CHAPTER 8. CONSTRUCTION SITE STORMWATER MANAGEMENT

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1.0 INTRODUCTION

The purpose of this chapter of the *Manual* is to provide technical guidance for erosion, sediment, and runoff control for construction activity along with the implementation of BMPs for the period of time from initial earth disturbance until the final landscaping and permanent stormwater measures are accepted by the City of Bella Vista and coverage under an ADEQ Construction Permit has been terminated.

The City of Bella Vista requires that a SWPPP be developed for construction sites in accordance with the ADEQ Construction General Permit prior to obtaining a Grading Permit. The specific requirements for when local permits are required are established in Article 1400 of the Grading, Erosion Control, and Storm Water Pollution Prevention Standards of the City's Subdivision Code. The City of Bella Vista has the right under the Federal Clean Water Act and the Arkansas Water and Air Pollution Control Act to require that BMPs for erosion, sediment, and runoff control be implemented at all sites where the soil will be disturbed.

1.1 Introduction

Surface runoff controls for construction sites and activities in Arkansas are mandated by the Clean Water Act of the Federal Government and the Arkansas Water and Air Pollution Control Act. All sites where construction will disturb soil or remove vegetation for all phases of work during the life of the construction project must be covered under the ADEQ Construction General Permit. This State Permit provides authorization to discharge stormwater associated with construction activity under the NPDES to all Arkansas receiving waters in accordance with effluent limitations, monitoring requirements, and other conditions set forth in the Construction General Permit. Coverage under the permit does not relieve the site owner or operator from addressing and obtaining other needed local, State and Federal permits (e.g. permit for work in a floodplain, Corps of Engineers 404 permit, building permit, local grading permit, etc.).

The SWPPP shall be prepared in accordance with good engineering practices and shall identify potential sources of pollution which may reasonably be expected to affect the quality of stormwater discharges from the construction site. In addition, the SWPPP shall describe and ensure the implementation of BMPs which are to be used to reduce pollutants in stormwater discharges and to assure compliance with the terms and conditions of the General Permit. The initial City-approved SWPPP has to be viewed as a starting point that will be modified as the work progresses and its effectiveness is tested in the field.

ADEQ identifies two construction project sizes: large and small construction sites. The owner or operator of large construction sites must submit a NOI and permit fee to ADEQ to be covered under the Construction General Permit. In addition, for large construction sites a copy of the SWPPP must be submitted to ADEQ. For small construction sites, an NOI and permit fee is not required, instead the owner

or operator must complete and sign a Construction Site Notice and post it at the construction site. For small construction sites, the SWPPP does not need to be submitted to ADEQ unless requested.

ADEQ requires qualified personnel (provided by the site owner or operator) to conduct inspections of all areas disturbed by construction activity and all storage areas that are exposed to precipitation. The inspectors must look for evidence of, or the potential for, pollutants to enter the stormwater system. Locations where vehicles enter or exit the site, discharge locations, and locations where erosion and sediment control measures are installed shall also be inspected. In addition to the City of Bella Vista, ADEQ or EPA may conduct inspections at any time.

Issuance of a NOV by the City, State or EPA sets the stage for enforcement action and fines. This is a regulatory program with many potential consequences and has to be taken seriously by site owners or operators. Conducting construction activities without a permit when one is needed has the potential of criminal action enforcement being taken against the violating party, which not only can carry much higher fines, but has a potential for jail sentences.

1.2 Performance Objectives

The following are objectives for erosion and sediment control during construction:

1. Conduct all land disturbing activities in a manner that effectively reduces accelerated soil erosion and reduces sediment movement and deposition off site.
2. Schedule construction activities to minimize the total amount of soil exposed at any given time to reduce the period of accelerated soil erosion.
3. Establish temporary or permanent cover on areas that have been disturbed as soon as possible after grading is completed.
4. Design and construct all temporary or permanent facilities to limit the flow of water to non-erosive velocities around, through or from disturbed areas.
5. Remove sediment from surface runoff water before it leaves the site.
6. Stabilize the areas of land disturbance with permanent vegetative cover and stormwater quality control measures.

1.3 Stormwater Pollution Prevention Plan

The owner is responsible for providing the SWPPP. It is recommended that the owner secure the services of a qualified professional knowledgeable in construction management practices to develop the SWPPP. The SWPPP must meet the requirements listed in the ADEQ Construction General Permit ARR150000,

"Authorization to Discharge under the National Pollutant Discharge Elimination System and the Arkansas Water and Air Pollution Control Act" available at www.adeq.state.ar.us.

Three copies of the SWPPP shall be submitted for review and approval to the City of Bella Vista for all development sites. Approval of the SWPPP does not imply acceptance or approval of Drainage Plans, Street Plans, Design of Retaining Walls, or any other aspect of the site development.

The City of Bella Vista will review the SWPPP submitted for the site and will return either an approval of the SWPPP or a request for revisions. Construction activity, including any soil disturbance or removal of vegetation, shall not commence on the site until the City of Bella Vista and ADEQ has issued an approval of the SWPPP.

The City of Bella Vista will review the proposed BMPs on all submitted erosion control plans.

1.4 Grading Permit

Any person proposing to engage in clearing, filling, cutting, quarrying, construction, or similar activities on any piece of disturbed land shall apply for a Grading Permit with the City of Bella Vista. Subdivision Code Article 1400, other applicable local, state, and federal codes should be consulted.

All erosion control plans must be approved by the City of Bella Vista prior to issuance of a Grading Permit.

1.5 Construction Phase

During the construction phase, the following sequence is recommended for the implementation of the project and the SWPPP:

1. The owner and/or the contractor shall designate a manager for the implementation of the SWPPP. This person shall be responsible for implementing all permit conditions and shall communicate the City of Bella Vista and other agencies.
2. Install all BMPs shown on the SWPPP that need to be installed in advance of proceeding with construction, such as construction entrances and exits, perimeter controls, etc.
3. Identify construction equipment and materials storage and maintenance areas. Install BMPs to prevent pollutant migration from these areas.
4. Install any additional BMPs that are called for in the SWPPP before grading begins.
5. Strip off and stockpile topsoil for reuse. Provide perimeter controls and cover for the pile. If the soil will not be stockpiled, haul off for proper disposal.
6. Open areas not planned for immediate use shall be seeded or sodded. Soil which is exposed for more than 14 days with no construction activity shall be seeded, mulched, or re-vegetated.

7. Insure that BMPs are installed and fully operational in advance of each construction phase as called for in the SWPPP.
8. After construction and re-vegetation is complete to ADEQ standards permanent post-construction BMPs that were used as construction sediment controls shall be cleaned and restored.

1.6 Re-vegetation Phase

Once re-vegetation has been deemed acceptable by the City of Bella Vista, the owner shall request release of any surety, letters of credit or other financial guarantees that the City of Bella Vista may have required the permit holder to provide at the time the permit was issued. A NOT of the Construction General Permit from ADEQ shall also be pursued at this time.

The City requires a 12-month landscape guarantee on all projects that will not be released until 12-months after the project has been completed and a re-inspection shows that no repair or replacement work needs to be completed.

2.0 FUNDAMENTALS FOR THE MANAGEMENT OF CONSTRUCTION SITES

2.1 Erosion and Sedimentation

2.1.1 Erosion

Soil erosion is the process by which the land surface is worn away by the action of wind; water; ice; and gravity. This section of the *Manual* addresses erosion caused by water and wind. The rate of soil erosion is increased greatly by many urban activities - especially construction activities. Any activity that disturbs the natural soil and vegetation increases the erosion potential since bare and loose soil is easily moved by wind or water.

Photograph 1. Example of Erosion during Construction

Wind erosion is caused when winds of sufficient velocity create movement of soil particles. The potential for wind erosion is dependent upon soil cover, soil particle size, wind velocity, duration of wind and unsheltered distance. Wind erosion can begin

at a wind velocity as low as 10 mph, and can even result from turbulences created by passing vehicles.

Water erosion has five primary mechanisms: raindrop erosion, sheet erosion, rill erosion, gully erosion, and channel erosion. Raindrops detach soil particles and splash them into the air. These detached particles are then vulnerable to be carried off by stormwater runoff, and/or ice or snowmelt.

2.1.2 Sedimentation

During a typical rainstorm in urban areas, runoff normally builds up rapidly to a peak and then diminishes. The amount of sediment a watercourse can carry is dependent upon the velocity and volume of runoff. Sediment is deposited as runoff velocity and volume decreases. The deposited sediments may be re-suspended when future runoff events occur. In this way, sediments are moved progressively downstream in the waterway system.

Windblown silt and sand particles are deposited whenever the force of the wind lessens. Much of the wind-eroded material is deposited behind fences; in landscaped areas; or downwind of buildings; and/or other obstructions. Dust will form "drifts" just like snow.

2.1.3 Factors Influencing Erosion

Physical properties of soils such as particle size, cohesiveness, and density affect its erodibility. Loose silt and sand-sized particles are more susceptible to erosion than "sticky" clay soils. Rocky soils are also less susceptible to wind erosion, but are often found on steep slopes that are subject to water erosion.

Vegetation plays an extremely important role in controlling erosion. Roots bind particles together and the leaves or blades of grass reduce raindrop impact forces on the soil. Grass, forest floor litter and other ground cover not only trap rain to promote infiltration but also reduce runoff velocity and shear stress at the surface. Vegetation and other ground covers reduces wind velocity at the ground surface, and provides a rougher surface which will trap particles moving along the ground. Once these are removed, soils are no longer protected and erosion may increase.

When surface vegetative cover and soil structure are disturbed, the soil's erodibility potential increases. Construction activities, such as excavating and grading, disrupt both the soil structure and its vegetative cover.

2.2 Principles of Erosion and Sediment Control

Erosion controls limit the amount and rate of erosion occurring on disturbed areas. Sediment controls attempt to capture the soil that has been eroded before it leaves the construction site. Despite the use of

both erosion control and sediment control measures (also called BMPs), it is recognized that some amount of sediment will remain in runoff leaving a construction site.

The purpose of BMPs is to minimize the sediment displacement to the maximum extent feasible. Construction activities management shall address six major elements:

1. The erosion control measures that will be used to limit erosion of soil from disturbed areas at a construction site.
2. The sediment and runoff control measures to limit transport of sediment off-site to downstream properties and receiving waters.
3. The waterway protection measures to protect waterways located on, up, or downstream of the construction site from erosion and sediment damages.
4. The construction practices management to limit pollutant movement off-site resulting from construction equipment maintenance and storage and from materials storage and handling.
5. The stabilization practices to return the site to either a vegetative state or employ non-erosive surfaces where disturbances have occurred. Stabilization may include both temporary and permanent stabilization methods.
6. The onsite infiltration measures used to infiltrate stormwater runoff onsite where appropriate.

2.3 Stormwater Planning Process

Stormwater planning should occur early in the site development process. The planning process can be divided into 6 separate steps:

1. Gather information on topography, soils, drainage, vegetation and other predominant site features.
2. Analyze the information in order to anticipate erosion, sedimentation, and runoff problems.
3. Devise a plan which schedules construction activities and minimizes the amount of erosion created by development.
4. Develop a SWPPP which specifies effective erosion, sediment and runoff control measures as well as waste management and construction phasing.
5. Follow the SWPPP and revise it when necessary.
6. Remove temporary BMPs once the site has reached final stabilization and file a NOT with ADEQ. Provide the City with a copy of the NOT.

2.3.1 Guidelines for SWPPP Development

The following guidelines are recommended in developing the SWPPP:

1. Determine the limits of clearing and grading. If the entire site will not undergo excavation and grading, or excavation and grading will occur in stages, the boundaries of each cut-and-fill operation should be defined. Buffer strips of natural vegetation may be utilized as a control measure.
2. Define the layout of buildings and roads.
3. Determine permanent drainage features. The location of permanent channels and stormwater systems should be defined. The SWPPP shall be consistent with the hydraulic features of the final drainage plan.
4. Determine extent of temporary channel diversions. If improvements will be made to a permanent channel, the location, routing, sizing, lining, and type of temporary channel diversion should be determined.
5. Determine the boundaries of watersheds. The size of on- and off-site drainage areas will determine the types of sediment controls to be used. Areas located upstream of the site that contribute overland flow must be assessed. Measures to limit the size of upland overland flow areas, such as diversion dikes, may be initially considered at this stage.
6. Determine schedule of construction. The schedule of construction will determine what areas must be disturbed at various stages throughout the development plan. The opportunity for staging cut-and-fill operations to minimize the period of exposure of soils needs to be assessed and then incorporated into the submitted SWPPP.
7. Select Erosion, Sediment, and Runoff Controls. All areas of exposed soil will require a control measure which is dependent on the duration of exposure. Select the controls needed for each phase of the construction project based on the different demands.
8. Identify locations of topsoil stockpiles. Areas for storing topsoil should be determined and then proper measures to control their erosion and sediment movement. The City does not allow these locations to fall within the public road right-of-ways or adjacent to drainage channels.
9. Identify location of temporary construction roads, vehicle tracking controls, and material storage areas.
10. Identify areas where stormwater could potentially be infiltrated onsite during construction. Onsite infiltration measures (such as detention ponds and grass swales) will reduce the runoff that will require treatment prior to leaving the site.

Figures CS-1 through CS-3 illustrate how the implementation of a SWPPP may be done in phases. For example, grading phase, road and utility construction phase, major site re-vegetation phase, home building phase, and final acceptance phase. Each phase needs to address erosion, sediment, and runoff controls and the construction activities management for that phase of the construction activities. Each needs to take into account the specific physical layout and site conditions that will exist during that phase. Some projects may need more than the three phases shown to have an effective overall SWPPP.

