ORDINANCE NO. _____
BILL NO. _____

AN ORDINANCE AMENDING CARSON CITY MUNICIPAL CODE TITLE 18 ZONING, CHAPTER 18.16 DEVELOPMENT STANDARDS, BY ADDING DIVISION 13, EROSION AND SEDIMENT CONTROL, DIVISION 13.1 INTRODUCTION, WHICH STATES THE CITY'S RESPONSIBILITY FOR DEVELOPING, IMPLEMENTING AND ENFORCING A PROGRAM TO REDUCE POLLUTANTS FROM ENTERING THE CITY'S STORM WATER SYSTEM, DIVISION 13.2 MINIMUM REQUIREMENTS FOR EROSION AND SEDIMENT CONTROL, WHICH STATES THE TWELVE MINIMUM REQUIREMENTS TO MANAGE AND CONTROL EROSION AND SEDIMENT, DIVISION 13.3 CONSTRUCTION STORM WATER POLLUTION PREVENTION PLAN, WHICH GIVES THE REQUIREMENTS OF A STORMWATER POLLUTION PREVENTION PLAN, DIVISION 13.4 CHECKLIST FOR CONSTRUCTION STORM WATER POLLUTION PREVENTION PLANS, LISTS SPECIFC ITEMS NEEDED AND A CHECKLIST FORM FOR THE PREPARATION OF A STORM WATER POLLUTION PREVENTION PLAN, DIVISION 13.5 BEST MANAGEMENT PRACTICES, PROVIDES GENERAL GUIDANCE FOR SELECTING AND IMPLEMENTING BEST MANAGEMENT PRACTICES THAT WILL ELIMINATE OR REDUCE THE DISCHARGE OF POLLUTANTS FROM CONSTRUCTION SITES, AND OTHER MATTERS PROPERLY RELATED THERETO.

Fiscal Impact: None

THE BOARD OF SUPERVISORS OF CARSON CITY, NEVADA, DO ORDAIN:
That Division 13 of the Carson City Development Standards is hereby added as follows:

# Division 13

# Erosion & Sediment Control

**Development Standards**
**September 2006**

**Carson City,**
**Nevada**

## Table Of Contents

## 13.1 Introduction.

Carson City is responsible for developing, implementing and enforcing a program to reduce pollutants, generated from construction activities, from entering the City's municipal storm water conveyance system. This program includes the following:

### 13.1.1 Erosion & Sediment Control Ordinance, Chapter 12.18 of C.C.M.C.

The erosion and sediment control ordinance contains each of the following items:

- Requires any person applying for a permit to develop and submit a Erosion and Sediment Control Plan with their permit application,
- Requires any person who undertakes earth disturbance is subject to the ordinance ,
- States permit requirements and action for failure to complete the work,
- States general erosion and sediment requirements and maintenance.
- States procedure for notification of needed maintenance, enforcements and appeal process.

### 13.1.2 Program Goals and Objectives.

The erosion and sediment control program minimum requirements will be applied to construction activities that result in land disturbance of greater than or equal to one acre and/or as required elsewhere in code. Reduction of storm water discharges from construction activity disturbing less than one acre will be included in the program if that construction activity is part of a larger common plan of development or sale that would disturb one acre or more. The objective of this Division is to provide guidance for avoiding adverse stormwater impacts from construction and other activities on downstream resources and on-site storm water facilities. Minimization of storm water flows, prevention of soil erosion, capture of water-borne sediment that has been unavoidably released from exposed soils, and protection of water quality from on-site pollutant sources are all readily achievable when the proper best management practices (BMPs) are planned, installed and properly maintained.

The construction phase of a project is usually considered a temporary condition, which will be supplanted by the permanent improvements and facilities for the completed project. However, construction work may take place over an extended period of time, including several seasons over multiple years. All management practices and control facilities used in the

course of construction shall be of sufficient size, strength, and durability to readily outlast the longest possible construction schedule and the worst anticipated weather conditions. The goal of a construction storm water pollution prevention plan is to avoid immediate and long-term environmental loss and degradation typically caused by poorly managed construction sites.

Linear projects, such as roadway construction and utility installations, are special cases of construction activities and present their own, unique set of stormwater protection challenges. Many of the BMPs can be adapted and modified to provide the controls needed to adequately address these projects. It may be advantageous to segment long, linear projects into a series of separate units that can apply all necessary controls pertinent to that particular unit in a timely manner.

Soil erosion and the resulting sedimentation produced by land develop impact the environment, damage aquatic and recreational resources and create aesthetic problems. Examples of the impacts of erosion and sedimentation include:

- Natural nutrient rich topsoils are eroded away, making reestablishment of vegetation difficult. Consequently, soil amendments and fertilizers must be applied. A properly functioning soil system is a sustained storm water management mechanism. Vegetation and soil are not effectively sustained unless both are maintained in good condition

- Siltation fills culverts and storm drains, decreasing capacities and increasing flooding and maintenance frequency

- Detention facilities fill rapidly with sediment, decreasing storage capacity and increasing flooding

- Infiltration devices become clogged and fail

- Sediment in streams and rivers builds more rapidly. Resulting shallow areas become covered by aquatic plants, reducing usability. Increased nutrient loading from phosphorus attached to soil particles and transported to streams can cause a change in the water pH, algal blooms and oxygen depletion that leads to eutrophication and fish kills

- Treatment of water for domestic uses becomes more difficult and costly

- Aesthetically pleasing, clear, clean water is replaced with turbid water in streams and rivers

- Eroded soil particles decrease the viability of macro-invertebrates and food-chain organisms, impair the feeding ability of aquatic animals, clog gill passages of fish, and reduce photosynthesis

Successful fish spawning is diminished by sediment-clogged gravel. Sedimentation following spawning can smother the eggs or young fry.

The Carson City Erosion and Sediment Control Ordinance and this Division on Erosion and Sediment Control follows the requirements instituted by the US Environmental Protection Agency for owner/operators of private and public construction sites. Under the Phase II National Pollutant Discharge Elimination System (NPDES) program all construction site owners/operators of all proposed private and public construction sites that will disturb a total of one or more acres of land are required to obtain coverage under the Nevada Division of Environmental Protection's (NDEP) General Permit. The owners/operators must submit a Notice of Intent (NOI) and develop and implement a Storm Water Pollution Prevention Plan (SWPPP) that identifies the potential storm water pollution sources on the site and how storm water pollution will be prevented. The SWPPP remains on-site during the duration of the project.

### 13.1.3 Factors Influencing Erosion

Several factors influence the erosion potential of a site. These factors include:

- Soil characteristics
- Vegetative cover
- Topography and
- Climate

## 13.2 Minimum Requirements for Erosion & Sediment Control

The minimum requirements for erosion and sediment control on construction sites are documented through the preparation of a site plan and SWPPP detailing the BMPs that will be implemented, BMPs timing and maintenance responsibility.

An adequate construction SWPPP includes a narrative and drawings. The narrative is a written statement to explain and justify the pollution prevention decisions made for a particular project. The narrative contains concise information about existing site conditions, construction schedules, and other pertinent items that are not contained on the drawings. The drawing and notes describe where and when the various BMPs should be installed, the performance goals the BMPs are expected to achieve, and the actions to be taken if the performance goals are not achieved.

The minimum requirements for the erosion and sediment control measures that must be implemented for all projects in Carson City where one or more acres of land are disturbed are listed below. A step-by-step procedure for preparing and implementing a SWPPP is included in Division 13.3.

The SWPPP identifies the BMPs that will be employed to prevent sediment and pollutants from leaving the site, fulfilling the requirements of Division 13.5.4. For those projects that must obtain coverage under the NDEP General Permit, applicants may submit the SWPPP prepared for the NOI provided all of the Carson City erosion and sediment control minimum requirements are addressed in the SWPPP.

### 13.2.1 Minimum Requirement No. 1: Mark Clearing Limits.

1. Prior to beginning land disturbing activities, including clearing and grading, all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area must be clearly marked, both in the field and on the plans, to prevent damage and offsite impacts.

2. Plastic, metal, or stake wire fence must be used to mark the clearing limits.

### 13.2.2 Minimum Requirement No. 2: Establish Construction Access.

1. Vehicle Access. Construction vehicle access and exit shall be limited to one route if possible.

2. Tracking Sediment. Exit points shall be stabilized with quarry spalls or crushed rock to minimize the tracking of sediment onto public roads.

3. Wheel Wash. Wheel wash or tire baths should be located on-site, if applicable.

4. Clean Public Roads. Public roads shall be cleaned thoroughly at the end of each day. Sediment shall be removed from roads by shoveling or pickup sweeping and shall be transported to a controlled sediment disposal area. Street washing will not be allowed.

### 13.2.3 Minimum Requirement No. 3*:* Control Flow Rates.

1. General. Properties and waterways downstream from development sites shall be protected from erosion due to increases in the volume, velocity, and peak flow rate of stormwater runoff from the project site.

2. Downstream Analysis. Downstream analysis is necessary if changes in flows could impair or alter conveyance systems, stream banks, bed sediments or aquatic habitats.

3. BMPs Functional. Stormwater retention/detention facilities shall be constructed as one of the first steps in grading. Detention facilities shall

be functional prior to construction of site improvements (e.g. impervious surfaces).

4. Additional Flow Standards. The City Engineer may require pond designs that provide additional or different stormwater flow control if necessary to address local conditions or to protect properties and waterways downstream from erosion due to increases in the volume or velocity of stormwater runoff from the project site.

5. Permanent Infiltration Ponds. If permanent infiltration ponds are used for flow control during construction, these facilities should be protected from siltation during the construction phase.

### 13.2.4 Minimum Requirement No. 4: Install Sediment Controls.

1. Natural Vegetation. The native topsoil and natural vegetation shall be retained in an undisturbed state to the maximum extent practicable.

2. Sediment Removal BMPs. Prior to leaving a construction site, or prior to discharge to an infiltration facility, stormwater runoff from disturbed areas shall pass through a sedimentation pond or other appropriate sediment removal BMPs. Runoff from fully stabilized areas may be discharged without a sediment removal BMPs, but must meet the flow control performance standard of Minimum Requirement No. 3. Full stabilization means concrete or asphalt paving; quarry spalls used as ditch lining; or the use of rolled erosion products, a bonded fiber matrix product, or vegetative cover in a manner that will fully prevent soil erosion. The City Engineer shall inspect and approve areas stabilized by means other than pavement or quarry spalls.

3. BMPs Functional. Sediment ponds, vegetated buffer strips, sediment barriers or filters, dikes, and other BMPs intended to trap sediment on-site shall be constructed as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.

4. Seeding. Earthen structures such as dams, dikes, and diversions shall be seeded and mulched according to the timing indicated in Minimum Requirement No. 5.

### 13.2.5 Minimum Requirement No. 5: Stabilize Soils.

1. General. All exposed and unworked soils shall be stabilized by application of effective BMPs that protect the soil from the erosive forces of raindrop impact and flowing water, and wind erosion. Establish temporary or permanent stabilization practices on areas that have been disturbed as soon as practical but no later than 14 days after disturbance.

2. Applicable Practices. Applicable practices include, but are not limited to, temporary and permanent seeding, sodding, mulching, plastic covering, soil application of polyacrylamide (PAM), early application of gravel base on areas to be paved, and dust control.

3. Soil Stabilization. Soil stabilization measures selected should be appropriate for the time of year, site conditions, estimated duration of use, and potential water quality impacts that stabilization agents may have on downstream waters or ground water.

4. Soil Stockpiles. Soil stockpiles must be stabilized and protected with sediment trapping measures.

5. Linear Facilities. Work on linear construction sites and activities, including right-of-way and easement clearing, roadway development, pipelines, and trenching for utilities, shall not exceed the capability of the individual contractor for his portion of the project to install the bedding materials, roadbeds, structures, pipelines, and/or utilities, and to re-stabilize the disturbed soils, meeting the timing conditions listed above.

### 13.2.6 Minimum Requirement No. 6: Protect Slopes.

1. Cut and Fill Slopes. Cut and fill slopes shall be designed and constructed in a manner that will minimize erosion.

2. Soil Types. Consider soil type and its potential for erosion.

3. Runoff Velocities. Reduce slope runoff velocities by breaking up the continuous length of slope with terracing and diversions, decreasing slope steepness, and roughening the slope surface.

4. Diverted Flows. Divert upslope drainage and run-on waters from off-site with interceptors at top of slope. Off-site stormwater should be handled separately from stormwater generated on the site. Diversion of off-site stormwater around the site may be a viable option. Diverted flows shall be redirected to the natural drainage location at or before the property boundary.

5. Collected Flows. Contain down slope-collected flows in pipes, slope drains, or protected channels.

6. Ground Water. Provide drainage improvements to intercept and remove ground water, preventing seepage from flowing onto the slope surface of exposed soil areas.

7. Excavation. Excavated material shall be placed on the uphill side of trenches, consistent with safety and space considerations.

8. Check Dams. Check dams shall be placed at regular intervals within trenches that are cut down a slope.

9. Stabilize Soils. Stabilize soils on slopes, as specified in Minimum Requirement No. 5.

### 13.2.7 Minimum Requirement No. 7: Protect Drain Inlets.

1. General. All storm drain inlets made operable during construction shall be protected so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.

2. Roads. All approach roads shall be kept clean, and all sediment and street wash water shall not be allowed to enter storm drains without prior and adequate treatment unless treatment is provided before the storm drain discharges to waters of the State.

3. Inlets should be inspected weekly at a minimum and daily during storm events. Inlet protection devices should be cleaned or removed and replaced before six inches of sediment can accumulate.

### 13.2.8 Minimum Requirement No. 8: Stabilize Channels and Outlets.

1. General. All temporary on-site conveyance channels shall be designed, constructed and stabilized to prevent erosion from the expected peak flows velocity of the 6 months, 3 hour storm for the developed condition, referred to as the short duration storm.

2. Stabilization. Stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches shall be provided at the outlets of all conveyance systems.

### 13.2.9 Minimum Requirement No. 9: Control Pollutants.

1. General. All pollutants, including waste materials and demolition debris, that occur on-site during construction shall be handled and disposed of in a manner that does not cause contamination of stormwater.

2. Vandalism. Cover, containment, and protection from vandalism shall be provided for all chemicals, liquid products, petroleum products, and non-inert wastes present on the site.

3. Equipment Maintenance. Maintenance and repair of heavy equipment and vehicles involving oil changes, hydraulic system drain down, solvent and de-greasing cleaning operations, fuel tank drain down and removal, and other activities which may result in discharge or spillage of pollutants to the ground or into stormwater runoff must be conducted using spill prevention measures, such as drip pans. Contaminated surfaces shall be cleaned immediately following any discharge or spill incident. Emergency repairs may be performed on-site using temporary plastic placed beneath and, if raining, over the vehicle.

4. Wheel Wash. Wheel wash, or tire bath wastewater, shall be discharged to a separate on-site treatment system. It may be discharged to the sanitary sewer system only if expressly allowed by the City Engineer.

5. Agricultural Chemicals. Application of agricultural chemicals, including fertilizers and pesticides, shall be conducted in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Manufacturers' recommendations shall be followed for application rates and procedures.

6. pH Management. Management of pH-modifying sources shall prevent contamination of runoff and stormwater collected on the site. These sources include, but are not limited to, bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters.

### 13.2.10 Minimum Requirement No. 10: Control De-Watering.

1. General. All foundation, vault, and trench de-watering water, which have similar characteristics to stormwater runoff at the site, shall be discharged into a controlled conveyance system, prior to discharge to a sediment trap or sediment pond. Channels must be stabilized, as specified in Minimum Requirement No. 8.

2. Clean Water. Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to state surface waters, as specified in Minimum Requirement No. 8, provided the de-watering flow does not cause erosion or flooding of the receiving waters. These clean waters should not be routed through sediment ponds with stormwater.

3. Contaminated Water. Highly turbid or otherwise contaminated dewatering water, such as from construction equipment operation, clamshell digging, concrete tremie pour, or work inside a cofferdam, shall be handled separately from stormwater at the site.

4. Other Disposal Options. Depending on site constraints, additional methods of dewatering may include: infiltration; transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters; on-site treatment using chemical treatment; or other suitable treatment technologies.

### 13.2.11 Minimum Requirement No. 11: Maintain BMPs.

1. General. All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair shall be conducted in accordance with BMPs.

2. Inspection. Sediment control BMPs shall be inspected by the permittee weekly or after a runoff-producing storm event. The inspection frequency for stabilized, inactive sites shall be determined by the Public Works Department, Development Engineering based on the level of soil stability and potential for adverse environmental impacts.

3. Remove BMPs. All temporary erosion and sediment control BMPs shall be removed within 30 days after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment shall be removed or stabilized on-site. Disturbed soil areas resulting from removal of BMPs or vegetation shall be permanently stabilized.

### 13.2.12 Minimum Requirement No. 12: Manage The Project.

1. Phasing of Construction. Development projects shall be phased where feasible in order to prevent, to the maximum extent practicable, the transport of sediment from the project site during construction. Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the activities for any phase. Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. When establishing these permitted clearing and grading areas, consideration should be given to minimizing removal of existing trees and minimizing disturbance/compaction of native soils except as needed for building purposes. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas as may be required by the Director, shall be delineated on the site plans and the development site.

2. Coordination with Other Contractors. The permittee shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.

3. Inspection. All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Permittees or their agents should conduct construction site inspections at least once every seven days and within 24 hours of a storm event of that creates runoff at the site. Inspections should also occur prior to forecasted rain events to ensure that BMPs are in place and functioning properly. Inspections must be documented and the documents retained on site. Areas that require inspection include:

    a. Disturbed areas that have not attained final stabilization

    b. Material and equipment storage areas that are exposed to precipitation

    c. All erosion and sediment control measures installed at the site and downstream of the site

    d. All structural control measures and

    e. All locations where vehicles enter and/or exit the site

4. Modify SWPPP. Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, the SWPPP shall be modified, as appropriate, in a timely manner.
5. Construction SWPPP. The Construction SWPPP shall be retained on-site or within reasonable access to the site. The Construction SWPPP shall be modified whenever there is a significant change in the design, construction, operation, or maintenance of any BMP.

## 13.3 CONSTRUCTION STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

There are three basic steps in producing an erosion and sediment control plan or Construction SWPPP. This section outlines and describes a recommended step-by-step procedure for developing a Construction SWPPP from data collection to finished product. This procedure is written in general terms to be applicable to all types of projects.

The Construction SWPPP is a document that describes the potential for pollution problems on a construction project. The Construction SWPPP also explains and illustrates the measures to be taken on the construction site to control those problems.

While it is a good idea to include standards and specifications from the Construction SWPPP in the contract documents, the Construction SWPPP should be a separate document that can stand-alone. The Construction SWPPP must be located on the construction site or within reasonable access to the site for construction and inspection

personnel, although a copy of the drawings must be kept on the construction site at all times.

Division 13.4 includes a checklist for developing a Construction SWPPP. The Construction SWPPP may be a subset of the Technical Drainage Study, Improvement Plan or construction plan set. As site work progresses, the plan must be modified to reflect changing site conditions. The owner or lessee of the land being developed has the responsibility for Construction SWPPP preparation. The owner or lessee may designate someone (i.e., an engineer, architect, contractor, etc.) to prepare the Construction SWPPP, but he/she retains the ultimate responsibility.

### 13.3.1 What is an Adequate Plan?

The Construction SWPPP must contain sufficient information to satisfy the Public Works Department, Development Engineering that the problems of pollution have been adequately addressed for the proposed project. An adequate Construction SWPPP includes a narrative and drawings. The narrative is a written statement to explain and justify the pollution prevention decisions made for a particular project. The narrative contains concise information about existing site conditions, construction schedules, and other pertinent items that are not contained on the drawings. The drawings and notes describe where and when the various BMPs should be installed, the performance the BMPs are expected to achieve, and actions to be taken if the performance goals are not achieved.

On construction sites that discharge to surface water, the primary concern in the preparation of the Construction SWPPP is compliance with Nevada Water Quality Standards. Each of the 12 elements must be included in the Construction SWPPP unless an element is determined not to be applicable to the project and the exemption is justified in the narrative. The step–by-step procedure outlined in this section is recommended for the development of the Construction SWPPPs. The checklists presented in this section may be helpful in preparing and reviewing the Construction SWPPP.

On construction sites that infiltrate all stormwater runoff, the primary concern in the preparation of the Construction SWPPP is the protection of the infiltration facilities from fine sediments during the construction phase and protection of ground water from other pollutants. Several of the other elements are very important at these sites as well, such as marking the clearing limits, establishing the construction access, and managing the project.

### 13.3.2 BMP Standards and Specifications

Division 13.5 contains references for standards and specifications for the BMPs referred to in this Division. Wherever any of these BMPs are to be employed on a site, the specific title and number of the BMP should be clearly referenced in the narrative and marked on the drawings. The standards and specifications in Division 13.5 of this Division are not intended to limit any innovative or creative effort to effectively control erosion and sedimentation. In those instances where appropriate BMPs are not in this Division, experimental management practices can be considered. Minor modifications to standard practices may also be employed. However, such practices must be approved by the City Engineer before they may be used. All experimental management practices and modified standard practices are required to achieve the same or better performance than the BMPs listed in Division 13.5.

### 13.3.3 General Principles

The following general principals should be applied to the development of the Construction SWPPP.

- The native topsoil and natural vegetation should be retained in an undisturbed state to the maximum extent practicable
- Prevent pollutant release. Select source control BMPs as a first line of defense. Prevent erosion rather than treat turbid runoff
- Select BMPs depending on site characteristics (topography, drainage, soil type, ground cover, and critical areas) and the construction plan
- Divert runoff away from exposed areas wherever possible. Keep clean water clean
- Limit the extent of clearing operations and phase construction operations
- Before reseeding a disturbed soil area, amend all soils with compost wherever topsoil has been removed
- Incorporate natural drainage features whenever possible, using adequate buffers and protecting areas where flow enters the drainage system
- Minimize slope length and steepness
- Reduce runoff velocities to prevent channel erosion
- Prevent the tracking of sediment off-site

- Select appropriate BMPs for the control of pollutants other than sediment

- Be realistic about the limitations of control that you specify and the operation and maintenance of those controls. Anticipate what can go wrong, how you can prevent it from happening, and what will need to be done to fix it

### 13.3.4 STEP-BY-STEP PROCEDURE

The development of the Construction SWPPP includes the following three steps:

Step 1 – Data Collection
Step 2 – Data Analysis
Step 3 – Construction SWPPP Development and Implementation

#### a. Step 1 – Data Collection

Evaluate existing site conditions and gather information that will help develop the most effective Construction SWPPP. The information gathered should be explained in the narrative and shown on the drawings.

**Topography:** Prepare a topographic drawing of the site to show the existing contour elevations at intervals of 1 to 5 feet depending upon the slope of the terrain.

**Drainage:** Locate and clearly mark existing drainage swales and patterns on the drawing, including existing storm drainpipe systems.

**Soils:** Identify and label soil type(s) and erodibility (low, medium, high or an index value from the NRCS manual) on the drawing. Soils information can be obtained from the "*Soil Survey of Carson City Area, Nevada*." Soils can be characterized for permeability, percent organic matter, and effective depth. . These qualities can be expressed in averaged or nominal terms for most areas of Carson City. The information found in the Soil Survey lists the following information for each soil mapping unit or designation:

- a sieve analysis of the soils
- permeability (in/hr)
- available water-holding capacity (in/in)
- the percent of organic matter

**Ground Cover:** Label existing vegetation on the drawing. Such features as tree clusters, grassy areas, and unique or sensitive vegetation should be shown. Unique vegetation may include existing trees above a given diameter. In addition, existing denuded or exposed soil areas should be indicated.

**Critical Areas:** Delineate critical areas adjacent to or within the site on the drawing. Such features as steep slopes, streams, floodplains, wetlands, and geologic hazard areas, etc., should be shown. Delineate set backs and buffer limits for these features on the drawings. Other related jurisdictional boundaries such as the Federal Emergency Management Agency (FEMA) base floodplain should also be shown on the drawings.

**Adjacent Areas:** Identify existing buildings, roads, and facilities adjacent to or within the project site on the drawings. Identify existing and proposed utility locations, construction clearing limits and erosion and sediment control BMPs on the drawings.

**Existing Encumbrances:** Identify wells, existing and abandoned septic drain- fields, utilities, and site constraints.

**Precipitation Records:** Determine the average monthly rainfall and rainfall intensity for the required design storm events based on information available in the NOAA atlas.

**b. Step 2 - Data Analysis**

Consider the data collected in Step 1 to visualize potential problems and limitations of the site. Determine those areas that have critical erosion hazards. The following are some important factors to consider in data analysis:

**Topography:** The primary topographic considerations are slope steepness and slope length. Because of the effect of runoff, the longer and steeper the slope, the greater the erosion potential. Erosion potential should be determined by a qualified engineer, soil professional, certified erosion control specialist, or other qualified person.

**Drainage:** Natural drainage patterns that consist of overland flow, swales and depressions should be used to convey runoff through the site to avoid constructing an artificial drainage system. Man-made ditches and waterways will become part of the erosion problem if they are not properly stabilized. Care should also be taken to ensure that increased runoff from the site will not erode or flood the existing natural drainage system.

Possible sites for temporary stormwater retention and detention should be considered at this point. Direct construction away from areas of saturated soil - areas where ground water may be encountered - and critical areas where drainage will concentrate. Preserve natural drainage patterns on the site.

**Soils:** Evaluate soil properties such as surface and subsurface runoff characteristics, depth to impermeable layer, depth to seasonal ground water table, permeability, shrink-swell potential, texture, settleability, and erodibility. Develop the Construction SWPPP based on known soil characteristics. Infiltration sites should be properly protected from silt, which will reduce infiltration capacities.

**Ground Cover:** Ground cover is the most important factor in terms of preventing erosion. Existing vegetation that can be saved will prevent erosion better than constructed BMPs. Trees and other vegetation protect the soil structure. If the existing vegetation cannot be saved, consider such practices as phasing construction, temporary seeding, and mulching. Phasing of construction involves stabilizing one part of the site before disturbing another. In this way, the entire site is not disturbed at once.

**Critical Areas:** Critical areas may include flood hazard areas, mine hazard areas, slide hazard areas, sole source aquifers, wetlands, stream banks, fish-bearing streams, and other water bodies. Any critical areas within or adjacent to the development should exert a strong influence on land development decisions. Critical areas and their buffers shall be delineated on the drawings and clearly flagged in the field. Chain link fencing may be more useful than flagging to assure that equipment operators stay out of critical areas. Only unavoidable work should take place within critical areas and their buffers. Such unavoidable work will require special BMPs, permit restrictions, and mitigation plans.

**Adjacent Areas:** An analysis of adjacent properties should focus on areas upslope and down slope from the construction project. Water bodies that will receive direct runoff from the site are a major concern. The types, values, and sensitivities of and risks to downstream resources, such as private property, stormwater facilities, public infrastructure, or aquatic systems, should be evaluated. Erosion and sediment controls should be selected accordingly.

**Timing of the Project:** An important consideration in selecting BMPs is the timing and duration of the project. Projects that will

last through several seasons must take all necessary precautions to remain in compliance with the water quality standards.

**c. Step 3 - Construction SWPPP Development and Implementation**

After collecting and analyzing the data to determine the site limitations, the planner can then develop a Construction SWPPP. Each of the twelve minimum requirements must be considered and included in the Construction SWPPP unless site conditions render the minimum requirement unnecessary and the exemption from that element is clearly justified in the narrative of the SWPPP. The twelve minimum requirements are discussed in Division 13.2. A list of recommended BMPs for these minimum requirements is provided below.

### 13.3.5 Suggested BMPs for Twelve Minimum Requirements

**a. Suggested BMPs for Minimum Requirement No. 1: Mark Clearing Limits**

BMP EC-2: Preserving Natural Vegetation
BMP EC-3: Buffer Zones
BMP EC-4: High Visibility Plastic or Metal Fence

**b. Suggested BMPs for Minimum Requirement No. 2: Establish Construction Access**

BMP SC-1: Stabilized Construction Entrance
BMP SC-2: Wheel Wash
BMP EC-6: Construction Road/Parking Area Stabilization

**c. Suggested BMPs for Minimum Requirement No. 3: Control Flow Rates**

BMP SC-4: Storm Drain Inlet Protection
BMP SC-5: Sandbag Curb Inlet Sediment Barrier
BMP SC-6: Filter Strips
BMP SC-14: Sediment Trap
BMP SC-15: Temporary Sediment Pond

**d. Suggested BMPs for Minimum Requirement No. 4: Install Sediment Controls**

BMP SC-3: Straw Bale Barriers
BMP SC-6: Filter Strips
BMP SC-7: Silt Fence
BMP SC-8: Gravel Filter Berms
BMP SC-11: Brush Barrier
BMP SC-13: Straw Wattles
BMP SC-14: Sediment Trap
BMP SC-15: Temporary Sediment Pond
BMP SC-16: Construction Stormwater Filtration

**e. Suggested BMPs for Minimum Requirement No. 5: Stabilize Soils**

BMP EC-7: Dust Control
BMP EC-15: Wood Chip, Straw and Bark Mulches
BMP EC-16: Plastic Covering
BMP EC-17: Jute and Synthetic Netting
BMP EC-21: Seeding Practices
BMP EC-19: Polyacrylamide for Soil Erosion Protection
BMP EC-20: Topsoiling
BMP EC-22: Sodding

**f. Suggested BMPs for Minimum Requirement No. 6: Protect Slopes**

BMP EC-8: Level Spreader
BMP EC-9: Subsurface Drains
BMP EC-10: Pipe Slope Drains
BMP EC-12: Grassed Waterways and Outlets
BMP EC-14: Check Dams
BMP EC-21: Seeding Practices
BMP SC-10: Interceptor Dike and Swale

g. Suggested BMPs for Minimum Requirement No. 7: Protect Drain Inlets

BMP SC-4: Storm Drain Inlet Protection
BMP SC-5: Sandbag Curb Inlet Sediment Barrier

**h. Suggested BMPs for Minimum Requirement No. 8: Stabilize Channels and Outlets**

BMP EC-11: Channel Lining
BMP EC-13: Outlet Protection

**i. Suggested BMPs for Minimum Requirement No. 9: Control Pollutants**

BMP MC-1: Saw cutting and Surface Pollution Prevention
BMP MC-2: Concrete Handling

**j. Suggested BMPs for Minimum Requirement No. 10: Control De-Watering**

BMP SC-3: Straw Bale Barrier
BMP SC-6: Filter Strips
BMP SC-8: Gravel Filter Berms
BMP SC-13: Straw Wattles
BMP SC-14: Sediment Trap
BMP SC-15: Temporary Sediment Pond
BMP SC-16: Construction Stormwater Filtration

**k. Suggested BMPs for Minimum Requirement No. 11: Maintain BMPs**

Sediment control BMPs shall be inspected by project personnel every day when there is a discharge from the site (stormwater or non-stormwater), and at least weekly when there is no discharge.
Repair or replace BMP as necessary to ensure that BMP is performing as intended.
Remove BMPs within 30 days after final site stabilization is achieved or when they are no longer needed.

