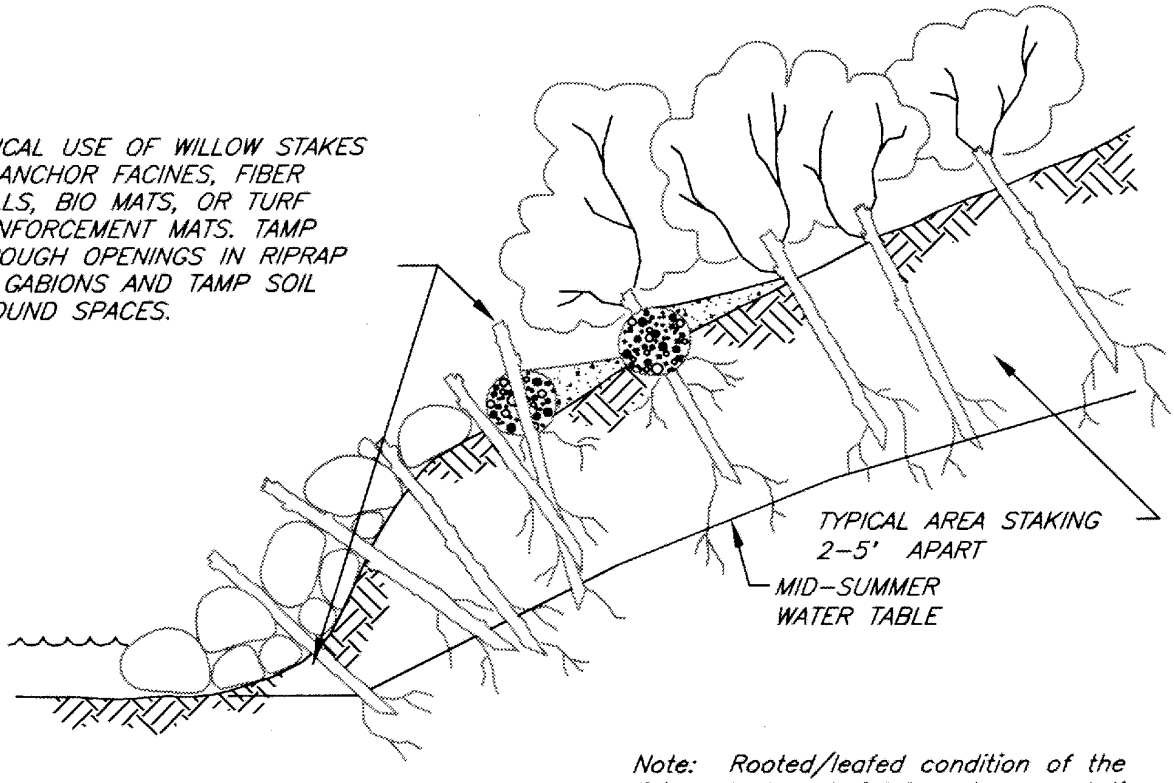
INSTALLATION TIPS ➔

- Harvest and install the live stakes during the dormant season.
- Make clean cuts, and do not to split ends during installation. Use a dead blow hammer.
- Use a saw for cuts rather than an ax – there is less chance for bark damage.
- Use a pilot bar or other tool to pre-drill holes in firm soils. Be careful on tool removal to not enlarge the hole reducing the ability of the live stake to remain in place and be effective.
- Determine whether temporary irrigation will be needed to establish growth. If using irrigation, it needs to infiltrate at least 2 inches deep.
- Assure soil is adequately worked in around the live stake.

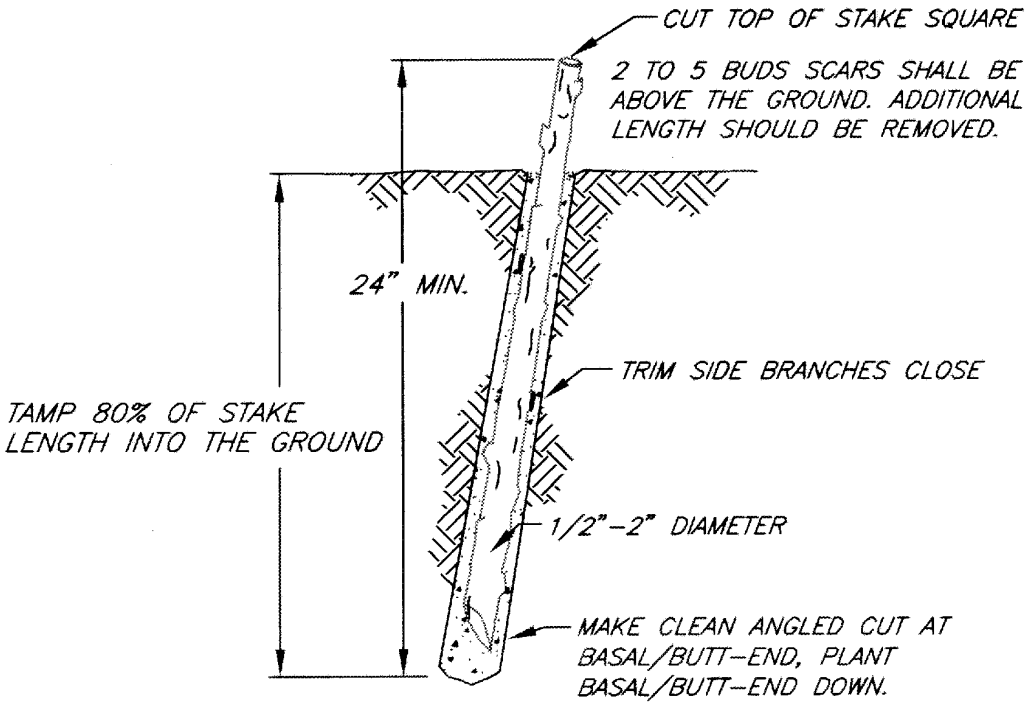
Signs of Failure

Symtoms	Cause	Solution
Live stake has dislodged or is gone.	Stake was not installed to correct depth. Soil was not adequately packed around live stake – tamping it in.	Replace missing stakes with adequate soil tamping. Verify stream or runoff flow problem has been corrected.
Stakes are not growing.	Lack of contact with soil. Live stake is dead due to lack of water or nutrients and/or anaerobic soil conditions.	Re-bury or replace, adding water and nutrients if needed.
Soil is running off bank or slope.	Live stakes used by themselves for erosion control.	Protect soils with blankets, mulches or other covers (including seed).

Detail Drawing 4.6 A - Live Stakes



Note: Rooted/leafed condition of the living plant material is notrepresentative at the time of installation.



DRAWING NOT TO SCALE

Live Fascines

DEFINITION ➔ Live facine structures are sausage-like bundles of live cut branches of wetland / streamside materials, usually willow or dogwood species. These bundles are placed into trenches along the streambank and grow out perpendicular to the bank providing protective vegetative cover and a root structure to stabilize banks.

PURPOSE ➔ To provide surface stability and prevention of erosion by holding soil on the face of the streambank and support for the invasion of the surrounding aquatic, riparian, or upland slope vegetation.

Temporary live or inert facines may be constructed to slow surface water flows and allow for more infiltration on sites with limited water supply. Note that these installations may not grow shrub canopy cover.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Streambanks which require immediate erosion protection and streambank revegetation projects.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Prepare the slope by grading back to a 3:1 or flatter slope, especially in less cohesive soils or soils with distinct material lenses.
- Assemble live fascines fresh plant cuttings, with alternating basal ends. Live fascines bundles are 6 to 8 inches in diameter and tied securely with twine or rope every 12 inches to 15 inches.
- Install live fascines shallowly on contour of banks with a face length of 15 feet or less to prevent ground disturbance. Install live fascines in shallow trenches that are a shovel deep and a shovel wide. Install from the bottom of the slope and work upto the top of the slope.

RECOMMENDED SPACING FOR LIVE FACINES (MEASURED ALONG THE BANK FACE)

Slope Steepness	Undisturbed Erosive Soils	Undisturbed Cohesive Soils	Fill Soils
3H to 1V or Flatter	3 - 5 feet	5 – 7 feet	3 – 5 feet *
Steeper than 3H to 1V (upto 1H to 1V)	3 feet *	3 – 5 feet	0

* not recommended alone – use with erosion control matting.
Robbin B. Sotir & Associates Inc.

- Live plant material stakes and dead stout or construction stakes are used to anchor the live facine bundles. Live stakes are at least 24 inches long and between 1/2 and 2 inches wide. Dead stout stakes are made from 2x4 inch untreated lumber. Stakes are 30 to 36 inches long and cut diagonally across the 4 inches face, tapering to a 1/8 to 1/4 inch tip.
- Stakes shall be installed directly through the live fascine bundle to ensure it will not lift up, nor allow water to move under the installation. Stakes are placed 3 feet apart. Best installation uses dead stout stakes for securing the facine bundles, with live stakes installed between facine rows.
- Place soil along the sides of the live fascines in and around the branches and at each stake to provide for growth media.
- Foot compact all soils around all facine bundles, dead stout and live stakes.
- Install facines as depicted in the Detail Drawings 4.6 B and 4.6 C.

MAINTENANCE REMOVAL GUIDANCE ➔

Live facines are permanent vegetative measures. Assure plant survival by providing adequate water, nutrients and aerobic soils conditions. Replace dead or provide additional vegetation as needed.

PRIMARY PURPOSE ➔

- To provide surface stability to streambanks.
- To support the establishment of permanent streambank cover.
- To slow surface flows by breaking up slopes and allowing vegetation to establish, which allows enhanced infiltration.

SHALL NOT BE USED ➔

- Live facines should never be used 1:1 or steeper slopes.

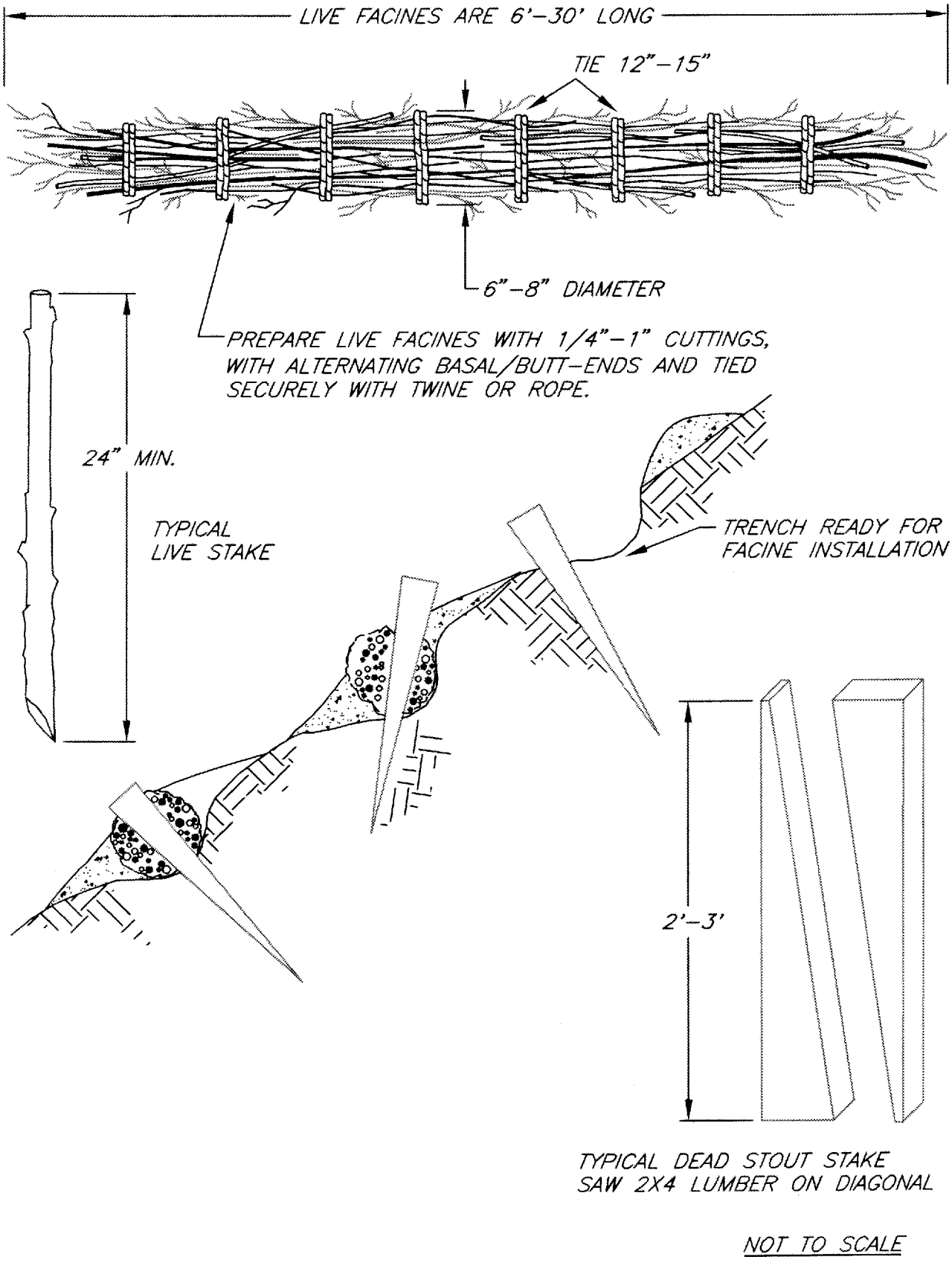
INSTALLATION TIPS ➔

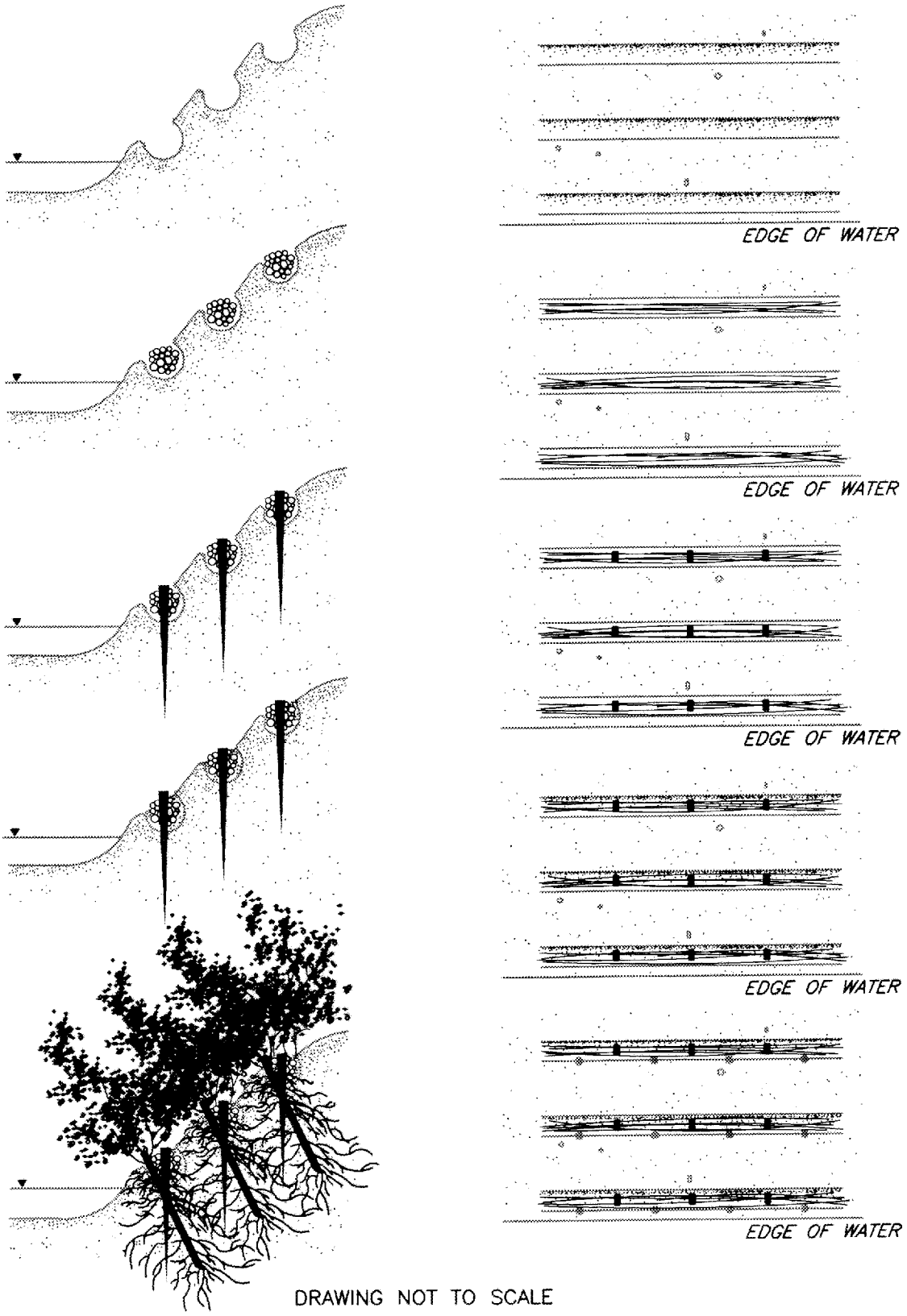
- Store vegetation in water until bound and installed.
- Install live fascines during the dormant season.
- Assure soil is adequately worked around bundle.
- Do not completely bury the live facine. The top branches should be visible.