Figure CS-1: Examples of Erosion Control Legend

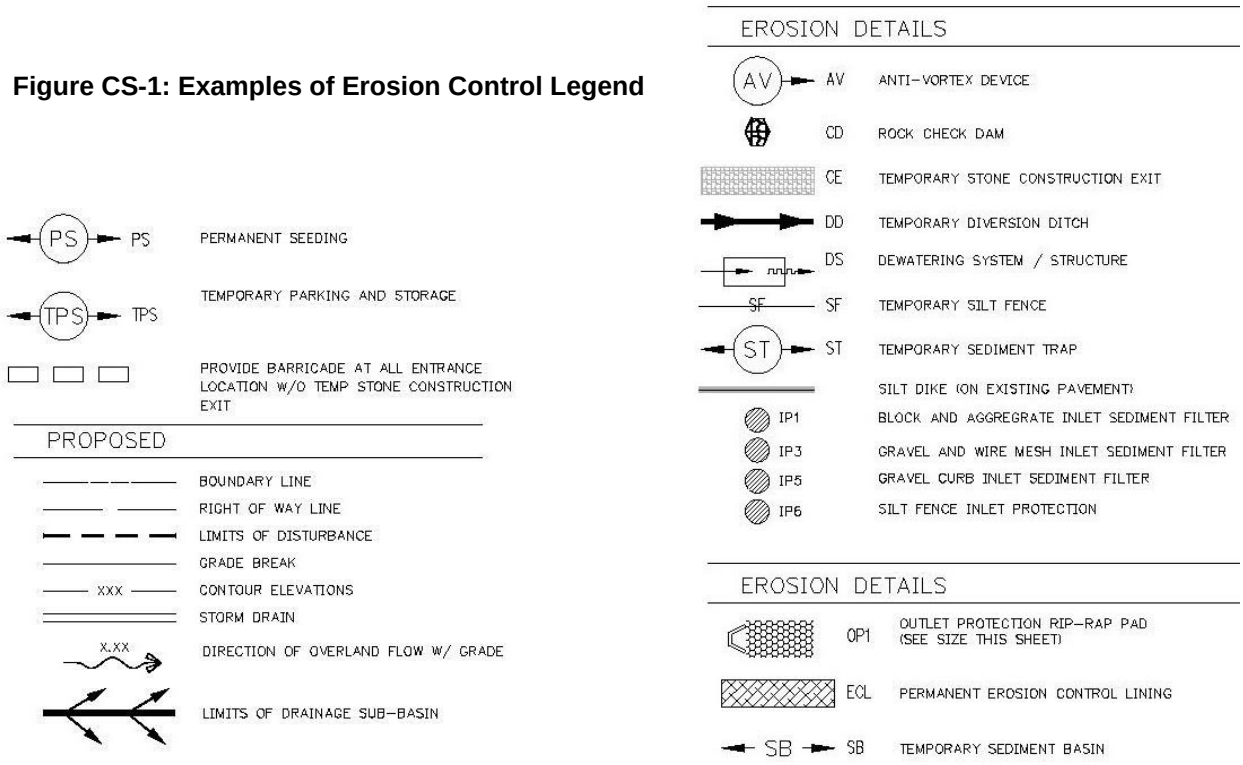


Figure CS-2: Example of Phase 1 Erosion Control

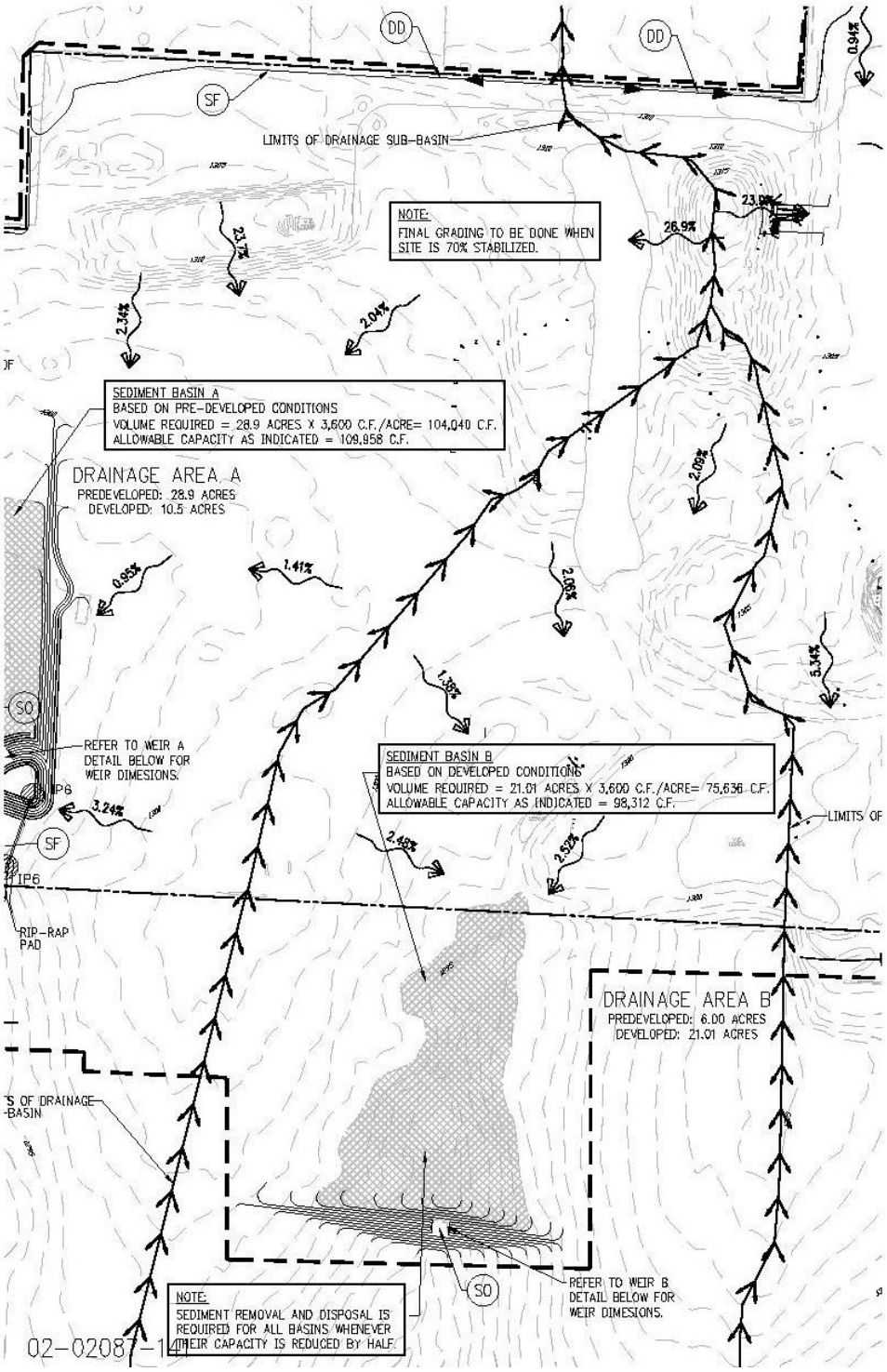
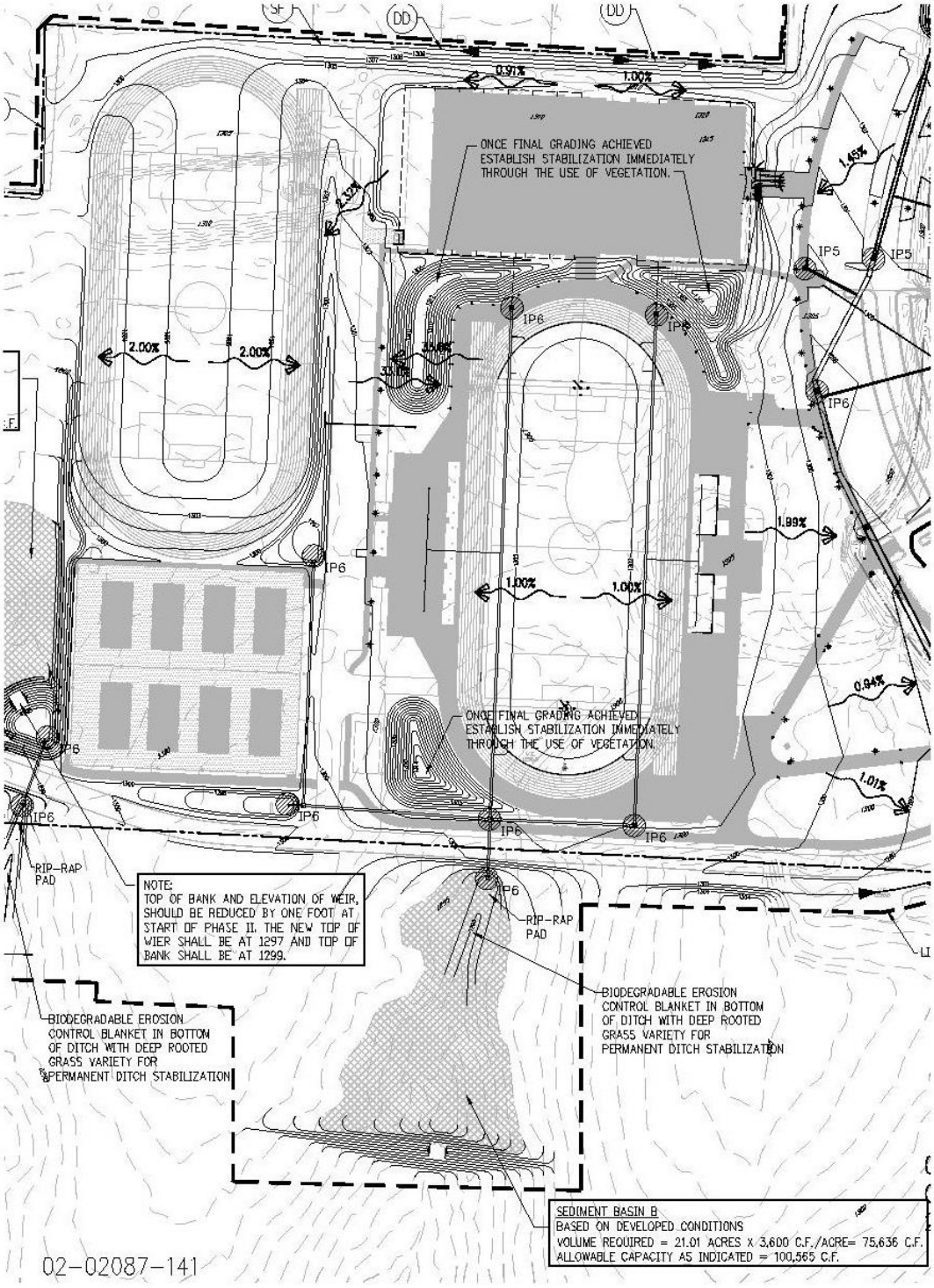


Figure CS-3: Example of Phase 2 Erosion Control



3.0 BEST MANAGEMENT PRACTICES FOR CONSTRUCTION SITES

Best Management Practices (BMPs) are used to reduce pollutants in stormwater discharges and to assure compliance with the terms and conditions of the General Permit.

The impacts to water quality resulting from construction management facilities can be managed by controls on equipment and material storage.

Erosion controls limit the amount and rate of erosion occurring on disturbed areas. They are surface treatments and source controls that stabilize the soil exposed by excavation or grading.

Sediment controls capture soil that has been eroded before it leaves the construction site. They allow soil particles that have been suspended in runoff to be filtered through a porous media or to be deposited by slowing the flow and allowing the natural process of sedimentation to occur.

The planning for the installation of temporary or permanent erosion and sediment controls needs to begin in advance of all major soil disturbance activities on the construction site. Minimizing the area being disturbed at any given time is one of the most effective erosion control measures. This principle needs to be kept in mind whenever developing a SWPPP. All areas of exposed soil will require a control measure to be defined that is dependent on the duration of exposure.

The erosion potential associated with a construction site is reduced when stabilization techniques are employed. Existing vegetation should be preserved where attainable. Stabilization measures should be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased.

Maximizing onsite infiltration will reduce the runoff that will require treatment prior to leaving the site. Sediment basins, detention ponds, grass swales, and sediment traps are BMPs that will encourage onsite infiltration. Infiltration should not be promoted in areas next to building foundations or in soils that are not appropriate.

Erosion and sediment control measures should also be effective in controlling wind erosion. The surface stabilization measures identified for control of precipitation-induced erosion should also prevent soils from becoming windborne. Although these guidelines were developed to control erosion by rainfall and snowmelt, they are consistent with design principles for wind erosion and will be effective for this purpose. Refer to ADEQ Regulation 18: Arkansas Air Pollution Code at www.adeq.state.ar.us.

BMP Fact Sheets have been provided for each of the following construction management practices, erosion controls, and sediment controls. They are to be used as guidelines to select the controls needed for each phase of the construction project based on the different demands.

Examples of construction best management practices are listed below in Table CS-1.

Table CS-1: List of BMPs for Construction Management Practices

BMP #	BMP Name
CM-1	Construction sequencing/phasing
CM-2	Hazardous waste management and chemical storage
CM-3	Solid waste management
CM-4	Concrete washouts
CM-5	Construction staging and maintenance areas
CM-6	Construction dewatering

Erosion control practices can include those BMPs listed in Table CS-2.

Table CS-2: List of BMPs for Erosion Control Practices

BMP #	BMP Name
EC-1	Chemical Stabilization
EC-2	Compost Blankets
EC-3	Geo-textiles, Erosion Control Blankets and Mats
EC-4	Terraces
EC-5	Mulching
EC-6	Temporary Outlet Protection, Energy Dissipation Devices, Riprap Apron
EC-7	Temporary and Permanent Re-vegetation
EC-8	Wind erosion or dust control
EC-9	Hydro-seeding and Hydro-mulching
EC-10	Surface Roughening
EC-11	Temporary Slope Drain
EC-12	Temporary Stream Crossings
EC-13	Level Spreader

Several Sediment Control and Runoff Control practices are listed in Table CS-3 on the next page.

Table CS-3: List of BMPs for Sediment Control and Runoff Control Practices

BMP #	BMP Name
SC-1	Stabilized construction entrance/exit
SC-2	Embedded Silt fence
SC-3	Inlet protection
SC-4	Chemical treatment
SC-5	Sediment trap
SC-6	Sediment basin
SC-7	Compost filter socks
SC-8	Fiber rolls/wattles
SC-9	Gravel bags
SC-10	Vegetative buffers
SC-11	Sediment filters and sediment chambers
RC-1	Check dams
RC-2	Triangular Silt Dike
RC-3	Grass-lined channels
RC-4	Interceptor and diversion dikes and swales
RC-5	Rough-cut street control
RC-6	Water bars

Many of the temporary controls used for sediment control can be modified into permanent structural controls. In addition, permanent stormwater quality controls can often be constructed at the initial stages of the project and modified to control sediment during construction phases. When that occurs, they will need to be modified and restored to the post-construction BMP configuration at the end of construction. Restoration of post-construction BMPs may involve removing, repairing, cleaning, and/or replacing the BMP because of the sediment that may have accumulated during construction.

4.0 WATERWAY PROTECTION

At times construction activities must occur within or immediately adjacent to a waterway (drainageway, creek, stream, river, lake, reservoir or wetland). Whenever this occurs, bottom sediment will be disturbed allowing movement to occur. The goal is to minimize the movement of sediments resulting from construction activities. This is accomplished by the use of erosion and sediment control practices described in this Manual.

4.1 Working Within or Crossing a Waterway

When working immediately adjacent to a waterway, the use of erosion and sediment control practices described earlier in this Manual is crucial. Activities such as minimizing disturbed areas adjacent to the waterways; timing construction so it occurs during no or low flows; using surface roughening techniques; mulching disturbed areas as quickly as possible; using silt fence; and using temporary slope diversions to

direct runoff to sediment basins before runoff enters the waterway. The inspection and maintenance of the erosion and sedimentation controls needs to be more aggressive.

When working within a waterway, steps must be taken to stabilize the work area during construction to control erosion. The channel banks and channel bed must be re-stabilized by the use of seeding, mulching, and/or erosion control matting, as quickly as possible. If it is not practical to do final seeding due to site conditions (e.g. frozen ground, prolonged wet weather, etc.), mulch shall be applied to the surface, and then seed and final mulch when conditions permit.

A permit is required for placement or removal of fill in a waterway under Section 404 of the Clean Water Act. The U.S. Army Corps of Engineers has issued a nationwide permit for Linear Transportation Projects (roads, highways, railways, trails, airport runways, etc.) along with the placement of temporary fill associated with the construction. Appropriate measures must be taken to maintain normal downstream flows and maintenance flooding. The U.S. Army Corps of Engineers has issued nationwide permit Number 12 for Utility Line Activities for construction of utility lines within Waters of the United States provided there is no change in pre-construction contours. The local office of the Corps of Engineers should be contacted concerning the requirements for obtaining a 404 permit.

In addition, a permit from the U.S. Fish and Wildlife Service may be needed if endangered species are of concern in the work area. For a list of endangered or threatened species, contact the Arkansas Natural Heritage Commission at (501) 324-9619 or www.naturalheritage.com or the U.S. Fish and Wildlife Services (USFWS) at (501) 324-5643 or www.fws.gov. Parts of Benton County have been designated areas of recharge that affect the habitat of endangered species so contacting the USFWS early in the design process is crucial to determine if the development needs to address these concerns. Typically the USFWS issues are addressed by a 404 permit if one is required. The City of Bella Vista should also be consulted and can provide assistance.

In addition, applicants of a Corps of Engineers 404 permit should also contact ADEQ for a Short Term Activity Authorization (STAA) needs determination for activities that have the potential to violate water quality criteria.

Besides permitting with the U.S. Army Corps of Engineers and USFWS, it may be necessary to submit the proper map revision application [(C)LOMA, (C)LOMR-F, (C)LOMR)] to FEMA depending on the type and level of work taking place within a waterway. Should any of the work occurring in and around a waterway create a situation that permanently alters the future hydraulic characteristics of the waterway (by removal or placement of fill in the waterway or the realignment of the waterway among other things), it will be necessary to coordinate such work with FEMA to ensure all necessary maps and hydraulic information are revised/updated for the impacted area of the waterway.

Where an actively-flowing watercourse must be crossed regularly by construction vehicles, a temporary stream crossing shall be provided. Three primary methods are available: (1) a culvert crossing, (2) a

stream ford, and (3) a bridge crossing. Refer to Figures CS-4 through CS-6 for examples of temporary stream crossings.

Construction vehicles shall be kept out of a waterway to the maximum extent practicable.

When working within a waterway, temporary facilities shall be installed to divert clean flowing water around the construction activities taking place within a waterway.

Whenever possible, construction in a waterway shall be sequenced to begin at the most downstream point and work progressively upstream installing required channel and grade control facilities.

Complete work in small segments, exposing as little of the channel at a time as possible. Where feasible, it is best to perform all in-channel work during historically low stream flow periods. This is the period when the chances of flash floods and flows higher than the 2-year flood peak flows are least likely.

Some construction activities within a waterway are short lived, namely a few hours or days in duration, and are minor in nature. These are typically associated with maintenance of utilities and stream crossings and minor repairs to outfalls and eroded banks. In these cases, construction of temporary diversion facilities often cause more soil disturbance and sediment movement than the maintenance activity itself.

4.2 Temporary Channel Diversions

Limiting construction activities within a waterway will significantly reduce erosion and sediment movement downstream. Construction berms can be used on portions of large channels to carry water around construction activities. The berms should be tall enough to contain at least the 2-year flood peak without being overtopped.

Temporary diversion channels that divert the entire waterway are appropriate for work in smaller waterways and for the construction of detention basins and dams located on drainage channels. Refer to Figure CS-6 for an example of a temporary channel diversion.

Whenever the temporary diversion is around the construction site of a detention basin or a dam, the detention basin behind the dam should be considered a temporary sediment basin. During construction such basins will need to be maintained as any other sediment basin. Once the construction site is stabilized, and before the temporary diversion is removed, all the accumulated sediment will need to be removed. The basin and its outlet facility will need to be configured to meet the requirements of the final design plans and specifications.

4.2.1 Temporary Channel Diversion Sizing

It is the responsibility of the designer and the contractor to assess their risk of having the temporary diversion be exceeded and to evaluate the damages such an event may cause to the project, adjacent

properties, and to others. For larger waterways, including ones controlled by flood control reservoirs, specific risk assessment may be appropriate to insure that the work and the waterways are protected. Risk assessment does not insure that the construction work will be 100 percent safe from high flows in the waterway. It merely provides a reasonable minimum level of flow for the design of temporary diversion channels.