**l. Suggested BMPs for Minimum Requirement No. 12: Manage the Project**

Inspection and Monitoring of BMPs
Phasing of Construction
Prepare and follow Construction SWPPP
BMP EC-1: Grading Season and Practices
BMP MC-1: Concrete Handling
BMP MC – 2: Saw cutting and Surface Pollution Prevention
BMP MC-3: Materials Management

## 13.4 CHECKLIST FOR THE CONSTRUCTION SWPPP

The Construction SWPPP consists of two parts: a narrative and the drawings. The following two sections describe the contents of the narrative and the drawings. A checklist is included that can be used as a quick reference to determine if all the major items are included in the Construction SWPPP.

### 13.4.1 Narrative

Twelve Minimum Requirements – Describe how the Construction SWPPP addresses each of the twelve minimum requirements. Include the type and location of BMPs used to satisfy the required element. If an element is not applicable to a project, provide a written justification for why it is not necessary.

Project description - Describe the nature and purpose of the construction project. Include the size of the project area, any increase in existing impervious area, the area disturbed, and the volumes of grading cut and fill that are proposed.

Existing site conditions - Describe the existing topography, vegetation, and drainage. Include a description of any structures or development on the parcel including the area of existing impervious surfaces.

Adjacent areas - Describe adjacent areas, including streams, wetlands, residential areas, and roads that might be affected by the construction project. Provide a description of the downstream drainage leading from the site to the receiving body of water. Also define the tributary upstream drainage area that may discharge runoff to the site.

Critical areas - Describe areas on or adjacent to the site that are classified as critical areas. Critical areas that receive runoff from the site shall be described up to ¼ mile away. The distance may be increased by the City Engineer. Describe special requirements for working near or within these areas.

Soil - Describe the soil on the site, giving such information as soil names, mapping unit, erodibility, settleability, permeability, depth, texture, and soil structure.

Potential erosion problem areas - Describe areas on the site that have potential erosion problems.

Construction phasing - Describe the construction sequence and any proposed construction phasing.

Construction schedule - Describe the construction schedule. If the schedule extends into the wet season, describe what activities will continue during the wet season and how the transport of sediment from the construction site to receiving waters will be prevented.

Financial/ownership responsibilities - Describe ownership and obligations for the project. Include bond forms and other evidence of financial

responsibility for environmental liabilities associated with construction.

Engineering calculations – Attach any calculations made for the design of such items as sediment ponds, diversions, and waterways, as well as calculations for runoff and stormwater detention design (if applicable). Engineering calculations must bear the signature and stamp of an engineer licensed in the state of Nevada.

Responsibility - The party responsible for the erosion control installation and maintenance shall be identified. Telephone and/or pager numbers should be included.

### 13.4.2 Drawings

a. Vicinity map - Provide a map locating the site in relation to the surrounding area and roads.

b. Site map - Provide a site map(s) showing the following features. The site map requirements may be met using multiple plan sheets for ease of legibility.

1. A legal description of the property boundaries or an illustration of property lines (including distances) in the drawings.
2. The direction of north in relation to the site.
3. Existing structures and roads, if present.
4. The descriptions and boundaries of the different soil types.
5. Areas of potential erosion problems.
6. Any on-site and adjacent critical areas, their buffers, FEMA base flood boundaries.
7. Existing contours and drainage basins and the direction of flow for the different drainage areas.
8. Final grade contours and developed condition drainage basins.
9. Areas that are to be cleared and graded.
10. Existing unique or valuable vegetation and the vegetation that is to be preserved.
11. Cut and fill slopes indicating top and bottom of slope catch lines.

12. Stockpile, waste storage, and vehicle storage/maintenance areas.

13. Estimated cut and fill quantities and the method of disposal for excess material.

c. Conveyance systems - Show on the site map the following temporary and permanent conveyance features:

1. Locations for swales, interceptor trenches, or ditches.

2. Drainage pipes, ditches, or cut-off trenches associated with erosion and sediment control and stormwater management.

3. Temporary and permanent pipe inverts and minimum slopes and cover.

4. Grades, dimensions, and direction of flow in all ditches, channels, swales, culverts, and pipe systems.

5. Details for perpetuating off-site runoff through the site, around disturbed areas.

6. Locations and outlets of any dewatering systems.

d. Detention Systems - Location of detention BMPs - Show on the site map the locations of stormwater detention BMPs.

e. Erosion and Sediment Control (ESC) Facilities - Show on the site map the following ESC facilities:

1. The location of sediment traps/ponds, pipes and structures.

2. Dimension trap/pond berm widths and inside and outside slopes.

3. The trap/pond storage required and the depth, length, and width dimensions.

4. Typical section views through trap/pond and outlet structure.

5. Typical details of gravel cone and standpipe, and/or other filtering devices.

6. Stabilization technique details for inlets and outlets.

7. Control/restrictor device location and details.

8. Mulch and/or recommended cover of berms and slopes.

9. Rock specifications and detail for rock check dam, if used.

10. Spacing for rock check dams as required.

11. Front and side sections of typical rock check dams.

12. The location, detail, and specification for silt fence or other perimeter protection.

13. The construction entrance location and a detail.

f. Detailed drawings - Any structural practices used that are not referenced in this manual or other local manuals should be explained and illustrated with detailed drawings.

g. Other pollutant BMPs - Indicate on the site map the location of BMPs to be used for the control of pollutants other than sediment.

h. Construction Notes - Notes addressing construction phasing and scheduling shall be included on the drawings.

**CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN CHECKLIST**

Project Name: _____
City Reference No. _____
Review Date: _____
On-site Inspection Review Date: _____
Construction SWPPP Reviewer: _____

## Section I – Construction SWPPP Narrative

### A. Construction Stormwater Pollution Prevention Elements

_____1. Describe how each of the Construction Stormwater Pollution Prevention Elements has been addressed through the Construction SWPPP.

_____2. Identify the type and location of BMPs used to satisfy the required element.

_____3. Written justification identifying the reason an element is not applicable to the proposal.

### B. Twelve Minimum Requirements - Construction Stormwater Pollution Prevention Plan

_____1. Mark Clearing Limits.
_____2. Establish Construction Access.
_____3. Control Flow Rates.
_____4. Install Sediment Controls.
_____5. Stabilize Soils.
_____6. Protect Slopes.
_____7. Protect Drain Inlets.
_____8. Stabilize Channels and Outlets.
_____9. Control Pollutants.
_____10. Control De-Watering.
_____11. Maintain BMPs
_____12. Manage the Project.

### C. Project Description

_____1. Total Project Area.
_____2. Total proposed impervious area.
_____3. Total proposed area to be disturbed.
_____4. Total volumes of proposed cuts/fill.

**Construction Stormwater Pollution Prevention Plan Checklist**

Project Name: _____
City Reference No. _____

## D. Existing Site Conditions

_____1. Description of the existing topography.
_____2. Description of the existing vegetation.
_____3. Description of the existing drainage.

## E. Adjacent Areas

1. Description of adjacent areas which may be affected by site disturbance

_____a. Streams
_____b. Wetlands
_____c. Residential Areas
_____d. Roads
_____e. Other

2. Description of the downstream drainage path leading from the site to the receiving body of water. (Minimum distance of 400 yards.)

3. Description of the upstream tributary drainage area that may discharge runoff to the site.

## F. Critical Areas

_____1. Description of critical areas that are on or adjacent to the site.
_____2. Description of special requirements for working in or near critical areas.

## G. Soils

_____1. Description of on-site soils.
_____a. Soil name(s)
_____b. Soil mapping unit

____ 2. Engineering Properties of on-site soils.
_____a. Erodibility
_____b. Settleability
_____c. Permeability
_____d. Depth
_____e. Texture
_____f. Soil Structure

**Construction Stormwater Pollution Prevention Plan Checklist**

Project Name: _____
City Reference No. _____

## H. Erosion Problem Areas

_____1. Description of potential erosion problems on site.
_____2. Description of sensitive on-site areas that need to be protected.

## I. Construction Phasing

_____1. Construction sequence
_____2. Construction phasing (if proposed)

## J. Construction Schedule

_____1. Provide a proposed construction schedule.
_____2. Provide names and phone number of contractors and sub-contractors.

## K. Financial/Ownership Responsibilities

_____1. Identify the property owner responsible for the initiation of bonds and/or other financial securities.
_____2. Describe bonds and/or other evidence of financial responsibility for liability associated with erosion and sedimentation impacts.

## L. Engineering Calculations

_____1. Provide Design Calculations.
_____a. Sediment Ponds/Traps
_____b. Diversions
_____c. Waterways
_____d. Runoff/Stormwater Detention Calculations
_____e. Upstream contributing flows

**Construction Stormwater Pollution Prevention Plan Checklist**

Project Name: _____
City Reference No. _____

## Section II - Erosion and Sediment Control Plans

### A. General

#### 1. General

_____a. Vicinity Map on cover sheet
_____b. Carson City Clearing and Grading Approval Block on cover sheet
_____c. Erosion and Sediment Control Notes

#### 2. Site Plan

_____a. Describe the subject property by showing the bearings and distances of all property lines.
_____b. North Arrow
_____c. Indicate boundaries of existing vegetation, e.g. tree lines, pasture areas, etc.
_____d. Identify and label areas of potential erosion problems.
_____e. Identify any on-site or adjacent critical areas and associated buffers.
_____f. Identify FEMA base flood boundaries (if applicable)
_____g. Show existing and proposed contours.
_____h. Indicate drainage basins and direction of flow for individual drainage areas. Indicate locations and flow rates for off site runoff entering the site.
_____i. Label final grade contours and identify developed condition drainage basins.
_____j. Delineate areas that are to be cleared and graded.
_____k. Show all cut and fill slopes indicating top and bottom of slope catch lines.

### B. Storm Water Detention & Conveyance

#### 1. Conveyance Systems

_____a. Designate locations for swales, interceptor trenches, or ditches.
_____b. Show all temporary and permanent drainage pipes, ditches, or cut-off trenches required for erosion and sediment control.
_____c. Provide minimum slope and cover for all temporary pipes or call out pipe inverts.
_____d. Show grades, dimensions, and direction of flow in all ditches, swales, culverts and pipes.

_____e. Provide details for bypassing off-site runoff around disturbed areas.
_____f. Indicate locations and outlets of any dewatering systems.

**2. Detention BMPs**

_____a. Identify location of detention BMPs.
_____b. Show all details of detention facilities.

**3. Erosion and Sediment Control Facilities**

_____a. Show the locations of sediment trap(s), pond(s), pipes and structures.
_____b. Dimension trap/pond berm widths and inside and outside pond slopes.
_____c. Indicate the trap/pond storage required and the depth, length, and width dimensions.
_____d. Provide typical section views through trap/pond and outlet structure.
_____e. Provide typical details of gravel cone and standpipe, and/or other filtering devices.
_____f. Detail stabilization techniques for outlet/inlet.
_____g. Detail control/restrictor device location and details.
_____h. Specify mulch and/or recommended cover of berms and slopes.
_____i. Provide rock specifications and detail for rock check dam(s), if applicable.
_____j. Specify spacing for rock check dams as required.
_____k. Provide front and side sections of typical rock check dams.
_____l. Indicate the locations and provide details and specifications for silt fence.
_____m. Locate the construction entrance and provide a detail.

**3. Detailed Drawings**

_____a. Any structural practices used that are not referenced in the Development Standards Manual shall be explained and illustrated with detailed drawings.
_____b. Any BMPs used that are not contained in the Carson City Standard Details shall be illustrated with detailed drawings.

**4. Other Pollutant BMPs**

_____a. Indicate on the site plan the location of BMPs to be used for the control of pollutants other than sediment, e.g. concrete wash water.
_____b. Identify all of the chemicals, solvents and paints to be used on the site and show where they will be stored.

5. **Monitoring Locations**

_____a. Indicate on the site plan any water quality sampling locations to be used for monitoring water quality on the construction site.

## 13.5 BEST MANAGEMENT PRACTICES

The following BMPs can be used on construction sites to reduce or prevent erosion, reduce or prevent the release of sediments to off-site areas and to prevention storm water pollution. The BMPs are grouped according to the main categories of;

- Erosion Control BMPs
- Sediment Control BMPs
- Management Source Control BMPs

The purpose of this compilation of BMPs is to provide general guidance for selecting and implementing BMPs that will eliminate or reduce the discharge of pollutants from construction sites. Many state, federal and local agencies and non-governmental groups have developed construction site BMPs handbooks. A list of the BMPs guidance and handbooks that were reviewed for this manual are listed below. The BMPs presented here include some of the most commonly used construction BMPs.

- *California Stormwater BMP Handbook, Construction,* California Stormwater Quality Association, 2003
- *Construction Best Management Practices, Drainage Criteria Manual, Volume 3,* Urban Drainage and Flood Control District, 1999
- *Handbook of Best Management Practices,* Nevada Division of Environmental Protection and Nevada Division of Conservation Districts, 1994
- *Regional Road Maintenance Endangered Species Act, Program Guidelines,* Regional Road Maintenance Technical Working Group, 2003
- *Stormwater BMP Menu,* U.S. Environmental Protection Agency
- *Stormwater Management Design Manual*, City of Boise
- *Stormwater Management for Eastern Washington, Chapter 7, Construction Stormwater Pollution Prevention,* Washington Department of Ecology, 2003
- *Stormwater Management Manual for Western Washington,* Washington Department of Ecology, 2001
- *Surface Water Design Manual,* King County, Washington Surface Water Management Division, 1998
- *Truckee Meadows Construction Site Best Management Practices Handbook,* Truckee Meadows Regional Stormwater Quality Management Program, 2003

### 13.5.1 BMP SELECTION

Excessive erosion and sedimentation are among the most visible water quality impacts due to construction activities. Other water quality impacts caused by construction activities include the discharge of gross pollutants such as metals, paint, nutrients, plant debris, pesticides, construction chemicals, trash, debris and floatables into storm water. Table 1 presents a matrix that identifies the most common source of storm water pollutants at construction sites.

| Table 1<br>Construction Activity Pollutants | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Construction Activity** | **Pollutants** | | | | | | |
| | **Sediment** | **Nutrients** | **Trace Metals** | **Pesticides** | **Oil, Grease, Fuels** | **Other Toxic Chemicals** | **Miscellaneous Waste** |
| **Construction Practices** | | | | | | | |
| Clearing and Grading Operations | X | | | | | X | |
| Dewatering Operations | X | | | | | | |
| Paving Operations | X | | | X | X | X | X |
| Structure Construction/Painting | | | X | | | X | X |
| **Material Management** | | | | | | | |
| Material Delivery and Storage | X | X | X | X | X | X | |
| Material Use | | X | X | X | X | X | |
| **Waste Management** | | | | | | | |
| Solid Waste | X | X | | | | | X |
| Hazardous Waste | | | | | | X | |
| Contaminated Spills | X | | | | | X | |
| Concrete Waste | | | | | | | X |
| Sanitary/Septic Waste | | | | | | | X |
| **Vehicle/Equipment Management** | | | | | | | |
| Vehicle/Equipment Fueling | | | | | | X | X |
| Vehicle/Equipment Maintenance | | | | | | X | X |

Based on: California Stormwater BMP Handbook, Construction, 2003

BMPs for erosion and sediment control must be selected to meet the BMP objectives based on site-specific conditions, construction activities, and cost. The goal of construction BMPs is to minimize the disturbed areas, stabilize disturbed areas and protect slopes and channels from erosion. Several considerations for selecting BMPs for contractor activities include:

Is it expected to rain? Selection of a BMP is different for the rainy season versus the dry season. Consider rescheduling activities until after the rains or perform in dry season.

How much water is being used for construction activities? The more water used the more likely that pollutants transported by this water will reach the drainage system or be transported off-site.

What are the site conditions? BMPs may differ depending on whether the activity is conducted on a slope or flat ground near a drainage structure or watercourse. Conducting activities away from certain sensitive areas will reduce the cost and inconvenience of implementing BMPs.

What about accidents? Controls for common activities should be established, and preparations should be made to allow for quick response to accidents or spills. In the event of a spill or exposure of construction compounds, what are the contingency plans for sampling the contaminated stormwater? Can the analysis be done in the field or should laboratory analysis be required? Are sample bottles available on-site, appropriated test strips, etc?

### 13.5.2 BMP MONITORING

All construction site BMPs must be monitored on a regular basis to ensure that the BMP is functioning as designed. The monitoring consists of visual inspection to determine whether the BMP was implemented and maintained according to the SWPPP. Site inspections can include:

**a. Contractor activity BMPs**

- Looking for evidence of spills and resulting clean-up procedures (e.g., supplies of spill cleanup materials)
- Verifying adequacy of trash receptacles
- Verifying waste disposal practices (e.g., recycle vs. hazardous waste bins)
- Examining integrity and use of containment structures
- Verifying use of employees education programs for the various activities
- Noting the location of activity (e.g., outdoor vs. indoor, concrete vs. grass)
- BMPs for any chemicals or fuels not addressed in the SWPPP must be developed

**b. Erosion and sediment control BMPs**

- Are erosion and sediment control BMPs installed properly? The SWPPP BMPs should include details or references to allow for the proper construction of structural or vegetative erosion and sediment control devices. The inspector should ensure that these systems are installed according to the SWPPP in the proper locations
- Are the BMPs effective? The effectiveness of the BMP would be based on the presence of sediment behind or within control devices, the presence of sediment downstream of the site, and signs of erosion in stabilized areas after a storm event
- Have drainage patterns changed? If the site has undergone significant grading operations, resulting in a change of drainage patterns, adjustment to the BMPs will likely be required to address this change. The inspectors shall determine the extent of changes to the drainage pattern and the necessity for additional or reconfigured BMPs
- Are areas stabilized as quickly as possible after completion of construction activities in an area? Disturbed active and inactive construction areas (inactive construction areas may be defined as areas

in which no construction activity will occur for a period of 30 days or longer) should be stabilized as soon as practical. If construction, climatological, or other site conditions do not allow stabilization, the SWPPP should define alternative approaches

- Are the BMPs properly maintained? Maintenance of erosion and sediment control BMPs is critical. Erosion controls should be installed as soon as practical after an area becomes inactive, and before the onset of rain. The capacity of sediment controls must be restored prior to the next rain event

### 13.5.3 BMP MAINTENANCE

The construction site should be inspected on a regular basis and during and after any storm generating runoff to determine maintenance requirements and general condition of the installed system. All maintenance related to a storm event should be completed within 48 hours of the storm event. The following maintenance tasks should be performed on a regular basis:

- Removal of sediment from barriers and sedimentation devices
- Replacement or repair of worn or damaged silt fence fabrics
- Replacement or repair of damaged structural controls
- Repair of damaged soil stabilization measures
- Other control maintenance as defined in each BMP fact sheet

### 13.5.4 EROSION AND SEDIMENT CONTROL BMPS

Table 2 lists the BMPs contained in this Division that are primarily installed to prevent or minimize erosion on the construction site by protecting the soil surface and preventing soil particles from being detached by rainfall, flowing water or wind. In addition, several of the erosion control BMPs are appropriately used to prevent erosion due to concentrated flow on off-site areas.

| TABLE 2 EROSION CONTROL BMPS | |
|---|---|
| EC-1 | Grading Season and Practices |
| EC-2 | Preserving Natural Vegetation |
| EC-3 | Buffer Zones |
| EC-4 | High Visibility Plastic or Metal Fence |
| EC-5 | Access Roads |
| EC-6 | Construction Road/Parking Area Stabilization |
| EC-7 | Dust and Wind Erosion Control |
| EC-8 | Level Spreader |
| EC-9 | Subsurface Drains |
| EC-10 | Pipe Slope Drains |
| EC-11 | Channel Lining |
| EC-12 | Grassed Waterways and Outlets |
| EC-13 | Outlet Protection |
| EC-14 | Check Dams |
| EC-15 | Wood Chip, Straw and Bark Mulches |
| EC-16 | Plastic Covering |
| EC-17 | Jute & Synthetic Netting and Blankets |
| EC-18 | Rock Riprap |
| EC-19 | Polyacrylamide (PAM) for Soil Erosion Protection |
| EC-20 | Topsoiling |
| EC-21 | Seeding Practices |
| EC-22 | Sodding |

Table 3 lists the sediment control BMPs contained in this Division. Sediment control BMPs are implemented to trap soil particles after they have been detached and moved by rain, flowing water or wind.

| **TABLE 3 SEDIMENT CONTROL BMPS** | |
|---|---|
| SC-1 | Stabilized Construction Entrance |
| SC-2 | Wheel Wash |
| SC-3 | Straw Bale Barrier |
| SC-4 | Storm Drain Inlet Protection |
| SC-5 | Sandbag Curb Inlet Sediment Barrier |
| SC-6 | Filter Strips |
| SC-7 | Silt Fence |
| SC-8 | Gravel Filter Berm |
| SC-9 | Gravel Bag Berm |
| SC-10 | Interceptor Dike and Swale |
| SC-11 | Brush Barrier |
| SC-12 | Willow Wattles |
| SC-13 | Straw Wattles |
| SC-14 | Sediment Trap |
| SC-15 | Temporary Sediment Pond |
| SC-16 | Construction Stormwater Filtration |

Table 4 lists the management source control BMPs contained in this manual. Management source control BMPs are implemented to prevent potential pollution generating materials from coming in contact with stormwater

| **TABLE 4 MANAGMENT SOURCE CONTROL BMPS** | |
|---|---|
| MC-1 | Concrete Handling |
| MC-2 | Sawcutting & Surfacing Pollution Prevention |
| MC-3 | Materials Management |

## A. EROSION CONTROL BMPS

### 1. BMP EC-1 GRADING SEASON AND PRACTICES

#### *Definition*

The grading season is determined by the local climate conditions. All grading, clearing, and excavation work should be conducted during this period in order to avoid climatic conditions that could increase the chances for erosion.

#### *Purpose*

To coordinate grading and construction activities such that bare and disturbed soil exposure is minimized during the winter snow, windy and rainy seasons.

#### *Applicability*

For construction or development projects in locations where there is an opportunity for snow or rain to occur to the extent that soils become saturated and surface soil erosion is possible.

#### *Planning Criteria*

Many counties and communities have established specific grading and construction seasons applicable to their local environment. Coordination with the local building department or public works department will clarify any regulatory requirements applicable to the development project.

#### *Methods and Materials*

The best time to begin construction is after the snow has melted. All grading and excavation work should be completed prior to setting in of winter. At that time, all building sites should be winterized. Grading should not take place during storm events, rain, or snow, and for the following period of time when the site is covered with snow or the soil is in a wet saturated, muddy, or unstable condition.

## 2. BMP EC-2: PRESERVING NATURAL VEGETATION

### *Purpose*

The purpose of preserving natural vegetation is to reduce erosion wherever practicable. Limiting site disturbance is the single most effective method for reducing erosion. Carefully planned preservation of existing trees, vines, shrubs, and grasses can protect soil from erosion.

### *Conditions of Use*

- Preservation of existing vegetation is suitable for use on most projects
- Natural vegetation should be preserved on steep slopes, near perennial and intermittent watercourses or swales, and on building sites in wooded areas
- Areas where Carson City or state regulations require preservation, e.g., wetland buffers, environmentally sensitive areas

### *Design and Installation Specifications*

Natural vegetation can be preserved in natural clumps or as individual trees, shrubs and vines. The preservation of individual plants is more difficult because heavy equipment is generally used to remove unwanted vegetation. The points to remember when attempting to save individual plants are:

- *Is the plant worth saving?* Consider the location, species, size, age, vigor, and the work involved. Local governments may also have ordinances to save natural vegetation and trees
- *Fence or clearly mark areas around trees that are to be saved.* It is preferable to keep ground disturbance away from the trees at least as far out as the drip line.

Plants need protection from three kinds of injuries:

- *Construction Equipment* - This injury can be above or below the ground level. Damage results from scarring, cutting of roots, and compaction of the soil. Placing a fenced buffer zone around plants to be saved prior to construction can prevent construction equipment injuries
- *Grade Changes* - Changing the natural ground level will alter grades, which affects the plant's ability to obtain the necessary air, water, and minerals. Minor fills usually do not cause problems although sensitivity between species does vary and should be checked. Trees can tolerate fill of 6 inches or less. For shrubs and other plants, the fill should be less. When there are major changes in grade, it may become necessary to supply air to the roots of plants. This can be done by placing a layer of gravel and a tile system over the roots before the fill is made. A tile system protects a tree from a raised grade. The tile system should be laid out on the original grade leading from a dry well around the tree trunk. The system should then be covered with small stones to allow air to circulate over the root area. Lowering the natural ground level can seriously damage trees and shrubs. The highest percentage

of the plant roots are in the upper 12 inches of the soil and cuts of only 2-3 inches can cause serious injury. To protect the roots it may be necessary to terrace the immediate area around the plants to be saved. If roots are exposed, construction of retaining walls may be needed to keep the soil in place. Plants can also be preserved by leaving them on an undisturbed, gently sloping mound. To increase the chances for survival, it is best to limit grade changes and other soil disturbances to areas outside the drip line of the plant

- *Excavations* - Protect trees and other plants when excavating for drain fields, power, water, and sewer lines. Where possible, the trenches should be routed around trees and large shrubs. When this is not possible, it is best to tunnel under them. This can be done with hand tools or with power augers. If it is not possible to route the trench around plants to be saved, then the following should be observed:
  - ✓ Cut as few roots as possible. When you have to cut, cut clean
  - ✓ Paint cut root ends with a wood dressing like asphalt base paint
  - ✓ Backfill the trench as soon as possible
  - ✓ Tunnel beneath root systems as close to the center of the main trunk to preserve most of the important feeder roots

***Maintenance Standards***

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed.

- Verify that protective measure remain in place. Restore damaged protection measures immediately
- Serious tree injuries shall be attended to by an arborist
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible
- Serrate soil that has been compacted over a tree's root zone by punching holes 12 inches deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 inches apart throughout the area of compacted soil under the tree crown
- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization

## 3. BMP EC-3: BUFFER ZONES

### *Purpose*

An undisturbed area or strip of natural vegetation or an established suitable planting that will provide a living filter to reduce soil erosion and runoff velocities.

### *Conditions of Use*

Natural buffer zones are used along streams, wetlands and other bodies of water that need protection from erosion and sedimentation. Vegetative buffer zones can be used to protect natural swales and can be incorporated into the natural landscaping of an area. Critical-areas buffer zones should not be used as sediment treatment areas. These areas shall remain completely undisturbed.

### *Design and Installation Specifications*

Preserving natural vegetation or plantings in clumps, blocks, or strips is generally the easiest and most successful method.

- Leave all unstable steep slopes in natural vegetation
- Mark clearing limits and keep all equipment and construction debris out of the natural areas. Steel construction fencing is the most effective method in protecting sensitive areas and buffers
- Alternatively, wire-backed silt fence on steel posts is marginally effective. Flagging alone is typically not effective
- Keep all excavations outside the drip line of trees and shrubs
- Do not push debris or extra soil into the buffer zone area because it will cause damage from burying and smothering
- Vegetative buffer zones for streams or other waterways shall be established by the local permitting authority or other state or federal permits or approvals

### *Maintenance Standards*

- Inspect the area frequently to make sure flagging remains in place and the area remains undisturbed

## 4. BMP EC-4: HIGH VISIBILITY PLASTIC OR METAL FENCE

### *Purpose*

Fencing is intended to: (1) restrict clearing to approved limits; (2) prevent disturbance of sensitive areas, their buffers, and other areas required to be left undisturbed; (3) limit construction traffic to designated construction entrances or roads; and, (4) protect areas where marking with survey tape may not provide adequate protection.

### *Conditions of Use*

To establish clearing limits, plastic or metal fence may be used:

- At the boundary of sensitive areas, their buffers, and other areas required to be left uncleared
- As necessary to control vehicle access to and on the site

### *Design and Installation Specifications*

- High visibility plastic fence shall be composed of a high-density polyethylene material and shall be at least four feet in height. Posts for the fencing shall be steel or wood and placed every 6 feet on center (maximum) or as needed to ensure rigidity. The fencing shall be fastened to the post every six inches with a polyethylene tie. On long continuous lengths of fencing, a tension wire or rope shall be used as a top stringer to prevent sagging between posts. The fence color shall be high visibility orange. The fence tensile strength shall be 360 lbs./ft. using the ASTM D4595 testing method
- Metal fences shall be designed and installed according to the manufacturer's specifications
- Metal fences shall be at least 3 feet high and must be highly visible
- Fences shall not be wired or stapled to trees

### *Maintenance Standards*

- If the fence has been damaged or visibility reduced, it shall be repaired or replaced immediately and visibility restored

## 5. BMP EC-5: ACCESS ROADS

### *Definition*

Roads to provide needed access to an area should be constructed in such a way that the quality of runoff water is preserved.

### *Purpose*

To provide a route for vehicle travel, for moving equipment, supplies, and products, and for providing access for proper operation and management of conservation enterprises without disturbing the quality of runoff water.

### *Applicability*

Where roads are needed to provide access from a county, state, or federal highway or to provide planned travel-ways within an area.

### *Planning Criteria*

1. *Location:* Roads should be located to serve the purpose intended and to facilitate the control and disposal of surface water.

2. *Gradient, Vertical, and Horizontal Alignment:* The gradient and alignment should be adapted to the development of which it is a part.

3. *Width:* The recommended minimum width of the road-bed is 14 feet for one-way traffic and 20 feet for two-way traffic. The tread width for two-way traffic should be increased approximately 5-feet for trailer traffic. The recommended minimum shoulder width is 2-feet on each side of the tread width. Widths less than recommended minimums may be used where topography or other natural conditions restrict the width.

4. *Side Slopes:* All cuts and fills should have side slopes that are stable for the soil or soil material involved. Typically side slopes should not be steeper than 2:1 (50% slope).

5. *Drainage:* Culverts, bridges, or grade dips should be provided at all natural drainage-ways. **Design of these structures should be conducted by a qualified engineer in keeping with sound engineering practices for the class of vehicle or equipment used on the road.**

   Roadside ditches should be adequate to provide surface drainage for the roadway and deep enough to serve as outlets for subsurface drainage.

6. *Erosion Control Measures:* Erosion control measures should be provided for roads, ditches, cut slopes, fill slopes, and cross drains.

7. *Surfacing:* Access roads should be given a wearing course or surface treatment when required for traffic needs, climate, erosion control, or dust control. The type of treatment will depend on local conditions, available materials, and the existing road base. Where these factors and the volume of traffic are not a problem, no special treatment of the surface is required. Sound engineering practices must be followed to ensure that the road will meet the requirements of its intended use.

8. *Intersection with Public Highways:* Traffic safety should be a prime factor in selecting the angle of intersection with public highways. Any access roads that connect to a state highway must be approved by the State Highway Department.

***Maintenance***

Roadways, drainage structures, and erosion control facilities must be maintained on an as needed basis given the site specifics of the access road to keep them operational. Proper and regular maintenance will minimize soil erosion and the degradation of surface and ground water resources.

***Effectiveness***

Proper installation and maintenance of access roads can be effective in reducing soil erosion and minimizing impacts to water quality.