NOTE: If a live facine fails to grow, it still acts as a mechanical barrier to slope flows.

Signs of Failure

Symtoms	Cause	Solution
Facine has dislodged or is gone.	Fascine was not appropriately anchored.	Replace bundles and re anchor with additional stakes and assure live facines are secured into the trench. Repack soil. Replace missing fascines with adequate anchoring. Verify stream or runoff flow problem has been corrected.
Live facines are not growing.	Lack of contact with live facine and soil. Live facines are dead due to lack of water, nutrients and/or anaerobic soil conditions.	Re-bury, adding water and nutrients if needed. Seed or add live stakes to streambank to provide for vegetative growth.


LIVE FACINES ARE 6'–30' LONG
TIE 12"–15"
6"–8" DIAMETER
PREPARE LIVE FACINES WITH 1/4"–1" CUTTINGS, WITH ALTERNATING BASAL/BUTT–ENDS AND TIED SECURELY WITH TWINE OR ROPE.
24" MIN.
TYPICAL LIVE STAKE
TRENCH READY FOR FACINE INSTALLATION
2'–3'
TYPICAL DEAD STOUT STAKE SAW 2X4 LUMBER ON DIAGONAL
NOT TO SCALE



DRAWING NOT TO SCALE

SECTION

PLAN

Robbin B. Sotir & Associates, Inc.

Brush Layers and Brush Packing

DEFINITION ➔ A brush layer, is a layer of plant material that is laid between successive lifts of a fill slope and brush packing, staking down layers of material within the rills or gullies to repair a fill slope, are most commonly used for upland slope conditions. Both systems require live branches laid horizontally within the slope that provide quick wildlife habitat.

PURPOSE ➔ To provide enhanced stabilization to fill slopes, by providing resistance to sliding and other types of displacement.

CONDITIONS WHERE PRACTICE APPLIES ➔

- During construction of fill slopes or embankments.
- On upland slopes needing repair.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔

- On steep slopes (l:l) exceeding 30 feet in slope length.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Determine layer spacing. Slope height should not excess 3 times the width of the reinforced volume. For example for a brush layer with 6 to 8 foot cuttings, the slope height should not exceed 24 feet.
- Prepare live woody plant materials with adequate rooting potential. Create cuttings 4 to 8 feet long, of materials 3/4 to 2 inches in diameter. Soak cuttings for at least 24 hours. Materials usually are long branch tips from woody plants.
- Prepare the slope bench. The surface or the bench is sloped so the outside edge is higher than the inside edge so the basal ends angle slightly down and back into the slope.
- Place layer materials. Layer plant cuttings 3 to 8 inches thick, in criss-cross or overlapping pattern. All growing tips protrude 6 to 12 inches from the slope face.
- Fill layers with soil, being careful to keep all moving equipment at least 6 inches away from the layer materials. Compact into successive lifts of a maximum 6 to 8 inches deep. Install the next layer 3 to 8 feet above the previous row. Continue to the top of the slope.
- Seed and mulch the slope.

MAINTENANCE REMOVAL GUIDANCE ➔

- Brush layering and brushpacking are permanent installations. Assure survival of plantings by providing adequate watering, nutrients and aerobic soil conditions.

PRIMARY PURPOSE ➔

- To provide stability for constructed fill slopes and embankments.
- To support the establishment of permanent vegetative cover.

SHALL NOT BE USED ➔

- For large areas of steep slopes. Limitation to angle of repose is suggested.

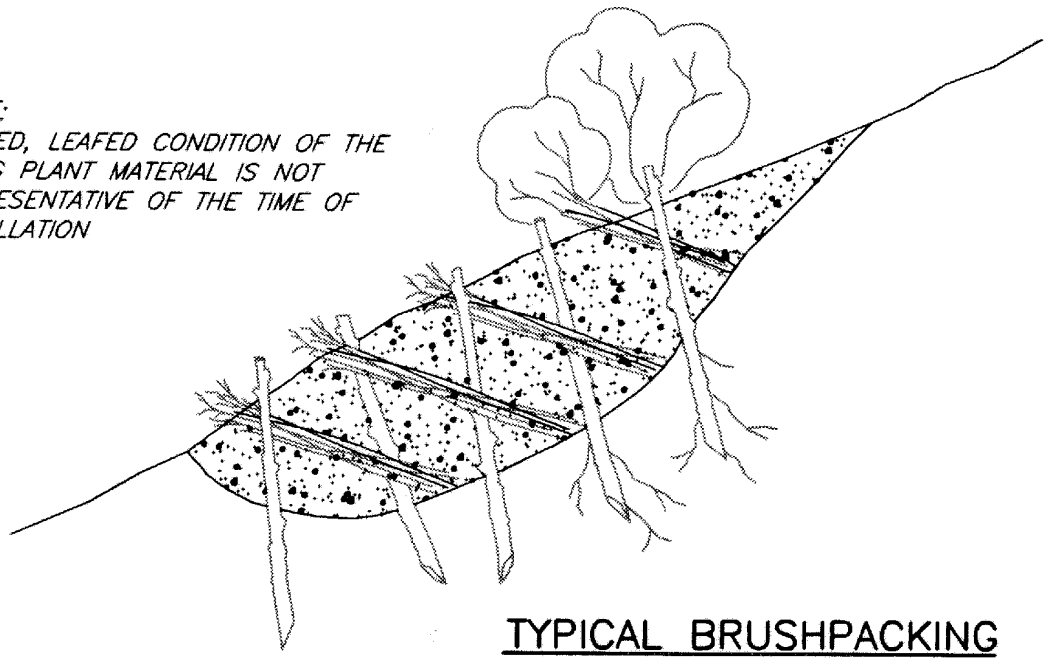
INSTALLATION TIPS ➔

- Store vegetation in water until installed.
- Install during the dormant season of the vegetation used.
- Assure soil is adequately worked around all plant materials.
- Do not drain water through brushlayer – gullies under the layer are likely to form.

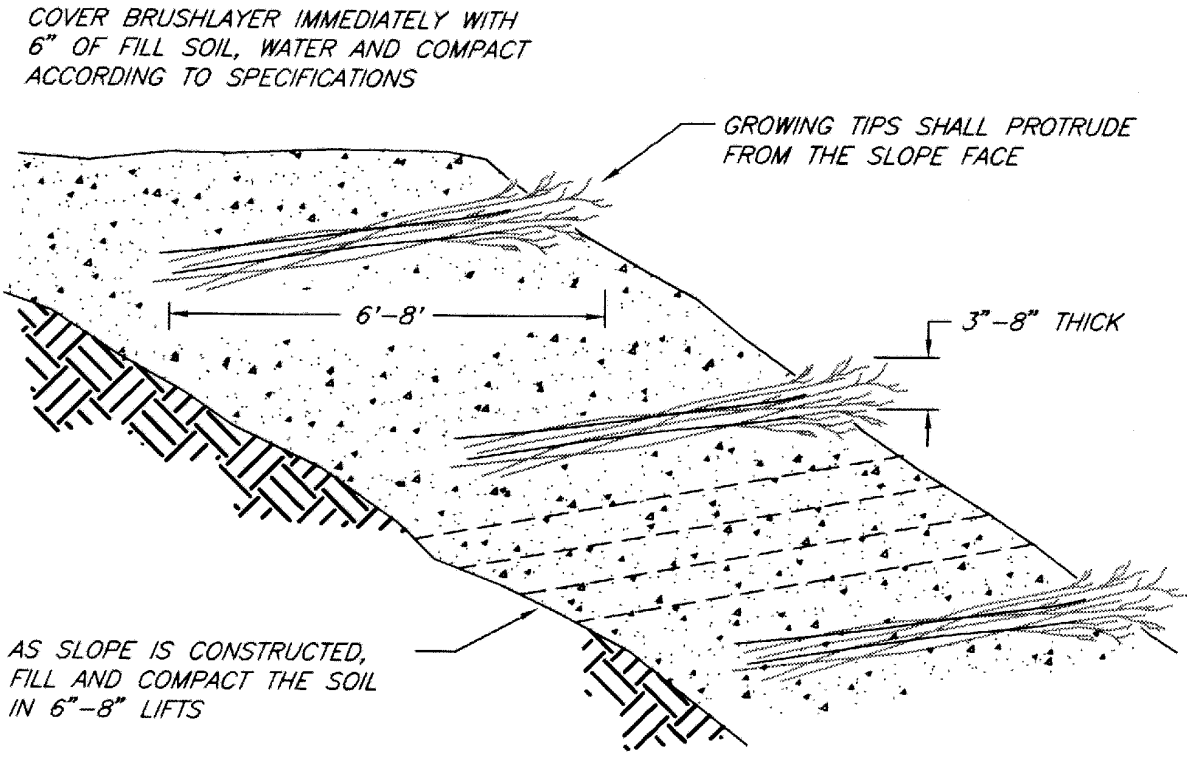
NOTE: If brush layer fails to grow, it still acts as a structural support to the slope.

Signs of Failure

Symtoms	Cause	Solution
Layer has dislodged or is gone.	Branches were not adequately compacted within lifts.	Add replacement materials and recompact effected lifts. Verify runoff flow problem has been corrected.
Brushlayers are not growing.	Materials are dead due to lack of water, lack of nutrients or anaerobic soil conditions.	Re-compact adding water and nutrients if needed. Seed or add additional live materials to provide for vegetative growth.



TYPICAL BRUSHPACKING



TYPICAL BRUSHLAYERING WITH SLOPE CONSTRUCTION

DRAWING NOT TO SCALE

Brushmattress

DEFINITION ➔ A brushmattress, is a combination of vegetated structures (live stakes, live fascines and branch covers) that are used to form a protective vegetated mattress over a streambank or other slope. This systems require a great deal of live plant material, but provide quick wildlife habitat.

PURPOSE ➔ To provide a protective layer of live plant materials that will root and grow to hold soils and provide permanent vegetative cover, primarily on streambanks. Provide immediate flood protection of exposed streambanks

CONDITIONS WHERE PRACTICE APPLIES ➔

- On banks or slopes which require immediate surface protection

DESIGN CRITERIA/SPECIFICATIONS ➔

- Smooth grade the slope to a minimum of a 2-3H to 1V slope. A flatter slope is preferred. Limit the bank face to 10 feet or less. Excavate a trench at the base of the bank or just above mean water level. Install a live fascine bundle or fiber roll in the trench to provide support the toe of the slope and assist in holding down the mattress branches
- Prepare live woody plant materials with adequate rooting potential and then assemble a few live fascine bundles as specified in the previous manual section. Live stakes for this installation are typically 1/2 to 1 1/2 inch inches in diameter. Branch mattress materials are 6 to10 feet long, flexible and 1/2 to 1 inch in diameter. Materials usually are long branch tips from woody plants.
- Wire or twine will be needed to tie down branch materials to the staked sections of the mattress. Do not put tension on the branches so that they rise off the slope face. Dead stout stakes will also be required. Cut as specified in live fascine description.
- Place live fascine bundles at slope toe and secure with live and dead stout stakes. Cover with soil as specified in fascine description.
- Tamp live stakes over the slope face in a multi row or square pattern, alternating between live and dead stout stakes. Dead stout stakes shape makes them ideal to hold down mattress branches. Stakes shall be 2 to 4 feet apart.
- Lay branch material between the previously installed stakes. Place the cut ends of the branch material at the base of the slope under the live fascine, with the growing tips directed upslope. Branches lie smoothly against the bank. Tie or wire branches between stakes, as close to the slope face as possible using a criss-cross pattern.
- Carefully retamp each stake in a little further to ensure that branches are close to the surface.
- Cover and tamp in soil to provide branch materials contact with growth media.

MAINTENANCE REMOVAL GUIDANCE ➔

Brush mattresses are permanent installations. Assure survival of plantings by providing adequate watering, nutrients and aerobic soil conditions.

PRIMARY PURPOSE ➔

- To provide stability of streambanks.
- To support the establishment of permanent vegetative cover.
- To provide immediate flood protection.

SHALL NOT BE USED ➔

- On greater that 2H to 1V slopes.