The maximum depth of flow for temporary diversion channels is 12 inches for flows less than 20 cfs, and a maximum depth of 36 inches for flows less than 100 cfs. Flows in excess of 100 cfs shall be designed in accordance with Chapter 7 – *Open Channel Flow Design* of the manual. The steepest side slope allowable for a temporary channel is 2:1 (horizontal:vertical). It is required that the design for temporary diversion channels include a minimum of 6 inches of freeboard.

4.2.2 Temporary Channel Stability Considerations

Temporary channels are not likely to be in service long enough to establish adequate vegetative lining. Temporary channel diversions must be designed to be stable for the design flow for the channel lining material. Unlined channels are not to be used unless it can be demonstrated that an unlined channel will not erode during the design flow. Table CS-4 gives allowable channel lining materials for a range of slope and flow depth. Table CS-5 gives Manning's 'n' values for lining materials. Design procedures for temporary channels are described in detail in the Hydraulic Engineering Circular No. 15 published by the Federal Highway Administration.

Table CS-4: Lining Materials for Temporary Channels

Slope Range	Maximum Flow Depth	
	12 inches	36 inches
0% - 0.005%	Jute Netting	Straw or Wood Fiber; Erosion Control Netting; or Plastic Membrane
0.005% - 1.0%	Straw or Wood Fiber; Erosion Control Netting; or Plastic Membrane	Straw or Wood Fiber; Erosion Control Netting
1.0% - 2.0%	Geo-textile with Overlay of Erosion Control Mat	D_{50} = 4" Rock to D_{50} = 6" Riprap
2.0% - 3.0%	D_{50} = 3" Rock to D_{50} = 6" Riprap	D_{50} = 9" Riprap
3.0% - 4.0%	D_{50} = 6" Riprap	D_{50} = 12" Riprap

Table CS-5: Temporary Channel Design Criteria

Lining Material	Manning's n for Flow Depth		
	0 ft to 1.0 ft	1.0 ft to 3.0 ft	3.0 ft to 5.0 ft
Plastic Membrane	0.011	0.010	0.009
Jute Netting	0.028	n/a	n/a
Straw or Curled Wood Mats	0.035	0.025	0.020
Riprap, D_{50} = 6" Riprap	0.070	0.045	0.035
Riprap, D_{50} = 9" Riprap	0.100	0.070	0.040
Riprap, D_{50} = 12" Riprap	0.125	0.075	0.045

Notes:
1. Maximum depth is 12 inches for flows less than 20 cfs.
2. Maximum depth is 36 inces for flows less than 100 cfs.
3. For flows greater than 100 cfs, design temporary diversion channels in accordance with Chapter 7 – Open Channel Flow Design of the Manual except the maximum side-slope steepness shall not exceed 2:1 (horizontal:vertical) unless structurally reinforced.
4. Determine the channel bottom width required using Manning's Equation and its n value given above.
5. Refer to Chapter 7 – Open Channel Flow Design of the Manual for riprap gradation.
6. Erosion protection shall extend a minimum of 6 inches above the design water depth.

4.2.3 Example: Temporary Channel Diversion Design

A simplified method for designing a non-erosive temporary diversion channel is given as follows:

Step One: Using the tributary area A (in acres) determine peak flow.

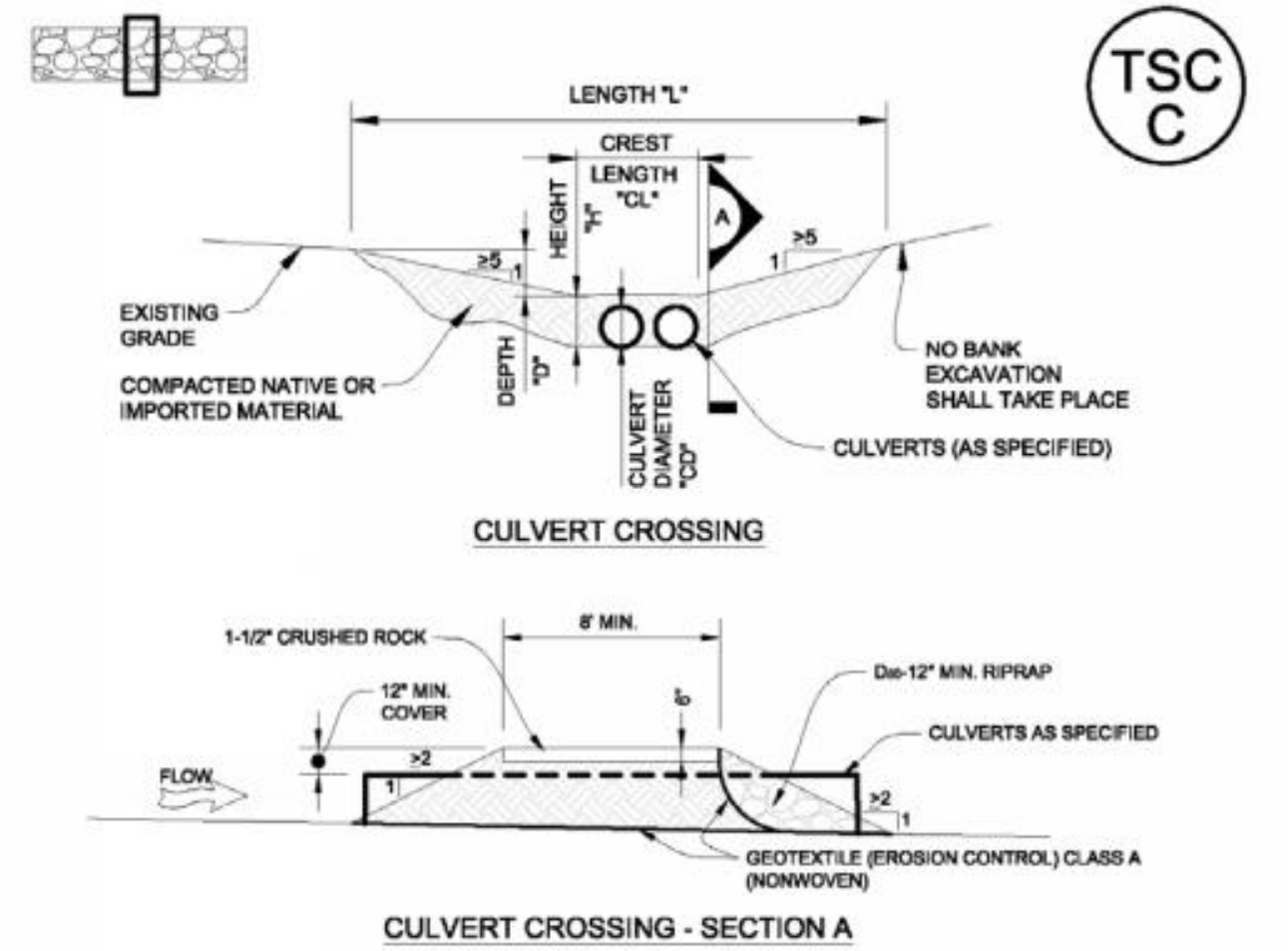
Step Two: Determine depth of flow, 12 inches maximum for flows less than 20 cfs and 36 inches maximum for flows less than 100 cfs. (Flows in excess of 100 cfs shall be designed in accordance with Chapter 7 – *Open Channel Flow Design*.)

Step Three: Determine channel slope based on existing and proposed site conditions.

Step Four: Pre-size the channel, determine maximum velocities and select lining material from Table CS-4.

Step Five: Determine the channel geometry and check the capacity using Manning's Equation and the "n" value given in Table CS-5. The steepest side slope allowable for a temporary channel is 2:1 (horizontal:vertical), unless vertical walls are installed using sheet piling, concrete or stacked stone. It is required that the design for temporary bypass channels include a minimum of 6 inches of freeboard.

Figure CS-4: Temporary Culvert Stream Crossing



TEMPORARY STREAM CROSSING INSTALLATION NOTES

1. SEE PLAN VIEW FOR:
   - LOCATIONS OF TEMPORARY STREAM CROSSING.
   - STREAM CROSSING TYPE (FORD OR CULVERT).
   - FOR CULVERT CROSSING: LENGTH, "L", CREST LENGTH, "CL", CROSSING HEIGHT, "H", DEPTH, "D", CULVERT DIAMETER, "CD", AND NUMBER, TYPE AND CLASS OR GAUGE OF CULVERTS.
2. TEMPORARY STREAM CROSSING DIMENSIONS, D $_{50}$, AND NUMBER OF CULVERTS INDICATED (FOR CULVERT CROSSING) SHALL BE CONSIDERED MINIMUM DIMENSIONS. ENGINEER MAY ELECT TO INSTALL LARGER FACILITIES. ANY DAMAGE TO STREAM CROSSING OR EXISTING STREAM CHANNEL DURING BASE-FLOW OR FLOOD EVENTS SHALL BE THE CONTRACTOR'S RESPONSIBILITY.
3. SEE TABLE MD-7, MAJOR DRAINAGE, VOL. 1 FOR RIPRAP AND 1-1/2" CRUSHED ROCK GRADATIONS.
4. FOR A TEMPORARY STREAM CROSSING THAT WILL CARRY H-10 OR GREATER LOADS, THE TEMPORARY STREAM CROSSING MUST BE DESIGNED BY THE ENGINEER STRUCTURAL

TEMPORARY STREAM CROSSING MAINTENANCE NOTES

1. THE SWMP MANAGER SHALL INSPECT STREAM CROSSINGS WEEKLY, DURING AND AFTER ANY STORM EVENT AND MAKE REPAIRS OR CLEAN OUT UPSTREAM SEDIMENT AS NECESSARY.
2. SEDIMENT ACCUMULATED UPSTREAM OF STREAM CROSSINGS SHALL BE REMOVED WHEN THE SEDIMENT DEPTH UPSTREAM OF FORD CROSSINGS IS WITHIN 6-INCHES OF THE CREST AND FOR CULVERT CROSSINGS IS GREATER THAN AN AVERAGE OF 12-INCHES.
3. STREAM CROSSINGS ARE TO REMAIN IN PLACE UNTIL NO LONGER NEEDED AND SHALL BE REMOVED PRIOR TO THE END OF CONSTRUCTION.
4. WHEN STREAM CROSSINGS ARE REMOVED, THE DISTURBED AREA SHALL BE COVERED WITH TOP SOIL, DRILL SEEDED AND CRIMP MULCHED AND COVERED WITH EROSION CONTROL BLANKET OR OTHERWISE STABILIZED IN A MANNER APPROVED BY THE LOCAL JURISDICTION.

DETAIL BASED ON DETAILS PROVIDED BY DOUGLAS COUNTY, COLORADO

Figure CS-5: Illustration of a Temporary Diversion Channel

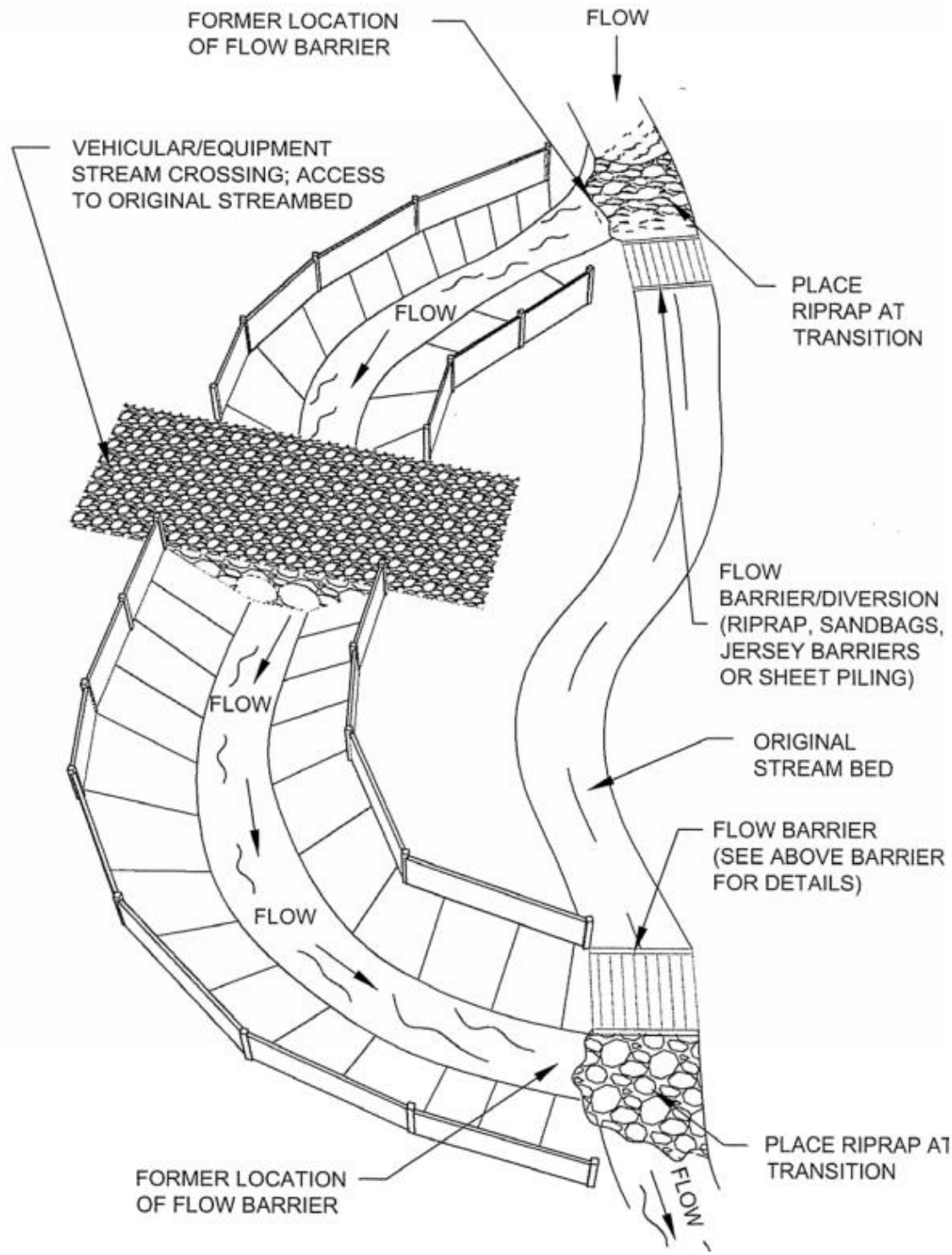
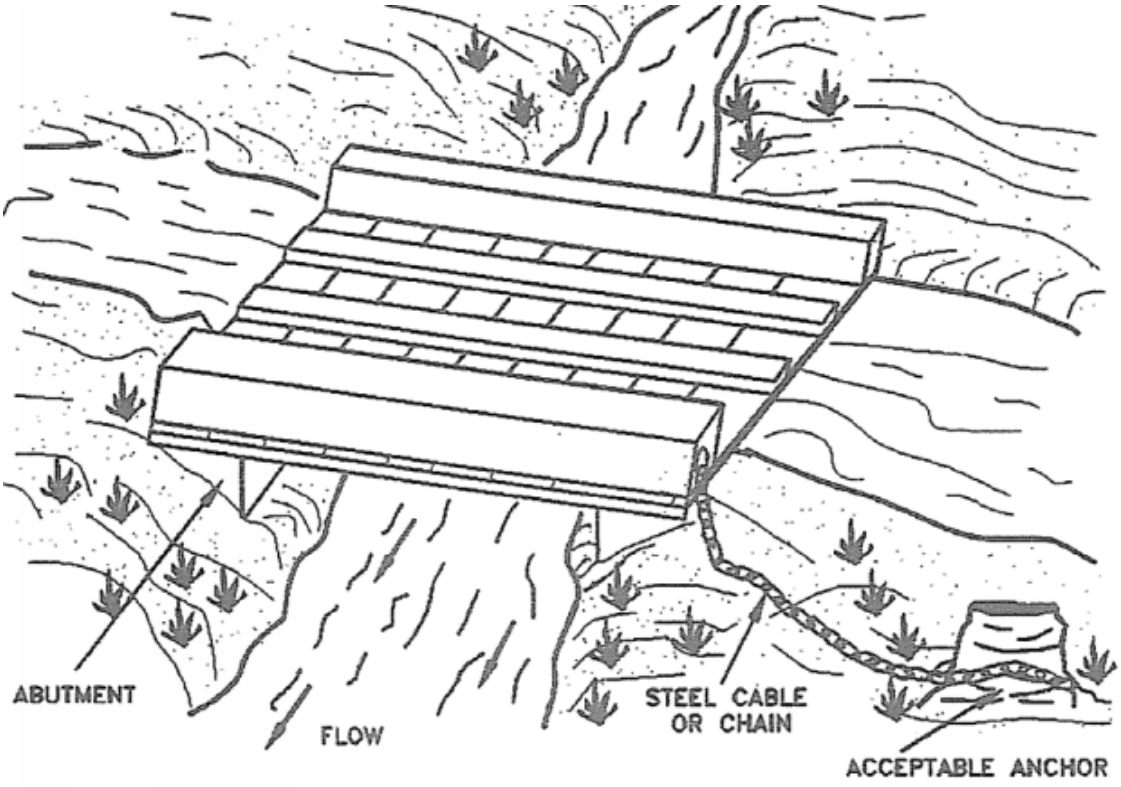


Figure CS-6: Graphical Illustration of a Temporary Bridge Stream Crossing



5.0 UNDERGROUND UTILITY CONSTRUCTION – PLANNING AND IMPLEMENTATION

The construction of underground utility lines will be subject to the following criteria:

- The City of Bella Vista has the right to limit the amount of trench excavated in advance of underground line placement. In general, such trenching shall not exceed 400 feet.
- Where consistent with safety and space considerations, excavated material is to be placed on the uphill side of trenches.
- Trench dewatering devices must discharge in a manner that will not adversely affect flowing streams, wetlands, drainage systems, or off-site property. Dewatering that discharges water in a manner that may enter into waters of the State require a permit from ADEQ.