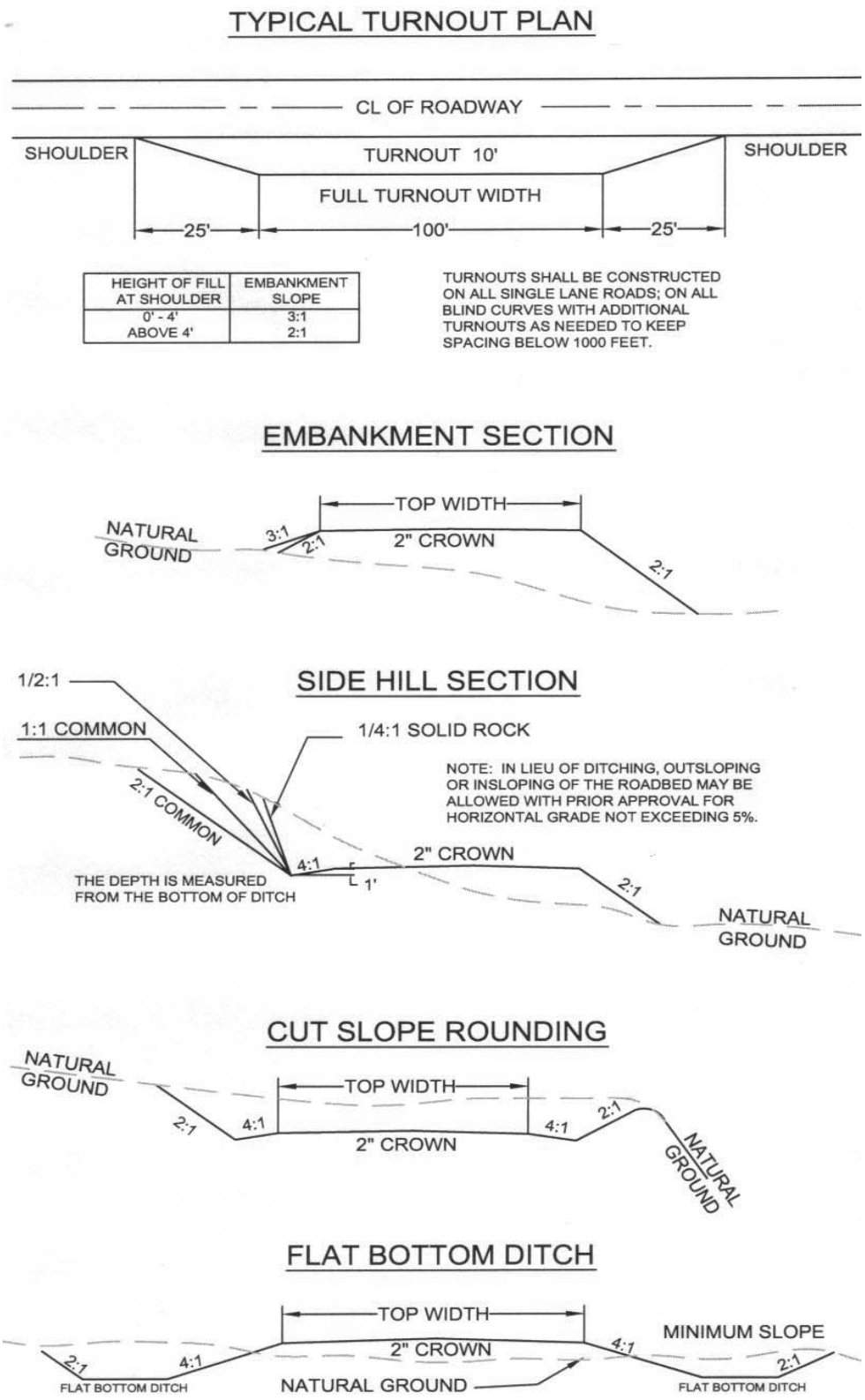



**FIGURE EC-5-1 TYPICAL ACCESS ROAD CROSS SECTIONS**

From: Handbook of Best Management Practices, Nevada Division of Environmental Protection and Nevada Division of Conservation Districts, 1994

## 6. BMP EC-6: CONSTRUCTION ROAD/PARKING AREA STABILIZATION

### *Purpose*

Stabilizing subdivision roads, parking areas, and other onsite vehicle transportation routes immediately after grading reduces erosion caused by construction traffic or runoff.

### *Conditions of Use*

- Roads or parking areas, whether permanent or temporary, shall be stabilized wherever they are constructed, for use by construction traffic
- Fencing (see BMPs EC-4) shall be installed, if necessary, to limit the access of vehicles to only those roads and parking areas that are stabilized

### *Design and Installation Specifications*

- Construct on level ground where possible
- On areas that will receive asphalt as part of the project, install the first lift as soon as possible
- A 6-inch depth of 2- to 4-inch crushed rock, gravel base, or crushed surfacing base course shall be applied immediately after grading or utility installation. A 4-inch course of asphalt treated base (ATB) may also be used, or the road/parking area may be paved. It may also be possible to use cement or calcium chloride for soil stabilization. If cement or cement kiln dust is used for road base stabilization, pH monitoring and BMPs are necessary to evaluate and minimize the effects on stormwater. If the area will not be used for permanent roads, parking areas, or structures, a 6-inch depth of hog fuel may also be used, but this is likely to require more maintenance. Whenever possible, construction roads and parking areas shall be placed on a firm, compacted subgrade
- Temporary road gradients shall not exceed 15 percent. Roadways shall be carefully graded to drain. Drainage ditches shall be provided on each side of the roadway in the case of a crowned section, or on one side in the case of a super-elevated section. Drainage ditches shall be directed to a sediment control BMP
- Rather than relying on ditches, it may also be possible to grade the road so that runoff sheet-flows into a heavily vegetated area with well-developed topsoil. Landscaped areas are not adequate. If this area has at least 50 feet of vegetation, then it is generally preferable to use the vegetation to treat runoff, rather than a sediment pond or trap. The 50 feet shall not include wetlands. If runoff is allowed to sheet flow through adjacent vegetated areas, it is vital to design the roadways and parking areas so that no concentrated runoff is created
- Storm drain inlets shall be protected to prevent sediment-laden water entering the storm drain system (see BMP SC-4)

***Maintenance Standards***

- Inspect stabilized areas regularly, especially after large storm events
- Crushed rock, gravel base, hog fuel, etc. shall be added as required to maintain a stable driving surface and to stabilize any areas that have eroded
- Following construction, these areas shall be restored to pre-construction condition or better to prevent future erosion

## 7. BMP EC-7: DUST AND WIND EROSION CONTROL

### *Purpose*

Dust control prevents wind transport of dust from disturbed soil surfaces onto roadways, drainage ways, and surface waters. Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

### *Conditions of Use*

In areas (including roadways) subject to surface and air movement of dust where on-site and off-site impacts to roadways, drainage ways, or surface waters are likely. Wind erosion control BMPs are suitable during the following construction activities:

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

### *Limitations*

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

### *Planning Criteria*

1. Plan and schedule work to open the least amount of land possible at one time. Surface disturbances should be stabilized or reclaimed before additional land is disturbed.

2. Install permanent erosion control measures as soon as construction or development work is completed.
3. The irrigation water supply should be developed before land is opened so that water is available for establishing vegetation.
4. When possible, schedule construction and development operations during months with the least wind erosion hazard. This is usually during later summer through fall.

***Design and Installation Specifications***

- Vegetate or mulch areas that will not receive vehicle traffic. In areas where planting, mulching, or paving is impractical, apply gravel or landscaping rock
- Limit dust generation by clearing only those areas where immediate activity will take place, leaving the remaining area(s) in the original condition, if stable. Maintain the original ground cover as long as practical
- Construct natural or artificial windbreaks or windscreens. These may be designed as enclosures for small dust sources
- Sprinkle the site with water until surface is wet. Repeat as needed. To prevent carryout of mud onto street, refer to Stabilized Construction Entrance (BMP SC-1)
- Irrigation water can be used for dust control. Irrigation systems should be installed as a first step on sites where dust control is a concern
- Spray exposed soil areas with a dust palliative, following the manufacturer's instructions and cautions regarding handling and application. Used oil is prohibited from use as a dust suppressant. Local governments may approve other dust palliatives such as calcium chloride or PAM
- PAM (BMP EC-19) added to water at a rate of 0.5 lbs. per 1,000 gallons of water per acre and applied from a water truck is more effective than water alone. This is due to the increased infiltration of water into the soil and reduced evaporation. In addition, small soil particles are bonded together and are not as easily transported by wind
- Adding PAM may actually reduce the quantity of water needed for dust control. Since the wholesale cost of PAM is about $ 4.00 per pound, this is an extremely cost effective dust control method
- Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust

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

Techniques that can be used for unpaved roads and lots include:

- Lower speed limits. High vehicle speed increases the amount of dust stirred up from unpaved roads and lots
- Upgrade the road surface strength by improving particle size, shape, and mineral types that make up the surface and base materials
- Add surface gravel to reduce the source of dust emission. Limit the amount of fine particles (those smaller than .075 mm) to 10 to 20 percent
- Use geotextile fabrics to increase the strength of new roads or roads undergoing reconstruction
- Encourage the use of alternate paved routes, if available
- Restrict use by tracked vehicles and heavy trucks to prevent damage to road surface and base
- Apply chemical dust suppressants using the admix method, blending the product with the top few inches of surface material. Suppressants may also be applied as surface treatments
- Pave unpaved permanent roads and other trafficked areas
- Use vacuum street sweepers
- Remove mud and other dirt promptly so it does not dry and then turn into dust
- Limit dust-causing work on windy days
- Contact your local Air Pollution Control Authority for guidance and training on other dust control measures. Compliance with the local Air Pollution Control Authority constitutes compliance with this BMP

Additional preventive measures include:

- Schedule construction activities to minimize exposed area
- Limit onsite vehicle traffic to 15 mph
- Control the number and activity of vehicles on a site at any given time
- Identify and stabilize key access points prior to commencement of construction
- Minimize the impact of dust by anticipating the direction of prevailing winds
- Direct most construction traffic to stabilized roadways within the project site
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution
- All distribution equipment should be equipped with a positive means of shutoff
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project
- If reclaimed wastewater is used, non-potable water should not be conveyed in tanks or drainpipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies
- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion control benefits
- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads
- Provide covers for haul trucks transporting materials that contribute to dust
- Provide for wet suppression or chemical stabilization of exposed soils
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas
- Stabilize inactive construction sites using vegetation or chemical stabilization methods

***Inspection and Maintenance***

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation
- Regular maintenance is critical to effective dust control, whether temporary or permanent measures are being utilized. Most dust control measures require frequent, often daily, or multiple times per day attention
- Regular water applications are necessary given specific site conditions. Mulches should be replaced or reapplied as necessary
- Vegetative cover should be established and maintained on surface disturbance areas Check areas protected to ensure coverage
- Keep windbreak and barriers in good conditions by repairing or replanting any openings
- Protect sensitive areas from additional surface disturbances

***Effectiveness***

Dust control will reduce sediment delivery by runoff waters, control degradation of water in nearby streams from windblown sediments and minimize the loss of topsoil.

## 8. BMP EC-8: LEVEL SPREADER

### *Purpose*

To convert concentrated flows into sheet flow for surface application at non-erosive velocities onto stabilized areas. To provide a temporary outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope.

### *Conditions of Use*

- Used when a concentrated flow of water needs to be dispersed over a large area with existing stable vegetation
- Items to consider are:
  1. What is the risk of erosion or damage if the flow may become concentrated?
  2. Is an easement required if discharged to adjoining property?
  3. Most of the flow should be as ground water and not as surface flow
  4. Is there an unstable area downstream that cannot accept additional ground water?
- Use only where the slopes are gentle, the water volume is relatively low, and the soil will adsorb most of the low flow events

### *Planning Criteria*

Detailed design is not required, but extreme care must be used during construction to ensure that the outlet lip is exactly level and uniform from end to end. Failure to meet these requirements will cause concentrated flow and consequent erosion of the stabilized area. The excavation for the spreader should be on well-stabilized soils (vegetated or rock armored).

Determine through topographical mapping the length and degree of slope, contributing watershed and associated drainage ways. Baseline soils data should be gathered and analyzed for erodability.

### *Design and Installation Specifications*

- Use above undisturbed areas that are stabilized by existing vegetation
- Runoff to the spreader should be from areas that have been stabilized to eliminate sediment buildup in the spreader
- If the level spreader has any low points, flow will concentrate, create channels and may cause erosion
- Discharge area below the outlet must be uniform with a slope of less than 5H: 1V
- Outlet to be constructed level in a stable, undisturbed soil profile (not on fill)
- The runoff shall not concentrate after release unless intercepted by another downstream measure
- The grade of the channel for the last 20 feet of the dike or interceptor entering the level spreader shall be less than or equal to 1 percent. The grade of the level spreader shall be 0 percent to ensure uniform spreading of storm runoff

- A 6-inch high gravel berm placed across the level lip shall consist of washed crushed rock, 2- to 4-inch or 3/4-inch to 1½-inch size
- The spreader length shall be determined by estimating the peak flow expected from the 10-year, 24-hour design storm. The length of the spreader shall be a minimum of 15 feet for 0.1 cfs and shall be 10 feet for each 0.1 cfs there after to a maximum of 0.5 cfs per spreader. Use multiple spreaders for higher flows
- The width of the spreader should be at least 6 feet
- The depth of the spreader as measured from the lip should be at least 6 inches and it should be uniform across the entire length
- Level spreaders shall be setback from the property line unless there is an easement for flow
- Level spreaders, when installed every so often in grassy swales, keep the flows from concentrating. Materials that can be used include sand bags, lumber, logs, concrete, and pipe. To function properly, the material needs to be installed level and on contour

***Maintenance Standards***

- The spreader should be inspected and repaired as necessary after every runoff event to ensure that it is functioning correctly
- Remove sediment as necessary
- The contractor should avoid the placement of any material on the structure and should prevent construction traffic from crossing over the structure
- If the spreader is damaged by construction traffic, it shall be immediately repaired

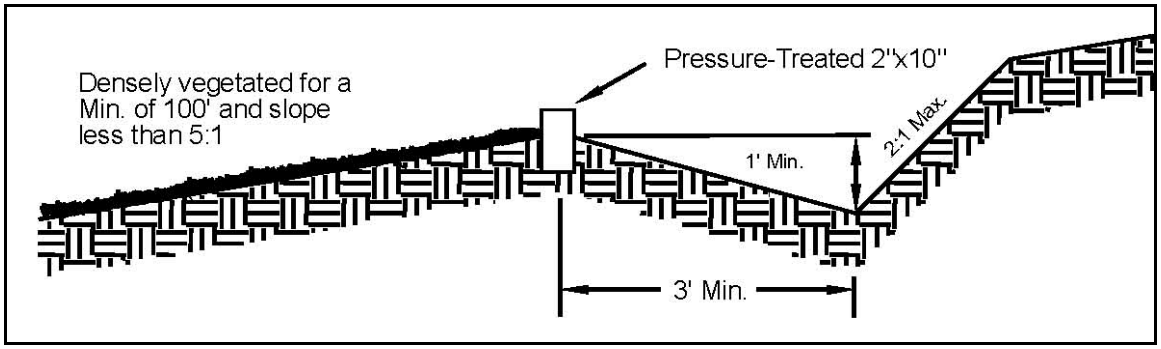



**FIGURE EC-8-1 CROSS SECTION OF LEVEL SPREADER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

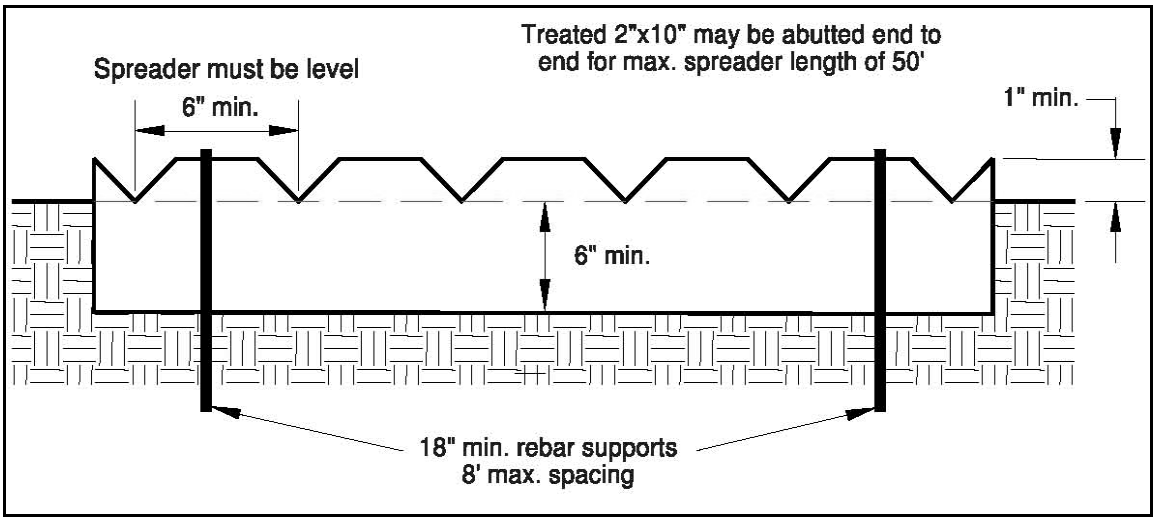



**FIGURE EC-8-2 DETAIL OF LEVEL SPREADER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 9. BMP EC-9: SUBSURFACE DRAINS

### *Purpose*

To intercept, collect, and convey ground water to a satisfactory outlet, using a perforated pipe or conduit below the ground surface. Subsurface drains are also known as "french drains." The perforated pipe provides a dewatering mechanism to drain excessively wet soils, provides a stable base for construction, improves stability of structures with shallow foundations, and reduces hydrostatic pressure to improve slope stability.

### *Conditions of Use*

Use when excessive water must be removed from the soil. The soil permeability, depth to water table and impervious layers are all factors which may govern the use of subsurface drains.

### *Design and Installation Specifications*

- *Relief drains* are used either to lower the water table in large, relatively flat areas, improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a grid pattern, a herringbone pattern, or a random pattern
- *Interceptor drains* are used to remove excess ground water from a slope, stabilize steep slopes, and lower the water table immediately below a slope to prevent the soil from becoming saturated. They are installed perpendicular to a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout
- *Depth and spacing of interceptor drains* - The depth of an interceptor drain is determined primarily by the depth to which the water table is to be lowered or the depth to a confining layer. For practical reasons, the maximum depth is usually limited to 6 feet, with a minimum cover of 2 feet to protect the conduit
- The soil should have depth and sufficient permeability to permit installation of an effective drainage system at a depth of 2 to 6 feet
- An adequate outlet for the drainage system must be available either by gravity or by pumping
- The quantity and quality of discharge needs to be accounted for in the receiving stream (additional detention may be required)
- This standard does not apply to subsurface drains for building foundations or deep excavations
- The capacity of an interceptor drain is determined by calculating the maximum rate of ground water flow to be intercepted. Therefore, it is good practice to make complete subsurface investigations, including hydraulic conductivity of the soil, before designing a subsurface drainage system
- *Size of drain* - Size subsurface drains to carry the required capacity without pressure flow. Minimum diameter for a subsurface drain is 4 inches
- The minimum velocity required to prevent silting is 1.4 ft./sec. The line shall be graded to achieve this velocity at a minimum. The maximum allowable velocity

using a sand-gravel filter or envelope is 9 ft/sec. Filter material and fabric shall be used around all drains for proper bedding and filtration of fine materials. Envelopes and filters should surround the drain to a minimum of 3-inch thickness

- The outlet of the subsurface drain shall empty into a sediment pond through a catch basin. If free of sediment, it can then empty into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining
- The trench shall be constructed on a continuous grade with no reverse grades or low spots
- Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material
- Backfilling shall be done immediately after placement of the pipe. No sections of pipe shall remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drainpipe is not displaced or damaged
- Do not install permanent drains near trees to avoid the tree roots that tend to clog the line. Use solid pipe with watertight connections where it is necessary to pass a subsurface drainage system through a stand of trees
- *Outlet* - Ensure that the outlet of a drain empties into a channel or other watercourse above the normal water level
- Secure an animal guard to the outlet end of the pipe to keep out rodents
- Use outlet pipe of corrugated metal, cast iron, or heavy-duty plastic without perforations and at least 10 feet long. Do not use an envelope or filter material around the outlet pipe, and bury at least two-thirds of the pipe length
- When outlet velocities exceed those allowable for the receiving stream, outlet protection must be provided

***Maintenance Standards***

- Subsurface drains shall be checked periodically to ensure that they are free-flowing and not clogged with sediment or roots
- The outlet shall be kept clean and free of debris
- Surface inlets shall be kept open and free of sediment and other debris
- Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees as a last resort. Drain placement should be planned to minimize this problem
- Where drains are crossed by heavy vehicles, the line shall be checked to ensure that it is not crushed

## 10. BMP EC-10: PIPE SLOPE DRAINS

### *Purpose*

A slope drain is a pipe used to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device, or stabilized area. Slope drains are used with earth dikes and drainage ditches to intercept and direct surface flow away from slope areas to protect cut or fill slopes.

### *Conditions of Use*

- Pipe slope drains should be used when a temporary or permanent stormwater conveyance is needed to move the water down a steep slope to avoid erosion
- Drainage for top of slope diversion dikes or swales
- Drainage for top of cut and fill slopes where water can accumulate
- Emergency spillway for a sediment basin
- Collect clean runoff from plastic sheeting and direct it away from exposed soil
- Installed in conjunction with silt fence to drain collected water to a controlled area
- Used to divert small seasonal streams away from construction. They have been used successfully on culvert replacement and extension jobs. Large flex pipe can be used on larger streams during culvert removal, repair, or replacement
- Connected to existing down spouts and roof drains and used to divert water away from work areas during building renovation, demolition, and construction projects There are several commercially available collectors that are attached to the pipe inlet and help prevent erosion at the inlet

### *Design and Installation Specifications*

- Permanent structures included in the project plans can often serve as construction BMPs if implemented early. However, the permanent structure must meet or exceed the criteria for the temporary structure
- Size the pipe to convey the flow. The capacity for temporary drains shall be sufficient to handle the peak flow from a 10-year, 24-hour storm event. Permanent pipe slope drains shall be sized for the 25-year, 24-hour peak flow
- Use care in clearing vegetated slopes for installation
- Re-establish cover immediately on areas disturbed by installation
- Use temporary drains on new cut or fill slopes
- Use diversion dikes or swales to collect water at the top of the slope
- Install slope drains perpendicular to slope contours
- Ensure that the entrance area is stable and large enough to direct flow into the pipe
- The entrance shall consist of a standard flared end section for culverts 12 inches and larger with a minimum 6-inch metal toe plate to prevent runoff from undercutting the pipe inlet. The slope of the entrance shall be at least 3 percent. Sand bags may also be used at pipe entrances as a temporary measure

- Debris racks are recommended at the inlet. Debris racks located several feet upstream of the inlet can usually be larger than racks at the inlet, and thus provide enhanced debris protection and less plugging
- Safety racks are recommended at the inlet and outlet of pipes where children or animals could become trapped
- The soil around and under the pipe and entrance section shall be thoroughly compacted to prevent undercutting and gully erosion
- The flared inlet section shall be securely connected to the slope drain and have watertight connecting bands
- Slope drain sections shall be securely fastened together, fused or have gasketed watertight fittings, and shall be securely anchored into the soil
- Thrust blocks should be installed anytime 90 degree bends are utilized. Depending on size of pipe and flow, these can be constructed with sand bags, straw bales staked in place, "t" posts and wire, or ecology blocks
- Pipe needs to be secured along its full length to prevent movement. This can be done with steel "t" posts and wire. A post is installed on each side of the pipe and the pipe is wired to them. This should be done every 10-20 feet of pipe length or so, depending on the size of the pipe and quantity of water to diverted
- Interceptor dikes shall be used to direct runoff into a slope drain. The height of the dike shall be at least 1 foot higher at all points than the top of the inlet pipe
- The area below the outlet must be stabilized with a riprap apron (see BMP EC-13 Outlet Protection, for the appropriate outlet material)
- If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility
- Recommended materials include both metal and plastic pipe, either corrugated or smooth wall

***Maintenance Standards***

- Check inlet and outlet points regularly, especially after storms
- The inlet should be free of undercutting, and no water should be going around the point of entry. If there are problems, the headwall should be reinforced with compacted earth or sand bags
- The outlet point should be free of erosion and installed with appropriate outlet protection
- For permanent installations, inspect pipe periodically for vandalism and physical distress such as slides and wind-throw
- Normally the pipe slope is so steep that clogging is not a problem with smooth wall pipe, however, debris may become lodged in the pipe

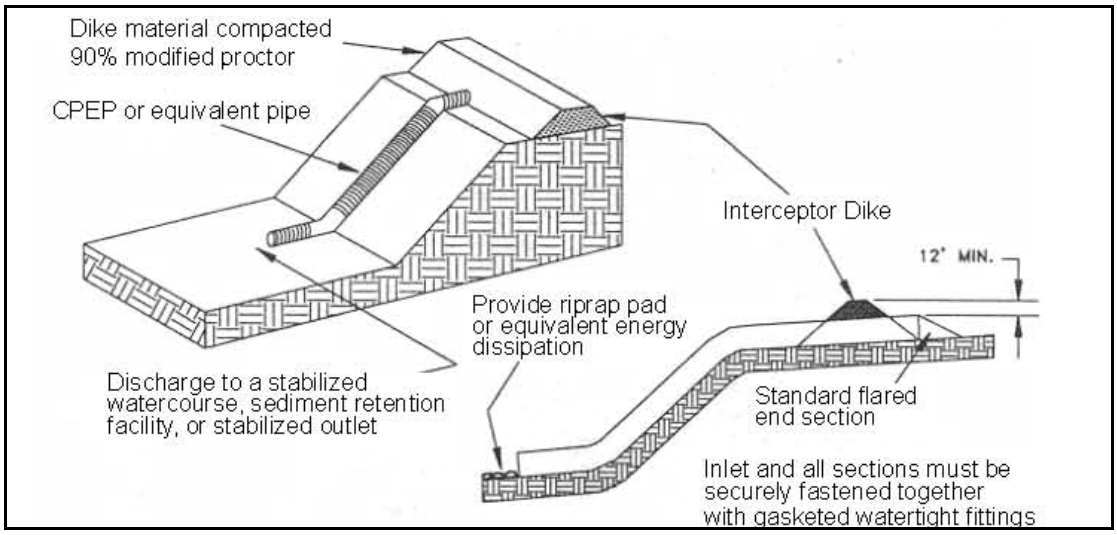



**FIGURE EC-10-1 PIPE SLOPE DRAIN**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 11. BMP EC-11: CHANNEL LINING

### *Purpose*

To protect erodible channels by providing a channel liner using either blankets or riprap.