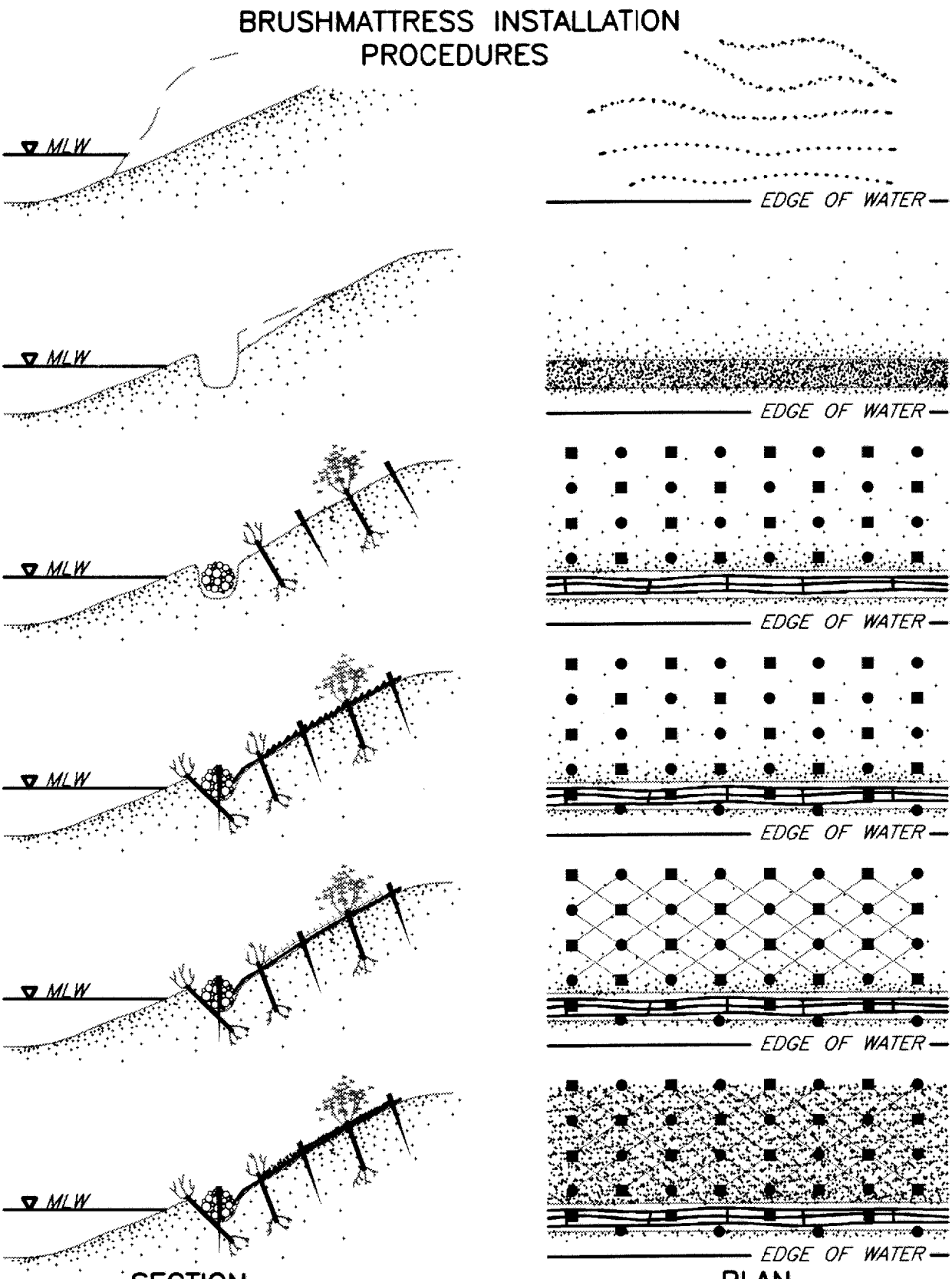
INSTALLATION TIPS ➔

- Store vegetation in water until bound and/or installed.
- Install during the dormant season of the vegetation used.
- Assure soil is adequately worked around all plant materials.
- Cover all live materials with soil so that branches are still visible. Do not bury completely.
- Do not drain water through brushmattress – gullies under the layer are likely to form.

NOTE: If brush mattress fails to grow, it is still acting as a mechanical barrier to rain splash and bank flows.

Signs of Failure

Symtoms	Cause	Solution
Mattress has dislodged or is gone.	Branches were not adequately tied down. Stakes are loose or missing.	Add replacement materials and retie with stronger material. Replace stakes and assure soil is tapped down around stakes. Verify stream flow problem has been corrected.
Cuttings are not growing.	Lack of contact with brush materials and soil. Materials are dead from lack of water, lack of nutrients or anaerobic soil conditions.	Re-bury adding water and nutrients if needed. Seed or add additional live materials to provide for vegetative growth.


BRUSHMATTRESS INSTALLATION
PROCEDURES
MLW
EDGE OF WATER
SECTION
DRAWING NOT TO SCALE
PLAN
Robbin B. Sotir & Associates, Inc.

Live Cribwall

DEFINITION ➔ A live cribwall is a rectangular framework of logs or timbers, rock and woody cuttings that protect eroding streambanks and provide overhead cover for fish. Design of these systems requires an in depth assessment and understanding of stream flows and stream behavior. Various types of installations are used (see design details).

PURPOSE ➔ To ensure bank stability and create an excellent natural habitat for a variety of fish, birds, and other animals.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Barren streambanks, especially where space is limited like on small narrow stream corridors.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Construct live cribwalls during low to normal flow conditions. Divert stream flows around the construction sites with berms or other barriers. Identify the mean low water level on the bank to be repaired.
- Prepare the bank. A crib wall extends as far back into the bank as necessary to assure structure stability. Excavate to an appropriate slope with a bank height of 4 feet or less. Excavate 2 to 3 feet below the streambed or channel bottom for live cribwall installation.
- Prepare plant materials. Strip base of logs or timbers to the bark-covered trunk, 4 to 6 inches in diameter, and cut to various lengths specific for the project. Logs must be long enough to provide adequate length to key (secure back) into the bank. Strip any branches that will interfere with keying the main trunk back into the crib wall. Live branches used to fill in with rock, soil and other materials, should be 1/2 to 2 inches in diameter and 4 to 6 feet long. Retain all side branches on log sections that protrude into streams to enhanced habitat and bank protection. Vegetation may protrude from other sections of the wall, if desired.
- Prepare rebar and cribwall fill. Rebar rods are used to secure crib sections to the banks and to secure logs to each other. Cut 3/4 inch rebar into 6 foot lengths for bank anchoring, and at least 10 inches or in lengths long enough to secure cross sections on the log wall. Fill material should drain well and provide enough nutrients and other soil factors to allow for plant growth. Explore reuse of excavated bank material. River rock or other gravels will be needed to stabilize the toe of the slope.
- Installation varies depending on the desired final slope of the wall (1H to 1V or 2H to 1V are the most common). The concept is to stack logs in a log cabin type cross hatch and backfill with rock, soil and live plant materials. Following the generalized installation procedures:
  - First install your anchor logs. These logs lie parallel to the stream flow. Anchor logs at the front and back of the wall sections. You may chose to not have a back anchor log to create an incline to your cribwall (see Detail Drawing 4.6 G). Anchor these logs with the 6 foot sections of rebar.
  - Then place the next layer of logs or timbers in the bottom of the excavation. Logs are long enough to key into the back of the bank. All logs are secured with rebar at each crossing point and back filled with 2 to 4 inches of compacted rock to help protect the bank slope. This process continues, backfilling with rock, until wall sections are above mean low water level.
    You may choose a 50 percent rock / 50 percent fill mix on the layer right at, or slightly above, water level to provide for plant establishment down to the waters edge.
  - Continue installation of logs in a crosshatch pattern, securing each level to the logs below with rebar. Backfill with prepared material for each layer above mean low water level. Add live material and brushy branches on the fill with the growing tips towards the stream. The final layer of logs, fill material and brush placement should reach the top of the original bank. Do
    not allow the main structure to protrude into the stream. The main wall lies flush with the existing streambank.
  - Protect the top layer of fill with erosion control blankets, grid systems or other reinforcements that allow for permanent plant establishment while protecting exposed soils.

PRIMARY PURPOSE ➔

- To provide and protect stability of streambanks.
- To support the establishment of permanent streambank cover.
- To provide overhead cover for fish.

SHALL NOT BE USED ➔

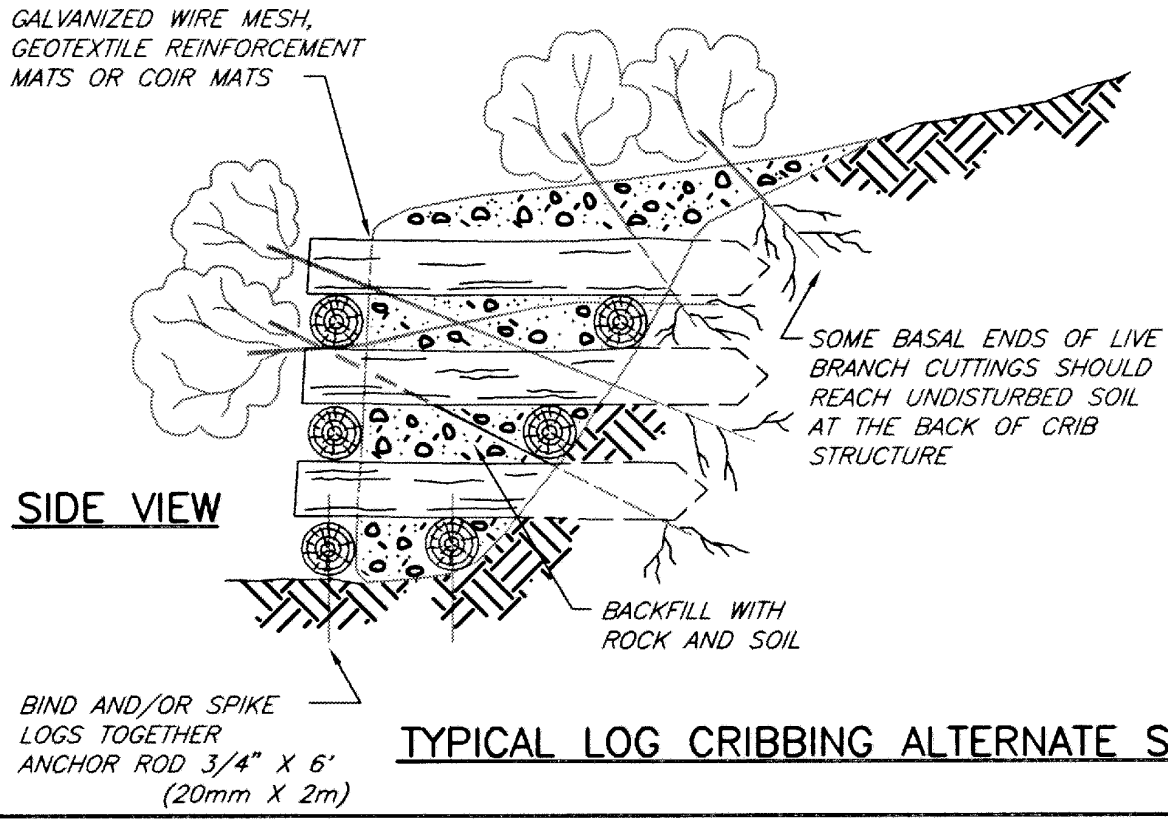
- On streambanks more than 4 feet high.

INSTALLATION TIPS ➔

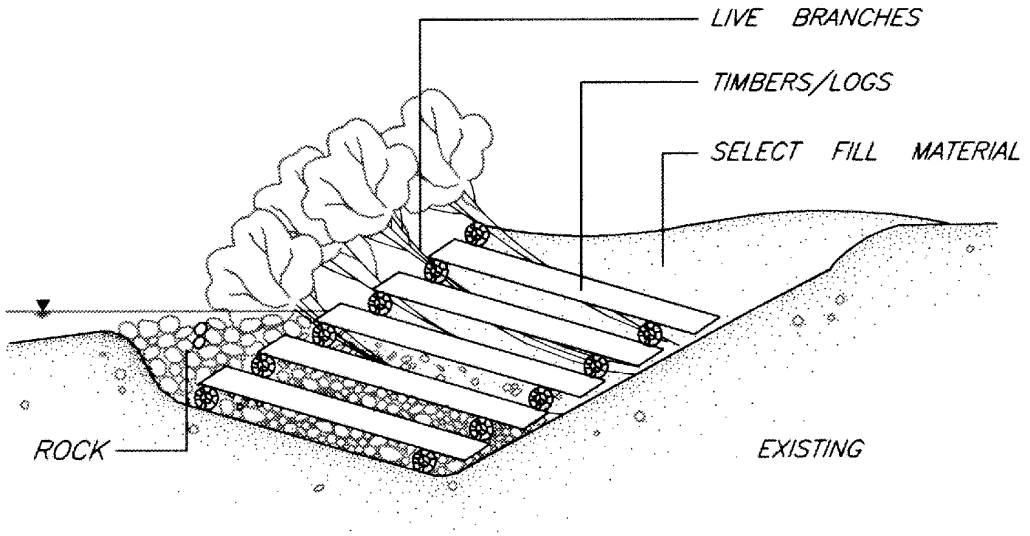
- Make sure there is a good foundation. Most live cribwalls fail due to insecure foundations. Assure anchor logs are well secured and that layered logs are well keyed back into the existing bank.
- To prevent scour on upstream and downstream ends – key the cribwall logs into the side banks as well as the rear banks.
- Assure live plant materials stay moist until installation.
- Determine whether temporary irrigation is necessary for plant establishment.
- Add live stakes on the top soil layer, which are long enough to reach bank and anchor into the original bank.

Signs of Failure

Symtoms	Cause	Solution
Cribwall has dislodged or is gone.	Cribwall was not appropriately anchored. Cribwall was not appropriately placed against flow.	Reexamine design and recheck stream flow assumptions. Replace missing cribwall sections, assuring they are adequately keyed back into the bank and anchored with rebar.
Cribwall backfill is eroding.	Flow has been directed into the cribwall.	Provide reinforcement (rock, blankets) for weak areas. Alter flow patterns away from wall.
Live planting are not growing.	Lack of contact with plants and soil. Soil is unable to support plant growth due to lack of water, lack of nutrients or anaerobic soils.	Re-bury plant ends adding water and nutrients if needed. Replace dead plants.



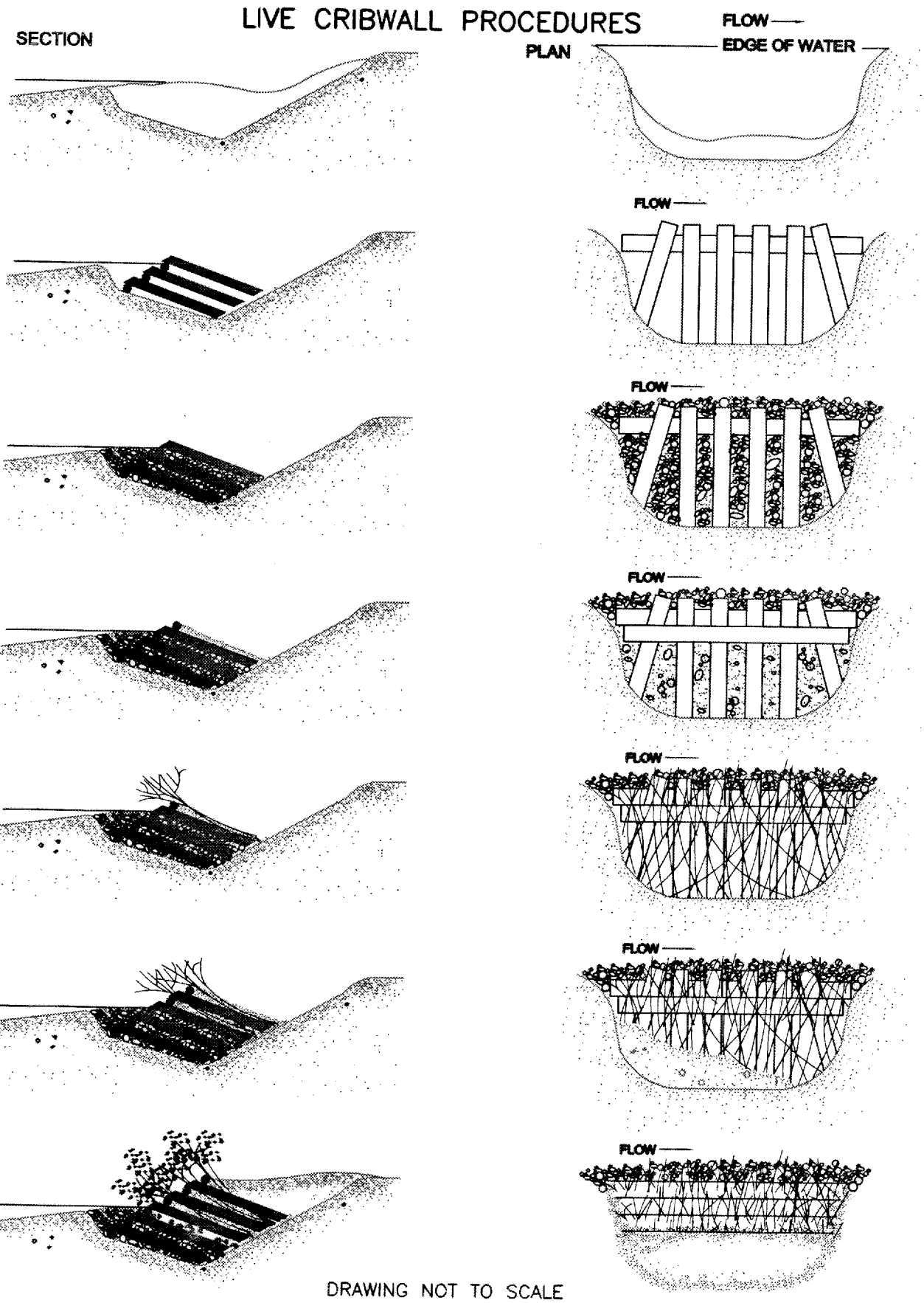
TYPICAL LOG CRIBBING ALTERNATE STYLE



50/50 SELECT FILL/ROCK MIX

LIVE CRIBWALL PREFERRED STYLE

DRAWING NOT TO SCALE


LIVE CRIBWALL PROCEDURES
SECTION
PLAN
FLOW
EDGE OF WATER
FLOW
FLOW
FLOW
FLOW
FLOW
FLOW
FLOW
DRAWING NOT TO SCALE

Instream BMPs are designed to provide sediment trapping for projects that must take place within the waterway. Projects that cross or otherwise work within the waterway should strive to limit the amount of work that occurs within the water flow line. Measures that can reduce the amount of instream work needed include: work from bank areas, stream diversion around work areas, or scheduling for seasons of no or limited flows.