- Provide storm sewer inlet protection whenever soil erosion from the excavated material has the potential for entering the storm drainage system.

Utility agencies shall develop and implement BMPs to prevent the release of sediment and discharge of pollutants from utility construction sites. Disturbed areas shall be minimized and managed. Construction site entrances shall be managed to prevent sediment tracking. Excessive sediment tracked onto public streets shall be removed immediately. The City of Bella Vista may adopt and impose BMPs on utility construction activity.

Prior to entering a construction site or subdivision development, utility agencies should obtain from the owner a copy of any SWPPP for the project. Any disturbance to BMPs resulting from utility construction shall be repaired immediately by the utility company in compliance with the SWPPP.

It is the responsibility of the utility agency to obtain necessary permits for the construction of utility lines within Waters of the United States.

6.0 REMOVAL OF TEMPORARY MEASURES

All temporary erosion and sediment control measures shall be removed and properly disposed of within 30 days after final stabilization is achieved; after the temporary measures are no longer needed; or as authorized by the City of Bella Vista. It may be necessary to maintain some of the control measures for an extended period of time until the upstream areas have been fully stabilized and vegetation has sufficiently matured to provide specified cover.

Trapped sediment and disturbed soil areas resulting from the removal of temporary measures must be returned to final plan grade and permanently stabilized to prevent further soil erosion.

The qualified professional preparing the SWPPP shall submit a schedule of removal dates for the temporary control measures. The schedule should be consistent with key construction phases such as street paving; final stabilization of disturbed areas; and installation of structural stormwater controls.

Permanent post-construction BMPs that were used as sediment controls during construction shall be refurbished to a fully operational capacity per the design plans; SWPPP; and/or manufacturer's specifications. The final site work will not be accepted by the City until these permanent post-construction BMPs are in a final and acceptable form.

7.0 MAINTENANCE

All temporary and permanent erosion and sediment controls shall be inspected; maintained; repaired; and/or replaced by the owner or operator during the construction phase to assure continued performance of their intended function. Refer to the individual BMP fact sheets for maintenance guidelines.

The qualified professional preparing the SWPPP shall submit a schedule of planned maintenance activities for the temporary and permanent erosion and sediment control measures.

8.0 STANDARDS AND SPECIFICATIONS FOR BMPS

The following BMPs should be employed on an as-needed basis as part of the SWPPP and Erosion Control Plans. They are divided into 3 categories: Construction Management (CM) practices aimed at managing the construction site appropriately; Erosion Controls (EC) aimed at preventing the erosion of sediment; and Sediment Controls (SC) aimed at preventing sediment from leaving the project site. Following the description of each BMP are design criteria to follow when proposing the use of them.

8.1 BMP CM-1 Construction Sequencing/Phasing

See also the City of Bella Vista's 2010 BMP Manual Sections 140, 150, & 170.

Description

Exposing soil before required for construction can expose the soil to erosion for an extended period.

Construction Sequencing coordinates land disturbing activities with construction requirements to minimize the amount of soil exposed to erosion at any time.

Applicability

Projects on larger sites or where land disturbing activities can be phased are best suited for Construction Sequencing.

Design Criteria

The potential for erosion is reduced when construction is performed in stages and the entire construction site is not disturbed all at the same time.

Areas of the site to be preserved should be clearly marked on the plans and delineated on the site. The timing of clearing and access to different areas of the site should be indicated in the contract documents.

Only land needed for building activities and vehicular traffic should be cleared.

Another way to phase construction is to minimize the disturbed areas during times of the year that traditionally receive large precipitation events.

Limitations

Sometimes, smaller projects do not lend themselves to sequencing of land disturbing activities.

Maintenance Requirements

Maintenance of protective and access control fencing as needed.

8.2 BMP CM-2 Hazardous Waste Management and Chemical Storage

See also the City of Bella Vista's 2010 BMP Manual Sections 120, 121, 122, 123, 130, 131, & 132.

Description

Often materials are used at a construction site that present a potential for contamination of stormwater runoff. Hazardous Waste Management is the proper staging, storage, handling, and disposal of construction material listed as hazardous by EPA and/or ADEQ to prevent pollutants from being released from the site to receiving waters.

Applications

All construction materials that are listed as hazardous by EPA and/or ADEQ.

Criteria

Guidelines published by EPA and OSHA for the types of materials to be used on the construction site should be incorporated into the SWPPP.

The types of materials that are generally considered hazardous are:

- Fuels (diesel, gas, etc.)
- Oils and greases (lubricating, cutting, etc.)
- Petroleum based materials (asphalt, emulsions, solvents)
- Paints (including wood preservatives, stains, and lead based)
- Solvents (paint thinners, cleaners, etc.)
- Pesticides, herbicides, insecticides

Proper management of hazardous materials entails:

- Replace hazardous materials with a non-hazardous materials
- Minimize the use of hazardous materials
- Reuse and recycle hazardous materials
- Proper use of hazardous materials
- Proper storage and handling of hazardous materials
- Proper disposal of hazardous materials

Employees must be trained in the use, storage, and disposal of hazardous wastes. Hazardous materials should be stored so only authorized personnel can use the material.

Areas at the construction site that are used for storage of toxic materials and petroleum products should be designed within an enclosure; under a roof if possible; within a container; or within a dike located around the perimeter of the storage area to prevent discharge of these materials in runoff from the construction site. These barriers will also function to contain spilled materials.

Measures to prevent spills or leaks of fuel, gear oil, lubricants, antifreeze, and other fluids from construction vehicles and heavy equipment should be considered to protect groundwater and runoff quality. All equipment maintenance should be performed in a designated area and measures, such as drip pans, used to contain petroleum products. Spills of construction-related materials, such as paints, solvents, or other fluids and chemicals, shall be cleaned up immediately and disposed of properly.

The following methods shall be followed for spill prevention and clean-up:

- The manufacturers recommended methods for spill clean-up shall be clearly posted and personnel shall be trained in the location of clean-up supplies and clean-up procedures.
- Clean-up supplies shall be kept in a secure area.
- Personnel shall wear proper protective clothing when cleaning up the spill.
- Spills shall be cleaned up immediately and the waste properly disposed of.
- Licensed hazardous waste haulers must be used to transport hazardous wastes to approved treatment and disposal sites.
- Additional measures for spill prevention, response, and material storage practices may be required.

8.3 BMP CM-3 Solid Waste Management

See also the City of Bella Vista's 2010 BMP Manual Sections 120, 121, 122, 123, 130, 131, & 132

Description

Solid wastes that are improperly disposed of can be blown or washed from construction sites causing others to pick up the wastes from their property. Solid Waste Management refers to the proper handling and disposal of all construction wastes.

Applications

All construction sites.

Criteria

Areas shall be designated for the storage and disposal of construction material waste (both solid and liquid) to prevent discharge or movement of these materials off of the construction site.

These containments shall be located away from all storm drainage facilities and waterways. Consider covering and/or fencing the waste storage areas to contain windblown materials. Consider constructing a perimeter dike to exclude or to contain runoff. These measures may not be necessary if all waste is placed immediately in covered waste containers at the site and is otherwise controlled in an effective manner. Trash and recycle receptacles shall be placed in convenient locations throughout the job site.

All waste shall be disposed only at approved landfill sites.

Maintenance Requirements

Trash and waste construction materials shall be picked up and disposed of daily unless part of a regular pick-up route, in which the container needs to be large enough to hold all materials to be placed in it between services.

8.4 BMP CM-4 Concrete Washouts

See also the City of Bella Vista's 2010 BMP Manual Section 132

Description

Concrete waste from washout of ready-mix trucks, concrete pumps, and other concrete equipment increases sediment and changes the pH of stormwater runoff.

Concrete Waste Management is the practice of providing a basin for disposing of concrete residue and to wash out concrete truck mixers.

Applications

All construction sites with concrete work.

Design Criteria

The concrete washout area shall have sufficient storage volume to accept the wash water and allow the suspended particles to settle out.

The concrete washout area shall provide a minimum of 6 cubic feet of containment volume for every 10 cubic yards of concrete to be poured.

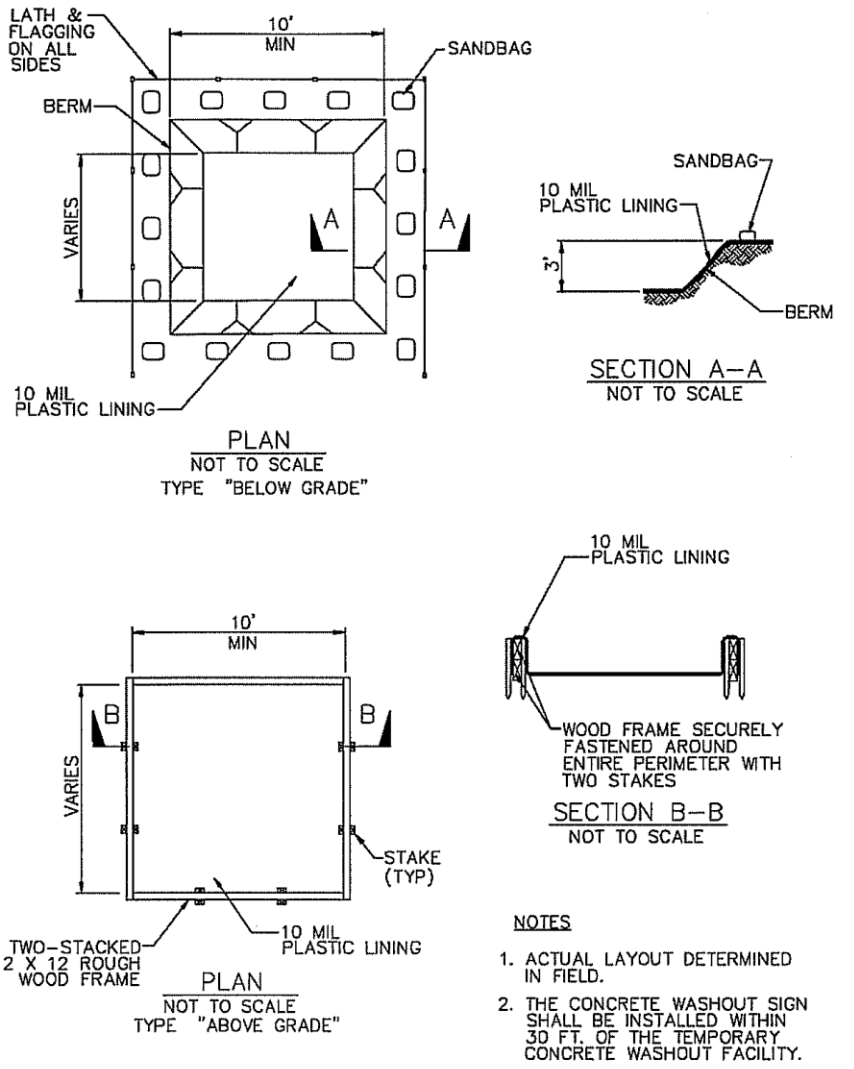
Limitations

Improperly sized washout area can overflow and washout will not be contained.

Maintenance Requirements

The washout pit shall be cleaned weekly; when 2/3 full; and/or as necessary to maintain capacity for wasted concrete. The waste material shall be disposed of properly.

Figure CS-7: Concrete Washout Detail (EPA)



8.5 BMP CM-5 Maintenance Areas

See also the City of Bella Vista's 2010 BMP Manual Sections 212 & 213

Description

Ideally, vehicle maintenance occurs in garages and wash facilities, not on active construction sites. However, if these activities must occur onsite, operators shall follow appropriate BMPs to prevent untreated nutrient-enriched wastewater or hazardous wastes from being discharged to surface or ground waters.

Applications

Vehicle maintenance and BMPs prevent construction site spills of wash water, fuel, or coolant from contaminating surface or ground water. They apply to all construction sites.

A covered, paved or gravel-lined area shall be dedicated to vehicle maintenance. A spill prevention and cleanup plan should be developed. Prevent hazardous chemical leaks by properly maintaining vehicles and equipment. Properly cover and provide secondary containment for fuel drums and toxic materials. Properly handle and dispose of vehicle wastes.

Implementation

Construction vehicles shall be inspected daily, and any leaks repaired immediately. All used oil, antifreeze, solvents and other automotive-related chemicals shall be disposed of according to manufacturer instructions. These wastes require special handling and disposal. Used oil, antifreeze, and some solvents can be recycled at designated facilities, but other chemicals must be disposed of at a hazardous waste disposal site. Local government agencies can help identify such facilities.

Limitations

There are construction costs for the enclosed maintenance area, along with labor costs for hazardous waste storage, handling, and disposal.

Maintenance

Vehicle maintenance operations produce substantial amounts of hazardous and other wastes that require regular disposal. Clean up spills and dispose of cleanup materials immediately. Inspect equipment and storage containers regularly to identify leaks or signs of deterioration.

(Source: EPA)

8.6 BMP CM-6 Construction Dewatering

See also the City of Bella Vista's 2010 BMP Manual Section 420

Description

Construction dewatering practices involve the removal of sediment from trench or groundwater prior to it being discharged from the construction site. It is also appropriate for the removal of stormwater from depressed areas at a construction site.

Implementation

If trench or ground waters contain sediment, it must pass through a sediment settling pond or other equally effective sediment control device, prior to being discharged from the construction site. Sediment may be removed by settling in place or by dewatering into a sump pit, filter bag, or use of comparable practice.

Groundwater dewatering which does not contain sediment or other pollutants is not required to be treated prior to discharge. However, care must be taken when discharging groundwater to ensure that it does not become pollutant-laden by traversing over disturbed soils or other pollutant sources.

Dewatering discharges must not cause erosion at the discharge point.

Limitations

Dewatering operations will require, and must comply with, applicable local permits. Dewatering that discharges water in a manner that may enter any waters of the State require a permit from ADEQ. This permit will need to be obtained by the owner and all conditions stipulated in that permit strictly adhered to. It is the responsibility of the owner and their SWPPP manager to insure that this occurs.

Photograph 2. Example of Dewatering Bag

8.7 BMP EC-1 Chemical Stabilization

See also the City of Bella Vista's 2010 BMP Manual Sections 250 & 430

Description

Erosion is caused by rainfall impact detaching soil particles. The resulting water runs off carrying the particles downslope. Chemical stabilization is the practice of spraying chemicals (tackifiers, soil binders) on the soil to hold the soil particles in place and protect against erosion.

Applicability

Areas that have been cleared of vegetation or do not have a protective cover on the soil. If temporary seeding cannot be used or would not be effective due to the time of year; steepness of slope; or other reasons, chemical stabilizers can be applied to protect against erosion. Chemical stabilization can often be used in conjunction with seeding and mulching.

Design Criteria

The type of chemical used, the application rate, and application method should meet the manufacturer's recommendations. Examples include asphalt emulsion, poly-acryl amides (PAM), vinyl, or rubber.

Limitations

Improper application methods or rates can result in over-application which can diminish infiltration and cause additional runoff.

Maintenance Requirements

Chemically stabilized areas shall be inspected regularly and after every 1/2-inch or greater rainfalls and stabilizer reapplied as required.

8.8 BMP EC-2 Compost Blankets

See also the City of Bella Vista's 2010 BMP Manual Section 230

Description

A compost blanket is a layer of loosely applied compost or composted material that is placed on the soil in disturbed areas to control erosion and retain sediment resulting from sheet-flow runoff. It can be used in place of traditional sediment and erosion control tools such as mulch, netting, or chemical stabilization. When properly applied, the erosion control compost forms a blanket that completely covers the ground surface. This blanket prevents stormwater erosion by (1) presenting a more permeable surface to the oncoming sheet flow which facilitates infiltration; (2) filling in small rills and voids to limit channelized flow; and (3) promoting establishment of vegetation on the surface.

Compost blankets can be placed on any soil surface: rocky, frozen, flat, or steep. The method of application and the depth of the compost applied will vary depending upon slope and site conditions. The compost blanket can be vegetated by incorporating seeds into the compost before it is placed on the disturbed area (recommended method). Or the seed can be broadcast onto the surface before or after installation of the blanket.

Applications

Compost blankets are most effective when applied on slopes between 4:1 (horizontal:vertical) and 2:1 (horizontal:vertical), such as stream banks, road embankments, and construction sites, where stormwater runoff occurs as sheet flow.

Compost blankets can be used on steeper slopes, such as 1:1 (horizontal:vertical), if netting or confinement systems are used in conjunction with the compost blanket to further stabilize the compost and the slope or if the compost particle size and compost depth are specially designed for the application.