### *Conditions of Use*

- When natural soils or vegetated stabilized soils in a channel are not adequate to prevent channel erosion
- When a permanent ditch or pipe system is to be installed and a temporary measure is needed
- In almost all cases, synthetic and organic coconut blankets are more effective than riprap for protecting channels from erosion. Blankets can be used with and without vegetation. Blanketed channels can be designed to handle any expected flow and longevity requirement. Some synthetic blankets have a predicted life span of 50 years or more, even in sunlight
- Other reasons why blankets are better than rock include the availability of blankets over rock. Blankets can be delivered anywhere. Rock requires the use of dump trucks to haul and heavy equipment to place. Blankets usually only require laborers with hand tools, and sometimes a backhoe
- The Federal Highway Administration recommends not using flexible liners whenever the slope exceeds 10 percent or the shear stress exceeds 8 lbs/ft2

### *Design and Installation*

- See EC-17 for information on blankets
- Disturbance of areas where riprap is to be placed should be undertaken only when final preparation and placement of the riprap can follow immediately behind the initial disturbance. Where riprap is used for outlet protection, the riprap should be placed before or in conjunction with the construction of the pipe or channel so that it is in place when the pipe or channel begins to operate
- Determine the riprap size that will be stable under the flow conditions. Based on riprap gradations actually available in the area, select the size or sizes that equal or exceed the minimum size. The possibility of drainage structure damage by children shall be considered in selecting a riprap size, especially if there is nearby water or a gully in which to toss the stones
- Stone for riprap shall consist of fieldstone or quarry stone of approximately rectangular shape. The stone shall be hard and angular and of such quality that it will not disintegrate on exposure to water or weathering and it shall be suitable in all respects for the purpose intended
- Rubble concrete may be used provided it has a density of at least 150 pounds per cubic foot, and otherwise meets the requirement of this standard and specification
- A lining of engineering filter fabric (geotextile) shall be placed between the riprap and the underlying soil surface to prevent soil movement into or through the riprap. The geotextile should be keyed in at the top of the bank

- Filter fabric shall not be used on slopes greater than 1-1/2:1 as slippage may occur
- Filter fabric should be used in conjunction with a layer of coarse aggregate (granular filter blanket) when the riprap to be placed is 12 inches and larger

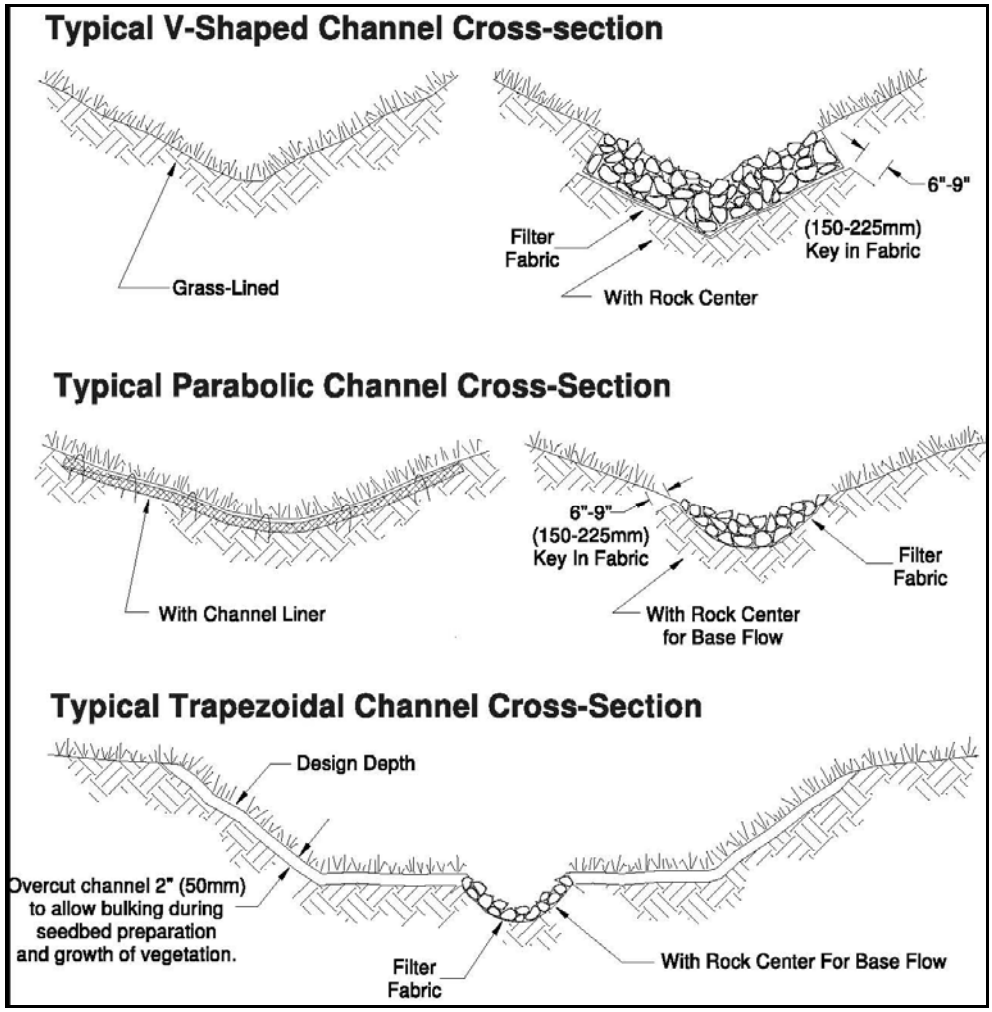



**FIGURE EC-11-1 TYPICAL GRASS-LINED CHANNELS**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

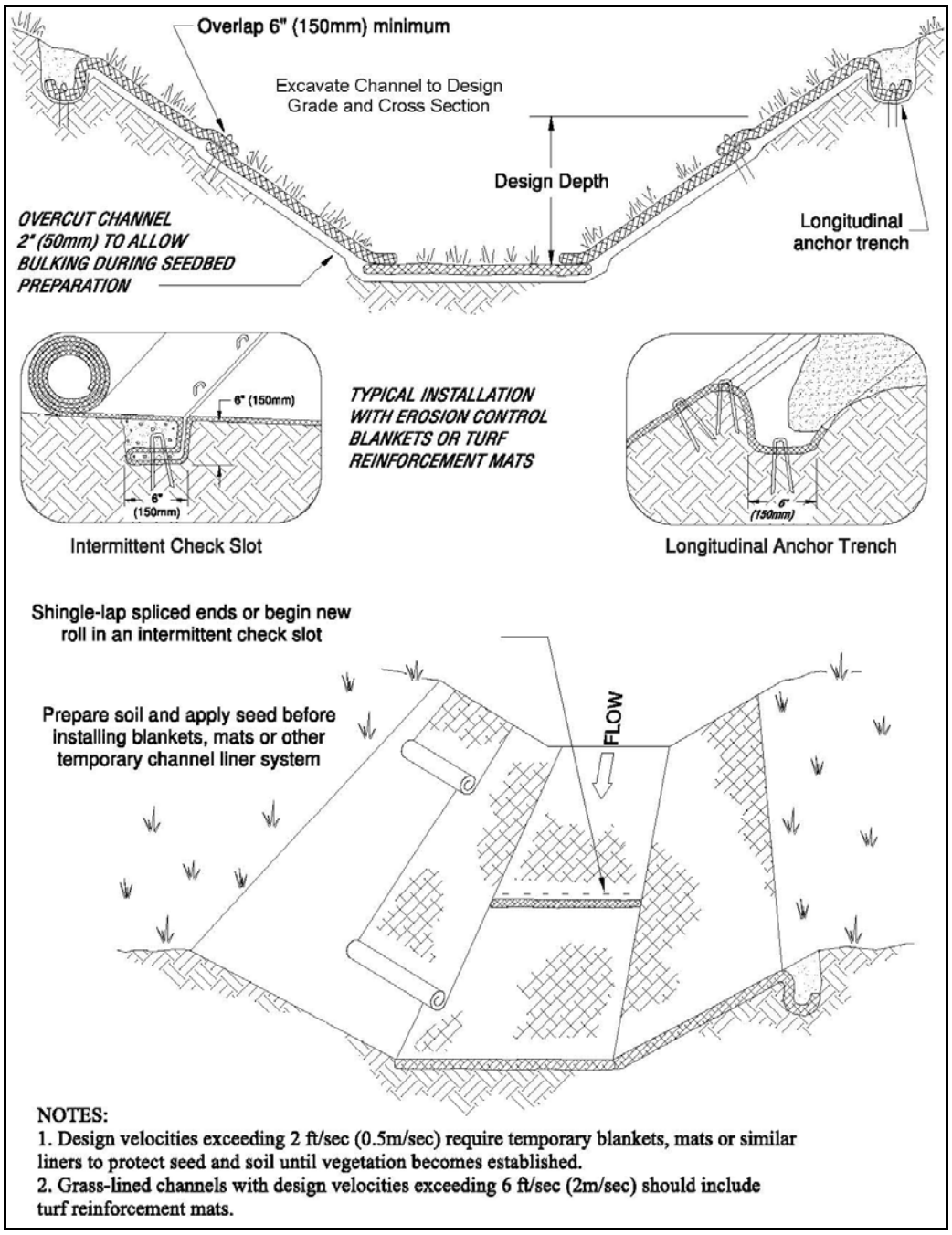



**FIGURE EC-11-2 TEMPORARY CHANNEL LINERS**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 12. BMP EC-12: GRASSED WATERWAYS AND OUTLETS

### *Purpose*

A grassed waterway is a natural or constructed waterway or outlet with a vegetative cover of adapted grasses for safe disposal of runoff water without erosion.

### *Conditions of Use*

- This practice applies to construction sites where concentrated runoff needs to be contained to prevent erosion or flooding and where soil and site conditions are suitable for establishing adequate grass cover
- When channel slopes are generally less than 5 percent and space is available for a relatively large cross section
- Typical uses include roadside ditches, channels at property boundaries, outlets for diversions, and other channels and drainage ditches in low areas
- Channels that will be vegetated should be installed before major earthwork and hydroseeded with a bonded fiber mulch (BFM). The vegetation should be well established (i.e., 75 percent cover) before water is allowed to flow in the ditch. With channels that will have high flows, erosion control blankets should be installed over the hydroseed. If vegetation cannot be established from seed before water is allowed in the ditch, sod should be installed in the bottom of the ditch in lieu of hydromulch and blankets
- The grass species selected must be appropriate for the Carson City area. Moisture from natural precipitation or irrigation must be adequate to establish and maintain good grass cover

### *Design and Installation Specifications*

- Locate the channel where it can conform to the topography and other features such as roads
- Locate them to use natural drainage systems to the greatest extent possible
- Avoid sharp changes in alignment or bends and changes in grade
- Do not reshape the landscape to fit the drainage channel
- Design velocities are to be below 5 ft/sec.; however, the design velocity should be based on soil conditions, type of vegetation, and method of establishment
- An **established** grass or vegetated lining is required before the channel can be used to convey stormwater, unless stabilized with nets or blankets
- If design velocity of a channel to be vegetated by seeding exceeds 2 ft/sec, a temporary channel liner is required. Geotextile or special mulch protection such as fiberglass roving or straw and netting provide stability until the vegetation is fully established
- Check dams shall be removed when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal

- If vegetation is established by sodding, the permissible velocity for established vegetation may be used and no temporary liner is needed
- Do not subject grass-lined channel to sedimentation from disturbed areas. Use sediment-trapping BMPs upstream of the channel
- **V-shaped grass channels** generally apply where the quantity of water is small, such as in short reaches along roadsides. The V-shaped cross section is least desirable because it is difficult to stabilize the bottom where velocities may be high
- **Trapezoidal grass channels** are used where runoff volumes are large and slope is low so that velocities are nonerosive to vegetated linings. (Note: it is difficult to construct small parabolic shaped channels)
- Provide outlet protection at culvert ends and at channel intersections
- Grass channels, at a minimum, should carry peak runoff for temporary construction drainage facilities from the 10-year, 24-hour storm without eroding. Where flood hazard exists, increase the capacity according to the potential damage
- Grassed channel side slopes generally are constructed 3:1 or flatter to aid in the establishment of vegetation and for maintenance
- Construct channels a minimum of 0.2 foot larger around the periphery to allow for soil bulking during seedbed preparations and sod buildup

***Maintenance Standards***

- During the establishment period, check grass-lined channels after every rainfall.
- After grass is established, periodically check the channel; check it after every heavy rainfall event. Immediately make repairs
- It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes
- Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel
- Protect waterways from excessive grazing and vehicle use
- Keep waterway clear of debris, brush, and excess growth
- Fertilize as needed to maintain grass stand and plant vigor
- Reseed any damaged or open areas in the grass cover

## 13. BMP EC-13: OUTLET PROTECTION

### *Purpose*

Outlet protection prevents scour at conveyance outlets and minimizes the potential for downstream erosion by reducing the velocity of concentrated stormwater flows.

### *Conditions of use*

Outlet protection is required at the outlets of all ponds, pipes, ditches, or other conveyances, and where runoff is conveyed to a natural or manmade drainage feature such as a stream, wetland, or ditch when discharge velocities and energies at the outlet are sufficient to erode the immediate downstream reach. The outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

### *Design and Installation Specifications*

- The receiving channel at the outlet of a culvert shall be protected from erosion by rock lining a minimum of 6 feet downstream and extending up the channel sides a minimum of 1–foot above the maximum tailwater elevation or 1-foot above the crown, whichever is higher. For large pipes (more than 18 inches in diameter), the outlet protection lining of the channel is lengthened to four times the diameter of the culvert
- Standard wing walls, and tapered outlets and paved channels should also be considered when appropriate for permanent culvert outlet protection. However, rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. Rock can also serve to trap sediment and reduce flow velocities
- Organic or synthetic erosion blankets, with or without vegetation, are usually more effective than rock, cheaper, and easier to install. Materials can be chosen using manufacturer product specifications. ASTM test results are available for most products and the designer can choose the correct material for the expected flow
- With low flows, vegetation (including sod) can be effective
- The following guidelines shall be used for riprap outlet protection:
    1. If the discharge velocity at the outlet is less than 5 fps (pipe slope less than 1 percent), use 2-inch to 8-inch riprap. Minimum thickness is 1-foot.
    2. For 5 to 10 fps discharge velocity at the outlet (pipe slope less than 3 percent), use 24-inch to 4-foot riprap. Minimum thickness is 2 feet.
    3. For outlets at the base of steep slope pipes (pipe slope greater than 3 percent), an engineered energy dissipater shall be used.
- Filter fabric or erosion control blankets should always be used under riprap to prevent scour and channel erosion
- For proper operation of apron, align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron

***Maintenance Standards***

- Inspect BMP prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately
- Clean energy dissipater if sediment builds up
- Remove temporary devices as soon as the surrounding drainage area has been stabilized or at the completion of construction

## 14. BMP EC-14: CHECK DAMS

### *Purpose*

Construction of small dams across a swale or ditch reduces the velocity of concentrated flow and dissipates energy at the check dam. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion. Check dams also help keep the flow spread evenly across the bottom of wide trapezoidal cross sections, thus helping to prevent scouring.

### *Conditions of Use*

- Where temporary channels or permanent channels are not yet vegetated, channel lining is infeasible, and velocity checks are required
- To promote sedimentation behind the dam
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales
- In small open channels that drain 10 acres or less
- In steep channels where stormwater runoff velocities exceed 5 ft/s
- In wide trapezoidal cross sections to keep flow spread evenly

### *Limitations*

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

### *Design and Installation Specifications*

- Whatever material is used, the dam should form a triangle when viewed from the side. This prevents undercutting as water flows over the face of the dam rather than falling directly onto the ditch bottom
- Check dams in association with sumps work more effectively at slowing flow and retaining sediment than just a check dam alone. A deep sump should be provided immediately upstream of the check dam
- In some cases, if carefully located and designed, check dams can remain as permanent installations with very minor regrading. They may be left as either spillways, in which case accumulated sediment would be graded and seeded, or as check dams to prevent further sediment from leaving the site
- Check dams can be constructed of either rock or pea-gravel filled bags. Numerous products are also available for this purpose. They tend to be re-usable, quick and easy to install, effective, and cost efficient

- Design check dams so that the capacity of the waterway remains adequate for the design flow
- Check dams should be placed perpendicular to the flow of water
- The maximum spacing between the dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam
- Keep the maximum height at 2 feet at the center of the dam
- Keep the center of the check dam at least 12 inches lower than the outer edges at natural ground elevation
- Keep the side slopes of the check dam at 2:1 or flatter
- Key the stone into the ditch banks and extend it beyond the abutments a minimum of 18 inches to avoid washouts from overflow around the ends of the dam
- Use filter fabric foundation under a rock or sand bag check dam. If a blanket ditch liner is used, this is not necessary. A piece of organic or synthetic blanket cut to fit will also work for this purpose
- Rock check dams shall be constructed of appropriately sized rock. The rock must be placed by hand or by mechanical means (no dumping of rock to form dam) to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges. The rock used must be large enough to stay in place given the expected design flow velocities through the channel
- In the case of grass-lined ditches and swales, all check dams and accumulated sediment shall be removed when the grass has matured sufficiently to protect the ditch or swale - unless the slope of the swale is greater than 4 percent. The area beneath the check dams shall be seeded and mulched immediately after dam removal
- Ensure that channel appurtenances, such as culvert entrances below check dams, are not subject to damage or blockage from displaced stones

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location
- If significant erosion occurs between dams, install a protective riprap liner in that portion of the channel
- Remove check dam and accumulated sediment when check dams are no longer needed

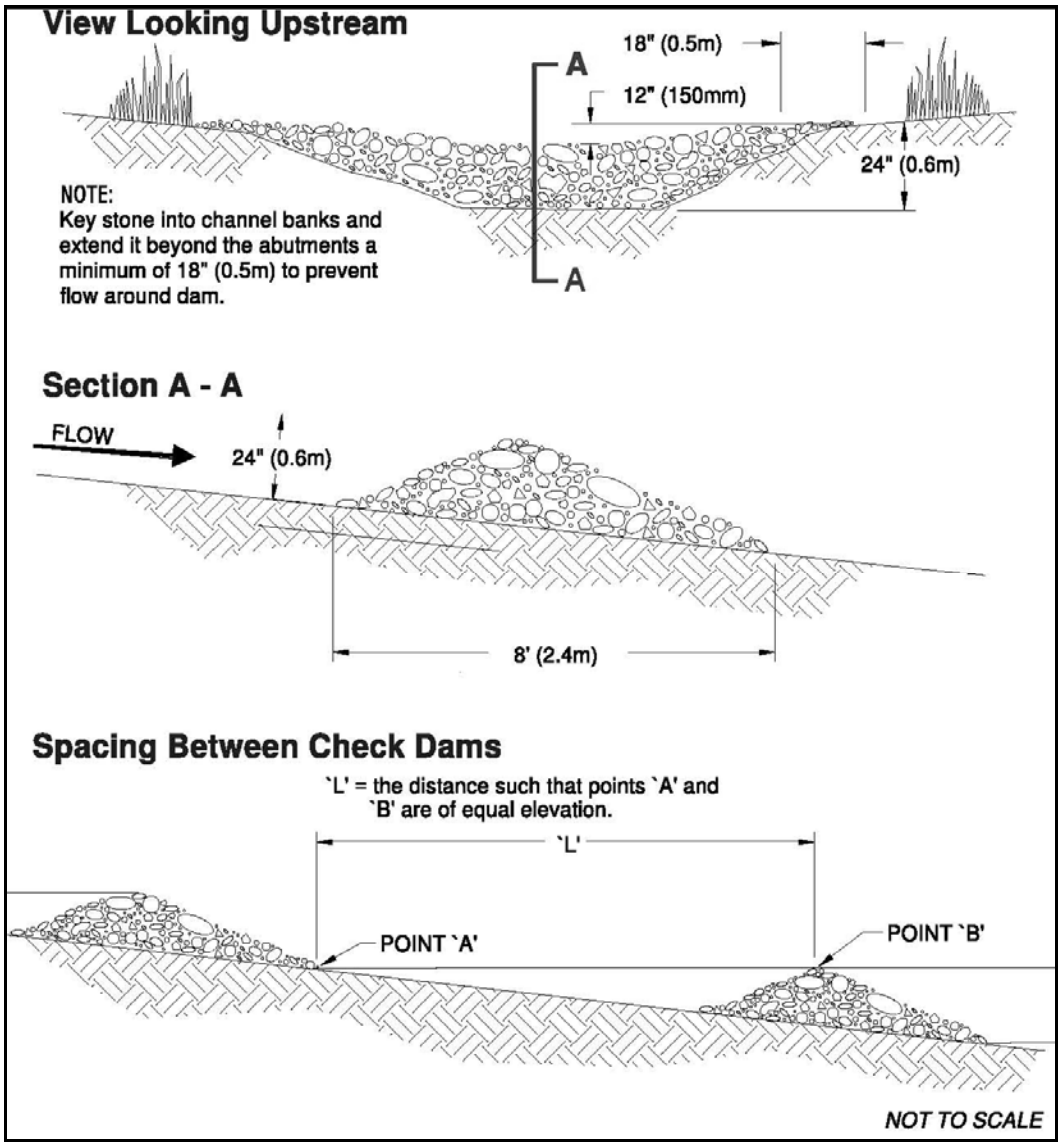



**FIGURE EC-14-1 CHECK DAMS**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 15. BMP EC-15: WOOD CHIP, STRAW, AND BARK MULCHES

### *Purpose*

Wood chips, straw, and bark mulches are used in landscape areas as ornamental decoration, soil stabilization, and areas recently seeded. Mulches are used to protect the soil surface from raindrop and irrigation impact, to create a microenvironment, to increase infiltration, to conserve moisture around tree and shrub plantings, to prevent soil compaction or crusting and to decrease runoff.

### *Applicability*

Bark and wood chip mulches as applicable to any landscape area where trees and shrubs have been planted. Straw mulch is utilized in new seedings to create a microenvironment, protect the soil surface and improve seed germination.

### *Planning Criteria*

Wood chips can be produced on-site by processing tree trunks, limbs, and branches in a wood chipper. Chips should range in size from 1/2- to 3-inches in length, 1/2- to 1-1/2-inches in width, and 1/3- to 1/2-inch in thickness. Chips produced from tree trimmings with significant quantities of leaves or small twigs are not effective as mulch. Straw mulches are widely used in revegetation projects. Straw must be anchored to the soil by one or more of the following methods to prevent wind blowing:

- Crimping, rolling, disking, or punching
- Covering with netting or
- Spraying with a chemical or tackifier

The steeper the slope or in wind prone areas, the greater the need for anchoring the straw. Bark requires a large tree source for on site processing or it can be purchased in varying sizes. The larger sizes, greater than 6-inches, withstand wind and are not as likely to move.

### *Methods and Materials*

Wood or bark chips may be processed from any clean, green, soft wood. A permeable landscape cloth should be placed over the soil surface and the chips blown or spread by hand to a uniform thickness, which fully covers the project area. Excess chips can be safely returned to the undisturbed forest floor to supplement existing organic cover. Chips should not be used on decomposed granite slopes over 30%.

Only clean wheat, barley, oat or rice straw should be utilized to prevent the spread of noxious weeds. Straw can be blown on or applied by hand to a uniform depth of approximately 2-inches or approximately 2 tons per acre. The straw must be anchored by an appropriate method immediately after application. Slopes steeper than 3:1 and areas

adjacent to streams or drainages should be netted to prevent sliding of material and material entering the watercourse.

***Maintenance***

Mulched areas must be regularly inspected for damage and remulched as necessary. Inspections and repairs should also be conducted after precipitation or storm events.

***Effectiveness***

Wood chip and bark mulches deteriorate slower than the wood fiber in hydromulches and, therefore, retain their effectiveness longer. Wood chips and bark are heavier than straw and less subject to removal by wind. Straw mulch is very effective if it is applied, anchored, and maintained properly.

## 16. BMP EC-16: PLASTIC COVERING

### *Purpose*

Plastic covering provides immediate, short-term erosion protection to slopes and disturbed areas.

### *Conditions of Use*

- Plastic covering may be used on disturbed areas that require cover measures for less than 30 days, except as stated below
- Plastic is particularly useful for protecting cut and fill slopes and stockpiles. Note: The relatively rapid breakdown of most polyethylene sheeting makes it unsuitable for long-term (greater than six months) applications
- Clear plastic sheeting can be used over newly-seeded areas to create a greenhouse effect and encourage grass growth if the hydroseed was installed too late in the season to establish 75 percent grass cover, or if the wet season started earlier than normal. Clear plastic should not be used for this purpose during the summer months because the resulting high temperatures can kill the grass
- Due to rapid runoff caused by plastic sheeting, this method shall not be used upslope of areas that might be adversely impacted by concentrated runoff. Such areas include steep and/or unstable slopes
- While plastic is inexpensive to purchase, the added cost of installation, maintenance, removal, and disposal make this an expensive material, up to $1.50-2.00 per square yard
- Whenever plastic is used to protect slopes, water collection measures must be installed at the base of the slope. These measures include plastic-covered berms, channels, and pipes used to convey clean rainwater away from bare soil and disturbed areas. At no time is clean runoff from a plastic covered slope to be mixed with dirty runoff from a project
- Other uses for plastic include:
  1. Temporary ditch liner.
  2. Pond liner in temporary sediment pond.
  3. Liner for bermed temporary fuel storage area if plastic is not reactive to the type of fuel being stored.
  4. Emergency slope protection during heavy rains and
  5. Temporary drainpipe ("elephant trunk") used to direct water.

### *Design and Installation Specifications*

- Plastic slope cover must be installed as follows:
  1. Run plastic up and down slope, not across slope.
  2. Plastic may be installed perpendicular to a slope if the slope length is less than 10 feet.
  3. Minimum of 8-inch overlap at seams.
  4. On long or wide slopes, or slopes subject to wind, all seams should be taped.

5. Place plastic into a small (12-inch wide by 6-inch deep) slot trench at the top of the slope and backfill with soil to keep water from flowing underneath.
6. Place sand filled burlap or geotextile bags every 3 to 6 feet along seams and pound a wooden stake through each to hold them in place.
7. Inspect plastic for rips, tears, and open seams regularly and repair immediately This prevents high velocity runoff from contacting bare soil that causes extreme erosion.
8. Sandbags may be lowered into place tied to ropes. However, all sandbags must be staked in place.

- Plastic sheeting shall have a minimum thickness of 0.06 millimeters (2.5 mils)
- If erosion at the toe of a slope is likely, a gravel berm, riprap, or other suitable protection shall be installed at the toe of the slope in order to reduce the velocity of runoff

***Maintenance Standards***

- Torn sheets must be replaced and open seams repaired
- If the plastic begins to deteriorate due to ultraviolet radiation; it must be completely removed and replaced
- When the plastic is no longer needed it shall be completely removed

## 17. BMP EC-17: JUTE & SYNTHETIC NETTING AND BLANKETS

### *Purpose*

Erosion control nets and blankets are intended to prevent erosion and hold seed and mulch in place on steep slopes and in channels so that vegetation can become well established. Netting provides stability to surface disturbances and reduces the soil erosion potential.

Nets (commonly called matting) are strands of material woven into an open, but high-tensile strength net (for example, coconut fiber matting). Blankets are strands of material that are not tightly woven, but instead form a layer of interlocking fibers, typically held together by a biodegradable or photodegradable netting (for example, excelsior or straw blankets). They generally have lower tensile strength than nets, but cover the ground more completely. Coir (coconut fiber) fabric comes as both nets and blankets.

Netting is applicable to any situation that straw or wood chip mulch is utilized. Typical applications include: revegetation of surface disturbances, road cut and fill slopes, ski slopes, mine reclamation sites, etc. Netting can be utilized in both temporary and permanent applications.

### *Conditions of Use*

Erosion control nets and blankets should be used:

- To aid permanent vegetated stabilization of slopes 2H: 1V or greater and with more than 10 feet of vertical relief
- For drainage ditches and swales (highly recommended). The application of appropriate netting or blanket to drainage ditches and swales can protect bare soil from channelized runoff while vegetation is established. Nets and blankets also can capture a great deal of sediment due to their open, porous structure. Synthetic nets and blankets can be used to permanently stabilize channels and may provide a cost-effective, environmentally preferable alternative to riprap. 100 percent synthetic blankets manufactured for use in ditches may be easily reused as temporary ditch liners

Disadvantages of blankets include:

- Surface preparation required
- On slopes steeper than 2.5:1, blanket installers may need to be roped and harnessed for safety
- They cost at least $4,000-6,000 per acre installed

Advantages of blankets include:

- Can be installed without mobilizing special equipment
- Can be installed by anyone with minimal training
- Can be installed in stages or phases as the project progresses
- Seed and fertilizer can be hand-placed by the installers as they progress down the slope

- Can be installed in any weather
- There are numerous types of blankets that can be designed with various parameters in mind. Those parameters include: fiber blend, mesh strength, longevity, biodegradability, cost, and availability

***Design and Installation Specifications***

- Seed and/or mulch the disturbed areas
- Starting above the mulched and/or seeded area, anchor the top end of the netting by burying it in a trench at least 4 inches deep by 8 inches wide; backfill and compact the excavated material into this trench
- The netting should extend beyond the edge of the mulched or seeded area at least 1 foot on the sides, and 3 feet at the top and bottom. Fasten with a row of wire stapes on 1-foot centers
- Roll the netting out, perpendicular with the slope and secure with staples on 3-foot centers. The "U" shaped staples should be 6 inches to 10 inches long, with a 1-inch crown. Longer staples should be used in loose or sandy soils
- Overlap netting at least 1 foot on the sides and secure with staples on 1-foot centers along the overlap
- Overlap the lower end of the uphill strip over the downhill strip at least 1 foot and secure with staples on 1 foot centers
- Continue adding strips of netting until the entire mulched area is covered and secured with staples
- The netting should be cut to fit around protruding rocks or other large objects, and tucked in around smaller rocks or objects preventing "bridging"

***Maintenance Standards***

- Good contact with the ground must be maintained, and erosion must not occur beneath the net or blanket
- Any areas of the net or blanket that are damaged or not in close contact with the ground shall be repaired and stapled
- If erosion occurs due to poorly controlled drainage, the problem shall be fixed and the eroded area protected

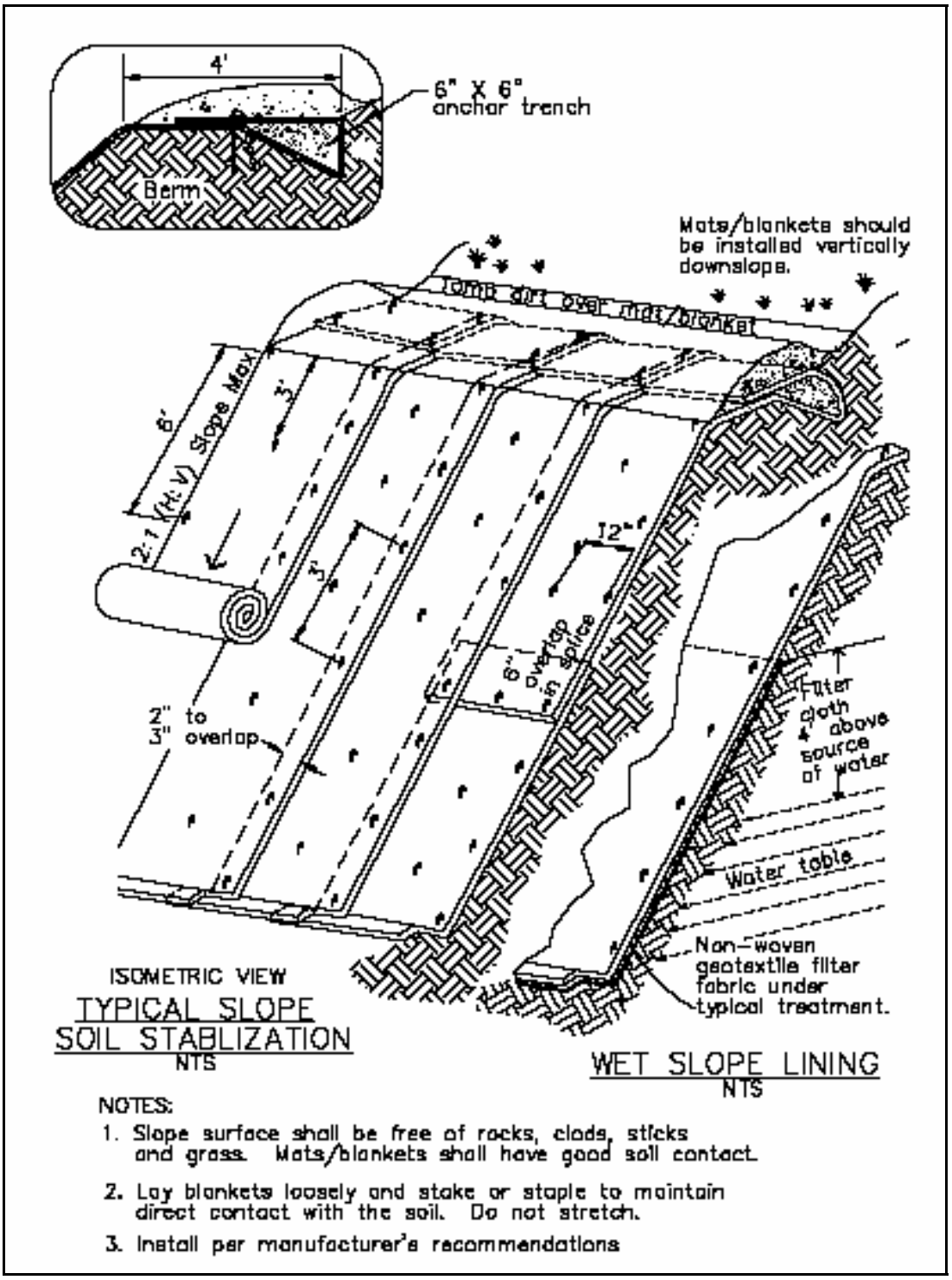



**FIGURE EC-17-1 TYPICAL INSTALLATION DETAIL**

From: California Stormwater BMP Handbook Construction, California Storm Water Quality Association, 2003

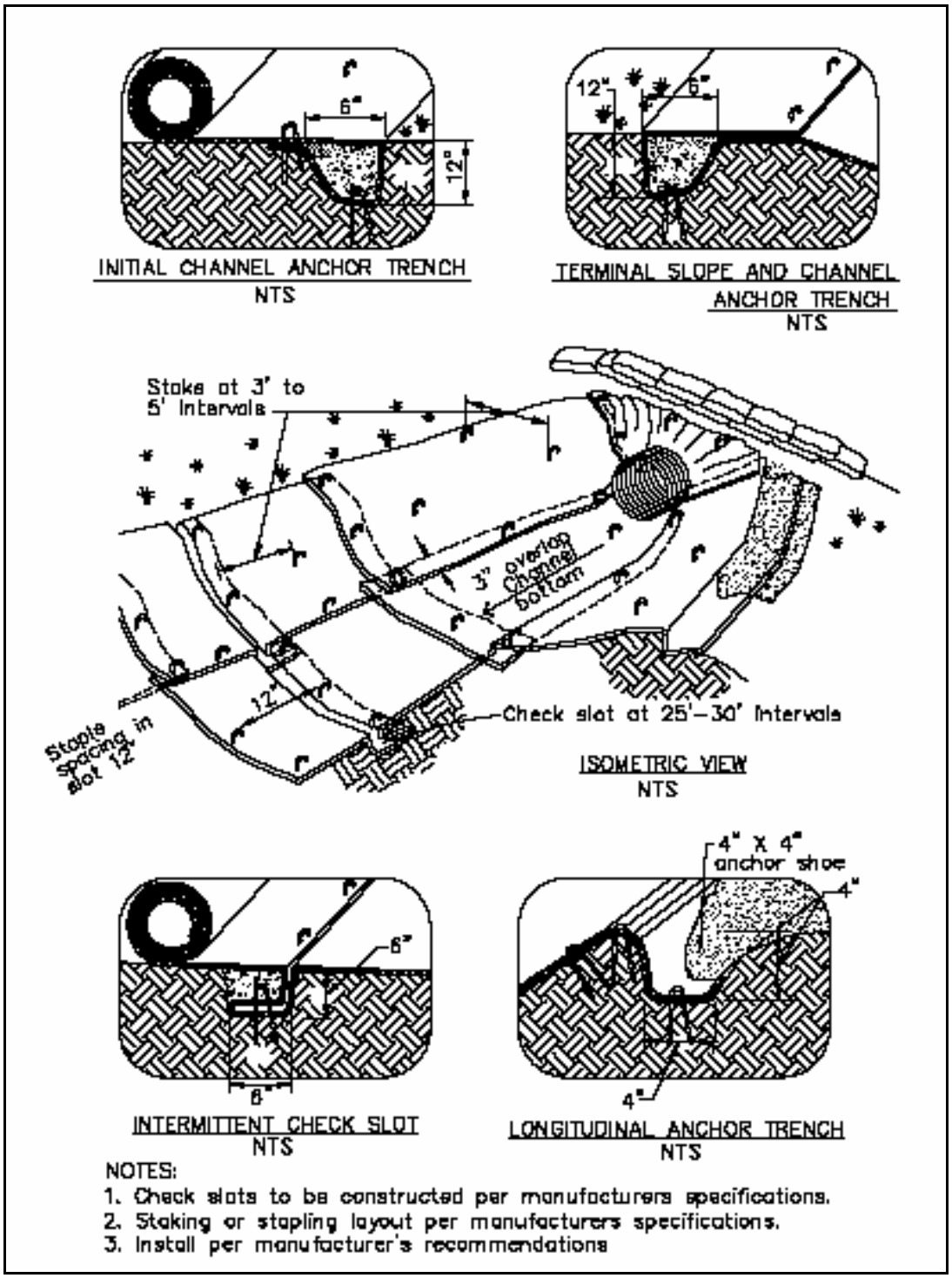



**FIGURE EC-17-2 TYPICAL INSTALLATION DETAIL**

From: California Stormwater BMP Handbook Construction, California Storm Water Quality Association, 2003

## 18. BMP EC-18: ROCK RIPRAP

### *Purpose*

Rock riprap is a layer of loose rock placed over an erodible soil or surface disturbance to protect the soil surface, provide for slope stabilization on steep slopes and reduce soil erosion within a project area.