Instream Sediment Trapping Devices

DEFINITION ➔ Instream sediment trapping devices include both floating materials (turbidity curtains) anchored to the watercourse bottom and instream sediment collection mats that run along the watercourse bottom (Sedimat™). These materials are specifically designed to limit sediment transport impacts within a body of water.

PURPOSE ➔ To provide sedimentation protection for in-stream, bank or upslope ground disturbance or from dredging or filling within a waterway.

CONDITIONS WHERE PRACTICE APPLIES ➔ Within a flowing watercourse, lake or other area of water impoundment or flow that has aquatic resources needing protection.

4-7

NOTE: Various state (DSL, DEQ) or Federal Permits (ACOE) may be needed for these installations.

CONDITIONS WHERE PRACTICE DOES NOT APPLY ➔ Turbidity curtains shall not be installed across streams unless specifically engineered to stop sand bar creation.

DESIGN CRITERIA/SPECIFICATIONS ➔

These BMPs are designed and selected for specific flow conditions. For sites with flow velocities or currents greater than 5 feet per second, a qualified engineer and product manufacturer must approve of the use.

- Turbidity curtains shall be installed parallel to flow of the watercourse allowing for 10 to 20 percent variance in the straight-line measurements. Allow for at least 50 feet between joints in the curtain and no more than 100 feet between anchor or stake locations.
- Instream sediment mats can be aligned either direction along the watercourse bottom, as long as upstream mat overlaps the downstream mat (like a drainage ditch erosion control blanket installation). Assure the upstream edge is firmly trenched in to prevent flows from going under the mat. Mats should cross the entire stream and be staked or use stones to keep the mat in place. Follow the manufacturer's specifications for length of mat needed for your site's flow rate.
- Turbidity curtains shall extend the entire depth of the watercourse. In significant wind, wave or tidal action areas a 10 to 12 foot depth is the most practical due to fabric and mooring anchor strain from the heavy water and sediment loads.
- Soils shall be allowed to settle for a minimum of 6 to 12 hours prior to BMP removal or cleaning. All cleaning operations shall also use good sediment control practices. Consider sizing materials adequately to allowing for maintenance only prior to removal, and not throughout project.
- For tidal situations or in areas heavily impacts by wind generated wave action; turbidity curtains must have slack to follow the rise and fall of the water level without submerging. Curtains shall also maintain adequate flow through, usually by using heavier woven fabric for the bottom sections of the curtain.

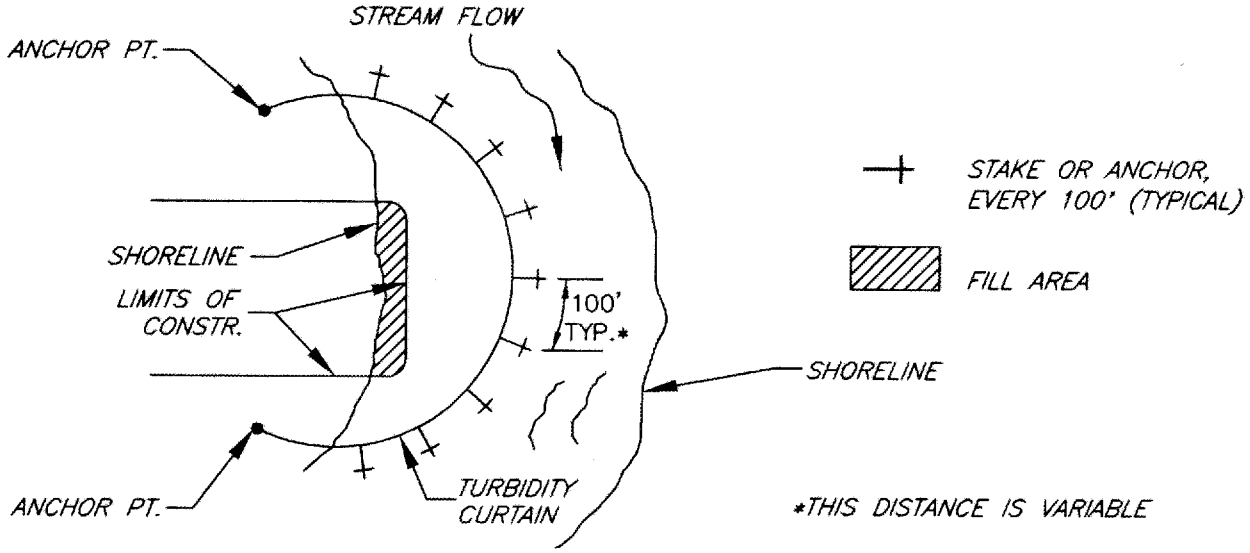
- Materials shall be of strong, heavy weight materials that have UV inhibitors. The tensile strength shall be sufficient to withstand predicted flows. All material seams and line attachments shall be sewn or vulcanized welded into place. Materials shall be of bright colors, when applicable, to attract attention of boaters or swimmers using areas near the work site. Flotation devices for turbidity curtains shall be flexible, buoyant units contained in an individual flotation sleeve or collar attached to the curtain.
- Turbidity curtains shall be anchored by vinyl-sheathed steel cable at the top with a breaking strength as per engineer specifications or 10,000 pounds. At the bottom a load line with chain incorporated into the bottom hem of the curtain shall be used for ballast to hold the curtain vertical.
- Shoreline turbidity curtain anchors and instream sediment mat anchors shall be 2x4-foot wood or 1.33 pounds/lineal foot metal stakes. Bottom anchors for turbidity curtains shall hold the curtain in position and may be any of the following anchor types: plow, fluke, mushroom; or a grappling hook. All instream anchors shall have a floating anchor buoy or other identifying mark.
- Best installation is achieved by setting the upstream anchor points first, then unfurling the fabric letting the flow carry the fabric downstream or to vertical position for turbidity curtains.

MAINTENANCE REMOVAL GUIDANCE ➔

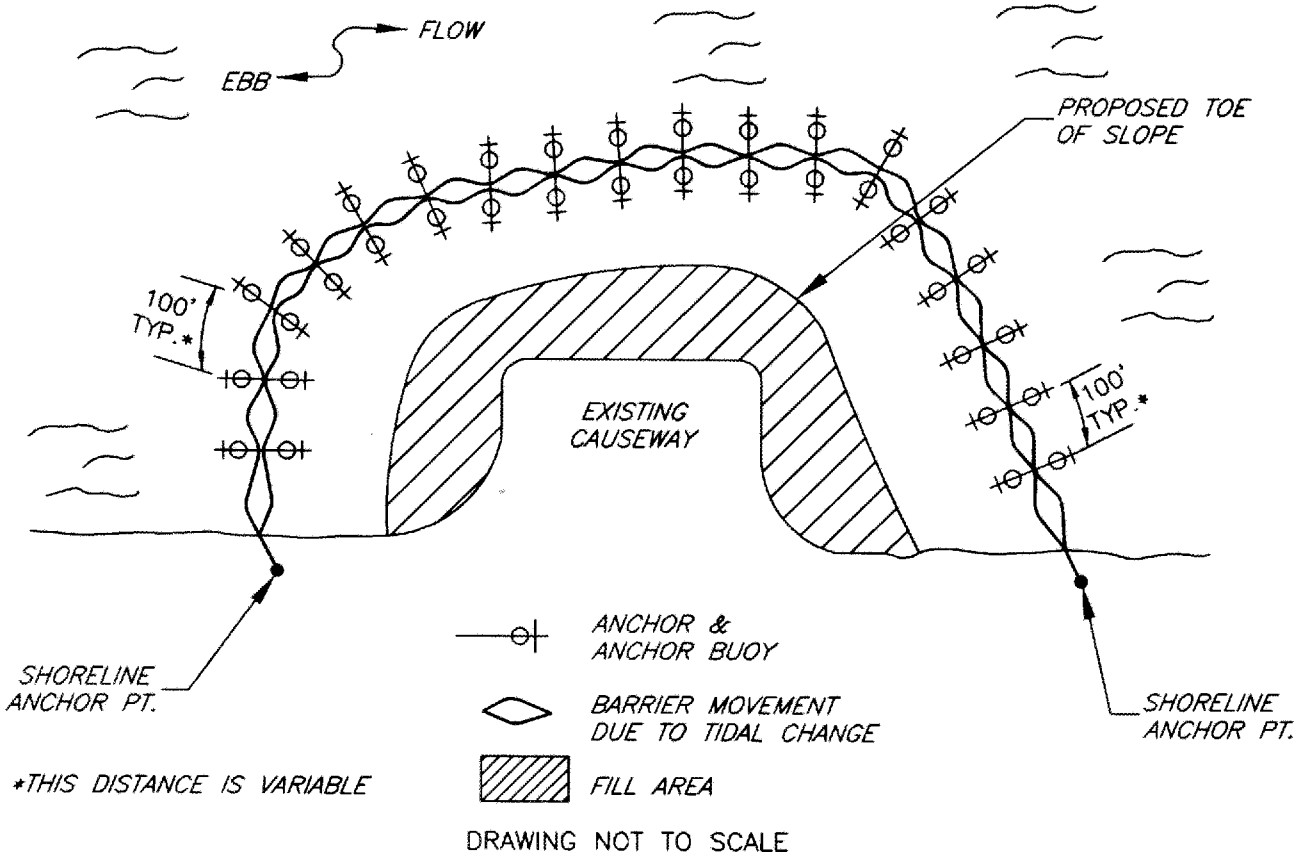
- Follow manufacturer instructions for fabric and material repair.
- All materials shall be removed at low flows and in such a fashion as to scoop and trapped sediments within the fabric. The removal area should be clear of any obstructions that could tear the fabric. For mats , consider rolling up from the downstream end to trap silts in the mat roll. For curtains, consider pulling the bottom line and top lines in together like a parachute to pull soils ashore.
- Spoils should be reused and controlled for erosion on a nearby bank or upland area needing stabilization.

TURBIDITY CURTAIN

TYPICAL LAYOUTS:
STREAMS, PONDS & LAKES (PROTECTED & NON-TIDAL)



TIDAL WATERS AND/OR HEAVY WIND & WAVE ACTION



DRAWING NOT TO SCALE

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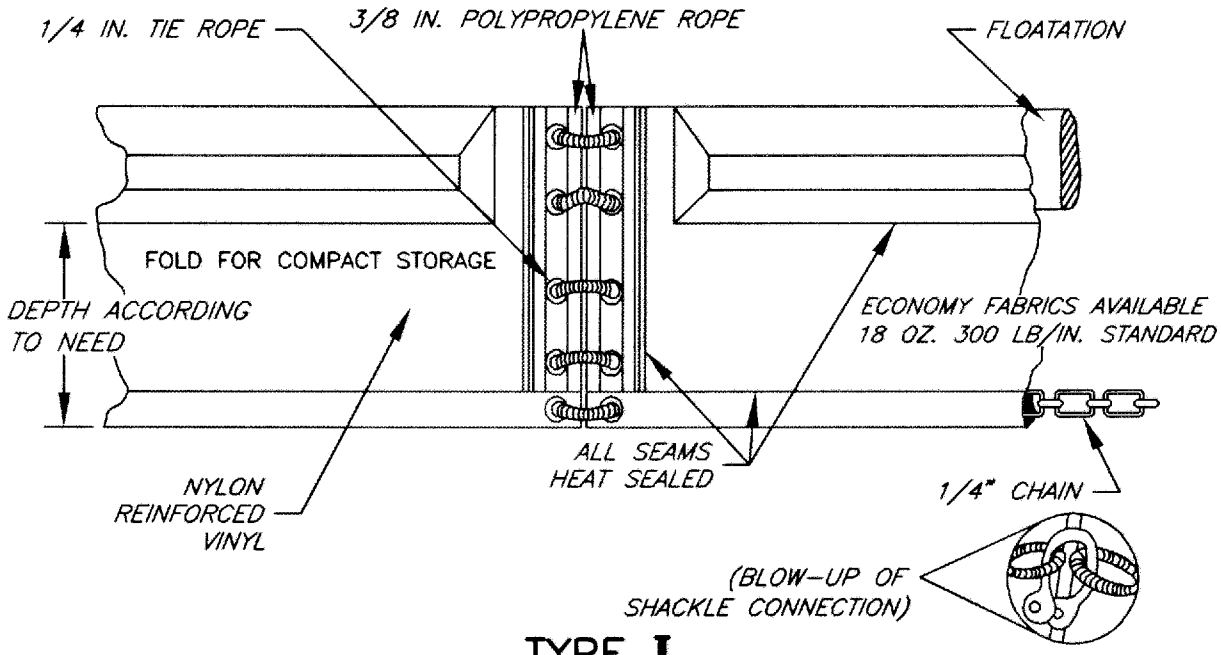
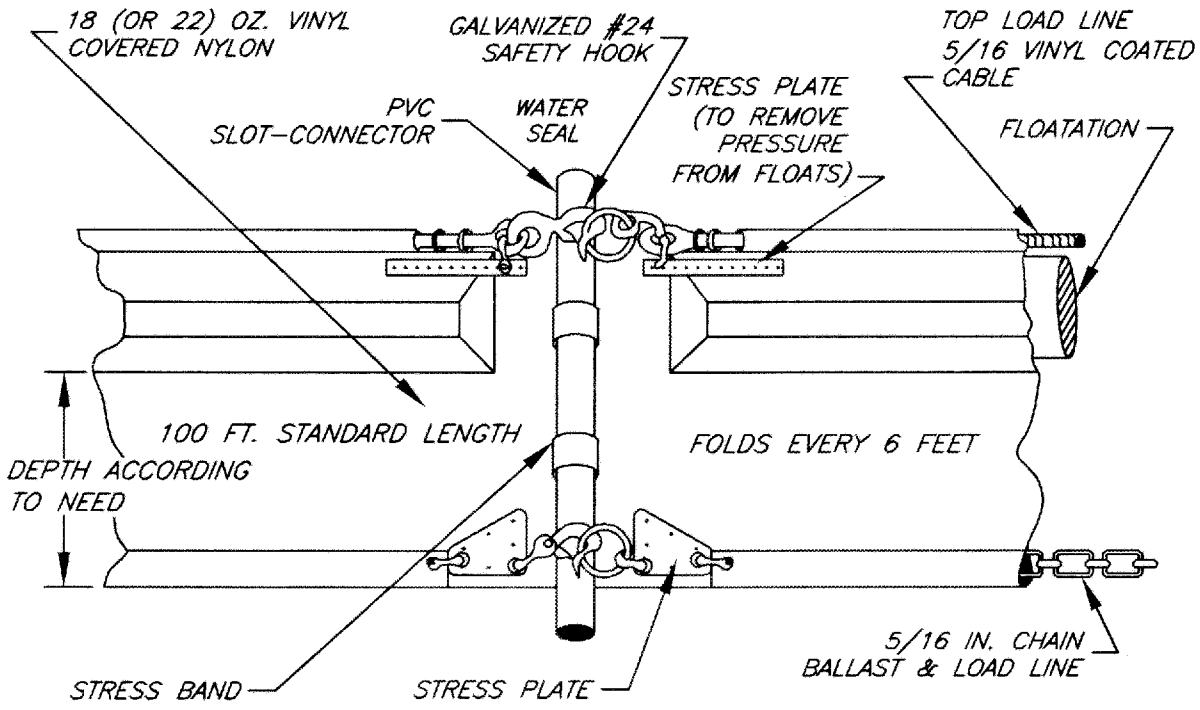
TURBIDITY CURTAIN