Limitations

Compost blankets are not applicable for locations with concentrated flow.

Compost blankets are not generally used on slopes greater than 2:1

(Source: US Environmental Protection Agency)

8.9 BMP EC-3 Geo-textiles, Erosion Control Blankets and Mats

See also the City of Bella Vista's 2010 BMP Manual Section 230

Description

Geo-textiles are porous fabrics also known as filter fabrics, road rugs, synthetic fabrics, construction fabrics, or simply fabrics. Geo-textiles are manufactured by weaving or bonding fibers that are often made of synthetic materials such as polypropylene, polyester, polyethylene, nylon, polyvinyl chloride, glass, and various mixtures of these materials. As a synthetic construction material, Geo-textiles are used for a variety of purposes such as separators, reinforcement, filtration and drainage, and erosion control (USEPA, 1992).

Some Geo-textiles are made of biodegradable materials such as mulch matting and netting. Mulch mats of jute or other wood fibers that have been formed into sheets are more stable than normal mulch. Netting is typically made from jute, wood fiber, plastic, paper, or cotton and can be used to hold the mulching and matting to the ground. Netting can also be used alone to stabilize soils while the plants are growing; however, it does not retain moisture or temperature well. Mulch binders (either asphalt or synthetic) are

sometimes used instead of netting to hold loose mulches together. Geo-textiles can aid in plant growth by holding seeds, fertilizers, and topsoil in place. Fabrics come in a wide variety to match the specific needs of the site and are relatively inexpensive for certain applications.

Applications

Geo-textiles can be used in various ways for erosion control on construction sites. Use as matting to stabilize the flow of channels or swales or to protect seedlings on recently planted slopes until they become established. Use on tidal or stream banks where moving water is likely to wash out new plantings. Geo-textiles can be used to protect exposed soils immediately and temporarily, such as when active piles of soil are left overnight. They can also be used as a separator between riprap and soil, which prevents the soil from being eroded from beneath the riprap and maintains the riprap's base. Geo-textiles can also be used as covers on stockpiles.

Design Considerations

There are many types of Geo-textiles available; therefore, the selected fabric needs to match its purpose. To ensure the effective use of Geo-textiles, keep firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil, and erosion will occur underneath the material.

Limitations

Geo-textiles (primarily synthetic types) have the potential disadvantage of disintegrating when exposed to light. Consider this before installing them. Some Geo-textiles might increase runoff or blow away if not firmly anchored. Depending on the type of material used, Geo-textiles might need to be disposed of in a landfill, making them less desirable than vegetative stabilization. If the geo-textile fabric is not properly selected, designed, or installed, its effectiveness may be reduced drastically.

Maintenance

Inspect geo-textiles regularly to determine if cracks, tears, or breaches have formed in the fabric; if so, repair or replace the fabric immediately. It is necessary to maintain contact between the ground and the geo-textile at all times. Remove trapped sediment after each storm event.

(Source: EPA)

Photograph 3. Example of Erosion Control Blanket

8.10 BMP EC-4 Terraces

See also the City of Bella Vista's 2010 BMP Manual Section 261

Description

Terraces are earthen embankments or ridge and channel systems that reduce erosion by slowing, collecting and redistributing surface runoff to stable outlets that increase the distance of overland runoff flow. Terraces hold moisture and help trap sediments while minimizing sediment-laden runoff.

Sediment can be controlled on slopes that are particularly steep by the use of terracing. During grading, relatively flat sections or terraces, are created and separated at intervals by steep slope segments. The steep slope segments are prone to erosion, however, and must be stabilized by mulching or other techniques. Retaining walls, gabions, cribbing, deadman anchors, rock-filled slope mattresses and other types of soil retention systems are available for use. These should be specified in the plan and installed according to manufacturer's instructions.

Applications

Terraces perform most effectively in barren areas with an existing or expected water erosion problem. Gradient terraces are effective only if suitable runoff outlets are available. Do not build terraces on slopes comprised of rocky or sandy soil because these soil types may not adequately redirect flows.

Implementations

Terraces should be properly spaced and constructed with an adequate grade, and they should have adequate and appropriate outlets toward areas not susceptible to erosion or other damage. Whenever possible, use vegetative cover in the outlet.

Terraced (stair-stepping) slopes shall have the vertical cuts no more than 2 feet deep and the horizontal steps shall be wider than the depth of the vertical cut. The horizontal step shall slope backward to the vertical cut upslope on the hill.

Limitations

Terraces are inappropriate for use on sandy or shallow soils, or on steep slopes. If too much water permeates a terrace system's soils, sloughing could occur; potentially increasing cut and fill costs.

Maintenance

Terraces shall be inspected after major storms and at least once annually to ensure that they are structurally sound and have not eroded.

(Source: US Environmental Protection Agency)

8.11 BMP EC-5 Mulching

See also the City of Bella Vista's 2010 BMP Manual Section 221

Description

Erosion is caused by rainfall impact detaching soil particles and runoff carrying the particles downslope. Mulch can be applied to the area to hold the soil particles in place and protect against erosion.

Mulching is the practice of applying a layer of organic material (hay, straw, wood fiber, paper fiber, etc.) to protect the soil from impact of precipitation.

Applicability

Areas that have been cleared of vegetation or do not have a protective cover on the soil. Mulches are typically used to protect areas that have been seeded. Mulching can be used in conjunction with chemical stabilization.

Design Criteria

Mulch should be applied consisting of clean, weed-free and seed-free, long-stemmed grass hay (preferred) or cereal grain straw. Hay is preferred as it is less susceptible to removal by wind. At least 50% of the grass hay mulch, by weight, shall be 10 inches or more in length.

Straw mulch shall be evenly applied at a rate of 2 tons of dry straw per acre. The mulch shall be attached to the soil immediately after application as an anchor and not merely placed on the surface. This can be accomplished mechanically by crimping or with the aid of tackifiers or nets. Anchoring with a crimping implement is preferred, and is the recommended method for all areas equal to or flatter than 3:1. Mechanical crimpers must be capable of tucking the long mulch fibers into the soil four (4) inches deep without cutting them.

Mulch is typically applied using a mulch blower, but it can be applied by hand in small or hard to reach areas.

Soil which is exposed for more than 14 days with no construction activity shall be seeded, mulched, or re-vegetated.

On small areas sheltered from the wind and from heavy runoff, spraying a tackifier on the mulch is satisfactory for holding it in place. Hydraulic mulching consisting of wood cellulose fibers must be mixed with water and a tackifying agent and applied at a rate of no less than 2,000 pounds per acre with a hydraulic mulcher.

Mats, blankets, and nets are required to help stabilize steep slopes (3:1 and steeper) and waterways. Depending on the product, these may be used alone or in conjunction with grass or straw mulch.

Normally, use of these products will be restricted to relatively small areas. Mats made of straw and jute, straw-coconut, coconut fiber, or excelsior can be used instead of mulch. Whichever material is used, blankets need to be bio-degradable.

Some synthetic tackifiers or binders may be used to anchor mulch in order to limit erosion and, if approved by review agency, provide soil stabilization. Caution should be used to prevent the introduction of any potentially harmful and non-biodegradable materials into the environment. Manufacturer's recommendations should be followed at all times.

Rock (gravel, slag, crushed stone, river rock) of aggregate base-coarse size can also be used as mulch on disturbed areas for temporary or permanent stabilization. It provides protection of exposed soils to wind and water erosion and allows infiltration of precipitation. Rock must be removed from those areas to be planned for vegetation establishment.

Limitations

Wind and concentrated water flows can blow or wash mulch from the application area. Mulch should not be applied in areas with concentrated flows.

For steep slopes and special situations where greater control is needed, blankets anchored with stakes should be required instead of mulch.

Road cuts, road fills, and parking lot areas shall be covered as early as possible with the appropriate aggregate base course where this is specified as part of the pavement in lieu of mulching.

Maintenance Requirements

Mulched areas shall be inspected regularly and after every ½-inch or greater rainfalls and mulch reapplied as required.

8.12 BMP EC-6 Temporary Outlet Protection, Energy Dissipation Devices, Riprap Apron

See also the City of Bella Vista's 2010 BMP Manual Chapter 3

Description

Water exiting a channel, swale, pipe, or culvert (any water carrying conduit) typically is in a concentrated stream with a relatively high velocity. This high energy stream of water erodes unprotected soil.

Energy Dissipation is a structural BMP placed at the exit of a water carrying conduit to slow the velocity and decrease the turbulence of the water. Permanent energy dissipation controls can be used as temporary devices during the construction phase of the project, and shall be designed according to methods described in Chapter 7 – *Open Channel Flow Design*. A riprap apron is considered the most cost effective type of temporary energy dissipation device; meaning that the energy dissipation device is only

needed during construction and will be removed once construction is complete. However, should a permanent energy dissipation device be required at the outlet end of a conduit it may be more economical to install a permanent energy dissipation device early in construction as a structural BMP, making sure to maintain and service the device during construction so it can be used permanently once construction is complete. Other types of energy dissipation devices include: Plunge Pools, Scourstop© Mats, Velocity Dissipaters, etc. The only type of temporary energy dissipation device that will be discussed in this *Manual* will be the riprap apron.

Applicability

All channels or pipes carrying runoff at velocities that will erode the soil in the discharge area.

Design Criteria

See Section 6.0 – *Outlet Protection* of Chapter 8 –*Culvert and Bridge Hydraulic* Design for additional design information on sizing riprap apron outlet protection.

Determine the required median size (d_{50}) of riprap using graph in the “Riprap Apron Sizing” Figure(s) below for the condition at hand. Enter the graph on the X-axis with the discharge in cubic feet per second, move vertically to intersect either the appropriate depth of flow (d) line or the velocity of flow (v) line, and then read horizontally to the Y-axis on the right side to determine the required median diameter of riprap (d_{50}).

Determine the minimum required apron length using the graph in the “Riprap Apron Sizing” Figures CS-8to CS-10. Enter the graph on the X-axis with the discharge in cubic feet per second, move vertically to the second set of lines to intersect the appropriate depth of flow (d), and then read horizontally to the left to determine the minimum required length of apron (L_a) in feet.

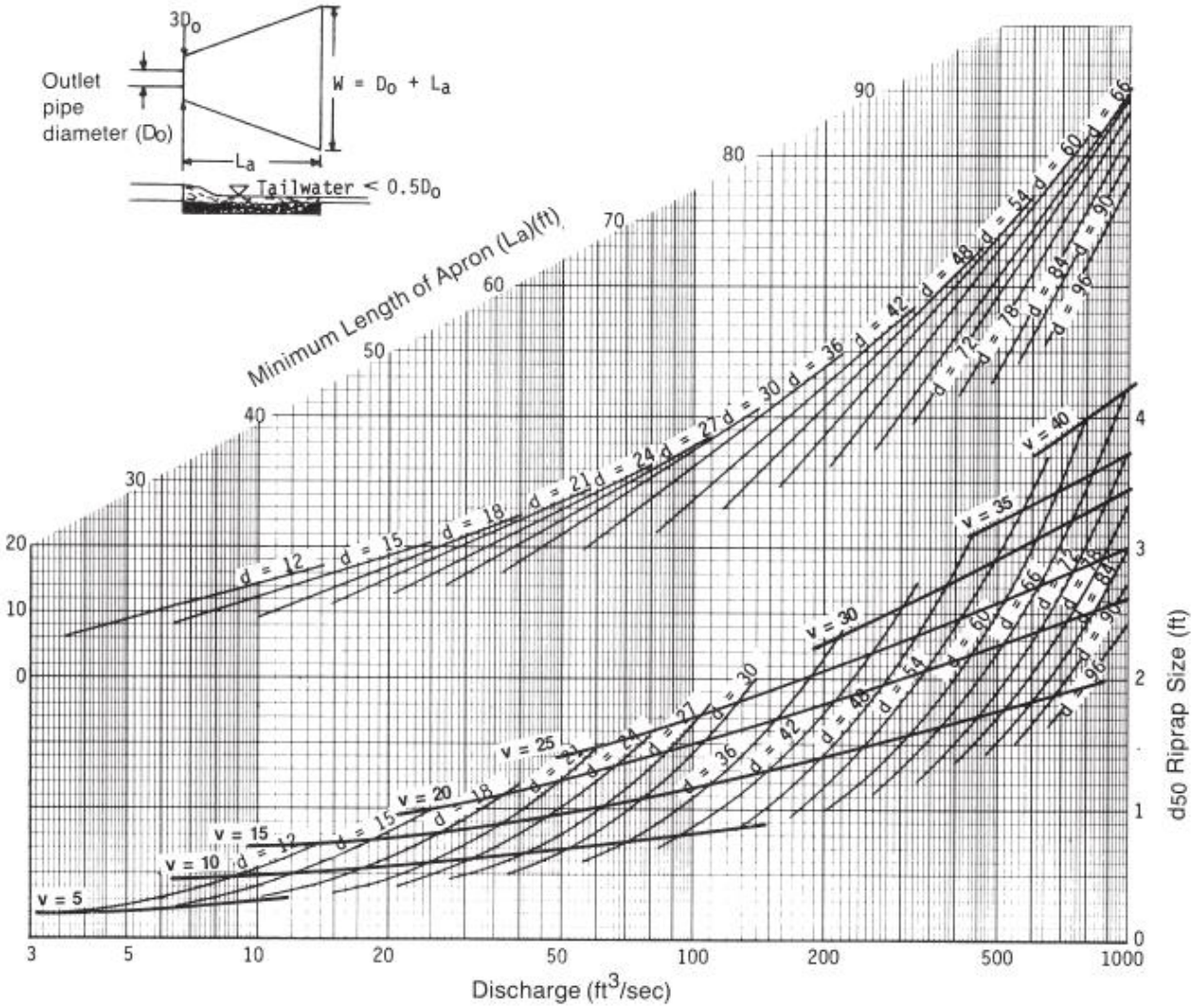
Limitations

Riprap aprons are best suited for applications where the Froude Number at the conduit exit is less than 2.5.

Maintenance Requirements

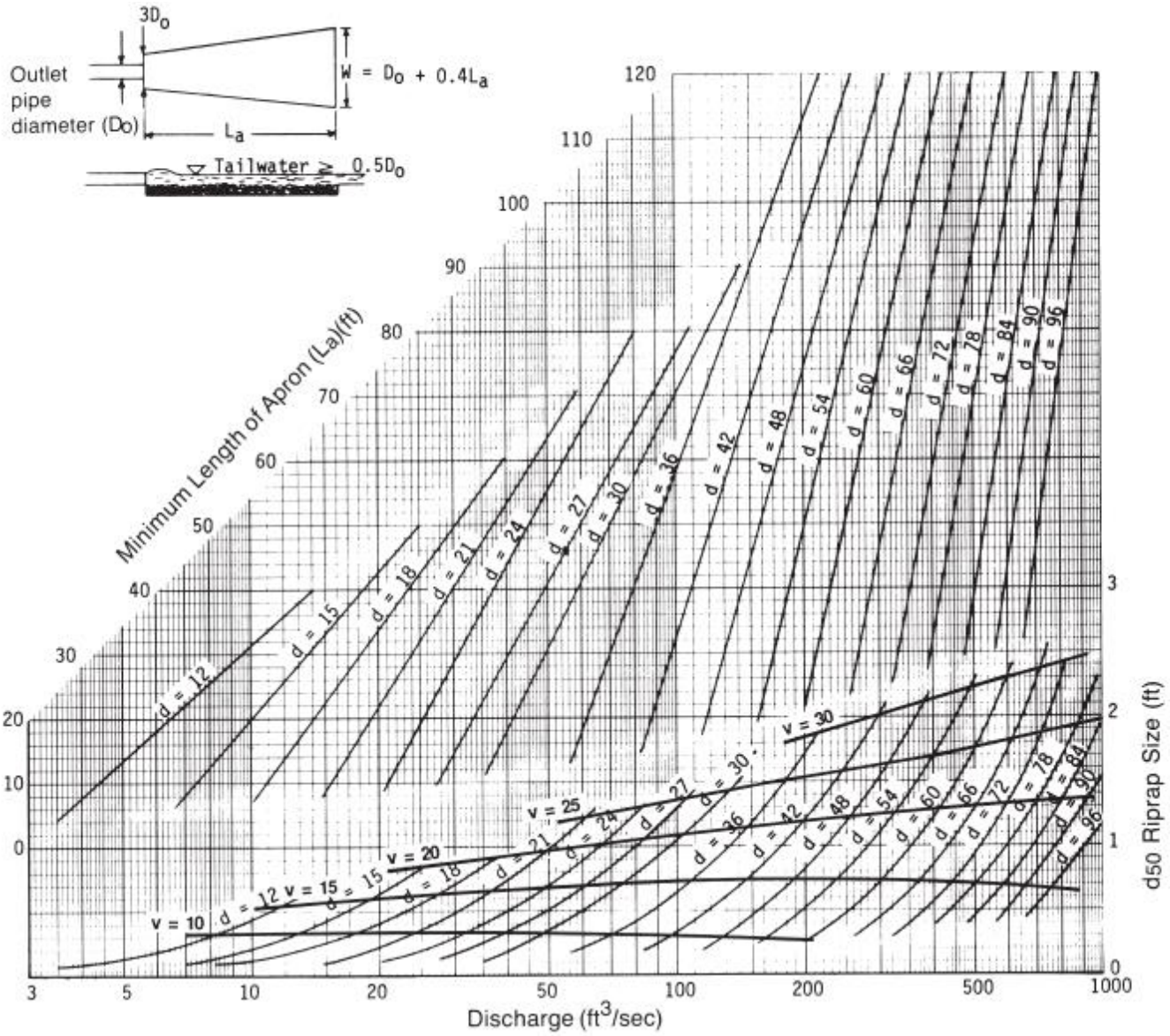
The apron should be inspected after large storms to ensure that the devices are in place. Riprap and other dissipators should be replaced when it is dislodged or missing.