### *Conditions of Use*

- Rock riprap is primarily utilized in drainage stabilization projects such as channel and ditch linings and energy dissipaters
- Rock riprap is used on steep, difficult slopes where vegetation has not been successful
- Seed, shrubs, and trees have been incorporated with rock riprap by interplanting
- A source of rock riprap of the appropriate size and the associated transportation cost are the primary planning criteria
- Depending upon the application, rock riprap can be utilized with revegetation efforts but the establishment of permanent vegetation is preferred for long-term stability and maintenance
- Rock riprap applied to active drainage-ways or channels usually requires an underlining of matting or fabric to prevent erosion
- Rock riprapping is an effective means of reducing soil erosion in channels and drainage-ways
- Rock riprap can be expensive depending upon the source and transportation costs

### *Design and Installation Specifications*

- The rock riprap should be sound, dense, and durable rock with a specific gravity of not less than 2-1/2 and greater than 12 inches in diameter
- Seeding should occur prior to rock placement
- If to be used within an active drainage channel, a synthetic mat or fabric should be installed prior to rock placement
- Depending on the specifics of the site, rock riprap can be placed by hand or by equipment
- Existing trees and vegetation should be protected and rock riprap placed by hand in these areas
- Rocks should be securely bedded and homogenous in the layering
- Depth of application depends upon the size of the drainage-way, slope degree and length and the other specifics of the site

***Maintenance Standards***

- Inspect BMP prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Inspect for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material
- Inspect for scour beneath the riprap and repair immediately
- Remove temporary devices as soon as the surrounding drainage area has been stabilized or at the completion of construction

## 19. BMP EC-19: POLYACRYLAMIDE (PAM) FOR SOIL EROSION PROTECTION

### *Purpose*

Polyacrylamide (PAM) is used on construction sites to prevent soil erosion. Applying PAM to bare soil in advance of a rain event significantly reduces erosion and controls sediment in two ways. First, PAM increases the soil's available pore volume, thus increasing infiltration through flocculation and reducing the quantity of stormwater runoff. Second, it increases flocculation of suspended particles and aids in their deposition, thus reducing stormwater runoff turbidity and improving water quality.

### *Conditions of Use*

- PAM is suitable for use on disturbed soil area that discharge to a sediment trap or sediment basin
- PAM is typically used in conjunction with other BMPs to increase their performance
- PAM can be applied to the following areas:
  - ✓ Rough graded soils that will be inactive for a period of time
  - ✓ Final graded soils before application of final stabilization (e.g., paving, planting, mulching)
  - ✓ Haul roads prior to placement of crushed rock surfacing
  - ✓ Compacted soil road base
  - ✓ Construction staging, materials storage, and layout areas
  - ✓ Soil stockpiles
  - ✓ Areas that will be mulched

### *Limitations*

- PAM must not be directly applied to water or allowed to enter a water body
- Do not use PAM on a slope that flows into a water body without passing through a sediment trap or sediment basin
- PAM will work when applied to saturated soil but is not as effective as applications to dry or damp soil
- On all sites, the use of silt fence shall be maximized to limit the discharges of sediment from the site
- All areas not being actively worked shall be covered and protected from rainfall. PAM shall not be the only cover BMP used
- Some PAMs are more toxic and carcinogenic than others. Only the most environmentally safe PAM products should be used
- PAM designated for erosion and sediment control should be "water soluble" or "linear" or "non-cross linked"
- PAM, combined with water, is very slippery and can be a safety hazard. Care must be taken to prevent spills of PAM powder onto paved surfaces. During an application of PAM, prevent over-spray from reaching pavement, as pavement will become slippery. If PAM powder gets on skin or clothing, wipe it off with a rough

towel rather than washing with water-this only makes cleanup messier and take longer
- A sampling and analysis plan must be incorporated into the SWPPP as PAM may be considered to be a source of non-visible pollutants

***Design and Installation Specifications***

- PAM may be applied in dissolved form with water, or it may be applied in dry, granular or powdered form. The preferred application method is the dissolved form. PAM is to be applied at a maximum rate of 1/2 pound PAM per 1000 gallons water per 1 acre of bare soil. Higher concentrations of PAM **do not** provide any additional effectiveness
- Pre-measure the area where PAM is to be applied and calculate the amount of product and water necessary to provide coverage at the specified application rate (1/2 pound PAM/1000 gallons/acre)
- PAM has infinite solubility in water, but dissolves very slowly. Dissolve pre-measured dry granular PAM with a known quantity of clean water in a bucket several hours or overnight. Mechanical mixing will help dissolve the PAM. Always add PAM to water - not water to PAM
- Pre-fill the water truck about 1/8 full with water. The water does not have to be potable, but it must have relatively low turbidity – in the range of 20 NTU or less.
- Add PAM/water mixture to the truck
- Completely fill the water truck to specified volume
- Spray PAM/water mixture onto dry soil until the soil surface is uniformly and completely wetted
- PAM may be applied as a powder at the rate of 5 lbs. per acre. This must be applied on a day that is dry. For areas less than 5-10 acres, a hand-held "organ grinder" fertilizer spreader set to the smallest setting will work. Tractor-mounted spreaders will work for larger areas

***Maintenance Standards***

The following shall be used for application of PAM:

- PAM may be reapplied on actively worked areas after a 48-hour period
- Proper application and re-application plans are necessary to ensure total effectiveness of PAM usage
- Reapplication is not required unless PAM treated soil is disturbed or unless turbidity levels show the need for an additional application. If PAM treated soil is left undisturbed a reapplication may be necessary after two months. More PAM applications may be required for steep slopes, silty and clayey soils (USDA Classification Type "C" and "D" soils), long grades, and high precipitation areas. When PAM is applied first to bare soil and then covered with straw, a reapplication may not be necessary for several months

**20. BMP EC-20: TOPSOILING**

***Purpose***

To provide a suitable growth medium for final site stabilization with vegetation. While not a permanent cover practice in itself, topsoiling is an integral component of providing permanent cover in those areas where there is an unsuitable soil surface for plant growth. Native soils and disturbed soils that have been organically amended not only retain much more stormwater, but they also serve as effective biofilters for urban pollutants and, by supporting more vigorous plant growth, reduce the water, fertilizer and pesticides needed to support installed landscapes. Topsoil does not include any subsoils but only the material from the top several inches including organic debris.

***Conditions of Use***

- Native soils should be left undisturbed to the maximum extent practicable. Native soils disturbed during clearing and grading should be restored, to the maximum extent practicable, to a condition where moisture-holding capacity is equal to or better than the original site conditions. This criterion can be met by using on-site native topsoil, incorporating amendments into on-site soil, or importing blended topsoil
- Topsoiling is a required procedure when establishing vegetation on shallow soils, and soils of critically low pH (high acid) levels
- Stripping of existing, properly functioning soil system and vegetation for the purpose of topsoiling during construction is not acceptable. If an existing soil system is functioning properly it shall be preserved in its undisturbed and uncompacted condition
- Depending on where the topsoil comes from, or what vegetation was on site before disturbance, invasive plant seeds may be included and could cause problems for establishing native plants, landscaped areas, or grasses
- Topsoil from the site will contain mycorrhizal bacteria that are necessary for healthy root growth and nutrient transfer. These native mycorrhiza are acclimated to the site and will provide optimum conditions for establishing grasses. Commercially available mycorrhiza products should be used when topsoil is brought in from off-site

***Design and Installation Specifications***

If topsoiling is to be done, the following items should be considered:

- Maximize the depth of the topsoil wherever possible to provide the maximum possible infiltration capacity and beneficial growth medium. Topsoil depth shall be at least 8 inches with a minimum organic content of 10 percent dry weight and pH between 6.0 and 8.0 or matching the pH of the undisturbed soil. This can be accomplished either by returning native topsoil to the site and/or incorporating organic amendments. Organic amendments should be incorporated to a minimum 8-inch depth except where tree roots or other natural features limit the depth of incorporation. Subsoils below the 12-inch depth should be scarified at least 2 inches to avoid stratified layers, where feasible. The decision to either layer topsoil over a

subgrade or incorporate topsoil into the underlying layer may vary depending on the planting specified

- If blended topsoil is imported, fines should be limited to 25 percent passing through a 200 sieve
- The final composition and construction of the soil system will result in a natural selection of certain plant species over time
- Locate the topsoil stockpile so that it meets specifications and does not interfere with work on the site. It may be possible to locate more than one pile in proximity to areas where topsoil will be used
- Allow sufficient time in scheduling for topsoil to be spread prior to seeding, sodding, or planting
- Care must be taken not to apply to subsoil if the two soils have contrasting textures. Sandy topsoil over clayey subsoil is a particularly poor combination, as water creeps along the junction between the soil layers and causes the topsoil to slough
- If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method to prevent a lack of bonding is to actually work the topsoil into the layer below for a depth of at least 6 inches
- Ripping or re-structuring the subgrade may also provide additional benefits regarding the overall infiltration and interflow dynamics of the soil system
- Field exploration of the site shall be made to determine if there is surface soil of sufficient quantity and quality to justify stripping
- Topsoil shall be friable and loamy (loam, sandy loam, silt loam, sandy clay loam, clay loam). Areas of natural ground water recharge should be avoided
- Stripping shall be confined to the immediate construction area. A 4- to 6- inch stripping depth is common, but depth may vary depending on the particular soil. All surface runoff control structures shall be in place prior to stripping

Stockpiling of topsoil shall occur in the following manner:

- Side slopes of the stockpile shall not exceed 2:1
- An interceptor dike with gravel outlet and silt fence shall surround all topsoil stockpiles during the rainy season or if the stockpile will remain in place for a longer period of time than active construction grading
- Erosion control seeding or covering with clear plastic or other mulching materials of stockpiles shall be completed within 7 days of the formation of the stockpile. Native topsoil stockpiles shall not be covered with plastic
- Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed sodding or seeding
- Previously established grades on the areas to be topsoiled shall be maintained according to the approved plan
- When native topsoil is to be stockpiled and reused the following should apply to ensure that the mycorrhizal bacterial, earthworms, and other beneficial organisms will not be destroyed:
    1. Topsoil is to be re-installed within 4 to 6 weeks.
    2. Topsoil is not to become saturated with water.

3. Plastic cover is not allowed.

***Maintenance Standards***

- Inspect stockpiles regularly, especially after large storm events. Stabilize any areas that have eroded

## 21. BMP EC-21: SEEDING PRACTICES

### *Purpose*

Seeding practices include a variety of techniques, which result in the sowing, or planting of seeds. Common practices include broadcast seeding (hand or mechanical), drill seeding, aerial seeding, and hydroseeding. The primary purpose of seeding a site is for soil stabilization through the establishment of a vegetative cover. Related objectives include: to reduce raindrop impacts and surface water flow, to reduce erosion from wind and water and to enhance aesthetics and the natural environment.

## CONDITIONS OF USE

- Seeding practices are applicable to any surface disturbance site requiring revegetation or reclamation
- Slopes must be mechanically stabilized prior to seeding, as vegetation alone will not stabilize a slope
- Drilling seeding is typically limited to slopes of 3:1 or flatter, but it is the most successful practice
- Hydroseeding is most effective in steep slope situations, which have little or no access (e.g., road cut or fill slopes, mine waste dumps, etc.)
- Broadcast seeding is less expensive but requires approximately twice the amount of seed over drill seeding
- Aerial seedings are typically applied in large areas with no access, such as forest or rangeland fires

### *Planning Criteria*

- The establishment of vegetation is the most efficient and cost effective form of erosion control and soil stabilization. Once established vegetation absorbs raindrop impact and prevents the mobilization of soil particles. Vegetation prevents erosion while other treatments such as filter fabric, sediment basins or filter strips only treat the sediment mobilization process
- **Seeding practices should be selected based upon the specifics of the site and the expertise of a qualified professional should be consulted**
- Typically economics, site topography and/or access are controlling factors in the selection process. Seeding practices should also be tailored to the plant material seed being applied (i.e. grasses, forbs, shrubs)
- Tree species are typically planted from container stock after establishment of a grass/forb/shrub cover
- Seeding practices are usually incorporated within a combined structural and vegetative approach to soil stabilization
- Vegetation alone will not stabilize a slope. Other nonvegetative techniques are also utilized to enhance the success of a seeding such as mulches, netting, matting, and chemical tacifiers

- Irrigation will assist in achieving a good seed/soil contact and is critical to plant establishment on dry sites. Over watering will cause washing and runoff, thus potentially transporting seed down gradient

***Design and Installation Specifications***

Vegetation or reclamation specialists should be consulted regarding mulch application rates, plant species selection, seeding rates, etc., to ensure a successful project.

- **Broadcast seeding (hand or mechanical):** Broadcast seeding can be accomplished by hand held seeders or a mechanically driven seeder typically mounted on a tractor or ATV vehicle. The seed mix is placed in a hopper, adjustments are made for the size of the seed and rate of application, and the seeder is operated by a hand crank or motor while walking or driving over the areas to be seeded. Broadcast seeding typically require twice the amount of seed to cover the same given area as a drill seeder due to wind drift, wildlife consumption, and lack of good soil to seed contact

- **Drill seeding:** Drill seeding requires the use of a Range drill or equivalent depending on the condition of the site. Drill seeders are pulled behind a tractor or bulldozer and actually place the seed to a pre-determined depth. The seed is then covered by the drill mechanism or a chain drag is utilized to cover the seed behind the drill. Drill seeding provides the best seed to soil contact and correspondingly the highest success rate

- **Aerial seeding:** Aerial seeding is conducted by helicopter or fixed wing aircraft and can cover larger areas of inaccessible terrain. It is the most efficient method for large disturbance areas such as forest or rangeland fires. Germination success is usually low given wind drift, soil conditions, and poor seed to soil contact, but application timing can greatly improve success. If seeding can occur shortly after a wild land fire and before a soil crust is formed, success is greatly improved

- **Hydroseeding:** The wood fiber and water mixture are well agitated in a large tank and then blown through a hose and nozzle by compressed air. The apparatus is typically truck or trailer mounted and has sufficient capacity to complete several acres at a time. Mulch application rates and/or seeding rates depend upon the site specifics of the project area and the project goals. Typically irrigation is necessary to successfully establish a vegetative cover with hydroseeding

***Maintenance***

- Seeded areas require regular inspection and potentially reapplication if necessary
- The treatment areas should be protected from foot or vehicle traffic until vegetation is well established which may require fencing, barriers, and signing

## 22. BMP EC-22: SODDING

### *Purpose*

The purpose of sodding is to establish permanent turf for immediate erosion protection and to stabilize drainage ways where concentrated overland flow will occur.

### *Conditions of Use*

Sodding may be used in the following areas:

- Disturbed areas that require short-term or long-term cover
- Disturbed areas that require immediate vegetative cover
- All waterways that require vegetative lining. Waterways may also be seeded rather than sodded, and protected with a net or blanket

### *Design and Installation Specifications*

Sod shall be free of weeds, of uniform thickness (approximately 1-inch thick), and shall have a dense root mat for mechanical strength. The following steps are recommended for sod installation:

- Shape and smooth the surface to final grade in accordance with the approved grading plan. The swale needs to be over excavated 4 to 6 inches below design elevation to allow room for placing soil amendment and sod
- Amend 4 inches (minimum) of compost into the top 8 inches of the soil if the organic content of the soil is less than ten percent or the permeability is less than 0.6 inches per hour. Compost used should meet Ecology publication 94-038 specifications for Grade "A" quality compost
- Fertilize according to the supplier's recommendations
- Work lime and fertilizer 1 to 2 inches into the soil, and smooth the surface
- Lay strips of sod beginning at the lowest area to be sodded and perpendicular to the direction of water flow. Wedge strips securely into place. Square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple on slopes steeper than 3H: 1V. Staple the upstream edge of each sod strip
- Roll the sodded area and irrigate
- When sodding is carried out in alternating strips or other patterns, seed the areas between the sods immediately after sodding

### *Maintenance Standards*

If the grass is unhealthy, the cause shall be determined and appropriate action taken to reestablish a healthy groundcover. If it is impossible to establish a healthy groundcover due to frequent saturation, instability, or some other cause, the sod shall be removed, the area seeded with an appropriate mix, and protected with a net or blanket.

## B. SEDIMENT CONTROL BMPS

### 1. BMP SC-1: STABILIZED CONSTRUCTION ENTRANCE

***Purpose***

Construction entrances are stabilized to reduce the amount of sediment transported onto paved roads by vehicles or equipment by constructing a stabilized pad of quarry spalls at entrances to construction sites.

***Conditions of Use***

Construction entrances shall be stabilized wherever traffic will be leaving a construction site and traveling on paved roads or other paved areas within 1,000 feet of the site. On large commercial, highway, and road projects, the designer should include enough extra materials in the contract to allow for additional stabilized entrances not shown in the initial Construction SWPPP. It is difficult to determine exactly where access to these projects will take place; additional materials will enable the contractor to install them where needed.

***Design and Installation Specifications***

- A separation geotextile shall be placed under the spalls to prevent fine sediment from pumping up into the rock pad. The geotextile shall meet the following standards:
    - Grab Tensile Strength (ASTM D4751) 200 psi min
    - Grab Tensile Elongation (ASTM D4632) 30% max
    - Mullen Burst Strength (ASTM D3786-80a) 400 psi min
    - AOS (ASTM D4751) 20-45 (U.S. standard sieve size)
- Consider early installation of the first lift of asphalt in areas that will be paved; this can be used as a stabilized entrance. Also consider the installation of excess concrete as a stabilized entrance. During large concrete pours, excess concrete is often available for this purpose
- Hog fuel (wood-based mulch) may be substituted for or combined with quarry spalls in areas that will not be used for permanent roads. Hog fuel is generally less effective at stabilizing construction entrances and should be used only at sites where the amount of traffic is very limited. Hog fuel is not recommended for entrance stabilization in urban areas. The effectiveness of hog fuel is highly variable and it generally requires more maintenance than quarry spalls. The inspector may at any time require the use of quarry spalls if the hog fuel is not preventing sediment from being tracked onto pavement or if the hog fuel is being carried onto pavement. Hog fuel is prohibited in permanent roadbeds because organics in the subgrade soils cause degradation of the subgrade support over time
- Fencing (see BMP EC-4) shall be installed as necessary to restrict traffic to the construction entrance

- Whenever possible, the entrance shall be constructed on a firm, compacted subgrade. This can substantially increase the effectiveness of the pad and reduce the need for maintenance

***Maintenance Standards***

- Quarry spalls (or hog fuel) shall be added if the pad is no longer in accordance with the specifications
- If the entrance is not preventing sediment from being tracked onto pavement, then alternative measures to keep the streets free of sediment shall be used. This may include street sweeping, an increase in the dimensions of the entrance, or the installation of a wheel wash
- Any sediment that is tracked onto pavement shall be removed by shoveling or street sweeping. The sediment collected by sweeping shall be removed or stabilized on site. The pavement shall not be cleaned by washing down the street, except when sweeping is ineffective and there is a threat to public safety. If it is necessary to wash the streets, the construction of a small sump shall be considered. The sediment would then be washed into the sump where it can be controlled
- Any quarry spalls that are loosened from the pad, which end up on the roadway shall be removed immediately
- If vehicles are entering or exiting the site at points other than the construction entrance(s), fencing (see BMP EC-4) shall be installed to control traffic
- Upon project completion and site stabilization, all construction accesses intended as permanent access for maintenance shall be permanently stabilized

***Inspection and Maintenance***

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

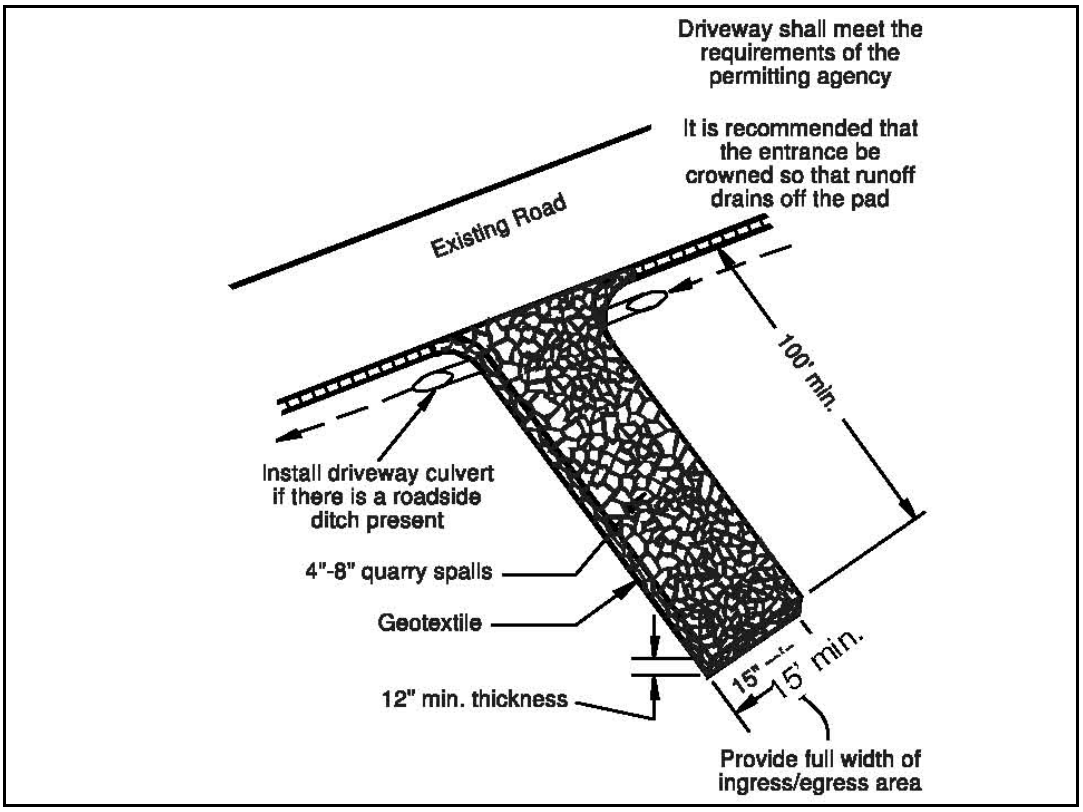



**FIGURE SC-1-1 STABILIZED CONSTRUCTION ENTRANCE**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 2. BMP SC-2: WHEEL WASH

### *Purpose*

Wheel washes reduce the amount of sediment transported onto paved roads by motor vehicles.

### *Conditions of Use*

When a stabilized construction entrance (see SC-1) is not preventing sediment from being tracked onto pavement.

- Wheel washing is generally an effective BMP when installed with careful attention to topography. For example, a wheel wash can be detrimental if installed at the top of a slope abutting a right-of-way where the water from the dripping truck can run unimpeded into the street
- Pressure washing combined with an adequately sized and surfaced pad with direct drainage to a large 10-foot x 10-foot sump can be very effective

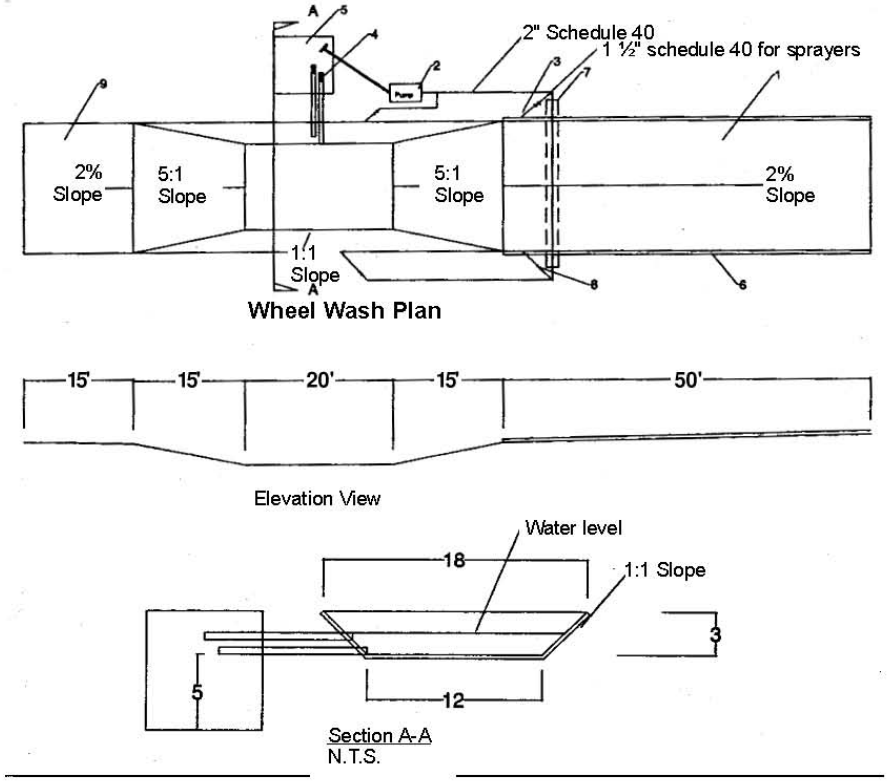
### *Design and Installation Specifications*

- Suggested details are shown in Figure SC-2-1
- A minimum of 6 inches of asphalt treated base (ATB) over crushed base material or 8 inches over a good subgrade is recommended to pave the wheel wash. Use a low clearance truck to test the wheel wash before paving. Either a belly dump or lowboy will work well to test clearance
- Keep the water level from 12 to 14 inches deep to avoid damage to truck hubs and filling the truck tongues with water
- Midpoint spray nozzles are only needed in extremely muddy conditions
- Wheel wash systems should be designed with a small grade change, 6 to 12 inches for a 10-foot-wide pond, to allow sediment to flow to the low side of pond to help prevent re-suspension of sediment
- A drainpipe with a 2- to 3-foot riser should be installed on the low side of the pond to allow for easy cleaning and refilling
- Polymers may be used to promote coagulation and flocculation in a closed-loop system. Polyacrylamide (PAM) added to the wheel wash water at a rate of 0.25 - 0.5 pounds per 1,000 gallons of water increases effectiveness and reduces cleanup time. If PAM is already being used for dust or erosion control and is being applied by a water truck, the same truck can be used to change the wash water

### *Maintenance Standards*

- The wheel wash should start out the day with fresh water
- The wash water should be changed a minimum of once per day. On large earthwork jobs where more than 10-20 trucks per hour are expected, the wash water will need to be changed more often

- Wheel wash or tire bath wastewater shall be discharged to a separate on-site treatment system, such as closed-loop recirculation or land application, or to the sanitary sewer with proper approval




Notes:
1. Asphalt construction entrance 6 in. asphalt treated base (ATB).
2. 3-inch trash pump with floats on the suction hose.
3. Midpoint spray nozzles, if needed.
4. 6-inch sewer pipe with butterfly valves. Bottom one is a drain. Locate top pipe's invert 1 foot above bottom of wheel wash.
5. 8 foot x 8 foot sump with 5 feet of catch. Build so can be cleaned with trackhoe.
6. Asphalt curb on the low road side to direct water back to pond.
7. 6-inch sleeve under road.
8. Ball valves.
9. 15 foot. ATB apron to protect ground from splashing water.

**FIGURE SC-2-1 WHEEL WASH**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 3. BMP SC-3: STRAW BALE BARRIER

### *Purpose*

To decrease the velocity of sheet flows and intercept and detain small amounts of sediment from disturbed areas of limited extent, preventing sediment from leaving the site. See Figure SC-3-1 for details on straw bale barriers.

### *Conditions of Use*

- Below disturbed areas subject to sheet and rill erosion
- Straw bales are among the most used and **least effective BMPs**. The best use of a straw bale is hand spread on the site
- Where the size of the drainage area is no greater than 1/4 acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 2:1
- Where effectiveness is required for less than three months
- **Under no circumstances should straw bale barriers be constructed in streams, channels, or ditches**
- Straw bale barriers should not be used where rock or hard surfaces prevent the full and uniform anchoring of the barrier

### *Design and Installation Specifications*

- Bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another
- All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings
- The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. The trench must be deep enough to remove all grass and other material that might allow underflow. After the bales are staked and chinked (filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier
- Each bale shall be securely anchored by at least two stakes or re-bars driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or re-bars shall be driven deep enough into the ground to securely anchor the bales. Stakes should not extend above the bales but instead should be driven in flush with the top of the bale for safety reasons
- The gaps between the bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Wedging must be done carefully in order not to separate the bales.