TYPE I

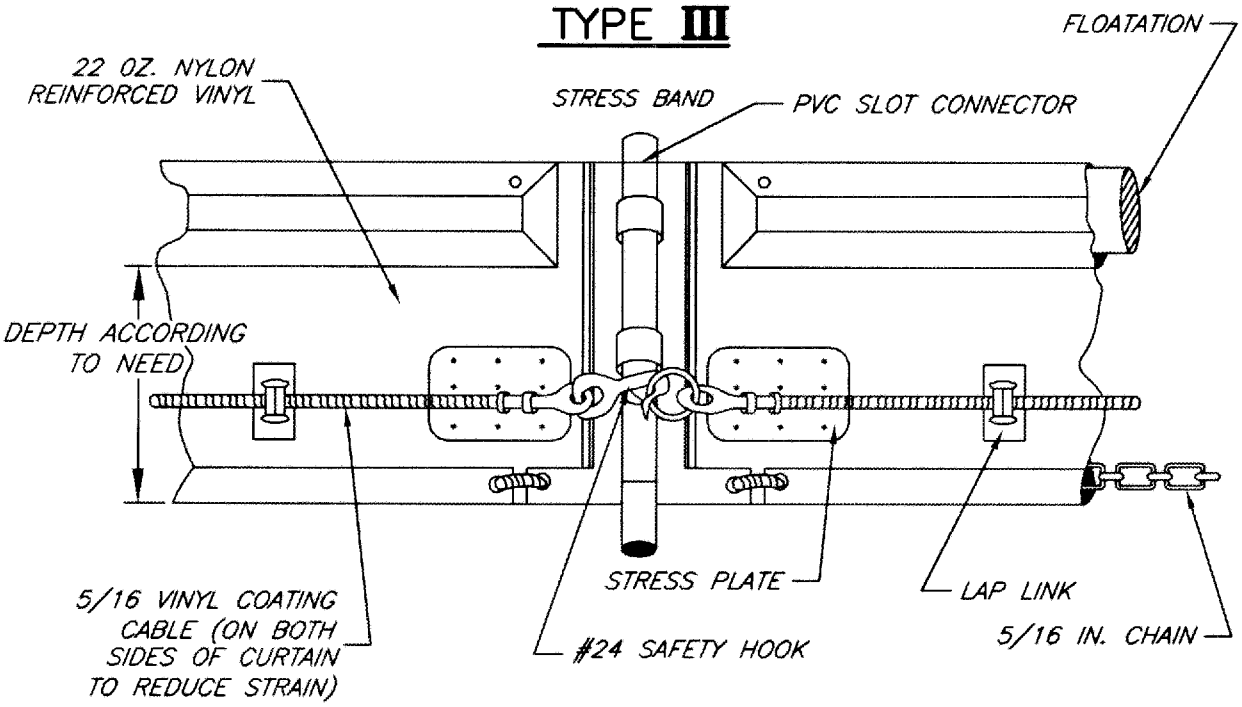


TYPE II

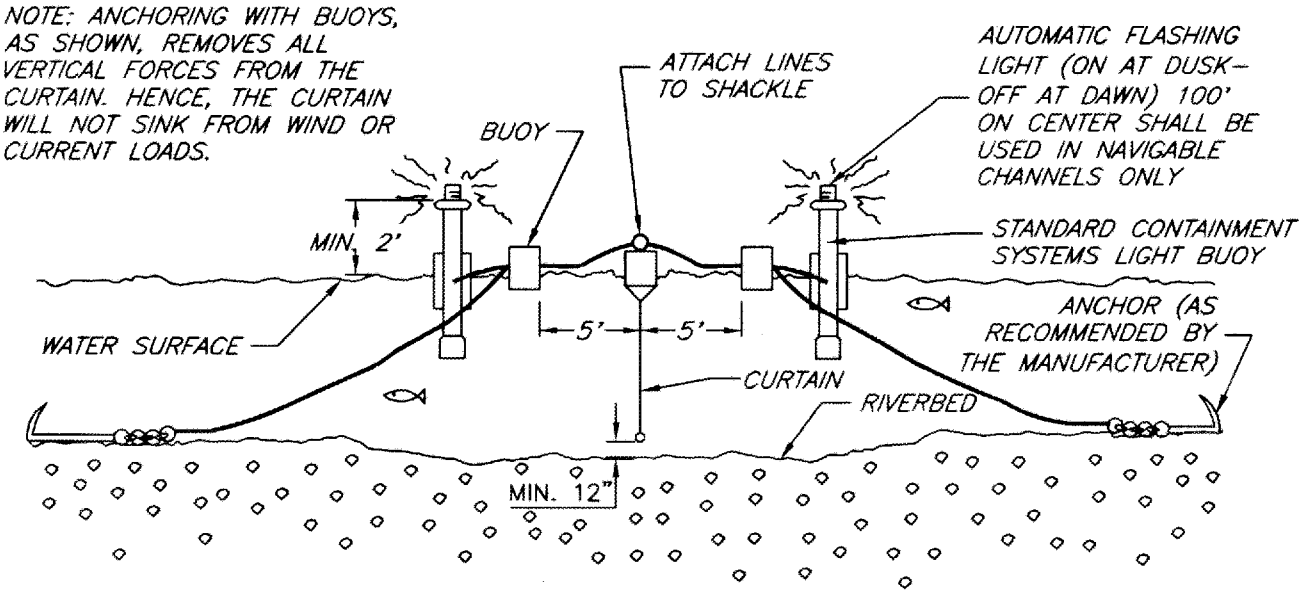
DRAWING NOT TO SCALE

TURBIDITY CURTAIN

TYPE III



ORIENTATION WHEN INSTALLED (TIDAL SITUATION –TYPE III)



DRAWING NOT TO SCALE

5 DEVELOPMENT ACTIVITY CONTROLS

CONSTRUCTION POLLUTANTS

Many development activities can generate other pollutants beyond sediment. The BMPs described in this chapter are designed to give guidance to the contractor in control of liquid and solid waste materials during development. Most of the following BMPs have a strong planning component and need to be considered during site lay out. Again the contractor is encouraged to practice prevention BMPs rather than control BMPs.

Although sediment is the most prominent pollutant that is generated at a development site, there are a number of other wastes, by-products and construction site materials that can be harmful to worker health, streets and stormwater conveyance systems, and to streams or other waterways. The following table describes some of the most common site pollutants generated by development activity and some of the impacts of those pollutants. It also gives general guidance of what to do with the materials.

In general good housekeeping practices are the main controls used for development related activities. Work rules and practices are created to reinforce pollution prevention and discharge control to all workers at job site. Worker education and training are essential.

COMMON CONSTRUCTION SITE POLLUTANTS

Activity	Waste	Impacts	Guidance **
Demolition Waste	Asbestos	Human Hazard.	Get a DEQ permit prior to removal. Assure that waste is disposed of at a landfill approved to take asbestos.
	Solid Waste	Poor Aesthetics. Dust. Tripping hazard. Inlet blockage. Reduces instream oxygen. Impairs fish movement and feeding.	Solid waste can degrade your site in the eyes of neighbors and potential buyers. Control wastes in a designated area or facility, and recycle as much as possible to lower landfill fees.
Equipment Fueling	Antifreeze	Reduces instream oxygen. Impairs groundwater resources. Toxic to pets and children.	Recycle, if possible. If not, contact local sewerage agency for discharge limitations and approvals. **DO NOT** pour into stormdrains or on ground.
	Gasoline Hydraulic Fluid Oils (gear, lubricating or engine) Brake Fluid	Flammability hazard for site and sewer workers. Can instantly kill fish, impair feeding or smother gravels. Reduces instream oxygen.	Minimize amount of fuels and oils needed onsite. Consider doing fueling and maintenance of vehicles back at yard or at other offsite controlled location. Store fuels or oils in designated and marked areas. Provide berms or protection from construction traffic. Provide adequate spill control structures and training.
Equipment Maintenance	Used Oil	May be a hazardous waste. (same as above)	Recycle or reuse if possible. If not, do a hazardous waste determination to determine appropriate level of disposal.
Concrete Work	Concrete Waste	Flammability hazard for site and sewer workers. Reduces instream oxygen.	Control wastes onsite in defined area. Dispose of wastes as per manufacturer. **DO NOT** allow wastes or curing materials to enter storm drain.
	Sealants	May be a hazardous waste. (same as above)	Don't buy or mix more than needed. Paint excess out on scraps, let dry and dispose of in dumpster. Any leftover materials should be disposed of at approved facility.
Framing Roofing	Wood Preservatives	Flammability or toxic hazard for site and sewer workers. Can directly kill fish. Reduces instream oxygen.	Consider use innovative products for areas exposed to the elements. Buy materials with preservatives already applied at the factory. Don't buy or mix more than needed. Any leftover materials should be disposed of at approved facility.
	Resins	Flammability or toxic hazard for site and sewer workers. Reduces instream oxygen.	Don't buy or mix more than needed. Completely dry out all containers and dispose of in dumpster. Any left over liquid must be disposed of at approved facility.
	Solid Waste	See above.	See above. Consider vacuuming or lining gutters to collect shingle debris. **DO NOT** rinse shingle debris down downspouts.

COMMON CONSTRUCTION SITE POLLUTANTS (continued)

Activity	Waste	Impacts	Guidance **
Plumbing HVAC	Solid Waste	Metal debris can leach long term harmful chemicals to streams.	See above.
	Solvents / Degreasers	Flammability hazard for site and sewer workers. Reduces instream oxygen. Impairs groundwater resources.	Reuse and recycle when at all possible. Contain materials on impervious surfaces. **DO NOT** rinse materials to storm drains or onto the ground. Dispose of materials through licensed waste management firm.
Painting	Paint Thinner	Same as Solvents.	Same as Solvents. Let thinners settle and strain out materials to allow for reuse. Dispose of material only after it is too contaminated to strain anymore.
	Paints	Flammability or toxic hazard for site and sewer workers. Reduces instream oxygen.	Reuse and recycle when at all possible. Latex - Paint excess out on scraps, let dry and dispose of in dumpster. Check with fire marshal for oil based disposal. Any leftover materials should be disposed of at approved facility.
Landscaping	Fertilizer	Increases algae growth Reduces instream oxygen. Affects pH balance.	Design sites with native and other plants that need little or no additional soil amendments. Use composts or organic fertilizers instead of nitrogen and phosphorus based fertilizers when at all possible. Control fertilizer piles, providing protection from rain and runoff if needed. Till all fertilizers well into the topsoil layer.
	Pesticides / Herbicides	May create health hazard for site and sewer workers. Can kill fish on contact or mutate over longer periods of time. Can impair groundwater resources.	Design sites with native and other plants that need little or no horticultural chemical care. Use biological and structural controls before resulting to chemical controls. If chemical control is needed, consider using organic compounds. Don't mix more than is needed for the site. Time application to specifically address pest or condition. Watch overspray, especially over water.

** For adequate disposal refer to Metro's guide for construction waste or call the Resource Information Center at 234-4000 for more information.

Hazardous and Special Wastes

As noted in the table above, some construction pollutants may require additional activities to comply with hazardous waste and materials handling and disposal laws. All contractors are encouraged to call the local DEQ hazardous materials program for more information (1-800-452-4011).

In general the following materials may require additional controls and or consideration during use and disposal:

Oil / Water Based Paints

Form Oil and Used Oils

Sealers

Degreasers

Petroleum Products

Vehicle Batteries

Pesticides and Herbicides

Fluorescent & High Density Lamps

PCBs (Polychlorinated Biphenyls – found in old electrical equipment)

Asbestos (in insulation, tiles, joint cements and caulks, stucco, and a variety of materials)

Lead (in paints, roofs, tank linings, plumbing soft solder)

If you have any of these materials onsite, call DEQ for information about the regulations that pertain to you.

Development Activity Controls are designed to prevent or reduce the discarge of pollutants to stormwater from the process of development or ground disturbance by using soil erosion controls, enclosing or covering material storage areas, using good housekeeping practices, using safer alternative products, and training employees. These BMPs should be used for all repair, renovation, and remodeling of existing structures, or where hazardous materials are to be used on the worksite. These BMPs strive to control raw materials, by-products, finished products, containers, and material storage areas exposed to wind, rain, or runoff that can contribute to water pollution. All sites should assure that workers know the rules and practices of the worksite and that there is a strong effort to enforce them.

Dewatering

PURPOSE ➔ To asses and appropriately dispose of rising groundwater or rainwater from excavations and other collection areas.

CONDITIONS WHERE PRACTICE APPLIES ➔

Public or Private properties with:

- Foundation work excavations
- Utilities and infrastructure installation and repair projects, including installation, repair and maintenance of:
  - Electrical conduits
  - Vaults / tanks
  - Sewer and storm drain systems
  - Phone and cable lines
  - Gas or other fuel lines.
- Other excavations or graded areas requiring dewatering.

DESIGN CRITERIA/SPECIFICATIONS ➔

Depending on season, flow rate, volume or residual contamination, discharge will be allowed to:

- The ground in a manner that ensures no runoff leaving the site. This may require a permit or other authorization from the local and/or State drainage authority.
- The storm drain system. All discharges shall meet the TSS and/or turbidity levels required by the local sewerage agency. A permit or letter of authorization with discharge restrictions may be required.
- The sanitary sewer. A permit or letter of authorization with discharge restrictions may be required.