Figure CS-8: Riprap Apron Sizing for a Round Pipe Flowing Full, Minimum Tailwater Condition (T_w < 0.5 diameter) (SCS, 1975)



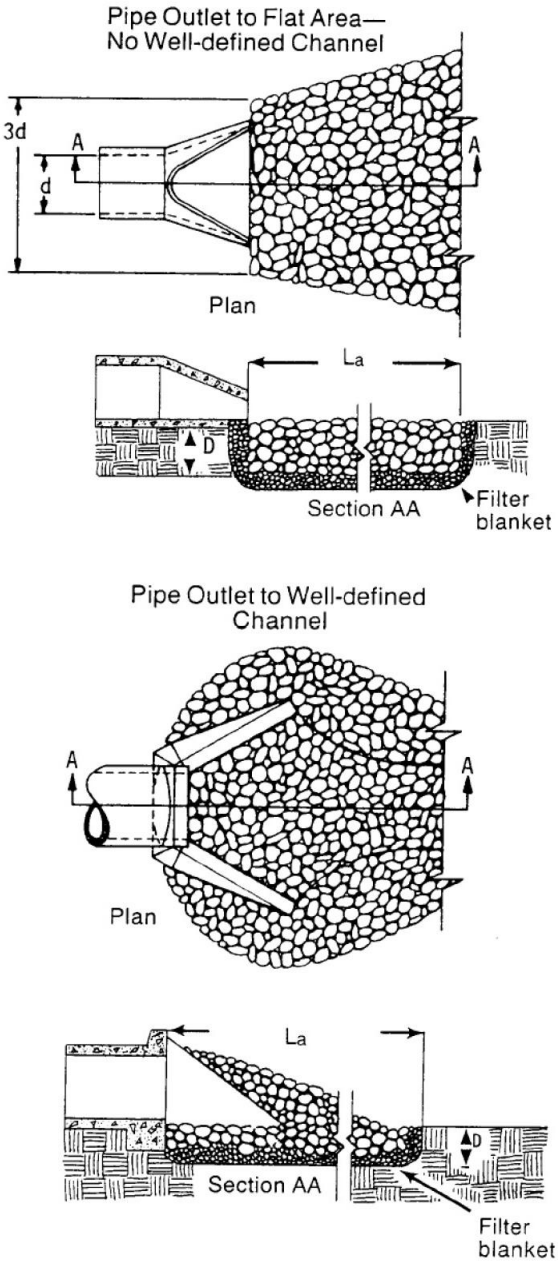
Curves may not be extrapolated.

Figure CS-9: Riprap Apron Sizing for a Round Pipe Flowing Full, Maximum Tailwater Condition ($T_w \geq 0.5$ diameter) (SCS, 1975)



Curves may not be extrapolated.

Figure CS-10: Riprap Apron Detail (Source: MESCG, 1996)



Notes

1. L_a is the length of the riprap apron.
2. D = 1.5 times the maximum stone diameter but not less than 6".
3. In a well-defined channel extend the apron up the channel banks to an elevation of 6" above the maximum tailwater depth or to the top of the bank, whichever is less.
4. A filter blanket or filter fabric should be installed between the riprap and soil foundation.

8.13 BMP EC-7 Temporary and Permanent Re-vegetation

See also the City of Bella Vista's 2010 BMP Manual Sections220, 221, 230, 240 & 241

Description

Erosion is caused by rainfall impact detaching soil particles and runoff carrying the particles downslope. Vegetation (seed or sod) can hold the soil particles in place and protect against erosion.

Applicability

Any area of a construction site that the natural vegetation has been removed. Seeding or sodding can be used as a temporary or a permanent erosion control measure.

Topsoil and Seedbed Preparation

Areas to be re-vegetated shall have soils capable of supporting vegetation. Overlot grading will oftentimes bring to the surface subsoils that have low nutrient value, little organic matter content, few soil microorganisms, rooting restrictions, and conditions less conducive to infiltration of precipitation. As a result, roto-tilling and adding topsoil, compost, and other soil amendments can be essential to achieve successful re-vegetation.

Topsoil should be salvaged during grading operations and used for spreading on areas to be re-vegetated later. Topsoil should be viewed as an important resource to be utilized for vegetation establishment, primarily due to its water-holding capacity. Native topsoil should have good soil structure, organic matter content, biological activity, and nutrient supply that support vegetation.

The upper 6 inches of topsoil can be stripped and stockpiled, and re-spread to a thicker depth on surfaces not planned for buildings or impervious areas. Stockpiled soils shall be seeded with a temporary or permanent grass cover. Mulching is recommended to ensure vegetation establishment. If stockpiles are located within 100 feet of a waterway, additional sediment controls (such as diversion dikes or embedded silt fences) should be provided.

If the soils have become compacted, they shall be loosened to a depth of at least 6 inches.

Soil roughening will assist in placement of a stable topsoil layer on steeper slopes, and allow percolation and root penetration to greater depth. Soil roughening techniques shall be used for slopes greater than 3:1.

Where topsoil is not available or utilized, subsoils can be treated to provide a plant-growth medium. Organic matter, such as well-digested compost, can be added to improve nutrient levels necessary for plant growth. Other treatments, such as liming, can be used to adjust soil pH conditions when needed. If the pH of the soil is less than 6, lime shall be added to the top 6 inches of soil. Soil testing needs to be done to determine appropriate amendments required. Fertilizer (10-10-10) can also be incorporated into the top 6 inches of soil at a rate of 100 lb/acre when a soil test confirms the need for it.

A suitable seedbed will enhance the success of re-vegetation efforts. The surface should be rough and the seedbed should be firm, but neither too loose nor compacted. The seed bed should be loose, without large clods, and uniform before seeding. The upper layer of soil should be in a condition suitable for seeding at the proper depth and conducive to plant growth.

Temporary Re-vegetation

The appropriate temporary vegetation for a site is dependent upon the time of year. Prior to application of seed, grading of the site shall be complete including all erosion and sediment control practices.

Soil which is exposed for more than 14 days with no construction activity shall be seeded, mulched, or re-vegetated. All temporary seeding shall be protected with mulch.

Typical broadcast rates for temporary vegetation are listed in Table CS-6 below.

Table CS-6: Temporary Seeding Planting Materials

Species	Planting Dates		Broadcast Rate (lb/acre)	Plant Characteristics
Oats	2/1 – 5/30	8/1 – 9/30	80	not cold tolerant
Rye/Wheat	1/1 – 5/31	7/15 – 11/15	90 / 120	cold tolerant
Millet/Sudangrass	5/1 – 8/15	---	45 / 60	warm season
Annual Ryegrass	1/1 – 5/31	7/15 – 9/30	75	not heat tolerant
Annual Lespedeza plus Tall Fescue	5/1 – 8/15	---	15 / 45	warm season

(Adapted from MAACD, 1998)

Permanent Re-vegetation

Permanent seeding is the process of establishing permanent vegetative cover through the use of perennial seed mix to control runoff and erosion on disturbed areas. Permanent re-vegetation protects bare soil surfaces from raindrop impact and by reduces the velocity and volume of overland flow.

Permanent seeding should be considered for any disturbed area where all construction or maintenance activities have ceased for a period of 30 days, or for areas where all construction has been finalized and is now ready for permanent vegetative cover.

All permanent seeding shall be protected with mulch. Mulch is required to protect seeds from heat, moisture loss, and transport due to runoff.

Vegetation is not considered established until a ground cover is achieved which is equivalent to at least 80% of the previously existing vegetation and is sufficiently mature to control soil erosion and can survive severe weather conditions.

Each site will have different characteristics, and a landscape professional should be contacted to determine the most suitable species or seed mix for a specific site. The recommended seed mix will depend on site specific information such as elevation, exposure, soils, water availability, and topography. Seeding shall be done at the proper time of year, and the proper application of fertilizers will contribute to the success of the seeding.

In lieu of a specific recommendation and for planning purposes, one of the perennial grass species appropriate for site conditions listed in Table CS-7 can be used. The seeding rates of application

recommended in these tables are considered to be absolute minimum rates for seed applied using proper drill-seeding equipment. Appropriate seeding dates are also provided in Table CS-7.

Table CS-7: Seeding Rates and Timing for Turf Grasses in Arkansas

Perennial Grass Species	Area of Adaptation	Seeding Rate (lbs/1,000 ft^2)	Days to Germinate	Planting Time
Tall fescue + Kentucky bluegrass	North	5.0 to 7.0	5 to 21	September-October preferred
Tall fescue	Central, North	8.0 to 10.0	5 to 10	September-October preferred (or early spring)
Bermuda Grass	Statewide	0.5 to 1.0	7 to 14	May-June
Centipede Grass	South	0.25 to 0.5	7 to 14	May-June
Zoysia Grass	Statewide	1.0 to 2.0	10 to 21	May-June
Annual or perennial ryegrass (over-seeding)	Statewide	6.0 to 10.0	5 to 8	September-November

(Source: Univ. of Arkansas – Cooperative Extension Service FSA2113)

Limitations

Vegetation is not appropriate for heavily-trafficked areas (vehicular and pedestrian) and is not appropriate for rocky, gravelly, or course grained soils. For these types of soils, apply 6 inches of clean topsoil before seeding.

Permanent seeding may only be applied during planting season. Temporary cover is required until that time.

Maintenance Requirements

Vegetated areas shall be protected from runoff from adjacent areas and traffic (vehicular and pedestrian).

Permanent seeding is the last phase of reclaiming any disturbed soils. Inspect all seeded areas on a regular basis and after each major storm event to check for areas where corrective measures may have to be made. Indicate which areas need to be reseeded or where other remedial actions are necessary to assure establishment of permanent seeding. Continue monitoring the site until permanent vegetation is established. Until established, the vegetation will require fertilization and water.

8.14 BMP EC-8 Wind Erosion or Dust Control

See also the City of Bella Vista's 2010 BMP Manual Sections110, 210, 211, 212, 213 & 250

Description

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.

Applications

Wind erosion control BMPs are suitable for construction vehicle traffic on unpaved roads; for drilling and blasting activities; for sediment tracking onto paved roads; for soil and debris storage piles; for batch drops from front-end loaders; for areas with unstabilized soil; and for final grading and site stabilization.

Limitations

Watering only prevents dust for a short period of time and should be applied daily (or more often) to be effective.

Over-watering may cause erosion.

The effectiveness of wind erosion control depends on soil, temperature, humidity, and wind velocity.

Implementation

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

Maintenance

Most dust control measures require frequent, often daily, or multiple times per day attention.

(Source: California Stormwater BMP Handbook, January 2003)

8.15 BMP EC-9 Hydro-seeding/Hydro-mulching

See also the City of Bella Vista's 2010 BMP Manual Sections220, 221 & 230

Description

Hydro-seeding typically consists of applying a mixture of wood fiber, seed, fertilizer, and stabilizing emulsion with hydro-mulch equipment to temporarily protect exposed soils from erosion by water and wind and provide an environment conducive to plant growth. Hydro-mulching is applying a slurry of water, wood fiber mulch, and a tackifier to prevent soil erosion. These terms are often used interchangeably. For our purposes we will refer to hydro-seeding only in this section, but all information shared below can and should be applied to hydro-mulching if its application is warranted in a design.

Applications

Hydro-seeding is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established. Hydro-seeding is also suitable for disturbed areas that will be re-disturbed following an extended period of inactivity.

Implementation

In order to select the appropriate hydro-seeding mixture, an evaluation of site conditions shall be performed with respect to soil conditions, site topography, season and climate, vegetation types, maintenance requirements, sensitive adjacent areas, water availability, and plans for permanent vegetation.

Prior to application, roughen the area to be seeded with the furrows trending along the contours.

Hydro-seeding can be accomplished using a multiple-step process. The multiple-step process ensures maximum direct contact of the seeds to soil. When the one step process is used to apply the mixture, the seed rate shall be increased to compensate for all seeds not having direct contact with the soil.

Follow up applications shall be made as needed to cover weak spots and to maintain adequate soil protection.

Avoid over-spray onto roads, sidewalks, drainage channels, and existing vegetation.

Limitations

Hydro-seeding may be used alone only when there is sufficient time in the season to ensure adequate vegetation establishment and coverage to provide adequate erosion control. Otherwise, hydro-seeding must be used in conjunction with mulching.

Steep slopes are difficult to protect with temporary seeding.

Temporary vegetation may have to be removed before permanent vegetation is applied.

Temporary vegetation is not appropriate for short term inactivity.

Maintenance

Hydro-seeding BMPs, along with irrigation systems, shall be inspected prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at 2-week intervals during the non-rainy season.

Where seeds fail to germinate, or they germinate and die, the area must be re-seeded, fertilized, and mulched within the planting season, using not less than 50% the original application rates.

(Source: California Stormwater BMP Handbook, January 2003)

8.16 BMP EC-10 Surface Roughening

See also the City of Bella Vista's 2010 BMP Manual Section 260

Description

Water flowing down a bare slope will erode soil and transport soil to the bottom of the slope. Surface roughening provides temporary stabilization of disturbed areas from wind and water erosion.

Soil roughening is the practice of increasing the roughness of exposed soil by making grooves, tracks, or terraces (stair-steps) which run perpendicular to the flow path (parallel to slope) slowing flow and trapping sediment.

Applications

Soil roughening can be used on a wide variety of slopes and in conjunction with seeding and mulching.

Soil roughening is particularly useful where temporary re-vegetation cannot be immediately established due to seasonal planting limitations.

Design Criteria

Surface roughening shall be performed after final grading. Fill slopes can be constructed with a roughened surface. Cut slopes that have been smooth graded can be roughened as a subsequent operation. Roughening ridges and depressions should follow along the contours of the slope.

Tracking with lugged tracked equipment is appropriate on sandy material so as to not excessively compact the soil.

Grooving can be accomplished using a plow with the furrows 3 inches deep and less than 15 inches apart.

Terraced (stair-stepping) slopes shall have the vertical cuts no more than 24 inches deep and the

horizontal steps shall be wider than the depth of the vertical cut. The horizontal step shall slope backward to the vertical cut upslope on the hill.

The slope shall be seeded immediately after roughening and mulch or chemical stabilization should be utilized where appropriate.

Limitations

Soil roughening should not be used on rocky soils or soils that are high in clay content. Tracking may cause excessive compaction which can lead to greater erosion.

Care should be taken not to drive vehicles or equipment over areas that have been roughened. Tire tracks will smooth the roughened surface and encourage runoff to collect into rills and gullies. As surface roughening is only a temporary control, additional treatments may be necessary to maintain the soil surface in a roughened condition.

Maintenance Requirements

Roughened slopes shall be inspected after every ½-inch and greater storms and problem areas noted. After a rain event, slopes may need reconstruction, re-roughening, re-seeding, and re-mulching.

8.17 BMP EC-11 Temporary Slope Drain

See also the City of Bella Vista's 2010 BMP Manual Sections 311 & 312

Description

Gullying and excessive erosion will take place on slopes subjected to concentrated flows of runoff.

Slope Drains are conduits (open or closed) used to direct water down a slope while protecting the slope from erosion.

Applicability

Slopes with the potential for intended or unintended concentrated flows.

Design Criteria

Slope drains (rundowns, pipe slope drains, etc.) should be placed where runoff from uphill drainage areas will concentrate. Slope drains shall be sized to handle a 10-year storm from an area no greater than 5 acres. Minimum size for a pipe slope drain is 12-inch diameter. Appropriate energy protection should be placed at the outlet of the pipe. Slope rundowns (stone or riprap lined channels) should be constructed with the middle sufficiently lower than the sides to ensure flow stays in the rundown. Slope drains operate best when used in conjunction with interceptor swales and dikes on the top of the slope. The discharge from all slope drains must be directed to a stabilized outlet, temporary or permanent channel, or sediment basin.

Limitations

For larger storms, the slope drain may not operate properly and can cause excessive gullying and slope erosion as well as damage to the construction site. Slope drains that are improperly designed or constructed such that the flow does not stay in the drain will cause excessive erosion.

Maintenance Requirements

Slope drains shall be inspected weekly and kept clear of trash, debris, and vegetation.

8.18 BMP EC-12 Temporary Stream Crossings

Description

A temporary stream crossing is a temporary culvert, ford, or bridge placed across a waterway to provide access for construction purposes. Temporary stream crossings are not intended to maintain traffic for the public. The temporary access will eliminate erosion and downstream sedimentation caused by vehicles.

Applications

Temporary stream crossings shall be installed at all designated crossings of perennial and intermittent streams on the construction site, as well as for dry channels that may be significantly eroded by construction traffic.