*Maintenance Standards*

- Straw bale barriers shall be inspected immediately after each runoff producing rainfall and at least daily during prolonged rainfall
- Close attention shall be paid to the repair of damaged bales, end runs, and undercutting beneath bales
- Necessary repairs to barriers or replacement of bales shall be accomplished promptly
- Sediment deposits should be removed after each runoff-producing storm event. They must be removed when the level of deposition reaches approximately one-half the height of the barrier
- Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded
- Straw bales used as a temporary straw bale barrier shall be removed after project completion and stabilization to prevent sprouting of unwanted vegetation

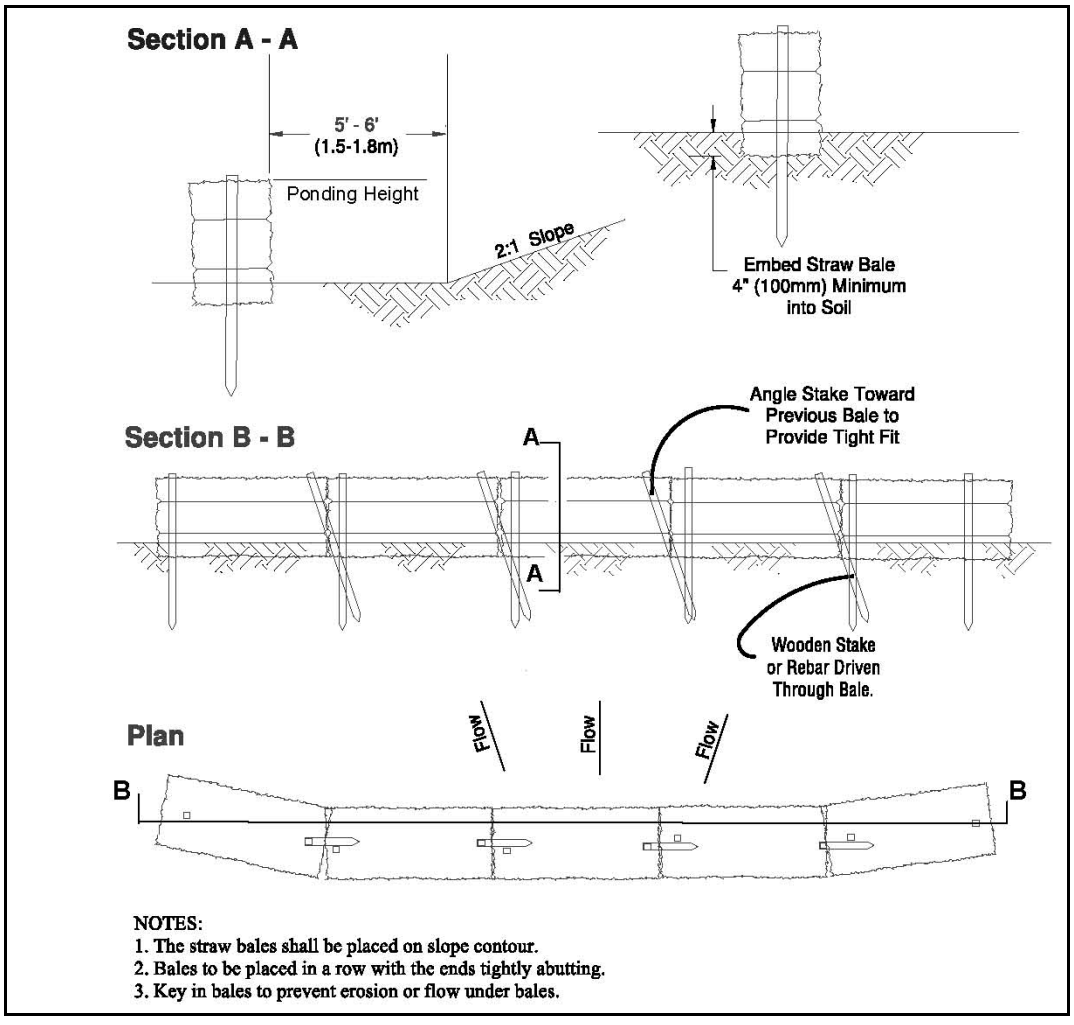



**FIGURE SC-3-1 STRAW BALE BARRIER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 4. BMP SC-4: STORM DRAIN INLET PROTECTION

### *Purpose*

To prevent coarse sediment from entering drainage systems prior to permanent stabilization of the disturbed area.

### *Conditions of Use*

- Where storm drain inlets are to be made operational before permanent stabilization of the disturbed drainage area
- Protection should be provided for all storm drain inlets down slope and within 500 feet of a disturbed or construction area, unless the runoff that enters the catch basin will be conveyed to a sediment pond or trap
- Inlet protection may be used anywhere to protect the drainage system. It is likely that the drainage system will still require cleaning
- All of the methods for storm drain inlet protection are prone to plugging and require a high frequency of maintenance
- Drainage areas should be limited to 1 acre or less
- Emergency overflows may be required where stormwater ponding would cause a hazard. If an emergency overflow is provided, additional end-of-pipe treatment may be required

### *Design and Installation Specifications*

*Excavated Drop Inlet Protection* - An excavated impoundment around the storm drain. Sediment settles out of the stormwater prior to entering the storm drain.

- Depth 1-2 ft as measured from the crest of the inlet structure
- Side Slopes of excavation no steeper than 2:1
- Minimum volume of excavation 35 cubic yards
- Shape basin to fit site with longest dimension oriented toward the longest inflow area
- Install provisions for draining to prevent standing water problems
- Clear the area of all debris
- Grade the approach to the inlet uniformly
- Drill weep holes into the side of the inlet
- Protect weep holes with screen wire and washed aggregate
- Seal weep holes when removing structure and stabilizing area
- It may be necessary to build a temporary dike to the down slope side of the structure to prevent bypass flow

*Block and Gravel Filter* - A barrier formed around the storm drain inlet with standard concrete blocks and gravel.

- Height 1 to 2 feet above inlet
- Recess the first row 2 inches into the ground for stability
- Support subsequent courses by placing a 2x4 through the block opening

- Do not use mortar
- Lay some blocks in the bottom row on their side for dewatering the pool
- Place hardware cloth or comparable wire mesh with ½-inch openings over all block openings
- Place gravel just below the top of blocks on slopes of 2:1 or flatter
- An alternative design is a gravel donut
- Inlet slope of 3:1
- Outlet slope of 2:1
- 1-foot wide level stone area between the structure and the inlet
- Inlet slope use stones 3 inches in diameter or larger
- Outlet slope use gravel ½- to ¾-inch at a minimum thickness of 1-foot

*Gravel and Wire Mesh Filter* - A gravel barrier placed over the top of the inlet. This structure does not provide an overflow.

- Hardware cloth or comparable wire mesh with ½-inch openings
- Coarse aggregate
- Height 1-foot or more, 18 inches wider than inlet on all sides
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1-foot beyond each side of the inlet structure
- If more than one strip of mesh is necessary, overlap the strips
- Place coarse aggregate over the wire mesh
- The depth of the gravel should be at least 12 inches over the entire inlet opening and extend at least 18 inches on all sides

*Catch basin Filters* - Inserts should be designed by the manufacturer for use at construction sites. The limited sediment storage capacity increases the amount of inspection and maintenance required, which may be daily for heavy sediment loads. The maintenance requirements can be reduced by combining a catch basin filter with another type of inlet protection. This type of inlet protection provides flow bypass without overflow and therefore may be a better method for inlets located along active rights-of-way.

- 5 cubic feet of storage
- Dewatering provisions
- High-flow bypass that will not clog under normal use at a construction site
- The catch basin filter is inserted in the catch basin just below the grating

*Curb Inlet Protection with Wooden Weir* – Barrier formed around a curb inlet with a wooden frame and gravel.

- Wire mesh with ½-inch openings
- Extra strength filter cloth
- Construct a frame
- Attach the wire and filter fabric to the frame
- Pile coarse washed aggregate against wire/fabric
- Place weight on frame anchors

*Block and Gravel Curb Inlet Protection* – Barrier formed around an inlet with concrete blocks and gravel.

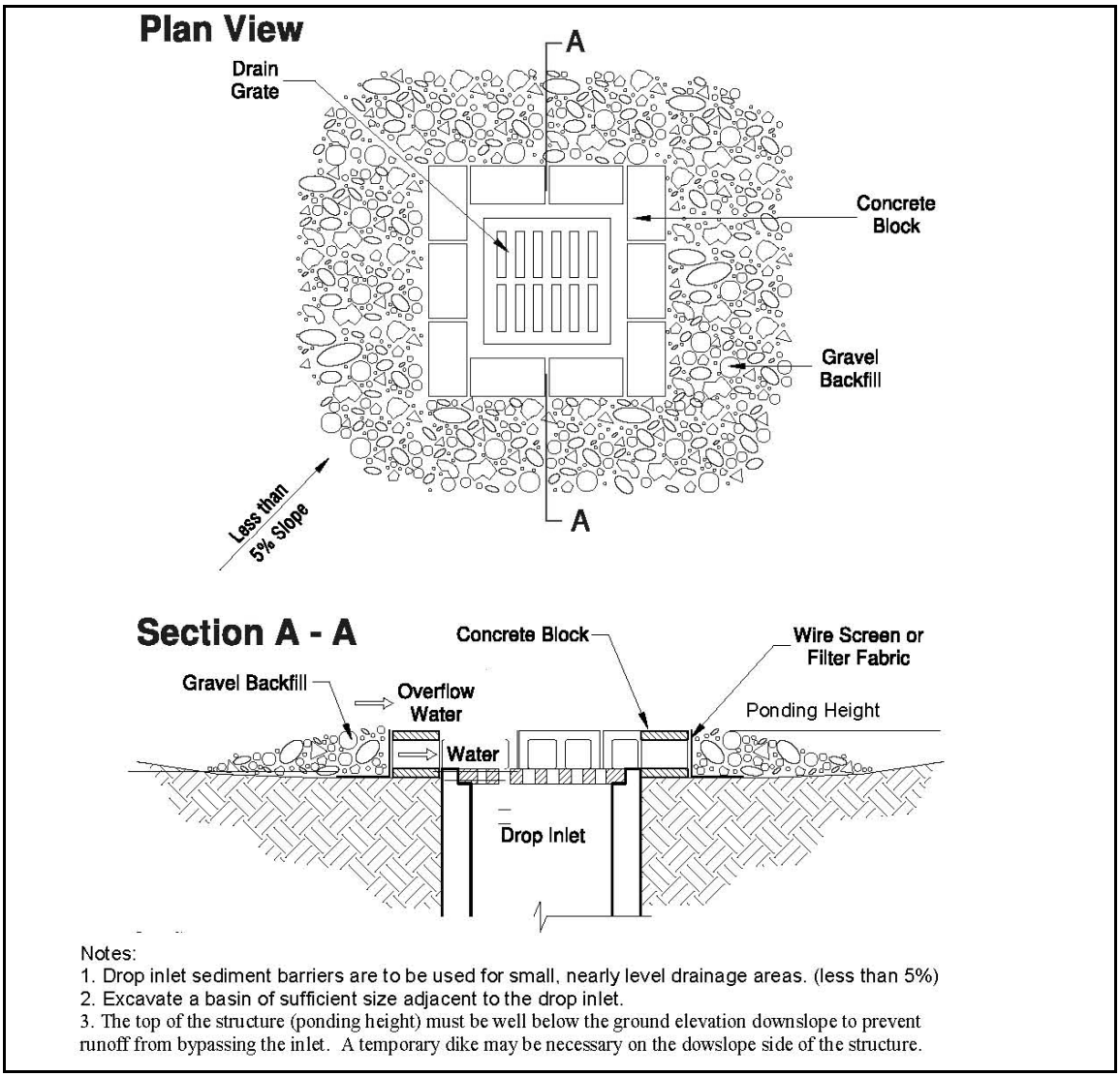
- Wire mesh with ½-inch openings
- Place two concrete blocks on their sides abutting the curb at either side of the inlet opening. These are spacer blocks
- Place a 2x4 stud through the outer holes of each spacer block to align the front blocks
- Place blocks on their sides across the front of the inlet and abutting the spacer blocks
- Place wire mesh over the outside vertical face
- Pile coarse aggregate against the wire to the top of the barrier

*Curb and Gutter Sediment Barrier* – Sandbag or rock berm (riprap and aggregate) 3 feet high and 3 feet wide in a horseshoe shape.

- Construct a horseshoe shaped berm, faced with coarse aggregate if using riprap, 3 feet high and 3 feet wide, at least 2 feet from the inlet
- Construct a horseshoe shaped sedimentation trap on the outside of the berm sized to sediment trap standards for protecting a culvert inlet

***Maintenance Standards***

- Catch basin filters should be inspected frequently, especially after storm events. If the insert becomes clogged, it should be cleaned or replaced
- For systems using stone filters: If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet
- Do not wash sediment into storm drains while cleaning. Spread all excavated material evenly over the surrounding land area or stockpile and stabilize as appropriate




Notes:
1. Drop inlet sediment barriers are to be used for small, nearly level drainage areas. (less than 5%)
2. Excavate a basin of sufficient size adjacent to the drop inlet.
3. The top of the structure (ponding height) must be well below the ground elevation downslope to prevent runoff from bypassing the inlet. A temporary dike may be necessary on the dowslope side of the structure.

**FIGURE SC-4-1 BLOCK AND GRAVEL FILTER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

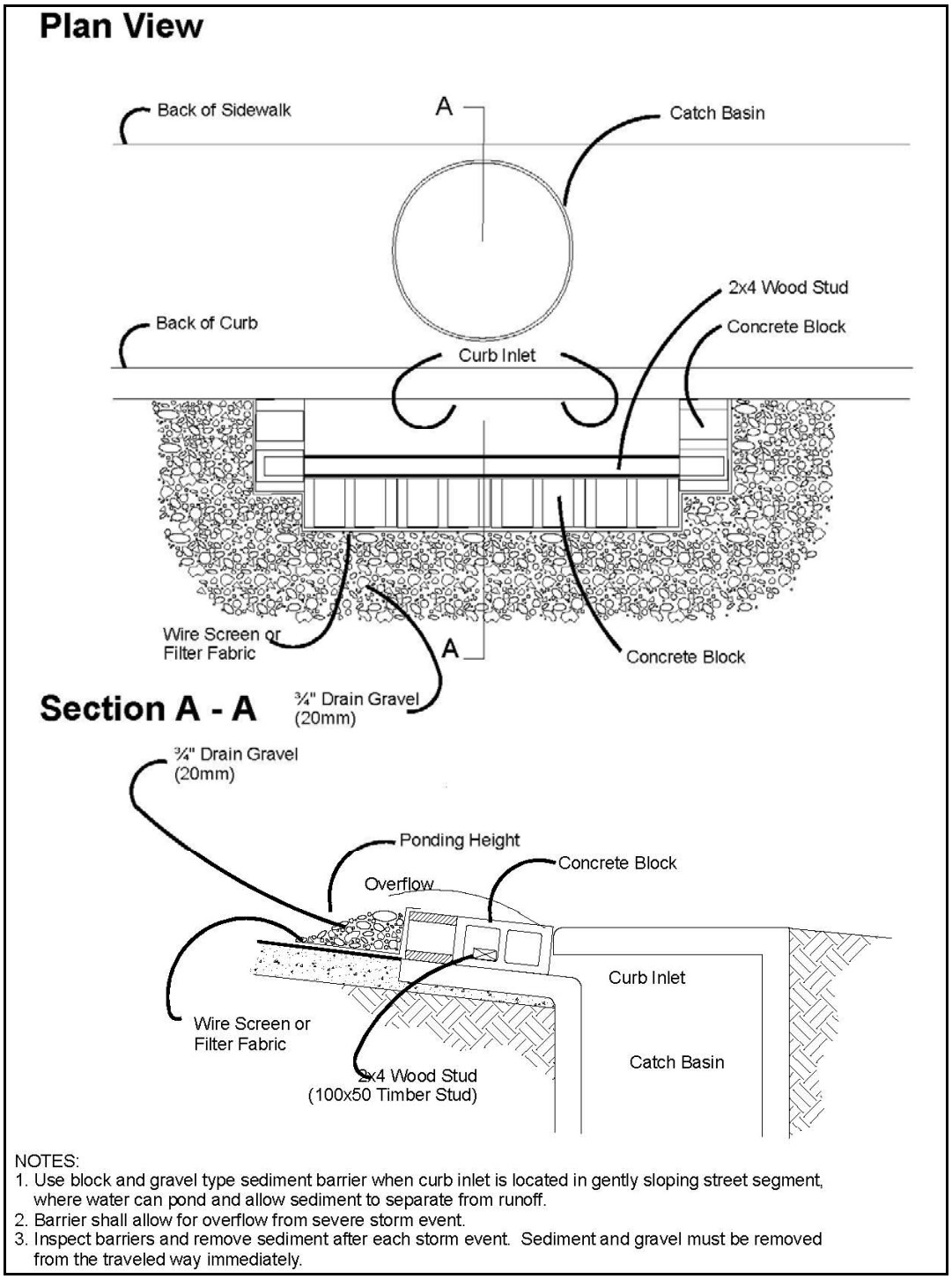



**FIGURE SC-4-2 BLOCK AND GRAVEL CURB INLET PROTECTION**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 5. BMP SC-5: SANDBAG CURB INLET SEDIMENT BARRIER

### *Purpose*

Sandbag curb inlet barriers are temporary sediment barriers consisting of sandbags placed on the uphill side of the inlet and overlapping onto the curb. Curb inlet sediment barriers are used to prevent sediment from entering the storm drain system in paved areas.

### *Conditions of Use*

- Applicable to all construction sites where the roads are already paved with the curb inlets in place
- The sandbag barriers are useful on streets which receive runoff flows of less than 0.5 cubic feet per second (cfs) for the ten year, 24 hour design storm

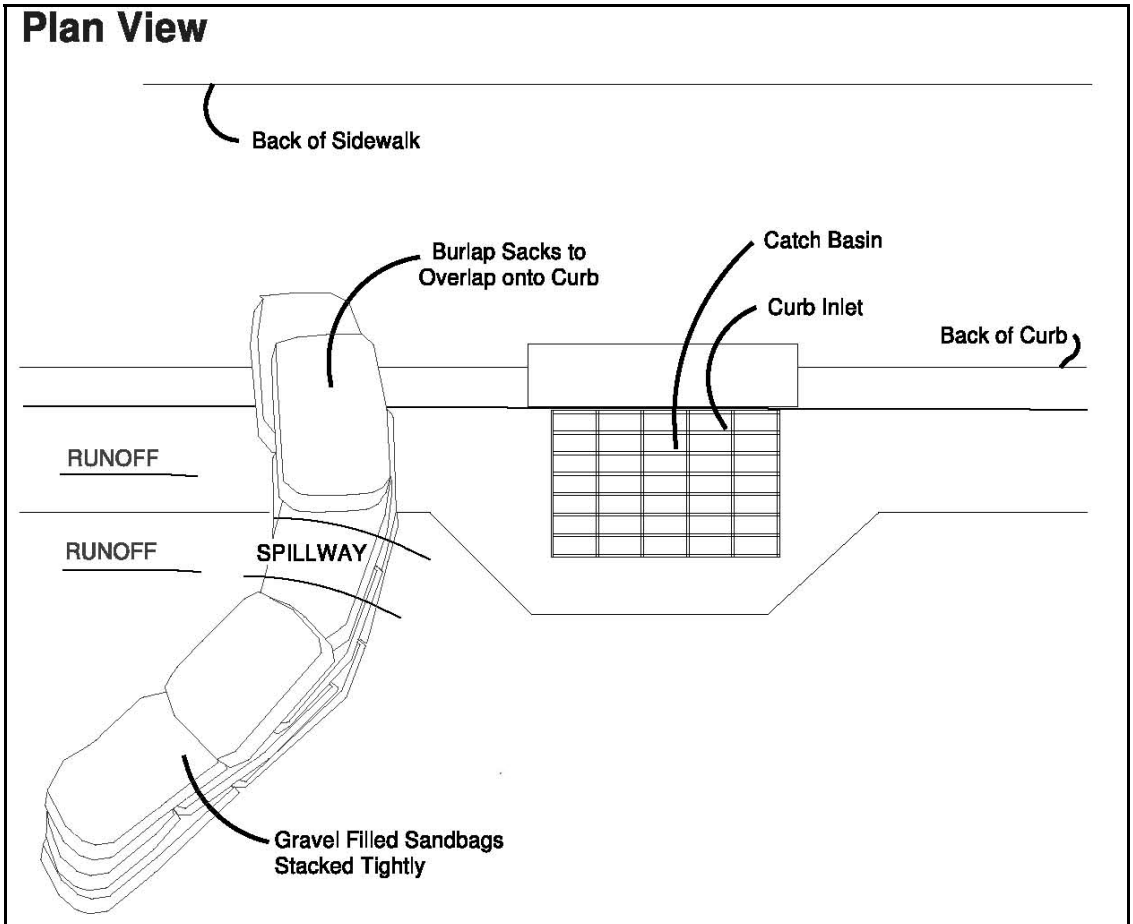
### *Design and Installation Specifications*

- The sandbag curb inlet sediment barriers are for drainage areas of less than 1 acre
- Sandbag curb inlet sediment barriers are designed to keep sediment out of the storm drain system when the roads are already paved
- A small area of sediment storage should be provided behind the sandbags
- The sandbag should be of plastic woven material rather than burlap. Burlap bags rot and deteriorate, and as a result, can cause more problems if broken
- Clean washed sand should be used to fill the bags
- The sandbags should be placed in a curved row from the top of the curb to at least 3 feet into the street
- The row should be at least 6 feet from the inlet and curved at the ends, which should be pointing uphill
- Several layers of bags should be overlapped and packed tightly together in order to eliminate any spaces between the bags
- Leave a 6-inch gap in the middle of the top row of sandbags to serve as the spillway

### *Maintenance Standards*

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags
- Reshape and replace sandbags as needed
- Repair washouts or other damage as needed
- Accumulated sediment should be removed and placed where it will not enter the storm drain. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location

- Additional sediment storage capacity can be obtained by constructing a series of sand bag barriers along the curb and gutter so that each barrier traps a small amount of sediment
- Remove sandbags when no longer needed. Remove sediment accumulation, and clean, regrade and stabilize the area




NOTES:
1. Place curb type sediment barriers on gently sloping street segments, where water can pond and allow sediment to separate from runoff.
2. Sandbags of either burlap or woven `geotextile' fabric, are filled with gravel, layered and packed tightly.
3. Leave a one sandbag gap in the top row to provide a spillway for overflow.
4. Inspect barriers and remove sediment after each storm event. Sediment and gravel must be removed from the traveled way immediately.

**FIGURE SC-5-1 CURB AND GUTTER BARRIER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 6. BMP SC-6: FILTER STRIPS

### *Purpose*

Filter strips, also known as vegetated strips, are strips of close growing vegetation located to receive runoff from diffuse sources, waterways, drains, and intermittent streams before the water enters a stream, or drainage pond. Filter strips reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

### *Conditions of Use*

- Applies to all land uses where topography, soils, and moisture supplies are suitable for establishment of filter strips
- The runoff water should be spread as it enters the filter strip either by natural topography or by installation of level spreader ditches
- Use strips or areas of existing vegetation where possible
- Width of the filter strip should be adequate to allow settlement of the sediments. The width will vary depending on slope, type of vegetation and quantity of anticipated runoff water
- Vegetated strips may be used down slope of all disturbed areas
- Vegetated strips are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond. The only circumstance in which overland flow can be treated solely by a strip, rather than by a sediment pond, is when the following criteria are met:

| Contributory Overland Flow | | |
|---|---|---|
| **Average Slope** | **Slope Percent** | **Flow path Length** |
| 1.5H:1V or less | 67% or less | 100 feet |
| 2H:1V or less | 50% or less | 115 feet |
| 4H:1V or less | 25% or less | 150 feet |
| 6H:1V or less | 16.7% or less | 200 feet |
| 10H:1V or less | 10% or less | 250 feet |

### *Design and Installation Specifications*

- The vegetated strip shall consist of a minimum of a 25-foot wide continuous strip of dense vegetation with a permeable topsoil. Grass covered, landscaped areas are generally not adequate because the volume of sediment overwhelms the grass. Ideally, vegetated strips shall consist of undisturbed native growth with a well-developed soil that allows for infiltration of runoff
- The slope within the strip shall not exceed 4H:1V
- The uphill boundary of the vegetated strip shall be delineated with clearing limits

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Any areas damaged by erosion or construction activity shall be seeded immediately and protected by mulch
- If more than 5 feet of the original vegetated strip width has had vegetation removed or is being eroded, sod must be installed
- If there are indications that concentrated flows are traveling across the buffer, surface water controls must be installed to reduce the flows entering the buffer, or additional perimeter protection must be installed

## 7. BMP SC-7: SILT FENCE

### *Purpose*

Use of a silt fence reduces the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow. See Figure EC-7-1 for details on silt fence construction.

### *Conditions of Use*

- Silt fence may be used down slope of all disturbed areas
- Silt fence is not intended to treat concentrated flows, nor is it intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond or trap. The only circumstance in which overland flow can be treated solely by a silt fence, rather than by a sediment pond or trap, is when the area draining to the fence is one acre or less and 10 year, 24 hour flow rates are less than 0.5 cfs
- Silt fences should not be constructed in streams or used in V-shaped ditches. They are not an adequate method of silt control for anything deeper than sheet or overland flow

### *Design and Installation Specifications*

- Drainage area of 1 acre or less or in combination with sediment basin in a larger site
- Maximum slope steepness (normal (perpendicular) to fence line) 1:1
- Maximum sheet or overland flow path length to the fence of 100 feet
- No flows greater than 0.5 cfs for 10 year, 24 hour event
- The geotextile used shall meet the following standards. All geotextile properties listed below are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the following table):

| Geotextile Standards | |
|---|---|
| Polymeric Mesh AOS (ASTM D4751) | 0.60 mm maximum for slit film woven (#30 sieve). 0.30 mm maximum for all other geotextile types (#50 sieve). 0.15 mm minimum for all fabric types (#100 sieve). |
| Water Permittivity (ASTM D4491) | 0.02 $sec^{-1}$ minimum |
| Grab Tensile Strength (ASTM D4632) | 180 lbs. Minimum for extra strength fabric. 100 lbs minimum for standard strength fabric. |
| Grab Tensile Strength (ASTM D4632) | 30% maximum |
| Ultraviolet Resistance (ASTM D4355) | 70% minimum |

- Standard strength fabrics shall be supported with wire mesh, chicken wire, 2-inch x 2-inch wire, safety fence, or jute mesh to increase the strength of the fabric. Silt fence materials are available that have synthetic mesh backing attached

- Filter fabric material shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0°F. to 120°F
- 100 percent biodegradable silt fence is available that is strong, long lasting, and can be left in place after the project is completed, if permitted by local regulations
- Standard Notes for construction plans and specifications follow

    - The contractor shall install and maintain temporary silt fences at the locations shown in the Plans. The silt fences shall be constructed in the areas of clearing, grading, or drainage prior to starting those activities. A silt fence shall not be considered temporary if the silt fence must function beyond the life of the contract. The silt fence shall prevent soil carried by runoff water from going beneath, through, or over the top of the silt fence, but shall allow the water to filter through the fence.

    - The minimum height of the top of silt fence shall be 2 feet and the maximum height shall be 2½ feet above the original ground surface.

    - The geotextile shall be sewn together at the point of manufacture, or at an approved location as determined by the Engineer, to form geotextile lengths as required. All sewn seams shall be located at a support post. Alternatively, two sections of silt fence can be overlapped, provided the Contractor can demonstrate, to the satisfaction of the Engineer, that the overlap is long enough and that the adjacent fence sections are close enough together to prevent silt laden water from escaping through the fence at the overlap.

    - The geotextile shall be attached on the up-slope side of the posts and support system with staples, wire, or in accordance with the manufacturer's recommendations. The geotextile shall be attached to the posts in a manner that reduces the potential for geotextile tearing at the staples, wire, or other connection device. Silt fence back-up support for the geotextile in the form of a wire or plastic mesh is dependent on the properties of the geotextile selected for use. If wire or plastic back-up mesh is used, the mesh shall be fastened securely to the up-slope of the posts with the geotextile being up-slope of the mesh back-up support.

    - The geotextile at the bottom of the fence shall be buried in a trench to a minimum depth of 4 inches below the ground surface. The trench shall be backfilled and the soil tamped in place over the buried portion of the geotextile, such that no flow can pass beneath the fence and scouring cannot occur. When wire or polymeric back-up support mesh is used, the wire or polymeric mesh shall extend into the trench a minimum of 3 inches.

    - The fence posts shall be placed or driven a minimum of 18 inches. A minimum depth of 12 inches is allowed if topsoil or other soft subgrade

soil is not present and a minimum depth of 18 inches cannot be reached. Fence post depths shall be increased by 6 inches if the fence is located on slopes of 3:1 or steeper and the slope is perpendicular to the fence. If required post depths cannot be obtained, the posts shall be adequately secured by bracing or guying to prevent overturning of the fence due to sediment loading.

- Silt fences shall be located on contour as much as possible, except at the ends of the fence, where the fence shall be turned uphill such that the silt fence captures the runoff water and prevents water from flowing around the end of the fence.

- If the fence must cross contours, with the exception of the ends of the fence, gravel check dams placed perpendicular to the back of the fence shall be used to minimize concentrated flow and erosion along the back of the fence. The gravel check dams shall be approximately 1-foot deep at the back of the fence. It shall be continued perpendicular to the fence at the same elevation until the top of the check dam intercepts the ground surface behind the fence. The gravel check dams shall consist of crushed surfacing base course, gravel backfill for walls, or shoulder ballast. The gravel check dams shall be located every 10 feet along the fence where the fence must cross contours. The slope of the fence line where contours must be crossed shall not be steeper than 3:1.

- Wood, steel or equivalent posts shall be used. Wood posts shall have minimum dimensions of 2 inches by 2 inches by 3 feet minimum length, and shall be free of defects such as knots, splits, or gouges.

- Steel posts shall consist of either size No. 6 rebar or larger, ASTM A 120 steel pipe with a minimum diameter of 1-inch, U, T, L, or C shape steel posts with a minimum weight of 1.35 lbs./ft. or other steel posts having equivalent strength and bending resistance to the post sizes listed. The spacing of the support posts shall be a maximum of 6 feet.

- Fence back-up support, if used, shall consist of steel wire with a maximum mesh spacing of 2 inches, or a prefabricated polymeric mesh. The strength of the wire or polymeric mesh shall be equivalent to or greater than 180 lbs. grab tensile strength. The polymeric mesh must be as resistant to ultraviolet radiation as the geotextile it supports.

- Silt fence installation using the slicing method specification details follow. Refer to Figure EC-7-2 for slicing method details

    - The base of both end posts must be at least 2 to 4 inches above the top of the silt fence fabric on the middle posts for ditch checks to drain properly. Use a hand level or string level, if necessary, to mark base points before installation.