In extremely rare instances, you may be required to haul pumped groundwater or impounded stormwater off-site for treatment and disposal at an appropriate waste treatment facility.

- **Site Assessment.** The site shall be assessed for the issues listed below to assist the local sewerage and/or drainage authority in determining which discharge option to approve.
  - Water clarity. If the water is cloudy or turbid, there are dissolved and/or settable solids in the water that must be filtered or settled out prior to discharge. See treatment options outlined below.
  - Determine if contaminants are present in impounded waters. Check for odors, discolora-

tion, or an oily sheen. Review Phase I environmental assessment to determine if contamination is likely. Check any soils and/or groundwater testing results
- Contamination may be or is present. A certified laboratory must test proposed discharge waters with results submitted to the local sewerage and/or drainage authority. Sampling and testing requirements will be determined on a case-by-case basis depending on site history or suspected pollutants. Contact the local sewerage and/or drainage authority before testing to get assistance in identifying the required parameters of concern and any specific sampling requirements. After review, the local sewerage and/or drainage authority will specify if any pretreatment is required prior to discharge.

- Sediments shall be settled prior to discharge. All settling systems shall be engineered and adequately sized for site conditions. In general settling and filtering options include:
  - Containment in a pond structure for at minimum of 4 hours or until water is clear. Place pump in a gravel bed at bottom of pond,
  - Pumping to a Baker tank or other settling tank with sampling ports,
  - Filtering through a sieve or other filter media (swimming pool filter). Simple onsite filter systems can be constructed including: wrapping the ends of the suction and discharge pipes with filter fabric; discharging through a series of drums filled with successively finer gravel and sand; and other filtering techniques like those described in the inlet protection section.
  - Manufactured bags, polymers, or other systems. These systems do not always work on fine clay soils, and will only be allowed for use where approved.
- Filtered material shall be either dried and reused onsite in a mixture with other site soils or shall be appropriately disposed of based on nature and levels of any contaminants present.

MAINTENANCE REMOVAL GUIDANCE ➔

- Remember to check filtering devices frequently to make sure they are unclogged and operating correctly. You may need to make adjustments depending on the amount of sediment in the water you're pumping.
- Systems shall be filled in or otherwise removed when permanent dewatering controls are in place and connected to an approved treatment and receiving system.

Spill Prevention and Control

5-2

PURPOSE ➔ To prevent or minimize accidental discharges or longer-term leakage of pollutants to stormwater systems and/or the ground.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Any area where vehicle and equipment maintenance, fueling or washing operation occurs.
- Any area where storage of more than 20 gallons of liquid materials or 30 pounds of materials and/or wastes occur.

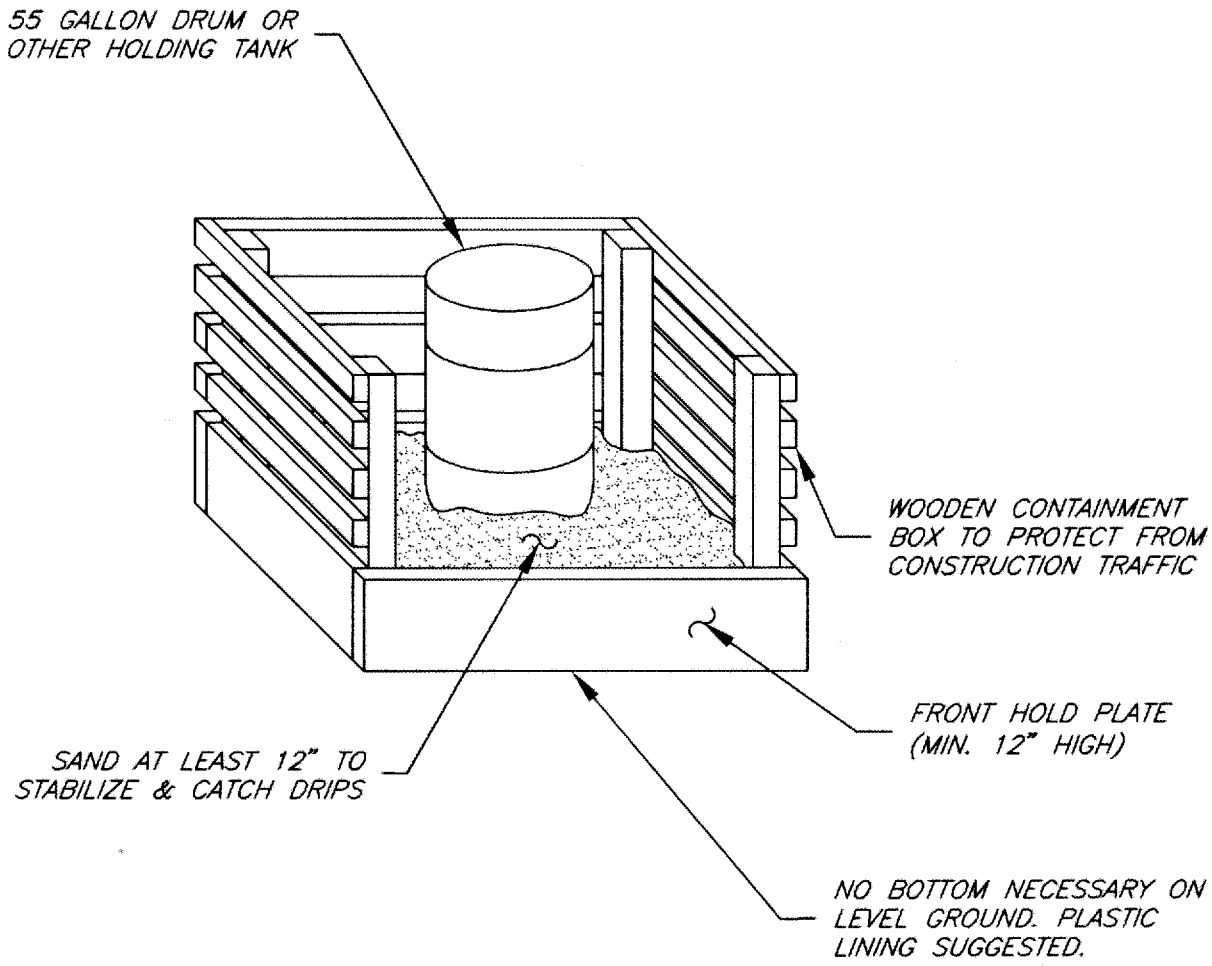
DESIGN CRITERIA/SPECIFICATIONS ➔

Use the following BMPs to control leaks and spills onsite:

- Prepare a Spill Response Plan for the site. Post spill hotline notification numbers, have spill kits on hand, and train employees what to do in the event of a spill. Provide specific clean up instructions for the material present or likely to be present on the site. Assign a worker to be responsible for overall site response and cleanup.
- Specify designated areas for liquid storage areas and all vehicle and equipment maintenance, fueling and washing operations. Sites shall be well marked and located away from drainage courses and systems. In no case shall any liquid storage drum, tank or other vessel (including porta potties) be stored over storm drains.
- Provide secondary containment for all vehicle and equipment fueling, maintenance, operation and liquid storage areas. Containment can include any or all of the following:
  - covers or canopies,
  - reverse grading,
  - area berms to contain flows,
  - drain pans or drop cloths, to catch spills or leaks when removing or changing fluids,
  - holding tanks or structures,
  - sand stabilization and containment piles (see drawing)
- Size secondary holding or containment tanks and structures to hold **10 percent** of total storage volume **of all containers** present in the work area or **110 percent** of the volume **of the largest container** in the area.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave full drip pans or other open containers lying around.
- Provide adequate traffic protection for all designated containment areas. Protection can include berms, flags, pinions, fencing or jersey barriers.
- Use adsorbent materials (pads, kitty litter, etc.) on small spills rather than hosing down or burying spilled materials. Assure adsorbent materials are collected and disposed of promptly. Verify the appropriate recycling or disposal location for the adsorbent material.
- Assure that all vehicle or equipment parts (oil filters, batteries, etc) are appropriately drained, stored and/or disposed of and not left onsite to seep materials to the ground or into stormdrains.

MAINTENANCE REMOVAL GUIDANCE ➔

- Periodic inspection and maintenance of storage areas shall be indicated as part of the ESPCP and recorded as part of the inspection report.



SPILL CONTROL STRUCTURE

DRAWING NOT TO SCALE

Solid Waste Management

5-2

PURPOSE ➔ Providing designated waste collection areas and containers to prevent or reduce the discharge of wind blown and floatable pollutants from construction or landscaping activities.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Construction sites, both large and small – commercial, residential, utilities and public improvements.
- Specific worksite areas with hazardous or recyclable waste streams.
- Demolition projects.
- Landscaping projects.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Evaluate waste likely to be generated at the site. Determine which wastes will warrant tighter controls due to hazardous nature or which wastes are reusable or recyclable.
- Consider buying some materials in bulk or alternative, reusable containers to cut down on packaging wastes.
- Select designated waste collection areas on-site. Collection areas may be specific to each piece of the operation – i.e. a metal recycling area to contain HVAC, plumbing or framing metal wastes. Be careful siting waste areas in the street or adjacent to other properties. There may be street permit or building code issues with your placement. Consider locating these receptacles adjacent to or within the site gravel entry access to allow for storage on a compacted base and easy removal of wastes.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it's windy. Make sure that dumpsters are only used for wastes approved for disposal in construction or municipal landfills. All hazardous or special wastes shall be segregated from standard trash and construction debris.

SPECIFIC SITES SOLID WASTE COLLECTION AND CONTAINMENT RECOMMENDATIONS ➔

- When working on roofs, line the gutter with fabric, plastic or other materials to collect wastes, or sweep or wash the gutter and trap the particles at the outlet of the downspout. A sock or geofabric placed over the outlet may effectively trap roofing wastes.
- Recycle used asphalt or concrete. Consider onsite grinding and reuse for subbase as approved by the local jurisdiction.

MAINTENANCE REMOVAL GUIDANCE ➔

- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier, or processed into wood chips, then used as mulch on graded areas.
- Collect site trash daily, especially during rainy and windy conditions. Remember to also check erosion and sediment control devices since then tend to collect floatables and litter. Remove this solid waste promptly. Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.

Vehicle and Equipment Fueling

PURPOSE ➔ To establish designated areas and preventative BMPs that prevent fuel spills and leaks, and reduce their impacts to stormwater and the ground.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Development sites with fueling operations

DESIGN CRITERIA/SPECIFICATIONS ➔

NOTE: It is assumed that all off-site fueling locations generally follow this guidance, but are regulated by other City and State codes and policies.

- Use off-site fueling stations as much as possible. These businesses are usually better-designed and equipped to handle fueling operations and spills properly.
- If fueling must occur on-site, follow all the spill prevention procedures outlined earlier in this manual. Cover, reverse grade and provide secondary containment when ever possible.
- Locate fueling facilities on impervious areas when at all possible. If paving or concrete pads are unavailable, locate areas on highly compacted soils and/or gravels.
- Avoid mobile fueling of mobile construction equipment around the site when possible; rather, transport the equipment to designated fueling areas.
- Discourage "topping-off" of fuel and other fluid tanks.
- Install vapor recovery nozzles to limit worker exposure to vapors, protect air quality and help control drips.
- Assure that dispensing mechanisms are either small enough to adequately fill the receiving device or have appropriate shut of valves or other controls. Provide appropriate signage as necessary.
- Train staff in proper use, clean up and spill response procedures.

MAINTENANCE REMOVAL GUIDANCE ➔

- Maintain dispensing devices as per manufacturer's instructions. Inspect often and log when devices have been cleaned or otherwise serviced.
- Use dry methods to clean fueling area. If using water to clean, install a temporary plug or containment device in the downstream drain. Pump out accumulated waters, treat and dispose of properly.

Vehicle and Equipment Maintenance

5-2

PURPOSE ➔ To provide off-site facilities and designated on-site areas that help prevent or reduce the discharge of pollutant to storm water from vehicle and equipment maintenance.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Development sites with vehicle maintenance activities.

DESIGN CRITERIA/SPECIFICATIONS ➔

NOTE: It is assumed that all off-site vehicle and equipment repair locations generally follow this guidance, but are regulated by other City and State codes and policies.

- Use off-site repair/maintenance shops as much as possible. These businesses are better designed and equipped to handle repair materials and wastes properly.
- If vehicle repair and maintenance must occur on-site, follow all the spill prevention procedures outlined earlier in this manual. Cover, reverse grade and provide secondary containment when ever possible.
- Clean vehicles and equipment often. Do not allow excessive build-up of oil and grease that may require harsher chemical or other cleaning processes to remove buildup.
- Check all incoming vehicles and equipment for leaking oil and fluids or worn hoses and other parts.
- Store any vehicles awaiting repair or maintenance in designated, preferably paved, areas. If storing for over a month, drain all fluids from the vehicle or equipment and store or dispose of liquids appropriately.
- Conduct all washing operations in designated, and preferably, paved areas. Power washing of parts, vehicles or equipment will likely require pretreatment for oils, grease, detergents and temperature prior to discharge. Discharge will likely be to the sanitary sewer or a dead end sump. Contact the local sewerage agency for more information and for discharge approvals.
- Segregate, reuse or recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmission fluids. Use an approved recycling or disposal company for all vehicle and equipment wastes that could potentially be considered hazardous.

MAINTENANCE REMOVAL GUIDANCE ➔

- Use dry methods to clean equipment repair/maintenance area. If using water to clean, install a temporary plug or containment device in the downstream drain. Pump out accumulated waters, treat and dispose of properly.

Concrete Waste Management

PURPOSE ➔ To prevent or minimize the discharge of pollutants to storm water from concrete waste.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Concrete pours, such as foundation, footing or pile sites.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Designate materials storage and mixing areas. Store dry and wet materials under cover, away from drainage systems.
- Perform washout of concrete trucks off site or in designated areas only. Do not wash out concrete trucks into storm drains, open ditches, streets, or streams. Do not allow excess concrete to be dumped on-site, except in designated areas.
- Locate designated washout areas as far from storm drains, open ditches, or water bodies as possible (over 50 feet away preferred on larger sites). Line entry/exit areas with gravel to catch washout residues leaking from trucks.
- Contain washout runoff in a temporary dead end sump, pit or level bermed area large enough to hold liquid and solid wastes. NEVER washout concrete trucks into a stormdrain, ditch or waterway. Facilities should be designed specifically for the maintenance equipment used, for easy access, and to avoid creation of a confined space. Designers are encouraged to create small areas with frequent maintenance rather than larger containment structures. Sumps and pits shall be designed by the site engineer, and in general should have less than 4 foot surface opening, protected by cover or fencing. Containment berms should be at least 2 feet tall, with sloping sides.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating erosion by draining the water to the side into a bermed or level area or into a sediment control structure. Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- Train all applicable employees in proper procedures for washout area use and maintenance.
- An alternative to establishing designated areas, is to use plastic lined drop boxes to hold and dispose of wastes. Assure boxes are leak proof and clean up any over splash immediately.

MAINTENANCE REMOVAL GUIDANCE➔

- Clean out designated washout facilities and areas often. Concrete can set, be broken up, and then disposed of properly.
- Refurbish facilities as needed.

Structure Preparation and Painting

5-2

PURPOSE ➔ To prevent or reduce the discharge of pollutants to storm water from structure preparation and painting activities.