Temporary stream crossings shall be installed at sites when alternate access routes impose significant constraints; when crossing perennial streams or waterways causes significant erosion; and when appropriate permits have been obtained for the stream crossing (such as Corps of Engineers 404 permit).

Implementation

Temporary stream crossings are used to provide a safe, erosion-free access across a stream for construction equipment. Minimum standards and specifications for the design, construction, maintenance, and removal of the structure should be established by a registered professional engineer. Design and installation requires knowledge of stream flows and soil strength. Both hydraulic and construction loading requirements should be considered.

The following types of temporary stream crossings should be considered:

- Culverts – A temporary culvert is effective in controlling erosion, but will cause erosion during installation and removal. A temporary culvert can be easily constructed and allows for heavy equipment loads.

- Fords – Fords are appropriate during the dry season and on low-flow perennial streams. A temporary ford provides little sediment and erosion control and is ineffective in controlling erosion in the stream channel. A temporary ford is the least expensive stream crossing and allows for maximum load limits. It also offers very low maintenance.
- Bridges – Bridges are appropriate for streams and high flow velocities, steep gradients, and where temporary restrictions in the channel are not allowed.

The temporary stream crossing should be located where erosion potential is low. They should be constructed during dry periods to minimize stream disturbance and reduce costs.

Temporary stream crossings should be constructed at or near the natural elevation of the streambed to prevent potential flooding upstream of the crossing.

A culvert crossing should be designed to pass at least the 2-year design flow accounting for the headwater and tailwater controls to meet its design capacity.

When a ford needs to and can be used (when a culvert is not practical or the best solution), it shall be lined with at least one 12-inch thick layer of 6" riprap (d_{50}) or 9" riprap (d_{50}) with void spaces filed with 1-1/2-inch diameter rock.

Limitations

Installation and removal of the temporary stream crossings usually disturb the waterway, therefore additional BMPs will be required to minimize soil disturbance.

Appropriate permits will need to be obtained for the fill associated with temporary stream crossings (such as Corps of Engineers 404 permit).

Installation may require dewatering or temporary diversion of the stream.

Fords shall only be used in dry weather.

Temporary stream crossings are not intended to maintain traffic for the public, only for construction purposes.

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 2-week intervals in the non-rainy season to verify continued BMP implementation.

Check for blockage in the channel; sediment buildup or trapped debris in culverts; and for blockage behind fords or under bridges. Remove sediment that collects behind fords, in culverts, and under bridges periodically.

Check for erosion of abutments, channel scour, riprap displacement, or piping in the soil.

Check for structural weakening of the temporary crossings, such as cracks, and undermining of foundations and abutments.

Remove temporary crossings promptly when they are no longer needed.

8.19 BMP EC-13 Level Spreader

See also the City of Bella Vista's 2010 BMP Manual Section 313

Description

A level spreader receives concentrated flow from channels, outlet structures, or other conveyance structures and converts them to sheet flow. Although a level spreader by itself is not considered a pollutant reduction device, it improves the efficiency of other facilities, such as vegetated swales, filter strips, or infiltration devices, which are dependent on sheet flow to operate properly. The slight depression allows water to collect and then disperse uniformly over the surrounding vegetated area to reduce erosion and concentrated stormwater runoff.

Applications

Level spreaders are used in wide, level areas where concentrated runoff occurs. The level spreader converts the concentrated runoff to sheet flow and releases it onto an area stabilized by vegetation. Flows to the spreader should be relatively free of sediment or the spreader will be quickly overwhelmed by sediment and lose its effectiveness.

Implementations

The spreader should be constructed absolutely level. Height of the spreader is based on depth of design flow, allowing for sediment and debris deposition. The length of the spreader is based on the design flow for the site.

The slope leading to the level spreader shall be less than 1% for at least 20 feet immediately upstream in order to keep velocities less than 2 fps at the spreader during the 10-year storm event. Slope of the outlet from the spreader shall be 6% percent or less.

Limitations

If the spreader is not absolutely level, flows will concentrate at the low point and may cause more problems than if no level spreader were used.

The drainage area shall be limited to 5 acres and discharge velocities to 40 cfs.

Maintenance

Regular inspection and maintenance is essential to ensure sheet flow discharge and to avoid channeling across the crest of the depression. The level spreader shall be inspected regularly and after large rainfall events. Inspection shall note and repair any erosion and low spots in spreader. Sediment shall be removed from behind spreader.

8.20 BMP SC-1 Stabilized Construction Entrance/Exit

See also the City of Bella Vista's 2010 BMP Manual Sections 210, 211, 212 & 213

Description

Mud and sediment carried off-site on the tires of equipment and vehicles will be deposited on the neighboring streets. This sediment will end up in the local streams if not cleaned up and removed from the travel path.

Construction Entrances are systems that clean vehicles of mud, sediment, and aggregate prior to leaving the site.

Applicability

Any controlled entrance/exit of a construction site.

Design Criteria

A 6-inch layer of B-stone (ranging in size from 1-1/2" minimum to 6" maximum, where the stone shall be uniformly graded and the amount passing the 1-1/2" sieve shall be not more than 10% by weight) can be used to stabilize construction site entrances. The stabilized entrance shall be a minimum length of 20% of the lot depth or 50 feet (whichever is greater) up to a maximum of 100 feet and of adequate thickness to minimize tracking onto the city street. If larger volumes of traffic are expected, a 2-lane entrance is appropriate.

Construction access shall be limited to locations approved by the City of Bella Vista.

Other methods of removing mud from vehicles include wheel wash facilities (dunk or mechanical) and rumble strips (cattle guard, logs, etc.).

A dunk wheel wash is a water filled, stabilized (1 inch or greater gravel or stone) pit. The water depth shall be at least 2 feet deep and the pit shall be at least 20 foot long. The pit shall have 2 vehicle lengths between the construction exit and entrance. The area between the wash pit and the pit exit shall be stabilized. These shall be provided on all sites.

Limitations

In order to avoid puncturing tires, stabilized entrances shall not be constructed with sharp-edge stones.

Maintenance Requirements

Stabilized entrances require periodic cleaning or will require the addition or replacement of stone as the voids in the stones fill with mud and sediment.

Wheel wash facilities and rubble strips will need to be cleaned as the pits fill in order to continue providing room to store mud and sediment.

The street in front of the entrance shall be cleaned as required to remove sediment that has been tracked off site.

Whenever sediment is transported onto a public road, regardless of the size of the site, the road shall be cleaned at the end of each day and before any anticipated rainstorm. Sediment shall be removed from roads by shoveling and sweeping and be transported to a controlled sediment disposal area. Washing of the street with a water hose or flushing the water downstream ***IS EXPRESSLY PROHIBITED***.

8.21 BMP SC-2 Embedded Silt Fence

See also the City of Bella Vista's 2010 BMP Manual Section 351

Description

Water flowing in shallow sheet flow will carry sediment downslope and off-site.

An embedded silt fence is a barrier made of geo-textile fabric placed along a contour to capture water, slow the flow rate, trap sediment, and allow water to filter through the fabric.

Applications

Small drainage areas with shallow sheet flow.

Design Criteria

Embedded silt fence is designed to be placed on a contour and hold runoff from a maximum 10-year design storm from an area not to exceed 100 square feet per each foot of length of fence. The maximum depth of retained water on the upstream side of the fence shall be 2 feet. The maximum slope length above the fence shall be no more than 100 feet. The maximum slope above the fence is 1:1.

The fabric shall be buried in a trench at least 8 inches deep and 8 inches wide. The fabric shall be place on the upstream side of the posts. The fabric shall be reinforced with either wire-backing (hog-wire fencing) or other City-approved fencing reinforcement.

Posts shall be made of metal (T-post) or wood (2”x2”) and placed 6 feet apart.

All embedded silt fence shall be wire-backed except when used as inlet protection.

Limitations

Silt fence must be embedded or it will not function properly. It should not be installed in rocky soil where it cannot be properly embedded.

Silt fence is not designed to hold back concentrated flow and so should not be placed across channels, gullies, or streams.

Silt fence shall not be run in a way that will concentrate flows; cause gully erosion; and/or cause downstream BMPs to fail.

Photograph 4. Example of Reinforced Silt Fencing

Maintenance Requirements

Embedded silt fence shall be inspected weekly and after every ½-inch or greater rainfall for holes; defective fencing; erosion on the ends; and excessive sediment buildup behind the fence (1/3 the fence height); and/or other needed repairs. Any sediment accumulated behind the fence must be removed and disposed of properly. Any defective measures shall be repaired or replaced as soon as possible or within 48 hours of being found.

8.22 BMP SC-3 Inlet Protection

See also the City of Bella Vista’s 2010 BMP Manual Sections 330, 340 & 351

Description

Runoff from a construction site often carries sediment into the stormwater sewer system, which discharges into local streams. Besides the problems caused by sediment, other pollutants (e.g. oil, grease, and nutrients) are often attached to the sediment.

Inlet Protection is the practice of placing a barrier around an inlet to allow runoff to pond and sediment to settle out prior to entering the stormwater sewer system.

Applications

Any storm drain inlet that could receive runoff from the construction site.

Photograph 5. Example of Inlet Protection

Design Criteria

If geo-textile fabric is used as the filtering material, the posts shall be driven at the edge of the inlet and shall be no more than 3 feet apart. The fence should be installed according to the Inlet Protection Detail.

For inlets in paved areas gravel, sandbags, or waddles should be used as the filtering medium. If gravel (bagged or unbagged) is to be used, the gravel shall be at least 1-inch in diameter. The dam shall be no more than 12 inches tall and the side shall have no greater than a 2:1 (horizontal:vertical) slope. If sand-bags are used, the bags shall be no heavier than 50 pounds and stacked no higher than 3 bags high with the bags stacked in a pyramid formation.

For inlets located in sump, it is important that the inlet continue to function while reducing the amount of sediment entering it. This can be accomplished for a curb opening or combination inlet in a sump by setting the maximum height of the protective barrier lower than the top of the curb opening. This allows overflow to occur during larger rainfall events even though sediment-laden runoff will enter the storm drainage system. If the inlet protection height is greater than the curb elevation, such as the filter being clogged from previous sediment deposits, runoff will not enter the inlet and bypass it. This may possibly cause more downstream erosion and damage than would occur without inlet protection. Area inlets located in a sump setting can be protected through the use of geo-textiles, concrete block and gravel filter, sandbags, excavated sediment trap, or “rock socks” imbedded in the adjacent soil and stacked around the area inlet.

For inlets located along a slope, flows in the gutter will merely bypass the inlet if the suggestions above are used. A more effective approach is to control sediment along a sloping street by trapping it before it enters the inlet, which can be done fairly effectively, but not completely, through the use of a series of

filters placed upstream of the inlet that can create small sediment basins while allowing water to filter through them. There are also several different proprietary products that work efficiently on slopes.

Limitations

Inlet protection control measures are not capable of handling large quantities of sediment and can require maintenance during rain events in order to protect nearby facilities and to eliminate flooding. Ponding can create flooding problems for surrounding facilities including streets.

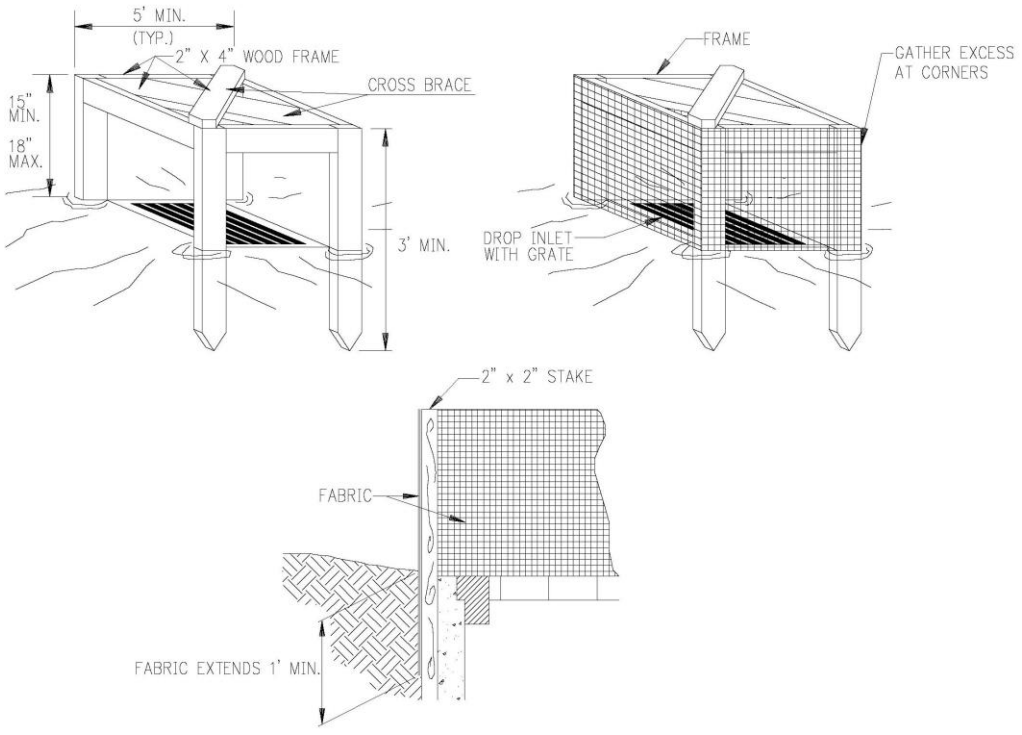
If the flow entering the inlet is being directed to a sedimentation basin, no inlet protection is needed. In those cases, it is much more effective to allow sediment to fall out in the sedimentation basin rather than creating a condition where the stormwater cannot enter the inlet and continues to move downstream, eventually overflowing into the waterway in an uncontrolled fashion.

Maintenance Requirements

Inlet protection measures should be inspected during storm events to ensure surrounding facilities are not flooded.

Inlet protection measures shall be inspected weekly and after every ½-inch or greater rainfalls for holes; defective filtering; erosion around the edges; excessive sediment buildup; and other needed repairs. Any defective measures should be repaired or replaced as soon as possible or within 48 hours of being found.

Figure CS-11: Inlet Protection Detail Using Geo-Textile



8.23 BMP SC-4 Chemical Treatment

See also the City of Bella Vista's 2010 BMP Manual Sections 421 & 430

Description

Chemical treatment includes the application of chemicals to stormwater to aid in the reduction of turbidity caused by suspended solids.

Applications

Chemical treatment can reliably provide exceptional reductions of turbidity and associated pollutants. Treatment should be considered where turbid discharges to sensitive waters cannot be avoided using other BMPs. Typically, chemical use is limited to waters with numeric turbidity or other water quality standards.

Implementation

Turbidity is difficult to control once fine particles are suspended in stormwater runoff from a construction site. Sedimentation ponds are effective at removing larger particulate matter by gravity settling, but are generally ineffective at removing smaller particulates such as clay and fine silt. Chemical treatment may be used to reduce the turbidity of stormwater runoff. Very high turbidities can be reduced to levels comparable to what is found in streams during dry weather when properly treated.

Chemically-treated stormwater discharged from construction sites must be non-toxic to aquatic organisms while meeting all applicable numeric water quality standards..

Maintenance

Chemical treatment systems must be operated and maintained by individuals with expertise in their use. Chemical treatment systems should be monitored continuously while in use.

(Source: California Stormwater BMP Handbook, January 2003)

8.24 BMP SC-5 Sediment Trap

See also the City of Bella Vista's 2010 BMP Manual Sections 211, 401, 402 & 410

Description

Water carrying sediment off-site can cause damage to neighboring property and local streams. A sediment trap provides an area for sediment to settle out of the runoff prior to discharge from the site.

Applications

Sediment traps are well suited for sites that will be required to have a permanent stormwater control basin; but, should be used above any concentrated flow (culvert, pipe, swale, etc.) that could have sediment in its discharge that leaves the site.

Design Criteria

The removal efficiency of sediment traps is a function of the total surface area of the pond; the shape of the pond; the influent flow rate; and the type of soil in the runoff. The maximum drainage area for a sediment trap shall be 3 acres. For larger areas, a sediment basin shall be used. See Section 8.25.

The minimum bottom area and spillway width for sediment traps are given in the Table CS-8 below. The berm or levee shall curve upstream to hold water. The berm shall have 3:1 side slopes (maximum) and have a maximum depth of 3 feet. The outlet spillway shall be made of 6 inches of a minimum 6-inch diameter stone that has been placed on a geo-textile fabric or an approved equal.