- Install posts 3 to 4 feet apart in critical retention areas and 6 to 7 feet apart in standard applications.

- Install posts 24 inches deep on the downstream side of the silt fence, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure.

- Install posts with the nipples facing away from the silt fence fabric.

- Attach the fabric to each post with three ties, all spaced within the top 8 inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1 inch vertically apart. In addition, each tie should be positioned to hang on a post nipple when tightening to prevent sagging.

- Wrap approximately 6 inches of fabric around the end posts and secure with 3 ties.

- No more than 24 inches of a 36-inch fabric is allowed above ground level.

- The rope lock system must be used in all ditch check applications.

- The installation should be checked and corrected for any deviation before compaction. Use a flat-bladed shovel to tuck fabric deeper into the ground if necessary.

- Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first and then each side twice for a total of four trips.

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Any damage shall be repaired immediately
- If concentrated flows are evident uphill of the fence, they must be intercepted and conveyed to a sediment pond or trap
- It is important to check the uphill side of the fence for signs of the fence clogging and acting as a barrier to flow and then causing channelization of flows parallel to the fence. If this occurs, replace the fence or remove the trapped sediment
- Sediment deposits shall either be removed when the deposit reaches approximately one-third the height of the silt fence, or a second silt fence shall be installed
- If the filter fabric (geotextile) has deteriorated due to ultraviolet breakdown, it shall be replaced

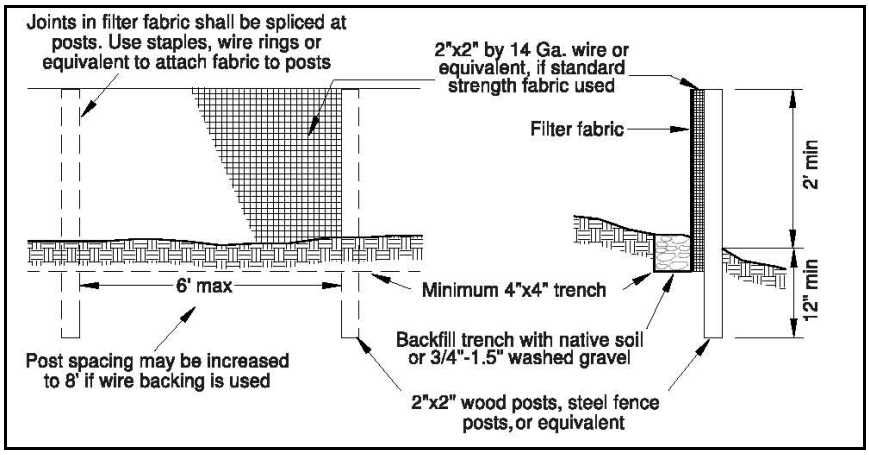



**FIGURE EC-7-1 SILT FENCE**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

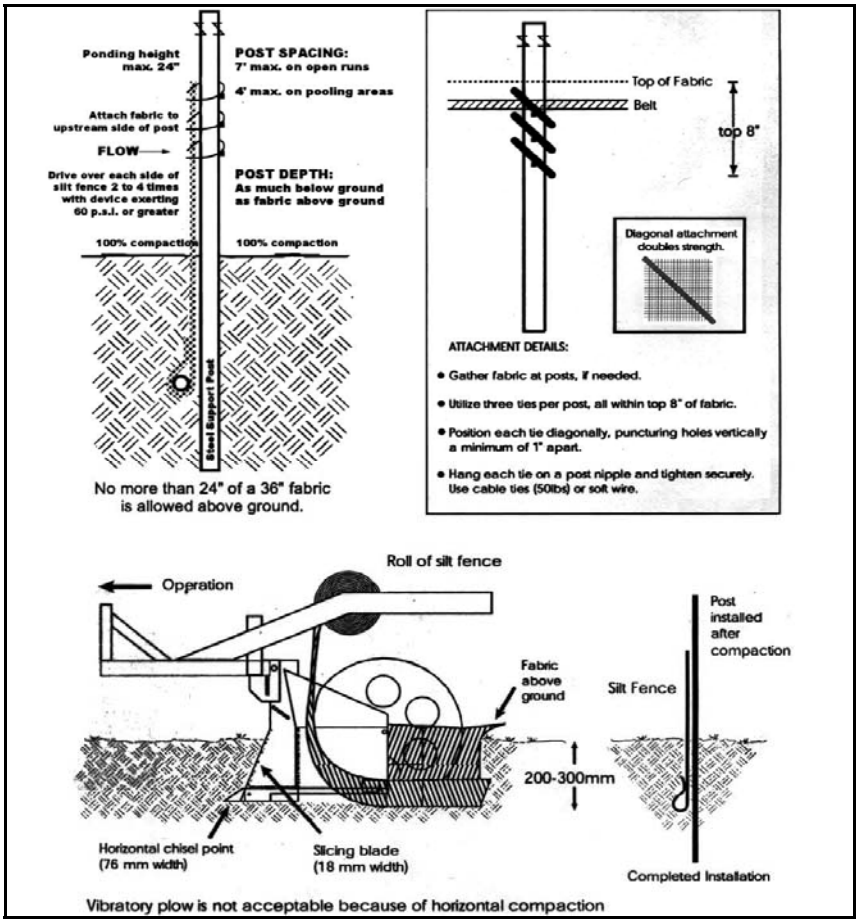



**FIGURE EC-7-2 SILT FENCE INSTALLATION BY SLICING METHOD**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 8. BMP SC-8: GRAVEL FILTER BERM

### *Purpose*

A gravel filter berm is constructed on rights-of-way or traffic areas within a construction site to capture and retain runoff from construction sites or roadways, to allow sediments to settle out, and to direct runoff water through filter berms at outlets to stabilize drainage ways.

### *Conditions of Use*

- Where a temporary measure is needed to retain sediment from rights-of-way or in traffic areas on construction sites
- Applicable to relatively flat construction sites and should be installed on the down slope sides of the disturbed areas

### *Design and Installation Specifications*

- Berm material shall be ¾ to 3 inches in size, washed well-graded gravel or crushed rock with less than 5 percent fines
- Spacing of berms:
  – Every 300 feet on slopes less than 5 percent
  – Every 200 feet on slopes between 5 percent and 10 percent
  – Every 100 feet on slopes greater than 10 percent
- Berm dimensions:
  – 1 foot high with 3:1 side slopes
  – 8 linear feet per 1 cfs runoff based on the 10-year, 24-hour design storm
- Berm should be mounded along the contour of the slope at the downhill side of the construction site
- The height of the ridge should be sufficient to contain the specified volume of runoff

### *Maintenance Standards*

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy seasons
- Sediment that accumulates in the BMP shall be removed when the sediment height reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Replace rock and filter material as needed

## 9. BMP SC-9: GRAVEL BAG BERM

### *Purpose*

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

### *Conditions of Use*

- Gravel Bag berms may be suitable:
  - ✓ As a linear sediment control measure
  - ✓ Below the toe of slopes and erodible slopes
  - ✓ As sediment traps at culvert/pipe outlets
  - ✓ Below other small cleared areas
  - ✓ Along the perimeter of a site
  - ✓ Down slope of exposed soil areas
  - ✓ Around temporary stockpiles and spoil areas
  - ✓ Parallel to a roadway to keep sediment off paved areas
  - ✓ Along streams and channels

- As linear erosion control measure:
  - ✓ Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
  - ✓ At the top of slopes to divert runoff away from disturbed slopes
  - ✓ As check dams across mildly sloped construction roads

### *Limitations*

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

### *Design and Installation Specifications*

- Locate gravel bag berms on level contours. Slopes between 20:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 50 ft. with the first row near the slope toe. Slopes 2:1 (H:V) or steeper: Gravel bags should be placed at a

maximum interval of 25 ft (a closer spacing is more effective), with the first row placed on slope toe

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage
- For installation near the toe of the slope, consider moving the gravel bag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers
- Drainage area should not exceed 5 acres
- In Non-Traffic Areas:
  - ✓ Height = 18 in. maximum
  - ✓ Top width = 24 in. minimum for three or more layer construction
  - ✓ Top width = 12 in. minimum for one or two layer construction
  - ✓ Side slopes = 2:1 or flatter
- In Construction Traffic Areas:
  - ✓ Height = 12 in. maximum
  - ✓ Top width = 24 in. minimum for three or more layer construction
  - ✓ Top width = 12 in. minimum for one or two layer construction
  - ✓ Side slopes = 2:1 or flatter
- Butt ends of bags tightly
- On multiple rows, or multiple layer construction, overlap butt joints of adjacent row and row beneath
- Use a pyramid approach when stacking bags
- Bag Material: Bags should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd2, Mullen burst strength exceeding 300 lb/in2 in conformance with the requirements of ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355
- Bag Size: Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials
- Fill Material: Fill material should be 0.5 to 1 in. Class 2 aggregate base, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags
- Reshape or replace gravel bags as needed
- Repair washouts or other damage as needed

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location
- Remove gravel bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of

## 10. BMP SC-10: INTERCEPTOR DIKE AND SWALE

### *Purpose*

Provide a ridge of compacted soil, or a ridge with an upslope swale, at the top or base of a disturbed slope or along the perimeter of a disturbed construction area to convey stormwater. Use the dike and/or swale to intercept the runoff from unprotected areas and direct it to areas where erosion can be controlled. This can prevent storm runoff from entering the work area or sediment-laden runoff from leaving the construction site.

### *Conditions of Use*

- Where the runoff from an exposed site or disturbed slope must be conveyed to an erosion control facility that can safely convey the stormwater
- Locate upslope of a construction site to prevent runoff from entering disturbed area
- When placed horizontally across a disturbed slope, it reduces the amount and velocity of runoff flowing down the slope
- Locate down slope to collect runoff from a disturbed area and direct it to a sediment basin

### *Design and Installation Specifications*

- Dike and/or swale and channel must be stabilized with temporary or permanent vegetation or other channel protection during construction
- Channel requires a positive grade for drainage, steeper grades require channel protection and check dams
- Construct trench along the slope contour including a conveyance to outlet flow to a level spreader or other stabilized discharge
- Place excavated materials on the down slope side of the trench or swale and spread to conform to the natural slope
- Review construction for areas where overtopping may occur
- Can be used at top of new fill before vegetation is established
- May be used as a permanent diversion channel to carry the runoff
- Sub-basin tributary area should be one acre or less
- Design capacity for 10-year, 24-hour storm for temporary facilities, 25-year, 24-hour storm for permanent facilities

**Interceptor dikes** shall meet the following criteria:

| | | |
|---|---|---|
| Top Width | 2 feet minimum | |
| Height | 1.5 feet minimum on berm | |
| Side Slope | 2:1 or flatter | |
| Grade | Depends on topography, however, dike system minimum is 0.5%, maximum is 1% | |
| Compaction | Minimum of 90 percent ASTM D698 standard proctor. | |
| Horizontal Spacing of Interceptor Dikes: | | |
| **Average Slope** | **Slope Percent** | **Flow path Length** |
| 20H:1V or less | 3-5% | 300 feet |
| (10 to 20)H:1V | 5-10% | 200 feet |
| (4 to 10)H:1V | 10-25% | 100 feet |
| (2 to 4)H:1V | 25-50% | 50 feet |
| Stabilization depends on velocity and reach: | | |
| Slopes <5% | Seed and mulch applied within 5 days of dike construction (*see EC-15, Mulching*) | |
| Slopes 5 - 50% | Dependent on runoff velocities and dike materials. Stabilization should be done immediately using either sod or riprap or other measures to avoid erosion. | |

- The upslope side of the dike shall provide positive drainage to the dike outlet. No erosion shall occur at the outlet. Provide energy dissipation measures as necessary. Sediment-laden runoff must be released through a sediment trapping facility
- Minimize construction traffic over temporary dikes. Use temporary cross culverts for channel crossing

**Interceptor swales** shall meet the following criteria:

| | |
|---|---|
| Bottom Width | 2 feet minimum; the bottom cross-section shall be level |
| Depth | 1-foot minimum |
| Side Slope | 2:1 or flatter |
| Grade | Maximum 5 percent, with positive drainage to a suitable outlet (such as a sediment pond or trap). |
| Stabilization | Seed as per *EC-21*, *Seeding practices*, or *EC-11*, *Channel Lining*, 12 inches thick of riprap pressed into the bank and extending at least 8 inches vertical from the bottom. |

***Maintenance Standards***

- Inspect diversion dikes and interceptor swales once a week and after every rainfall
- Immediately remove sediment from the flow area
- Damage caused by construction traffic or other activity must be repaired before the end of each working day

- Check outlets and make timely repairs as needed to avoid gully formation. When the area below the temporary diversion dike is permanently stabilized, remove the dike and fill and stabilize the channel to blend with the natural surface

## 11. BMP SC-11: BRUSH BARRIER

### *Purpose*

The purpose of brush barriers is to reduce the transport of coarse sediment from a construction site by providing a temporary physical barrier to sediment and reducing the runoff velocities of overland flow.

### *Conditions of Use*

- Brush barriers may be used down slope of all disturbed areas of less than one-quarter acre
- Brush barriers are not intended to treat concentrated flows, nor are they intended to treat substantial amounts of overland flow. Any concentrated flows must be conveyed through the drainage system to a sediment pond or trap. The only circumstance in which overland flow can be treated solely by a barrier, rather than by a sediment pond or trap, is when the area draining to the barrier is small
- Brush barriers should only be installed parallel to contours

### *Design and Installation Specifications*

- Height 2 feet (minimum) to 5 feet (maximum)
- Width 5 feet at base (minimum) to 15 feet (maximum)
- Filter fabric (geotextile) may be anchored over the brush berm to enhance the filtration ability of the barrier. Ten-ounce burlap is an adequate alternative to filter fabric
- Chipped site vegetation, composted mulch, or wood-based mulch (hog fuel) can be used to construct brush barriers
- A 100 percent biodegradable installation can be constructed using 10-ounce burlap held in place by wooden stakes. Figure SC-11-1 depicts a typical brush barrier

### *Maintenance Standards*

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- There shall be no signs of erosion or concentrated runoff under or around the barrier. If concentrated flows are bypassing the barrier, it must be expanded or augmented by toed-in filter fabric
- The dimensions of the barrier must be maintained

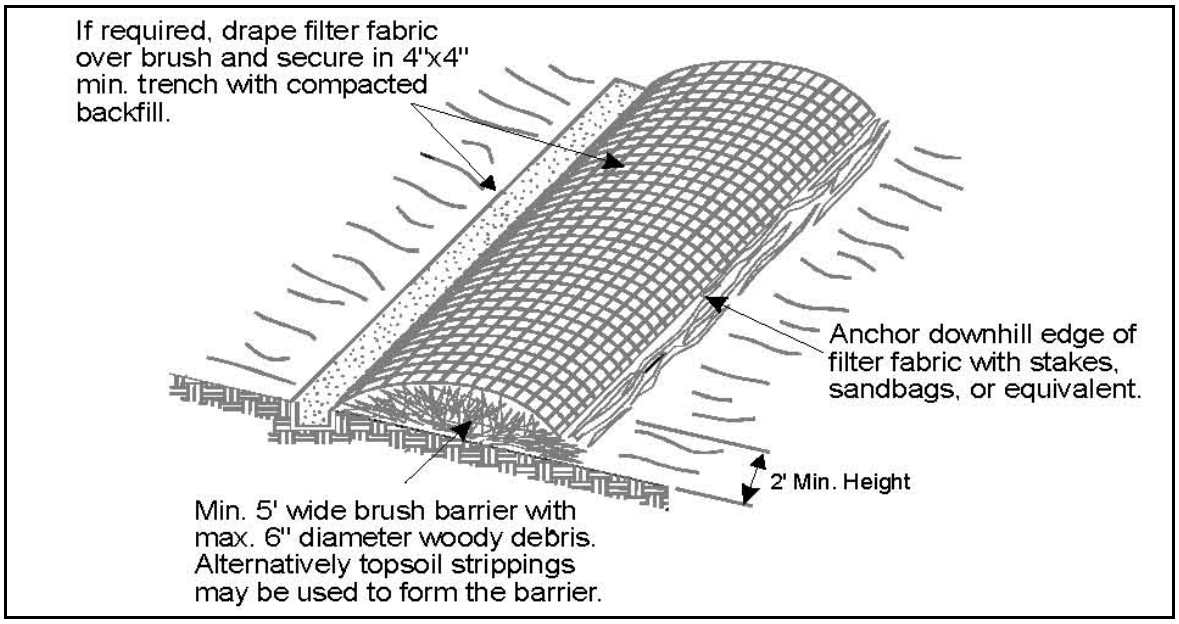



**FIGURE SC-11-1 BRUSH BARRIER**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 12. BMP SC-12: WILLOW WATTLES

### *Purpose*

Wattling is a revegetation technique consisting of placing bundles of willow cuttings in shallow trenches, on the contour of either cut or fill slopes to stabilize cut or fill slopes, to stabilize the surface, to reduce the velocity of surface runoff, to trap sediment, to increase infiltration, and to establish vegetation.

### *Conditions of Use*

- Applicable to surface disturbances involving cut or fill slopes
- Angle of repose is excessively steep
- As a type of revegetation, wattling is applicable on moist site or seeped areas
- Wattling is a valuable method to help achieve surface stability on a cut or fill slope, which is near its angle of repose, but continues to erode due to surface runoff
- Wattling bundles can vegetatively root and sprout and continue to stabilize slope surfaces as a revegetation planting. Rooting and sprouting will occur if adequate moisture is available at the time of placement and the first growing season
- Temporary irrigation can be very effective during establishment
- The placement of the wattling bundles along the contours can reduce slope lengths, which can provide long, uninterrupted paths for surface runoff
- The rows of wattling bundles act as small sediment traps and increases the amount of infiltration on site. Wattling should not be prescribed as a treatment on cut banks with shallow soils. The increased infiltration will saturate the subsoil and may lead to soil slippage and landslides

### *Design Criteria*

The followings steps for preparing and placing the wattling bundles are recommended:

- Wattling bundles should be prepared from living branches of willow (Salix spp.) within or near the project area. Willow is the ideal material because it sprouts and roots easily, branches are long, straight, and flexible. Wattling material can be cut with lopping shears, chain saws, or power brush cutting saws
- Wattling bundles may vary length, depending on the material available. Bundles 5 feet long are the easiest to work with. Bundles shall taper at the ends and shall be 1 to ½ feet longer than the average length of stems used to achieve this taper. The butts of individual stems shall not vary more than one half inch in diameter
- Stems shall be placed alternately (randomly) in each bundle so that approximately one-half of the butt ends are at each end of the bundle
- When compressed firmly and tied, each bundle shall be approximately eight inches in diameter
- Bundles shall be tied on not more than 15-inch centers with two warps of binder twine or heavier tying material with a nonslipping knot

- Bundles shall be prepared in advance of placement and kept covered and wet. They may be prepared up to seven days in advance of placement
- Grade for the wattling trenches shall be stakes with an Abney level, or similar device, and shall follow parallel to slope contours (horizontal)
- Trenches shall be three feet vertical spacing (or such other spacing specified. Economics may dictate wider placement)
- Bundles shall be laid in trenches dug to approximately one-half the diameter of the bundles, with ends of bundles overlapping at least 12 inches. The overlap shall be as long as necessary to permit staking as specified below
- Bundles shall be staked firmly in place with vertical stakes on the downhill side of the wattling. Vertical stakes should be spaced not more than 18 inches on center and diagonal stakes through the bundles on not more than 20-inch centers. Where bundle overlap occurs between previously set bottom or guide stakes, an additional bottom stake shall be used on the midpoint of the overlap. Bundle overlaps shall be "tied" with a diagonal stake through the ends of both bundles
- Stakes may be made of live wattling material greater than 1-½ inches in diameter or they may be construction stakes. Reinforcing bar may be substituted only as specified below
- All stakes shall be driven to a firm hold and a minimum of 18 inches deep. Where soils are soft and 24-inch stakes are not solid (i.e. if they can be moved by hand), 36 inch stakes shall be used. Where soils are so compacted that 24 inch stakes cannot be driven 18 inches deep, 3/8 – ½ inch steel reinforcing bar shall be used for staking
- Work shall progress from the bottom of the cut or fill toward the top and each row shall be covered with soil and packed firmly behind and on the uphill side of the wattling by tamping or by walking on the wattling as the work progresses or by a combination of these methods
- The downhill "lip" of the wattling bundle shall be left exposed when staking and covering are completed. However, the preceding specifications must be rigorously adhered to

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Inspection and repair is especially important during the first year
- Immediately replace or repair any stakes or bundles that have worked out of the ground
- Immediately repair any slope sloughing or gully formed due to failure of the wattles

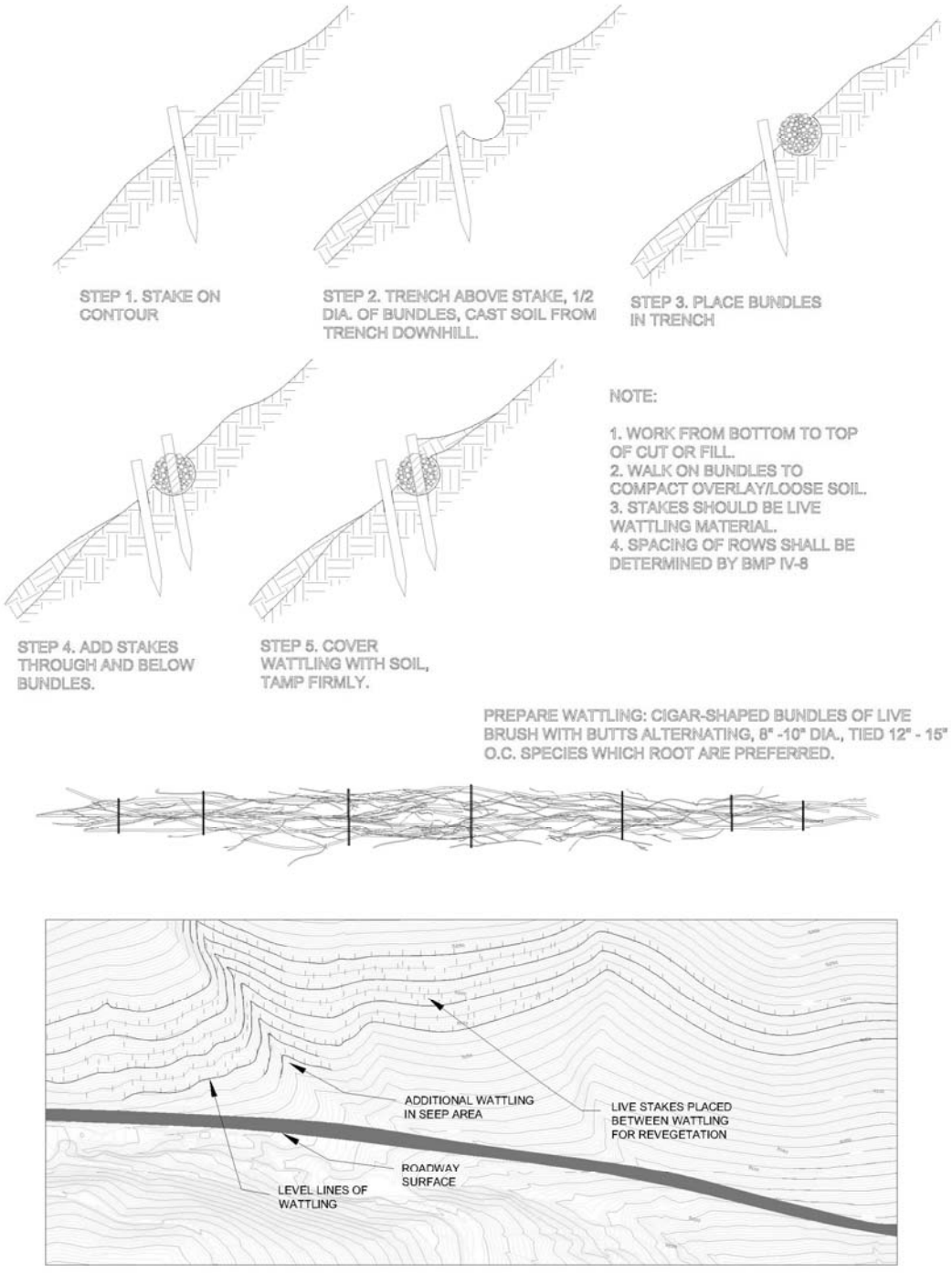



**FIGURE SC-12-1 WATTLING**

From: Handbook of Best Management Practices, Nevada Division of Environmental Protection and Nevada Division of Conservation Districts, 1994

## 13. BMP SC-13: STRAW WATTLES

### *Purpose*

Straw wattles are temporary erosion and sediment control barriers consisting of straw that is wrapped in biodegradable tubular plastic or similar encasing material. They reduce the velocity and can spread the flow of rill and sheet runoff, and can capture and retain sediment. Straw wattles are typically 8 to 10 inches in diameter and 25 to 30 feet in length. The wattles are placed in shallow trenches and staked along the contour of disturbed or newly constructed slopes.

### *Conditions of Use*

- Disturbed areas that require immediate erosion protection
- Exposed soils during the period of short construction delays, or over winter months
- On slopes requiring stabilization until permanent vegetation can be established
- Straw wattles are effective for one to two seasons
- If conditions are appropriate, wattles can be staked to the ground using willow cuttings for added revegetation
- Rilling can occur beneath wattles if not properly entrenched and water can pass between wattles if not tightly abutted together

### *Design Criteria*

- It is critical that wattles are installed perpendicular to the flow direction and parallel to the slope contour
- Narrow trenches should be dug across the slope on contour to a depth of 3 to 5 inches on clay soils and soils with gradual slopes. On loose soils, steep slopes, and areas with high rainfall, the trenches should be dug to a depth of 5 to 7 inches, or 1/2 to 2/3 of the thickness of the wattle
- Start building trenches and installing wattles from the base of the slope and work up. Excavated material should be spread evenly along the uphill slope and compacted using hand tamping or other methods
- Construct trenches at contour intervals of 3 to 30 feet apart depending on the steepness of the slope, soil type, and rainfall. The steeper the slope the closer together the trenches
- Install the wattles snugly into the trenches and abut tightly end to end. Do not overlap the ends
- Install stakes at each end of the wattle, and at 4-foot centers along entire length of wattle
- If required, install pilot holes for the stakes using a straight bar to drive holes through the wattle and into the soil
- At a minimum, wooden stakes should be approximately 3/4 x 3/4 x 24 inches. Willow cuttings or 3/8-inch rebar can also be used for stakes
- Stakes should be driven through the middle of the wattle, leaving 2 to 3 inches of the stake protruding above the wattle

*Maintenance Standards*

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Wattles may require maintenance to ensure they are in contact with soil and thoroughly entrenched, especially after significant rainfall on steep sandy soils
- Inspect the slope after significant storms and repair any areas where wattles are not tightly abutted or water has scoured beneath the wattles

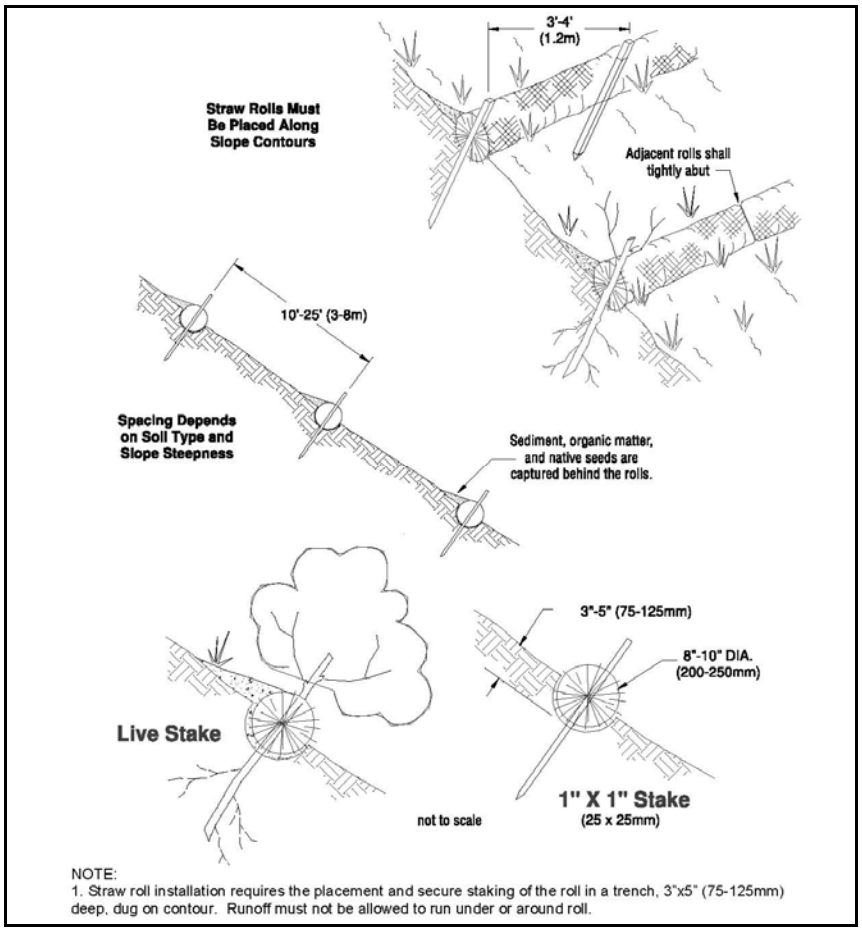



**FIGURE SC-13-1 STRAW WATTLES**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 14. BMP SC-14: SEDIMENT TRAP

### *Purpose*

A sediment trap is a small temporary ponding area with a gravel outlet used to collect and store sediment from sites cleared and/or graded during construction. Sediment traps, along with other perimeter controls, shall be installed before any land disturbance takes place in the drainage area.

### *Conditions of Use*

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or trap or other appropriate sediment removal best management practice. Non-engineered sediment traps may be used on-site prior to an engineered sediment trap or sediment pond to provide additional sediment removal capacity.

It is intended for use on sites where the tributary drainage area is less than 3 acres, with no unusual drainage features, and a projected build-out time of six months or less. The sediment trap is a temporary measure (with a design life of approximately 6 months) and shall be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps and ponds are only effective in removing sediment down to about the medium silt size fraction. Runoff with sediment of finer grades (fine silt and clay) will pass through untreated, emphasizing the need to control erosion to the maximum extent first.

Whenever possible, sediment-laden water shall be discharged into onsite, relatively level, vegetated areas (see BMP SC-6 – Filter Strip). This is the only way to effectively remove fine particles from runoff unless chemical treatment or filtration is used. This can be particularly useful after initial treatment in a sediment trap or pond. The areas of release must be evaluated on a site-by-site basis in order to determine appropriate locations for and methods of releasing runoff. Vegetated wetlands shall not be used for this purpose. Frequently, it may be possible to pump water from the collection point at the downhill end of the site to an upslope vegetated area. Pumping shall only augment the treatment system, not replace it, because of the possibility of pump failure or runoff volume in excess of pump capacity.