CONDITIONS WHERE PRACTICE APPLIES ➔

- Building washing and preparation operations
- Any painting operation.

DESIGN CRITERIA/SPECIFICATIONS ➔

- Store paints, preparation and cleaning materials and equipment in designated areas. Storage areas shall be protected to ensure that sediments, leakage, or wastes are prevented from being tracked off-site. Include storage for soiled rags, rollers, and other application and clean up materials. Protect materials from rainfall and wind by storing material indoors. When unable to do so, then material should be covered with a roof, or suitable temporary plastic or similar material. Portable sheds can provide good materials control, and a lockable structure can also provide good security. Keep outdoor storage containers in good condition
- Liquids shall be kept in designated areas, or on paved surfaces, with secondary containment measures. Storage of flammable materials shall be in accordance with Fire Department requirements and regulations.
- Materials that require mixing, like paint, shall be performed indoors, prior to arriving at a job site, or in a protected designated area. This limits exposure of the material to the elements of wind and water.
- Recycle or reuse excess materials whenever possible. Dispose of other waste materials in accordance with regulations that govern the materials. Latex paint may be dried and disposed of in the regular trash.
- Collect solid (paint chips) and liquid wastes from power washing or other structure preparation activities. Collect materials on tarps, canvasses or other materials. Route large quantities of liquid wastes into a collection area where solids can settle out, liquids decanted and solids removed and adequately disposed.
- Avoid or limit activities on rainy or windy days to avoid rinse off and airborne drift, especially when using hazardous materials. When possible or necessary, enclose or cover prep or painting operations. Using temporary scaffolding to hang drop cloths or draperies to help enclose work area.
- Using application equipment and methods that minimize overspray.

MAINTENANCE REMOVAL GUIDANCE➔

- Clean up of equipment shall be performed in an approved location, or into an approved sanitary sewer connection. Washout, or waste residue, shall be prohibited from entering the stormwater system. Washout paint supplies and spray gun cleanout onto a collection cloth, into a collection bucket, or into an approved sanitary connection.
- Work rags, coveralls, tarps, or similar type of equipment shall be stored properly, and disposed of properly. They should not be left out exposed to elements after a work shift. Materials should not be discarded or left at the work site.
- Inspect and maintain application equipment often. Periodic inspection and maintenance of storage areas shall be indicated as part of the ESPCP and recorded as part of the inspection report. Check storage areas periodically for leaks and spills, fixing any leaks when they occur. Appropriate authorities shall be informed of any incidents and cleanups.

APPENDIX

REFERENCES

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Kral, George, City of Portland Environmental Services Revegetation Program, Portland, OR, personal communication.

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Oregon Department of Transportation, State Highway Division. "Hydraulics Manual".

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U.S. Department of Agriculture, Forest Service Southern Region, 1992, "Stream Habitat Improvement Handbook".

U.S. Department of Agriculture, Science & Education Administration. December 1978. Predicting Rainfall Erosion Losses, A Guide to Conservation Planning. Agriculture Handbook No. 537.

USDA Soil Conservation Service and Washington County Soil and Water Conservation District. April 1981. "Urban Conservation Guide for Washington County, Oregon", parts A and B.

Virginia Department of Conservation and Recreation, 1992, "Virginia Erosion and Sediment Control Handbook, 3rd Edition".

Thanks to the following agency staff for their assistance in development of this manual:

City of Portland

Dawn Hottenroth – Environmental Services

Duane Launder – Environmental Services

Russ Lawrence – Environmental Services

Dawn Uchiyama – Parks and Recreation

George Helm – Planning and Development Review

Kermit Robinson – Planning and Development Review

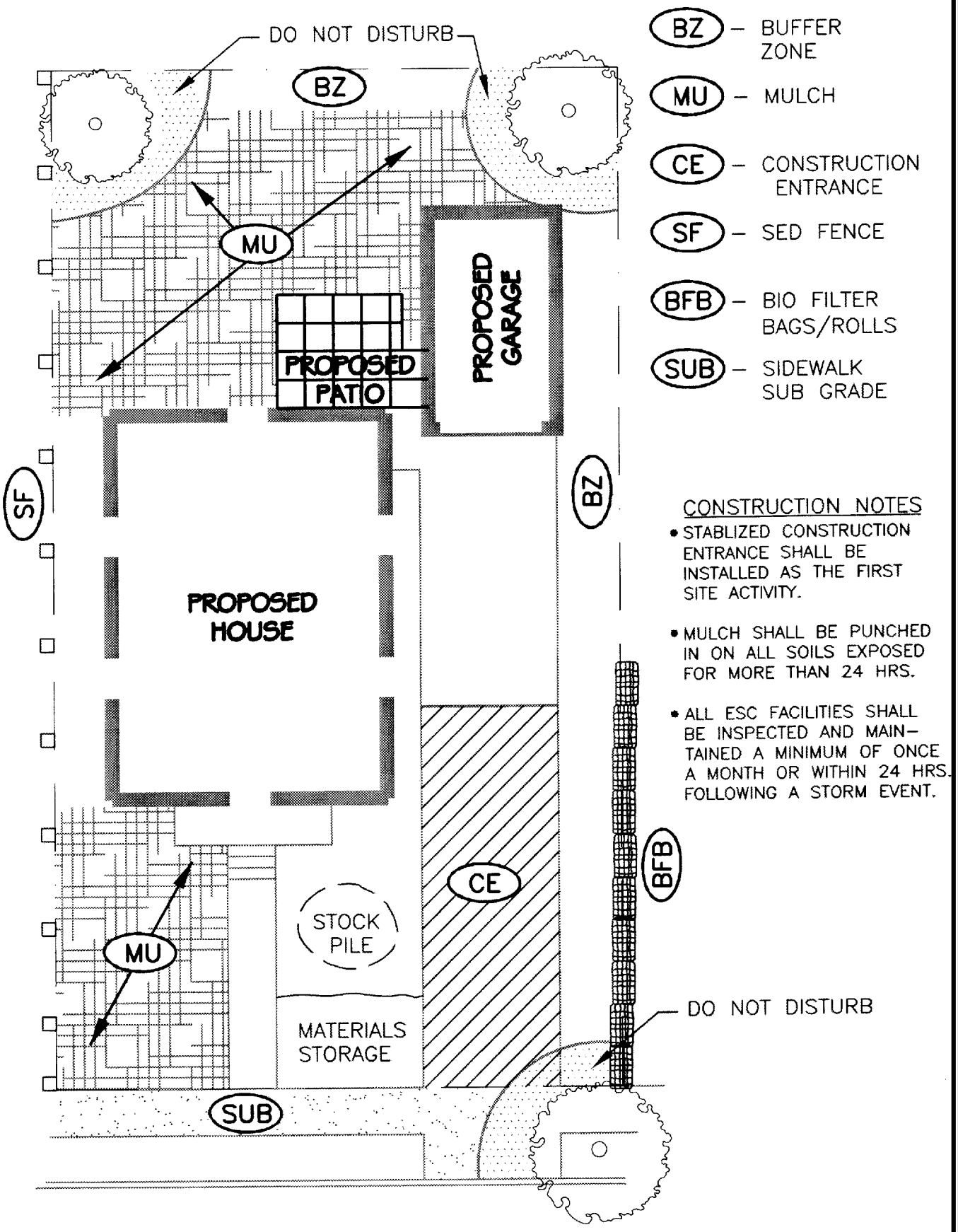
Russ Tilander - Planning and Development Review

Tom Imhoff – Transportation

Steve Townsen – Transportation

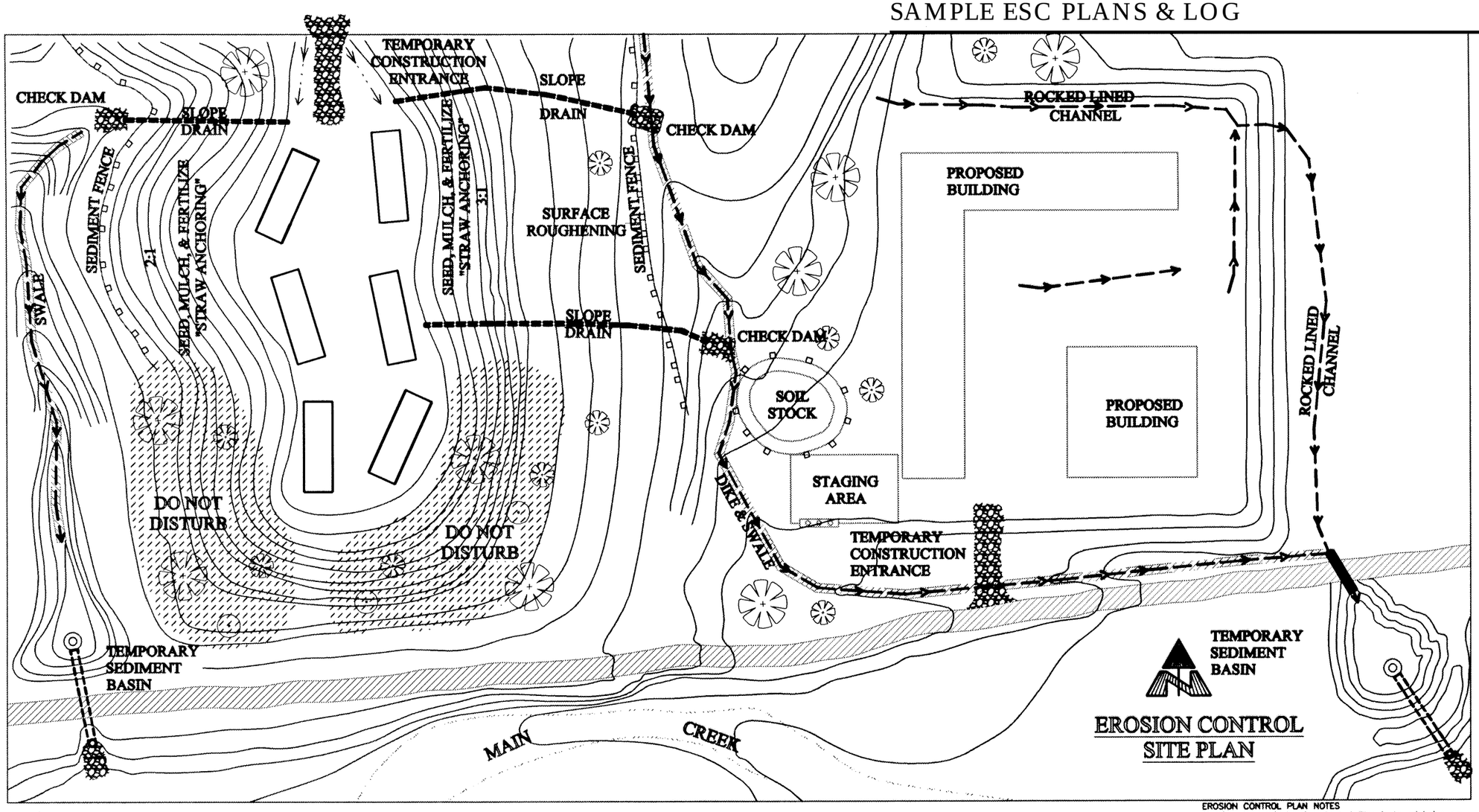
Unified Sewerage Agency

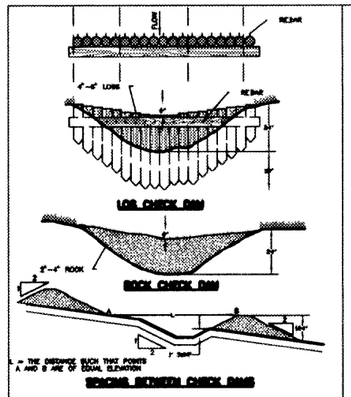
Fred Wright



CONSTRUCTION NOTES

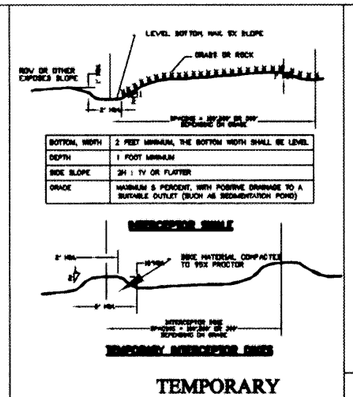
- STABLIZED CONSTRUCTION ENTRANCE SHALL BE INSTALLED AS THE FIRST SITE ACTIVITY.
- MULCH SHALL BE PUNCHED IN ON ALL SOILS EXPOSED FOR MORE THAN 24 HRS.
- ALL ESC FACILITIES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN 24 HRS. FOLLOWING A STORM EVENT.





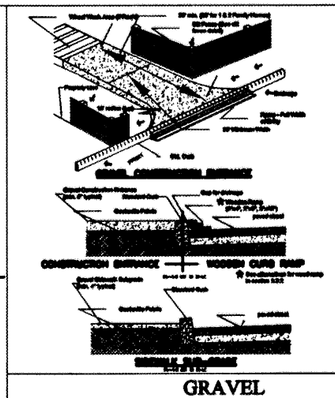
3.10.DWG

CHECK DAM



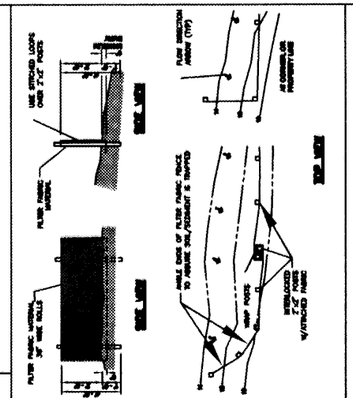
3.9.DWG

TEMPORARY INTERCEPTOR DIKES AND SWALES



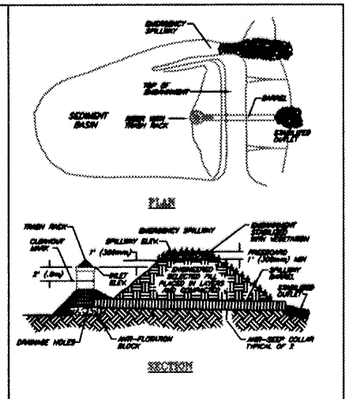
3.1.DWG

GRAVEL CONSTRUCTION ENTRANCE



3.4.DWG

TEMPORARY SEDIMENT FENCE



TYPICAL SEDIMENT BASIN

EROSION CONTROL PLAN NOTES

The intent of this Erosion Control Plan is to minimize any water quality impacts, in the form of sediment pollution, to Main Creek and tributaries. The construction area is underlain by moderately erosive, gravelly loam on 5–30% slopes. The proposed development will disturb approximately 13 acres. The Erosion Control Plan will be implemented to:

Treat erosion as soon as possible after disturbance.

Prevent sediment from leaving the construction area and entering Main Creek.

Construction activities will be scheduled to minimize erosion.

Only disturb, clear, or grade areas necessary for construction. Flag or otherwise delineate.

Construct temporary sediment basins as described in the Design Data Sheets, at the locations shown on the plans.

Locate construction entrances and exits as shown on plans. The entrance shall be maintained in a condition that will prevent tracking or flowing of sediment onto Public Right-of-Way.

Use grooving or tracking to roughen the face of the slope to facilitate vegetation establishment.
Apply seed, fertilizer and straw mulch and then track or punch in teh mulch with a bulldozer on 3:1 or less slopes.

Inspection and Maintenance
After each rainfall, inspect any structure used to trap sediment and clean out or repair promptly.
Inspect channels at regular intervals and after significant storms. Remove debris if necessary and make needed repairs. Repair eroded areas promptly.