All projects that are constructing permanent facilities for runoff quantity control should use the rough-graded or final-graded permanent facilities for traps and ponds. This includes combined facilities and infiltration facilities. When permanent facilities are used as temporary sedimentation facilities, the surface area requirement of a sediment trap or pond must be met. If the surface area requirements are larger than the surface area of the permanent facility, then the trap or pond shall be enlarged to comply with the surface area requirement. The permanent pond shall also be divided into two cells as required for sediment ponds. **If permanent infiltration facilities are used for temporary sediment traps, the bottom of the trap must be kept at least two feet higher that the bottom**

**elevation of the permanent facility. This will provide a vertical buffer to prevent sediment from plugging the native soils to be used for permanent infiltration. The permanent facility will be excavated to final depth once the site has been stabilized and the temporary trap is no longer necessary.**

Either a permanent control structure or the temporary control structure (described in BMP SC-15, Temporary Sediment Pond) can be used. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the pond. A shut-off valve may be added to the control structure to allow complete retention of stormwater in emergency situations. In this case, an emergency overflow weir must be added.

A skimmer may be used for the sediment trap outlet if approved by Carson City.

***Design and Installation Specifications***

- See Figures SC-14-1 and SC-14-2 for details
- If permanent runoff control facilities are part of the project, they should be used for sediment retention
- To determine the sediment trap geometry, first calculate the design surface area (*SA*) of the trap, measured at the invert of the weir. Use the following equation:

  $SA = FS(Q_2 / Vs)$

  where

  $Q_2$ = Design inflow based on the peak discharge from the developed 2-year, 24 hour runoff event from the contributing drainage area as computed in the hydrologic analysis. The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used

  *Vs* = The settling velocity of the soil particle of interest. The 0.02 mm (medium silt) particle with an assumed density of 2.65 g/cm3 has been selected as the particle of interest and has a settling velocity (*Vs*) of 0.00096 ft/sec

  *FS* = A safety factor of 2 to account for non-ideal settling

  Therefore, the equation for computing surface area becomes:

  $SA = 2xQ_2 / 0.00096$ or

  2080 square feet per cfs of inflow

  Note: Even if permanent facilities are used, they must still have a surface area that is at least as large as that derived from the above formula. If they do not, the pond must be enlarged.

- To aid in determining sediment depth, all sediment traps shall have a staff gauge with a prominent mark 1-foot above the bottom of the trap

- Sediment traps may not be feasible on utility projects due to the limited workspace or the short-term nature of the work. Portable tanks may be used in place of sediment traps for utility projects

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Sediment shall be removed from the trap when it reaches 1-foot in depth
- Any damage to the pond embankments or slopes shall be repaired

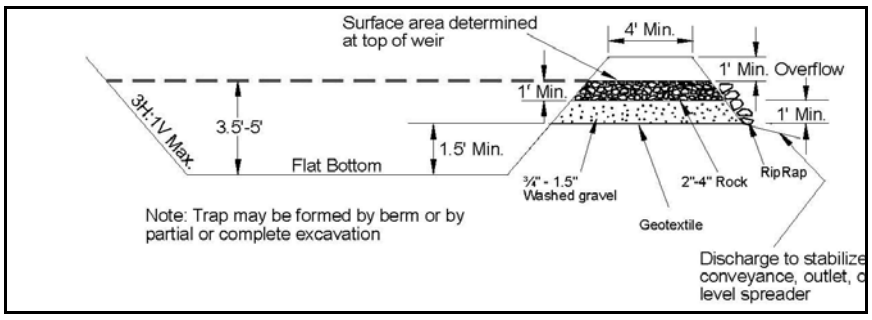



**FIGURE SC-14-1 CROSS-SECTION OF SEDIMENT TRAP**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

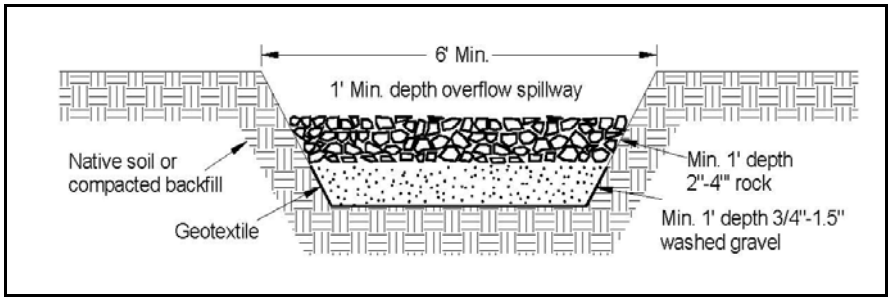



**FIGURE SC-14-2 SEDIMENT TRAP OUTLET**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 15. BMP SC-15: TEMPORARY SEDIMENT POND

### *Purpose*

Sediment ponds remove sediment from runoff originating from disturbed areas of the site. Sediment ponds are typically designed to remove sediment no smaller than medium silt (0.02 mm). Consequently, they usually reduce turbidity only slightly.

### *Conditions of Use*

Prior to leaving a construction site, stormwater runoff must pass through a sediment pond or other appropriate sediment removal best management practice.

A sediment pond shall be used where the contributing drainage area is 3 acres or more. Ponds must be used in conjunction with erosion control practices to reduce the amount of sediment flowing into the basin.

### *Design and Installation Specifications*

- Sediment basins must be installed only on sites where failure of the structure would not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. Also, sediment traps and ponds are attractive to children and can be very dangerous. Compliance with local ordinances regarding health and safety must be addressed. If fencing of the pond is required, the type of fence and its location shall be shown on the ESC plan
- Structures having a maximum height of 20 feet, and/or a maximum storage capacity of 20 acre-feet or larger are subject to dam safety regulations. Smaller impoundments may also be subject to dam safety regulations if they are determined to be "high-hazard" based on potential downstream impacts as determined by the Nevada Department of Water Resources
- See Figure SC-15-1, Figure SC-15-2, and Figure SC-15-3 for details
- If permanent runoff control facilities are part of the project, they should be used for sediment retention. The surface area requirements of the sediment basin must be met. This may require enlarging the permanent basin to comply with the surface area requirements. If a permanent control structure is used, it may be advisable to partially restrict the lower orifice with gravel to increase residence time while still allowing dewatering of the basin
- Use of infiltration facilities for sedimentation basins during construction tends to clog the soils and reduce their capacity to infiltrate. If infiltration facilities are to be used, the sides and bottom of the facility must only be rough excavated to a minimum of 2 feet above final grade. Final grading of the infiltration facility shall occur only when all contributing drainage areas are fully stabilized. The infiltration pretreatment facility should be fully constructed and used with the sedimentation basin to help prevent clogging
- Determining Pond Geometry

- Obtain the discharge from the hydrologic calculations of the peak flow for the 2-year, 24 hour runoff event ($Q_2$). The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used

  Determine the required surface area at the top of the riser pipe with the equation:

- To determine the sediment trap geometry, first calculate the design surface area (*SA*) of the trap, measured at the invert of the weir. Use the following equation:

  $SA = FS(Q_2 / Vs)$

  where

  $Q_2$ = Design inflow based on the peak discharge from the developed 2-year, 24 hour runoff event from the contributing drainage area as computed in the hydrologic analysis. The 10-year peak flow shall be used if the project size, expected timing and duration of construction, or downstream conditions warrant a higher level of protection. If no hydrologic analysis is required, the Rational Method may be used

  *Vs* = The settling velocity of the soil particle of interest. The 0.02 mm (medium silt) particle with an assumed density of 2.65 g/cm3 has been selected as the particle of interest and has a settling velocity (*Vs*) of 0.00096 ft/sec

  *FS* = A safety factor of 2 to account for non-ideal settling

  Therefore, the equation for computing surface area becomes:

  $SA = 2xQ_2 / 0.00096$ or

  2080 square feet per cfs of inflow

  Note: Even if permanent facilities are used, they must still have a surface area that is at least as large as that derived from the above formula. If they do not, the pond must be enlarged.

  The basic geometry of the pond can now be determined using the following design criteria:

  - Required surface area SA (from above) at top of riser
  - Minimum 3.5-foot depth from top of riser to bottom of pond
  - Maximum 3:1 interior side slopes and maximum 2:1 exterior slopes. The interior slopes can be increased to a maximum of 2:1 if 6 foot high chain-link fencing is provided at or above the maximum water surface
  - One foot of freeboard between the top of the riser and the crest of the emergency spillway
  - Flat bottom
  - Minimum 1-foot deep spillway
  - Length-to-width ratio between 3:1 and 6:1

- Sizing of Discharge Mechanisms

  The outlet for the basin consists of a combination of principal and emergency spillways. These outlets must pass the peak runoff expected from the contributing drainage area for a 100-year storm, 24 hour design. If, due to site conditions and basin geometry, a separate emergency spillway is not feasible, the principal spillway must pass the entire peak runoff expected from the 100-year storm. However, an attempt to provide a separate emergency spillway should always be made. The runoff calculations should be based on the site conditions producing the maximum amount of runoff, which is typically the developed paved condition, but could also be the rough graded condition if the developed site incorporates significant landscaping. The flow through the dewatering orifice cannot be utilized when calculating the 100-year storm elevation because of its potential to become clogged; therefore, available spillway storage must begin at the principal spillway riser crest.

  The principal spillway designed by the procedures contained in this standard will result in some reduction in the peak rate of runoff. However, if the basin for a permanent stormwater detention pond is used for a temporary sedimentation basin, the control structure for the permanent pond can be used to maintain predevelopment discharge limitations. The size of the basin, the expected life of the construction project, the anticipated downstream effects and the anticipated weather conditions during construction, should be considered to determine the need of additional discharge control. See Figure SC-15-4 for riser inflow curves.

  **Principal Spillway:** Determine the required diameter for the principal spillway (riser pipe). The diameter shall be the minimum necessary to pass the pre-developed 10-year, 24 hour peak flow ($Q_{10}$). Use Figure SC-15-4 to determine this diameter ($h$ = 1-foot).
  *Note: A permanent control structure may be used instead of a temporary riser.*

  **Emergency Overflow Spillway:** Determine the required size and design of the emergency overflow spillway for the developed 100-year, 24 hour peak flow using the method contained in Division 14.

  **Dewatering Orifice:** Determine the size of the dewatering orifice(s) (minimum 1-inch diameter) using a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice. Determine the required area of the orifice with the following equation:

$$A_o = \frac{A^5 (2h)^{0.5}}{0.6x3600Tg^{0.5}}$$

  where $Ao$ = orifice area (square feet)
  $As$ = pond surface area (square feet)
  $h$ = head of water above orifice (height of riser in feet)

$T$ = dewatering time (24 hours)
$g$ = acceleration of gravity (32.2 feet/second$^2$)

$$A_o = \frac{A^5(2h)^{0.5}}{294{,}166}$$

Convert the required orifice area to the required diameter $D$ of the orifice:

$$D = 24x\sqrt{A_o/\pi} = 13.53x\sqrt{A_o}$$

Where D= orifice diameter (inches)

The vertical, perforated tubing connected to the dewatering orifice must be at least 2 inches larger in diameter than the orifice to improve flow characteristics. The size and number of perforations in the tubing should be large enough so that the tubing does not restrict flow. The orifice should control the flow rate.

- Additional Design Specifications

  The **pond shall be divided** into two roughly equal volume cells by a permeable divider that will reduce turbulence while allowing movement of water between cells. The divider shall be at least one half the height of the riser and a minimum of one foot below the top of the riser. Wire-backed, 2- to 3-foot high, extra strength filter fabric supported by treated 4"x4"s can be used as a divider. Alternatively, staked straw bales wrapped with filter fabric (geotextile) may be used. If the pond is more than 6 feet deep, a different mechanism must be proposed. A riprap embankment is one acceptable method of separation for deeper ponds. Other designs that satisfy the intent of this provision are allowed as long as the divider is permeable, structurally sound, and designed to prevent erosion under or around the barrier.

  To aid in determining sediment depth, **one-foot intervals** shall be prominently marked on the riser.

  If an **embankment** of more than 6 feet is proposed, the pond must comply with dam safety regulations per Nevada Department of Water Resources, and must be designed based on recommendation from a qualified geotechnical engineer.

- The most common structural failure of sedimentation basins is caused by piping. Piping refers to two phenomena: (1) water seeping through fine-grained soil, eroding the soil grain by grain and forming pipes or tunnels; and, (2) water under pressure flowing upward through a granular soil with a head of sufficient magnitude to cause soil grains to lose contact and capability for support

  The most critical construction sequences to prevent piping will be:
  1. Tight connections between riser and barrel and other pipe connections
  2. Adequate anchoring of riser

3. Proper soil compaction of the embankment and riser footing
4. Proper construction of anti-seep devices

***Maintenance Standards***

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season
- Sediment shall be removed from the pond when it reaches 1–foot in depth
- Any damage to the pond embankments or slopes shall be promptly repaired

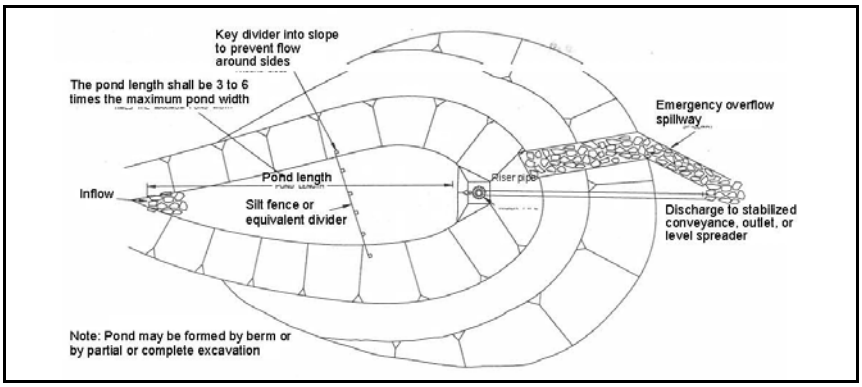



**FIGURE SC-15-1 SEDIMENT POND PLAN VIEW**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

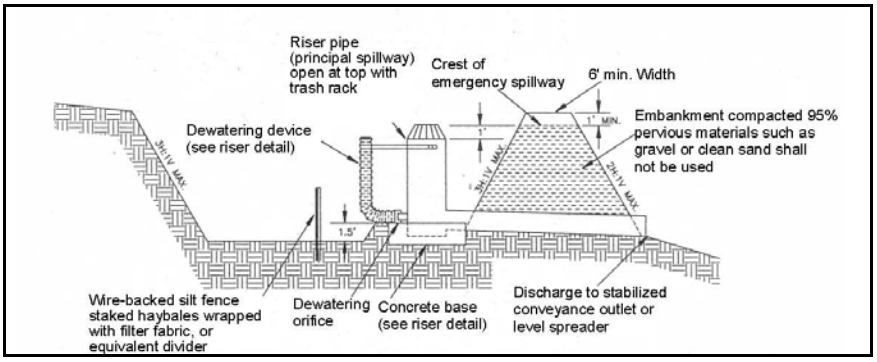



**FIGURE SC-15-2 SEDIMENT POND CROSS SECTION**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

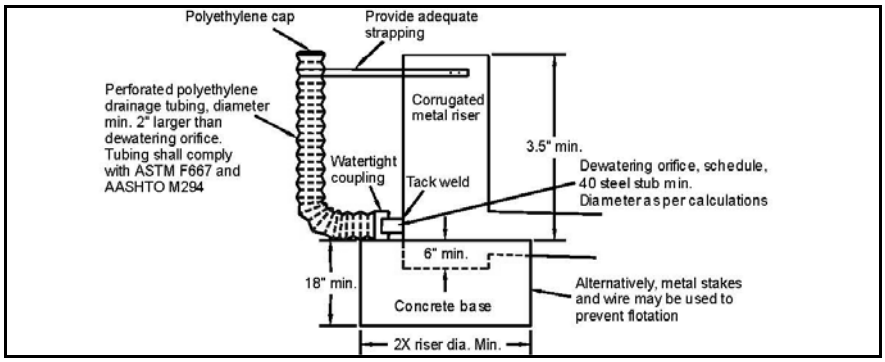



**FIGURE SC-15-3 SEDIMENT POND RISER DETAIL**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

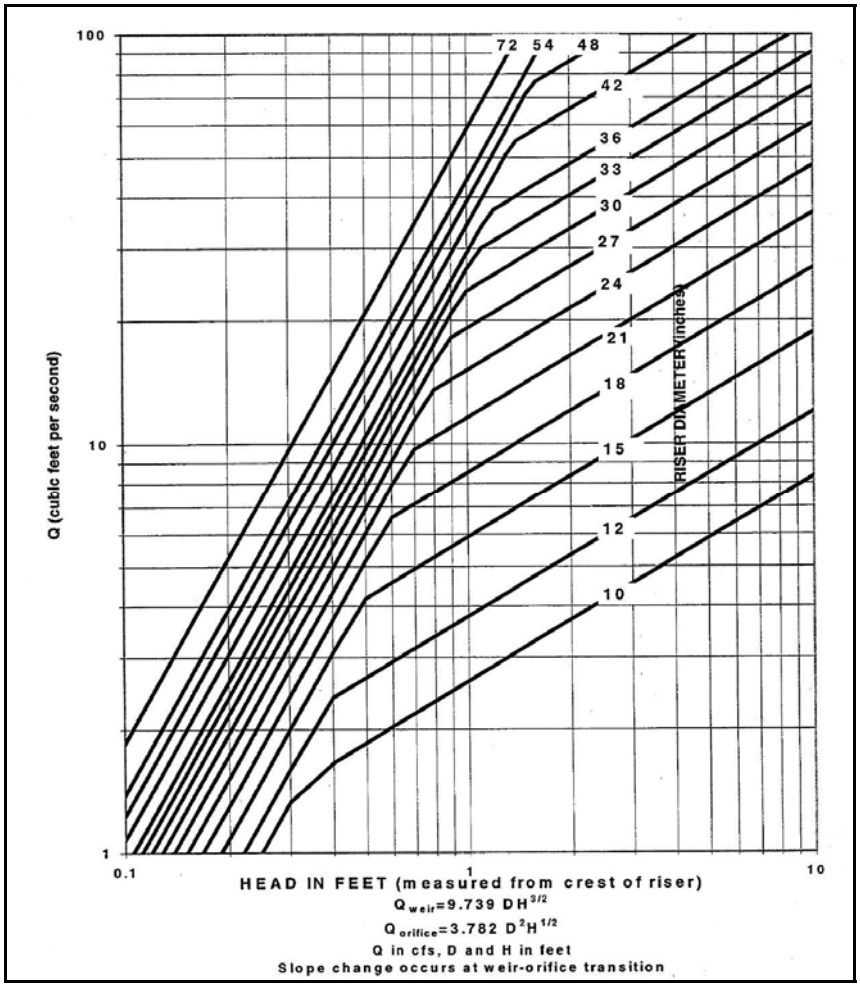



**FIGURE SC-15-4 RISER INFLOW CURVES**

From: Stormwater Management Manual for Western Washington, Washington Department of Ecology, 2001

## 16. BMP SC-16: CONSTRUCTION STORMWATER FILTRATION

### *Purpose*

Filtration removes sediment from runoff originating from disturbed areas of the site.

### *Conditions of Use*

Traditional BMPs used to control soil erosion and sediment loss from sites under development may not be adequate to ensure compliance with the water quality standard for turbidity in the receiving water. Filtration may be used in conjunction with gravity settling to remove sediment as small as fine silt (0.5 µm). The reduction in turbidity will be dependent on the particle size distribution of the sediment in the stormwater. In some circumstances, sedimentation and filtration may achieve compliance with the water quality standard for turbidity. Filtration may also be used in conjunction with polymer treatment in a portable system to assure capture of the flocculated solids.

### *Design and Installation Specifications*

### *Background Information*

Filtration with sand media has been used for over a century to treat water and wastewater. The use of sand filtration for treatment of stormwater has developed recently, generally to treat runoff from streets, parking lots, and residential areas. The application of filtration to construction stormwater treatment is currently under development.

Two types of filtration systems may be applied to construction stormwater treatment: rapid and slow. Rapid sand filters are the typical system used for water and wastewater treatment. They can achieve relatively high hydraulic flow rates, on the order of 2 to 20 gpm/sf, because they have automatic backwash systems to remove accumulated solids. In contrast, slow sand filters have very low hydraulic rates, on the order of 0.02 gpm/sf, because they do not have backwash systems. To date, slow sand filtration has generally been used to treat stormwater. Slow sand filtration is mechanically simple in comparison to rapid sand filtration but requires a much larger filter area.

**Filtration Equipment.** Sand media filters are available with automatic backwashing features that can filter to 50 µm particle size. Screen or bag filters can filter down to 5 µm. Fiber wound filters can remove particles down to 0.5 µm. Filters should be sequenced from the largest to the smallest pore opening. Sediment removal efficiency will be related to particle size distribution in the stormwater.

**Treatment Process Description.** Stormwater is collected at interception point(s) on the site and is diverted to a sediment pond or tank for removal of large sediment and storage of the stormwater before it is treated by the filtration system. The stormwater is pumped from the trap, pond, or tank through the filtration system in a rapid sand filtration system. Slow sand filtration systems are designed as flow through systems using gravity.

If large volumes of concrete are being poured, pH adjustment may be necessary.

***Maintenance Standards***

- Rapid sand filters typically have automatic backwash systems that are triggered by a pre-set pressure drop across the filter. If the backwash water volume is not large or substantially more turbid than the stormwater stored in the holding pond or tank, backwash return to the pond or tank may be appropriate. However, land application or another means of treatment and disposal may be necessary
- Screen, bag, and fiber filters must be cleaned and/or replaced when they become clogged
- Sediment shall be removed from the storage and/or treatment ponds as necessary Typically, sediment removal is required once or twice during a wet season and at the decommissioning of the ponds

## C. MANAGEMENT SOURCE CONTROL BMPS

### 1. BMP MC-1: CONCRETE HANDLING

***Purpose***

Concrete work can generate process water and slurry that contain fine particles and high pH, both of which can violate water quality standards in the receiving water. This BMP is intended to minimize and eliminate concrete process water and slurry from entering waters of the State.

***Conditions of Use***

- Any time concrete is used, these management practices shall be utilized Concrete construction projects include, but are not limited to, the following:
- Curbs
- Sidewalks
- Roads
- Bridges
- Foundations
- Floors
- Runways

***Design and Installation Specifications***

- Concrete truck chutes, pumps, and internals shall be washed out only into formed areas awaiting installation of concrete or asphalt
- Unused concrete remaining in the truck and pump shall be returned to the originating batch plant for recycling
- Hand tools including, but not limited to, screeds, shovels, rakes, floats, and trowels shall be washed off only into formed areas awaiting installation of concrete or asphalt
- Equipment that cannot be easily moved, such as concrete pavers, shall only be washed in areas that do not directly drain to natural or constructed stormwater conveyances
- Wash down from areas such as concrete aggregate driveways shall not drain directly to natural or constructed stormwater conveyances
- When no formed areas are available, wash water and leftover product shall be contained in a lined container. Contained concrete shall be disposed of in a manner that does not violate groundwater or surface water quality standards

***Maintenance Standards***

Containers shall be checked for holes in the liner daily during concrete pours and repaired the same day

## 2. BMP MC-2: SAWCUTTING AND SURFACING POLLUTION PREVENTION

### *Purpose*

Saw cutting and surfacing operations generate slurry and process water that contain fine particles and high pH (concrete cutting), both of which can violate the water quality standards in the receiving water. This BMP is intended to minimize and eliminate process water and slurry from entering waters of the State.

### *Conditions of Use*

Anytime saw cutting or surfacing operations take place, these management practices shall be utilized. Saw cutting and surfacing operations include, but are not limited to, the following:

- Sawing
- Coring
- Grinding
- Roughening
- Hydro-demolition
- Bridge and road surfacing

### *Design and Installation Specifications*

- Slurry and cuttings shall be vacuumed during cutting and surfacing operations.
- Slurry and cuttings shall not remain on permanent concrete or asphalt pavement overnight.
- Slurry and cuttings shall not drain to any natural or constructed drainage conveyance.
- Collected slurry and cuttings shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Process water that is generated during hydro-demolition, surface roughening or similar operations shall not drain to any natural or constructed drainage conveyance and shall be disposed of in a manner that does not violate groundwater or surface water quality standards.
- Cleaning waste material and demolition debris shall be handled and disposed of in a manner that does not cause contamination of water. If the area is swept with a pick-up sweeper, the material must be hauled out of the area to an appropriate disposal site.

### *Maintenance Standards*

Continually monitor operations to determine whether slurry, cuttings, or process water could enter waters of the State. If inspections show that a violation of water quality standards could occur, stop operations and immediately implement preventive measures such as berms, barriers, secondary containment, and vacuum trucks.

## 3. BMP MC-3: MATERIALS MANAGEMENT

***Purpose***

Discharge of materials other than stormwater and authorized non-stormwater discharges is prohibited from construction sites. Non-stormwater discharges that may be allowed include but are not limited to irrigation of vegetative erosion control measures and pipe flushing and testing.

Waste management and materials pollution control BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with stormwater. These BMPs involve day-to-day operations of the construction site and include operations under the control of the contractor. These BMPs are also referred to as "good housekeeping practices" which involve keeping a clean, orderly construction site. Waste management consists of implementing procedural and structural BMPs for handling, storing, and disposing of wastes generated by a construction project to prevent the release of waste materials into storm water runoff or discharges through proper management of solid, sanitary, hazardous and equipment related wastes.

***Implementation***

***Stockpile Management.*** Protection of stockpiles is a year-round requirement.

- ✓ Locate stockpiles away from stormwater flows, drainage courses and inlets
- ✓ Use temporary berms, dikes, silt fences, sandbags, gravel bags or straw bale barriers to protect stockpiles from storm water runon and to prevent transport of storm water pollutants
- ✓ Place bagged materials on pallets and under cover
- ✓ Stockpiles should be covered or protected with plastic sheeting or soil stabilization measures during the rainy season
- ✓ Repair or replace perimeter controls and covers as needed to keep them functioning properly

***Solid Waste Management.*** Solid wastes include trees and shrubs removed during land clearing, demolition of existing structures (rubble), packaging materials, scrap or surplus building materials, and domestic wastes (beverage cans, coffee cups, paper bags, etc.). Certain construction wastes may not necessitate stringent drainage related control during the non-rainy season.

- ✓ Select designated waste collection areas onsite
- ✓ Use only watertight trash-hauling dumpsters onsite. Inspect dumpsters for leaks and repair any dumpster that is not watertight
- ✓ Locate containers under cover or in a secondary containment
- ✓ Collect site trash daily and remove as needed
- ✓ Make sure toxic liquid waste (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris

- ✓ Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor
- ✓ Arrange for regular waste collection before containers overflow
- ✓ Storm water run-on should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces
- ✓ Store solid waste away from drainage facilities and water courses

***Material Delivery and Storage.*** Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

- ✓ Construction site areas should be designated for material delivery and storage. Temporary storage areas should be located away from vehicular traffic, drainage facilities and watercourses but near the construction entrance if possible.
- ✓ An up to date inventory of materials delivered and stored onsite should be kept.
- ✓ Hazardous materials storage onsite should be minimized. Hazardous materials should be handled as infrequently as possible.
- ✓ Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.
- ✓ Through the rainy season, each temporary containment facility should be covered during non-working days, prior to, and during rain events.
- ✓ Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.
- ✓ A supply of spill clean up material should be kept near storage areas.

***Vehicle and Equipment Fueling.*** Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of storm water.

- ✓ Use offsite-fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- ✓ When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the Construction SWPPP.
- ✓ Dedicated fueling areas should be protected from storm water run-on and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas. Protect fueling areas with berms and dikes to prevent run-on, runoff and to contain spills.
- ✓ Nozzles use in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- ✓ Do not top-off fuel tanks.
- ✓ Train employees and subcontractors in proper fueling and cleanup procedures.

- ✓ Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- ✓ Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.

***Vehicle and Equipment Cleaning.*** Cleaning BMPs eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations.

- ✓ Contract with an offsite or mobile commercial washing business when possible. These businesses may be better equipped to handle and dispose of the wash waters properly.
- ✓ Use phosphate-free, biodegradable soaps. Note, even phosphate-free biodegradable soaps have been shown to be toxic to fish before the soap degrades.
- ✓ All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- ✓ Do not steam clean equipment on site.
- ✓ When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should be:
    - located away from storm drain inlets, drainage facilities or watercourses
    - paved with concrete or asphalt and bermed to contain wash waters and to prevent run-on and runoff
    - configured with a sump to allow collection and disposal of wash water
    - prevent discharge of wash waters to storm drains or watercourses, and
    - used only when necessary

***Inspection and Maintenance***

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season, within 48 hours after a storm event, and at two-week intervals in the non-rainy season to verify continued BMP implementation
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented

# Appendix 1

**Recommended Standard Notes for Erosion Control Plans**
Plans should also identify with phone numbers the person or firm responsible for the preparation of and maintenance of the erosion control plan.

**NOTES**

1. Approval of this erosion/sedimentation control (ESC) plan 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.).

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

3. 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.

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

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

6. The ESC facilities on active sites shall be inspected daily by the applicant/contractor and maintained as necessary to ensure their continued functioning.

7. The ESC facilities on inactive sites shall be inspected and maintained a minimum of once a month or within 48 hours following a major storm event.

8. At no time shall more than one foot of sediment be allowed to accumulate within a trapped catch basin. All catch basins and conveyance lines shall be cleaned prior to paving. The cleaning operation shall not flush sediment-laden water into the downstream system.

9. 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 ensure that all paved areas are kept clean for the duration of the project.

## References:


1. *California Stormwater BMP Handbook, Construction,* California Stormwater Quality Association, 2003
2. *Construction Best Management Practices, Drainage Criteria Manual, Volume 3,* Urban Drainage and Flood Control District, 1999
3. *Handbook of Best Management Practices,* Nevada Division of Environmental Protection and Nevada Division of Conservation Districts, 1994
4. *King County 1998 Appendix D,* Page D-18
5. *Regional Road Maintenance Endangered Species Act, Program Guidelines,* Regional Road Maintenance Technical Working Group, 2003
6. *Stormwater BMP Menu,* U.S. Environmental Protection Agency
7. *Stormwater Management Design Manual*, City of Boise
8. *Stormwater Management for Eastern Washington, Chapter 7, Construction Stormwater Pollution Prevention,* Washington Department of Ecology, 2003
9. *Stormwater Management Manual for Western Washington,* Washington Department of Ecology, 2001
10. *Surface Water Design Manual*, King County, Washington Surface Water Management Division, 1998
11. *Truckee Meadows Construction Site Best Management Practices Handbook,* Truckee Meadows Regional Stormwater Quality Management Program, 2003

And that no other provisions of the Carson City Development Standards are affected by this ordinance.

PROPOSED this ___ day of _____ _____, 2006

PROPOSED BY Supervisor _____

PASSED on the ___ day of _____, 2006

VOTE: AYES: _____
_____
_____
_____
_____

NAYES: _____
_____

ABSENT: _____

_____
Marv Teixeira, Mayor

ATTEST:

_____
Alan Glover, Clerk Recorder

This Ordinance shall be in force and effect from and after the ____ day of _____, 2006.