Project Location/Site: _____

Contractor: _____

Job Site Foreman/Supervisor: _____

ESC On-site Individual: _____

Contactís Phone/Cell #: _____ Pager #: _____

■Sunday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Monday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Tuesday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Wednesday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Thursday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Friday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

■Saturday Date: _____ Weather Conditions: _____

Inspection Log/Events: _____

_____

_____

ESC Initials: _____ COP Insp: _____

Project Location/Site: _____

Contractor: _____

Job Site Foreman/Supervisor: _____

ESC On-site Individual: _____

Contactís Phone/Cell #: _____ Pager #: _____

■Sunday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Monday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Tuesday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Wednesday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Thursday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Friday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

_____

ESC Initials: _____ COP Insp: _____

■Saturday Date: _____ Weather Conditions: _____

■ Entry BMPs ■ Perimeter controls ■ Stormwater Controls
■ Erosion Prevention BMPs ■ Bioengineering BMPs ■ Sediment Control BMPs

Inspection Log/Events: _____

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ESC Initials: _____ COP Insp: _____

UNIVERSAL SOIL LOSS AND REVISED UNIVERSAL SOIL LOSS EQUATIONS

Some erosion control measures utilized for any construction site must be designed to achieve a disturbed area erosion loss of no more than 1 ton per acre per year, based on the Soil Conservation Service (SCS) Universal Soil Loss appropriately designed containment and sedimentation features. To assist you we suggest using one of 2 equations created by the National Resources Conservation Service: The Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) which is housed as a computer program. The erosion control measures outlined in the matrices in section 2.4 are designed to achieve the 1 ton per acre per year goal, based on a typical soil type for the urban Tualatin River basin area. Both equations are based on particular site conditions, different types or combinations of erosion control measures desired for a construction site. The SCS Universal Soil Loss Equation or other approved supporting methodology/information must be used to design the erosion control system. The design calculations must be submitted to the appropriate jurisdiction's permit review section with the proposed erosion control plan, and describe methodologies to determine the amount of soil loss off of any given site. The basics of the equations are laid out below.

A brief summary of the use of the Universal Soil Loss Equation follows. For more detailed information, Agriculture Handbook No. 537, "Predicting Rainfall Erosion Losses, A Guide to Conservation Planning" (USDA, 12/78) is recommended.

The Universal Soil Loss Equation is:

$$A = R \cdot K \cdot LS \cdot CV \cdot PR$$

where:

- **A** is the computed soil loss per unit area, generally in tons per acre per year.
- **R** is the rainfall and runoff factor. (R factors for the Tualatin River Basin can be found in Table 1, for factors for other areas, contact the local SCS office).
- **K** is the soil erodibility factor and can be found in County SCS Soil Survey manuals, in the table of Physical and Chemical Properties of Soils (K values for Washington County and portions of Multnomah County in the Tualatin Basin are presented in Tables 5 and 6).
- **LS** is the slope-length factor. LS can be determined for a site using the known slope length and percent slope of a site and Table 2.
- **CV** is the cover and management factor. Use 1.0 for a condition of no ground cover during construction. Other CV factors are presented in Tables 3 and 4.
- **PR** is the erosion control practice factor. Use 1.0 for a condition of bare slopes. Use 0.9 to represent a condition of trackwalking up and down slopes.

The Revised Universal Soil Loss Equation is actually a computer program that evaluates additional, more regional factors, than the older USLE. In general the RUSLE revises or adds the following factors:

Slope Length (LS in the USLE) is more narrowly defined as the distance from the origin of the flow, through the flow path, to the point where deposition begins.

R Factor is also more narrowly defined to the erosivity of the climate at a particular location.

C Factor also brings in canopy as cover (not just ground covers), surface roughness, root mass and organic material in the soil.

For more information on or to download the RUSLE go to the NRCS web site at

www.itc.nrcs.gov/focs/RUSLE/index.html

www.sedlab.olemiss.edu/rusle/status.

This site will assist you in using the computerized program.

To use the equation to determine the necessary measures to reduce the soil loss, first determine the loss expected from a cleared site without erosion control measures (only calculate erosion losses for cleared and disturbed areas). Then various factors of these equations can be manipulated to represent the effects of using different types and combinations of added erosion prevention and sediment control measures BMPs. and soil losses recalculated until the desired result is achieved.

Factors of the equations can be adjusted as follows to represent erosion control measures.

LS can be reduced by reducing slope lengths. This can be achieved by intercepting and re-routing flows uphill of the disturbed area and thus removing their erosive potential entirely from the site, or by adding interceptor dikes or swales in the disturbed area to direct flows from all or part of the area to a sediment trap or pond.

CV can be reduced by using cover practices such as seeding and mulching, erosion control blankets or plastic sheeting.

PR can be reduced by such measures as grooving or stair stepping steep slopes.

(Note: design criteria for the erosion control methods noted above are given in Chapter 4.)

The best means of reducing total tonnage of erosion from a site as well as reducing the amount of erosion control measures BMPs required is to minimize the ground area that is cleared and disturbed at any given time.

RECOMMENDED STANDARD NOTES FOR EROSION CONTROL PLANS

A. Approval of this erosion, sediment and pollution control plan (ESPCP) does not constitute an approval of permanent road or drainage design (e.g., size and location of roads, pipes, restrictors, channels, retention facilities, utilities, etc.)

B. The implementation of this ESPCP and the construction, maintenance, replacement, and upgrading of these ESPCP facilities is the responsibility of the applicant/contractor until all construction is completed and approved and vegetation/landscaping is established.

C. The boundaries of the clearing limits shown on this plan shall be clearly flagged in the field prior to construction. During the construction period, no disturbance beyond the flagged clearing limits shall be permitted. The flagging shall be maintained by the applicant/contractor for the duration of construction.

D. The ESPCP facilities shown on this plan must be constructed in conjunction with all clearing and grading activities, and in such a manner as to insure that sediment and sediment laden water do not enter the drainage system, roadways, or violate applicable water standards.

E. The ESPCP facilities shown on this plan are the minimum requirements for anticipated site conditions. During the construction period, these ESPCP facilities shall be upgraded as needed for unexpected storm events and to ensure that sediment and sediment-laden water do not leave the site.

F. The ESPCP facilities shall be inspected daily by the applicant/contractor and maintained as necessary to ensure their continued functioning.

G. The ESPCP facilities on inactive sites shall be inspected and maintained a minimum of once a month or within the 24 hours following a storm event.

H. Stabilized construction entrances shall be installed at the beginning of construction and maintained for the duration of the project. Additional measures may be required to insure that all paved areas are kept clean for the duration of the project.

Standard Notes for Sediment Fences:

1. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid use of joints. When joints are necessary, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and both ends securely fastened to the post, or overlap 2 inch x 2 inch posts and attach as shown on detail sheet 4-2A.
2. The filter fabric fence shall be installed to follow the contours where feasible. The fence posts shall be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 24 inches.
3. The filter fabric shall have a minimum vertical burial of 6 inches. All excavated material from filter fabric fence installation, shall be backfilled and compacted, along the entire disturbed area.
4. Standard or heavy duty filter fabric fence shall have manufactured stitched loops for 2 inch x 2 inch post installation. Stitched loops shall be installed on the up hill side of the sloped area.
5. Filter fabric fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently protected and stabilized.
6. Filter fabric fences shall be inspected by applicant/contractor immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.

EROSION CONTROL VENDOR LIST

EROSION CONTROL MATERIALS

ACF West Inc./Geosynthetic Products
8951 SE 76th Drive
Portland, OR 97206
Contact: Melissa Hurley
Phone: 503-771-5115
Fax: 503-771-1161

Bark Blowers Incorporated
PO Box 512
Beaverton, OR 97075-5513
Contact: Melinda Miller
Phone: 503-648-BARK (2275)
503-248-2275
Fax: 503-693-0416
Website: www.barkblowers.com

Coconut Palm Resources, Inc.
2459 SE TV Hwy #236
Hillsboro, OR 97123
Contact: Paul Turnbull
Phone: 503-649-8101
Fax: 503-259-0573

Coral Sales Company
10560 SE Hwy 212 / PO Box 577
Clackamas, OR 97015
Contact: Connie J. shipley
Phone: 503-655-6351
Fax: 503-657-9649
Voice: 503-306-0922

CSI Geosynthetics
3500 SE Columbia Way, Bldg. 44-100
Vancouver, WA 98661
Contact: Tammy / Kevin
Phone: 360-699-1426
800-426-7976 (OR/WA/ID/MT)
Fax: 360-699-1344
Website: www.csigeo.com
email: infor@csigeo.com

E. Mult. Soil & Water Conservation District
2115 SE Morrison, Room 201
Portland, OR 97214
Phone: 503-231-2270
Fax: 503-231-2271
email: erains@or.nrcs.usda.gov
sfedjr@or.nrcs.usda.gov

Emerald Seed & Supply
9330 NE Halsey St.
Portland, OR 97220
Contact: Arman Kluehe
Phone: 503-254-8414 / 800-826-8873
Fax: 503-254-8456
Website: emeraldseedandsupply.com
email: emeraldssc@uswest.net

Ben Fox, Inc.
7028 SE Renada St.
Milwaukie, OR 97267
Contact: Ben Fox
Phone: 503-654-8816

Granite Seed
1697 West 2100 North
Lehi, UT 84043
Contact: Don Bermant
Phone: 801-768-4422
Fax: 801-768-3967
Website: www.graniteseed.com
email: granite@graniteseed.com

Layfield Plastics
3890 Hammer Drive
Bellingham, WA 98226
Contact: Karl Herman
Phone: 360-647-3778
Fax: 360-647-5187
Website: www.geomembranes.com

Northwest Hydro-Mulchers, Inc.
37621 SE Bearcreek Lane
Boring, OR 97009-3706
Contact: Barry Cook
Phone: 503-668-5531
Cell: 503-349-5335
Fax: 503-668-5532

Northwest Linings & Geotextile Products, Inc.
21000 77th Ave. South
Kent, WA 98032
Contact: Rod Newton
Phone: 253-872-0244
Fax: 253-872-0245

Oregon Culvert Co., Inc.
P.O. Box 398
Tualatin, OR 97062
Contact: John Dissen
Phone: 503-692-0415
Fax: 503-692-0415

Pacific Northwest Natives
1525 Laurel Heights Drives NW
Albany, OR 97321
Phone: 541-928-8239
Fax: 541-924-8855
email: cwe@proaxis.com

Rexius
17550 SW 63rd
Lake Oswego, OR 97035
Contact: Jason Giles
Phone: 503-635-5865 / 800-285-7227
Fax: 503-635-5562

EROSION CONTROL VENDOR LIST (continued)

PLANT MATERIALS

Bosky Dell Natives, Inc.
2020 SW 8th Ave #323
West Linn, OR 97068
Contact: Laurie Hoffman
Phone: 503-638-5945
Fax: 503-638-8047

Emerald Seed & Supply
9330 NE Halsey St.
Portland, OR 97220
Contact: Arman Kluehe
Phone: 503-254-8414 / 800-826-8873
Fax: 503-254-8456
Website: emeraldseedandsupply.com
email: emeraldssc@uswest.net

Granite Seed
1697 West 2100 North
Lehi, UT 84043
Contact: Don Bermant
Phone: 801-768-4422
Fax: 801-768-3967
Website: www.graniteseed.com
email: granite@graniteseed.com

Pacific Northwest Natives
1525 Laurel Heights Drives NW
Albany, OR 97321
Phone: 541-928-8239
Fax: 541-924-8855
email: cwe@proaxis.com

COMPOSTING

James H. Lenhart, PE
2035 NE Columbia Blvd.
Portland, OR 97211
Contact: James H. Lenhart
Phone: 503 240-3393 / 800 548-4667
Fax: 503 240-9553
Website: www.stormwatermgt.com
email: jiml@stormwatermgt.com

DESIGN

Barrett Erosion & Sediment Control Service
7610 SE Holgate
Portland, OR 97206
Contact: James G. Barrett
Phone: 503-775-9829

Clearwater West
7306 SE Main St.
Portland, OR 97215
Contact: Martha S. Mitchell
Phone: 503-257-9359
Fax: 503-255-5824
email:mmitchel@teleport.com

Coconut Palm Resources, Inc.
2459 SE TV Hwy #236
Hillsboro, OR 97123
Contact: Paul Turnbull
Phone: 503-649-8101
Fax: 503-259-0573

Coral Sales Company
10560 SE Hwy 212 / PO Box 577
Clackamas, OR 97015
Contact: Connie J. shipley
Phone: 503-655-6351
Fax: 503-657-9649
Voice: 503-306-0922

Ben Fox, Inc.
7028 SE Renada St.
Milwaukie, OR 97267
Contact: Ben Fox
Phone: 503-654-8816

Granite Seed
1697 West 2100 North
Lehi, UT 84043
Contact: Don Bermant
Phone: 801-768-4422
Fax: 801-768-3967
Website: www.graniteseed.com
email: granite@graniteseed.com

Northwest Linings & Geotextile Products, Inc.
21000 77th Ave. South
Kent, WA 98032
Contact: Rod Newton
Phone: 253-872-0244
Fax: 253-872-0245

INSTALLATION

Barrett Erosion & Sediment Control Service
7610 SE Holgate
Portland, OR 97206
Contact: James G. Barrett
Phone: 503-775-9829

Coconut Palm Resources, Inc.
2459 SE TV Hwy #236
Hillsboro, OR 97123
Contact: Paul Turnbull
Phone: 503-649-8101
Fax: 503-259-0573

ESC Erosion Control Service
29895 SW Kinsman Rd.
Wilsonville, OR 97070
Contact: Bob Booth
Phone: 253-682-3211
Fax: 253-682-9876

EROSION CONTROL VENDOR LIST (continued)

Ben Fox, Inc.
7028 SE Renada St.
Milwaukie, OR 97267
Contact: Ben Fox
Phone: 503-654-8816

Northwest Hydro-Mulchers, Inc.
37621 SE Bearcreek Lane
Boring, OR 97009-3706
Contact: Barry Cook
Phone: 503-668-5531
Cell: 503-349-5335
Fax: 503-668-5532

Northwest Linings & Geotextile Products, Inc.
21000 77th Ave. South
Kent, WA 98032
Contact: Rod Newton
Phone: 253-872-0244
Fax: 253-872-0245

Pacific Northwest Natives
1525 Laurel Heights Drives NW
Albany, OR 97321
Phone: 541-928-8239
Fax: 541-924-8855
email: cwe@proaxis.com

Rexius
17550 SW 63rd
Lake Oswego, OR 97035
Contact: Jason Giles
Phone: 503-635-5865 / 800-285-7227
Fax: 503-635-5562

INSPECTION

Barrett Erosion & Sediment Control Service
7610 SE Holgate
Portland, OR 97206
Contact: James G. Barrett
Phone: 503-775-9829

Clearwater West
7306 SE Main St.
Portland, OR 97215
Contact: Martha S. Mitchell
Phone: 503-257-9359
Fax: 503-255-5824
email:mmitchel@teleport.com

ESC Erosion Control Service
29895 SW Kinsman Rd.
Wilsonville, OR 97070
Contact: Bob Booth
Phone: 253-682-3211
Fax: 253-682-9876

Ben Fox, Inc.
7028 SE Renada St.
Milwaukie, OR 97267
Contact: Ben Fox
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Northwest Linings & Geotextile Products, Inc.
21000 77th Ave. South
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