Table CS-8: Minimum Sediment Trap Dimensions

Drainage Area	Minimum Bottom Area	Overflow Spillway Width
Less than 1 acres	250 square feet	6 feet
1 to 2 acres	675 square feet	12 feet
2 to 3 acres	1,500 square feet	18 feet

Limitations

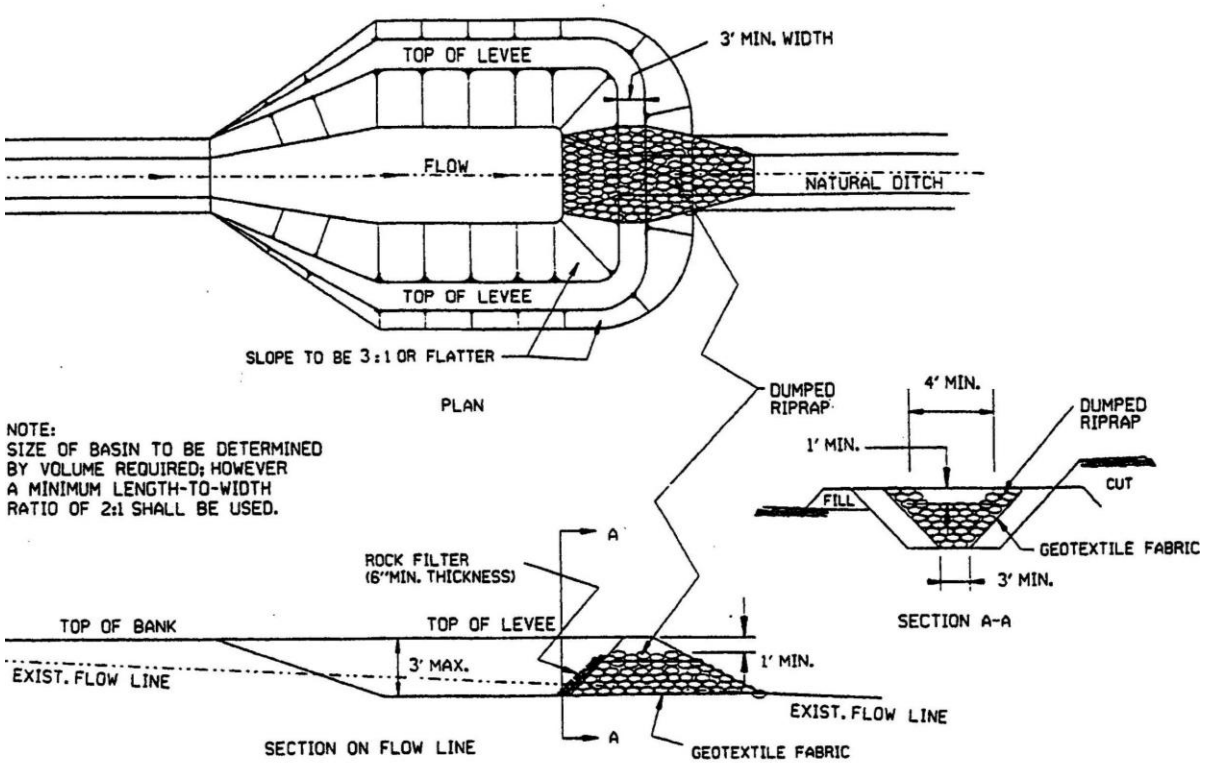
Sediment traps do not have sufficient surface area to allow for settling of very small particles (e.g. clay, silt).

Sediment traps are not appropriate for runoff from areas greater than 3 acres.

Maintenance

Sediment traps shall be inspected weekly and after every ½-inch or greater rainfalls for repairs; erosion on the ends; and/or excessive sediment buildup. Any defective measures should be repaired or replaced within 24 hours of being found.

Figure CS-12: Sediment Trap Detail (Adapted from: AHTD, 2001)



8.25 BMP SC-6 Sediment Basin

See also the City of Bella Vista's 2010 BMP Manual Sections 211, 401, 402 & 410

Description

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained to allow sediment to settle out before runoff is discharged.

Applications

Sediment basins should be considered for use when the drainage area is 3 acres or more. For smaller areas, a sediment trap shall be used. See Section 8.24.

Sediment basins should be considered where post-construction detention basins are required.

Implementation

A sediment basin is a controlled stormwater release structure formed by excavation; by construction of an embankment of compacted soil across a drainage way; or in other suitable locations. It is intended to trap sediment before it leaves the construction site. A basin is a temporary measure and needs to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins shall be properly located on the site, but not in a natural or undisturbed stream.

Limit the contributing area to a sediment basin to only the runoff from the disturbed soil areas of the site. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin, unless being used to treat water from upstream areas.

The volume of the sediment basin shall be 3,000 cubic feet per acre with average slopes over 5%. For property with average slopes less than 5%, the basin volume should be 1,500 cubic feet per acre. A properly-sized basin is required for each separate drainage area within the property being developed.

The outlet from a sediment basin shall be designed to empty its volume over an extended period of time so that the smaller sediment particles to settle to the bottom of the basin.

Maintenance

Sediment basins shall be inspected weekly and after every ½-inch or greater rainfalls for repairs; erosion around the inlet and/or outfall; and/or excessive sediment buildup during the site's development or construction and at least once per year after the site has been stabilized. Any defective measures should be repaired or replaced within 24 hours of being found.

Check inlet and outlet structures for any damage, obstructions, or erosion. Repair damage and remove obstructions as needed. The sediment basin must be maintained until final stabilization of the site.

Photograph 6. Example of Sediment Basin with Stone Outlet

8.26 BMP SC-7 Compost Filter Socks

See also the City of Bella Vista's 2010 BMP Manual Section 320

Description

A compost filter sock is a contained compost filter. Usually it is a mesh tube filled with a recycled or composted material that is placed perpendicular to sheet flow runoff to collect stormwater in order to control erosion and retain sediment in disturbed areas. A compost filter sock is round (oval to circular) in cross-section. It provides a three-dimensional filter that retains sediment and other pollutants while allowing the cleaned water to flow through. A filter sock can be used in place of other traditional sediment and erosion control tools, like a silt fence.

Applications

Compost filter socks can be used on disturbed sites where stormwater runoff occurs as sheet flow.

Implementation

Compost filter socks are generally placed along the perimeter of a site, or at intervals along a slope, to capture and treat stormwater sheet flow. They can be laid adjacent to each other; perpendicular to stormwater flow; or stacked in a pyramid to reduce flow velocity and soil erosion. They can be used on pavement as inlet protection.

No trenching is required; therefore, soil is not disturbed upon installation. Once the filter sock is filled and put in place, it needs to be anchored to the slope. The preferred anchoring method is to drive stakes through the center of the sock at regular intervals. Alternatively, stakes can be placed on the downstream side of the sock. The ends of the filter sock should be directed upslope, to catch and prevent stormwater from running around the end of the sock. The filter sock may be vegetated by incorporating seed into the compost prior to placement in the filter sock. Since compost filter socks do not have to be trenched into the ground, they can be installed on frozen ground or even pavement.

Limitations

The drainage areas for filter sock use shall not exceed ¼ acre per 100 feet of device length. Flow shall not exceed 1 cfs. To ensure optimum performance for compost filter socks, heavy vegetation and extremely uneven surfaces should be cut down, removed, and/or leveled to ensure that the compost filter sock uniformly contacts the ground surface. Filter socks can be installed perpendicular to flow in areas where a large volume of stormwater runoff is likely, but should not be installed in perennial waterways and large streams.

Maintenance

Compost filter socks shall be inspected regularly, as well as after each rainfall event to ensure that they are intact; the area behind the sock has not filled with sediment; and that the ends have not by eroded by bypassing flow.

If there is excessive ponding behind the filter sock, an additional sock shall be added on top or in front of the existing filter sock. If accumulated sediments reach the top of the sock, a new sock should be added several feet in front of the existing filter so that it and the accumulated sediment can be removed. The sediment needs to either be reinstalled on the disturbed area or hauled off for proper disposal.

If the filter sock was overtopped during a storm event, the operator should consider installing an additional filter sock on top of the original; placing an additional filter sock further up the slope; or using an additional BMP, such as a compost blanket.

(Source: US Environmental Protection Agency)

8.27 BMP SC-8 Fiber Rolls/Wattles

See also the City of Bella Vista's 2010 BMP Manual Section 320

Description

Similar to compost filter socks, fiber rolls help reduce sediment loads to receiving waters by filtering runoff and capturing sediments.

Fiber rolls (also called fiber logs, waddles, or wattles) are tubular erosion control devices filled with hay, straw, flax, rice, coconut fiber material, or a recycled or composted material. Each roll is wrapped with either a UV-degradable polypropylene netting or a 100% biodegradable materials like burlap, jute, or coir. Fiber rolls help to slow, filter, and spread overland flows. This helps to prevent erosion and minimizes rill and gully development. Fiber rolls also help reduce sediment loads to receiving waters by filtering runoff and capturing sediments.

Applications

Fiber rolls can be used along the toe, top, face, and at-grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow. They can be used along the perimeter of a project, as check dams in unlined ditches, downslope of exposed soil areas, and around temporary stockpiles.

Photograph 7. Example of Fiber Roll/Wattle

Implementations

Fiber rolls should be prefabricated rolls or rolled tubes of Geo-textiles fabrics. If creating the tubes on-site, make sure each tube is at least 8 inches in diameter. Bind the rolls at each end and every 4 feet along the length of the roll with jute-type twine. Pre-fabricated tubes can be purchased in a variety of diameters to serve different drainage areas and slopes.

On slopes, install fiber rolls along the contour with a slight downward angle at the end of each row to prevent over-topping at the midsection. Turn the ends of each fiber roll upslope to prevent runoff from flowing around the roll. Fiber rolls should be installed in shallow trenches and stacked to the ground every 6 to 8 feet.

Limitations

Fiber rolls are not effective unless trenched.

If not properly staked and entrenched, fiber rolls can be transported by high flows.

Fiber rolls have a very limited sediment capture zone.

Fiber rolls can be difficult to move once saturated.

Maintenance

Inspect fiber rolls to ensure that they remain firmly anchored in place and are not crushed or damaged by equipment traffic. Monitor fiber rolls daily during prolonged rain events. Repair, reinforce, or replace rolls that have been split, torn, become unraveled, or are slumping.

(Source: US Environmental Protection Agency)

8.28 BMP SC-9 Gravel Bags

See also the City of Bella Vista's 2010 BMP Manual Sections 321 & 324

Description

A series of gravel-filled bags placed on a level contour to intercept sheet flows is called a gravel berm. This berm will pond sheet flow runoff which allows sediment to settle out. The berm will also release the stormwater runoff slowly to prevent erosion.

Applications

Gravel bag berms are suitable for sediment control when placed downslope of exposed soil areas; as sediment traps at pipe outlets; along the perimeter of a site; around temporary stockpiles; parallel to a roadway to keep sediment off paved areas; and along streams and channels.

Gravel bag berms are also suitable for erosion control at the top of slopes to divert runoff away from disturbed slopes; along the face and at grade breaks of exposed and erodible slopes to shorten length and spread runoff as sheet flow; and as check dams across mildly-sloped construction roads and small intermittent drainage channels.

Implementations

Gravel bag berms are to be placed on level contours. For slopes between 20:1 and 2:1 (horizontal-to-vertical), gravel bag berms should be placed at a maximum interval of 50 feet between the top and bottom. For slopes 2:1 (horizontal:vertical) or steeper, gravel bag berms should be placed at a maximum interval of 25 feet. The ends of the gravel bag barriers should be upslope from the berm's overflow to prevent runoff from going around the berm. Allow sufficient space upslope from the berm to allow

ponding, and/or to provide room for sediment storage. Use a pyramid approach when stacking bags. If stacking gravel bags to create the berm, a “spillway” location can be formed on the berm by removing 1 or 2 bags from the top row of the pyramid.

Limitations

Gravel bag berms may not be appropriate for drainage areas larger than 5 acres.

Runoff will pond upstream of the berm, possibly causing flooding if sufficient space is not provided.

Installation can be labor-intensive.

Maintenance

Gravel bag berms shall be inspected prior to forecasted rain; daily during extended rain events; after rain events; and every 2-weeks during the non-rainy season.

Gravel bags exposed to extended periods of sunlight will need to be replaced every 2 or 3 months due to the degrading of the bags.

Sediment shall be removed when the sediment accumulation reaches 1/3 the barrier height.

Remove gravel bag berms when no longer needed, but only after all the accumulated sediment has first been removed. If the berm is to remain as a permanent post-construction BMP, City approval will be required as well as a long-term maintenance plan established.

(Source: California Stormwater BMP Handbook, January 2003)

8.29 BMP SC-10 Vegetative Buffers

See also the City of Bella Vista’s 2010 BMP Manual Sections 101, 102, 103, 104, 201, 202, 302, 303 & 304

Description

Vegetative buffers are areas of natural or established vegetation to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff; provide an area where runoff can permeate the soil; contribute to ground water recharge; and filter sediment. Slowing runoff also helps to prevent soil erosion and stream bank collapse.

Applications

Vegetated buffers can be used in any area able to support vegetation. They are most effective and beneficial on floodplains; near wetlands; along stream banks; and on unstable slopes.

Implementations

Most vegetation will be removed from a construction site during clearing and grading operations. A perimeter buffer strip should be maintained around all disturbed areas for erosion control purposes and

shall be kept undisturbed except for reasonable access for maintenance. The width of this strip shall be 6% of the lot's width/depth on the side it is located on. The minimum width shall be 25 feet and the maximum shall be 40 feet. In no event shall these temporary buffer strips be less than the width of the permanent buffers required for the development.

Vegetative buffers shall be used along streams; creeks; rivers; lakes; and other water bodies. The stricter criteria should be used between:

- ADEQ Construction General Permit buffer requirements; and
- A minimum strip 25 feet wide, undisturbed except for reasonable access.

The strip shall be provided along each side of streams having a peak 10-year storm flow rate of over 150 cfs. The strip shall be measured from the top of bank. An exception to this requirement is allowed where the only work being done on the site is public street construction.

Limitations

Adequate land must be available for a vegetative buffer.

Maintenance

Inspect after every rainfall of ½-inch or greater and at least once every fourteen calendar days during construction and stabilization periods. Once stabilized, seasonal inspections and maintenance work should be all that is needed.

Once established, vegetated buffers preferably do not require maintenance beyond routine procedures and periodic inspections. Inspections should focus on encroachment; gully erosion; the density of the vegetation; evidence of concentrated flows through the areas; and any damage from foot or vehicular traffic. If over6 inches of sediment has accumulated, remove it.

(Source: US Environmental Protection Agency)

8.30 BMP SC-11 Sediment Filters and Sediment Chambers

See also the City of Bella Vista's 2010 BMP Manual Sections 101, 102, 202, 301, 302, 303, 304, 310, 321, 322, 323, 324, 350, 351, 401, 402, 410 & 440

Description

Sediment filters are sediment-trapping devices typically used to remove pollutants and other particulates from stormwater runoff. Sediment filters have four components: (1) inflow regulation, (2) pretreatment, (3) filter bed, and (4) outflow mechanism. Sediment chambers are one component of a sediment filter system.

Inflow regulation is diverting stormwater runoff into the sediment-trapping device. After runoff enters the filter system, it enters a pretreatment chamber. This chamber is used for removing large debris, floatables, and heavy sediments. It is usually no more than a wet detention basin. As ponding water reaches a pre-determined level, it flows over a weir into a bed of a filter medium. The medium is typically sand, but it can consist of sand; soil; gravel; peat; compost; or a combination. The filter bed removes small sediments and other pollutants from the stormwater as it percolates through the filter medium. Finally, treated flow exits the sediment filter system via an outflow mechanism which returns it to the stormwater conveyance system.

Sediment filter systems can be confined or unconfined, on-line or off-line, and aboveground or belowground. Confined sediment filters are constructed with the filter medium contained in a structure, often a concrete vault. Unconfined sediment filters are made without a confining structure. For example, sand might be placed on the banks of a permanent wet pond detention system to create an unconfined filter. On-line systems retain stormwater in its original stream channel or storm drain system. Off-line systems divert stormwater.

Applications

Sediment filters might be a good alternative for small construction sites where a wet pond is being considered as a sediment-trapping device. They are widely applicable, and they can be used in urban areas with large amounts of highly impervious area. Confined sand filters are man-made systems, so they can be applied to most development sites and have few constraining factors. However, for all sediment filter systems, the drainage area to be serviced shall be no more than 10 acres.

The available space is important to the design of sediment filters. Another important consideration is the amount of available head. Head is the vertical distance available between the inflow of the system and the outflow point. Because most filtering systems depend on gravity to move water through the system, if enough head is not available, the system will not be effective.

Limitations

For sediment filter systems, the drainage area to be serviced shall be less than ten 10 acres.

Sediment filters are usually limited to removing pollutants from stormwater runoff. To provide flood protection, they have to be used with other stormwater management practices.

Sediment filters are likely to lose effectiveness in cold regions because of freezing conditions.

(Source: US Environmental Protection Agency)

8.31 BMP RC-1 Check Dams

See also the City of Bella Vista's 2010 BMP Manual Sections 321, 322, 323 & 324

Description

Excessive velocity of water in swales or channels causes erosion and transports the eroded sediment downstream to local streams.

Check Dams (ditch check) slow water in channels and provide an area for sediment to settle out of the water before it flows over the dam.

Applications

Any unlined channel or any channel where vegetative protection has not developed. Steeper banks (side slopes) are more subject to erosion than flatter slopes.

Design Criteria

Place ditch checks so that the top of the downstream check is at the same elevation as the bottom of the next upstream check.

Checks must be constructed such that the top elevation of the center of the dam's overflow is at least 6 inches below the bottom elevation of both ends of the check. The dam must be excavated into the channel no less than 6 inches as shown in the following figures.

Limitations

If improperly constructed, water will flow around or through the check dam. This will erode the banks or bottom of the channel. Large flows (less frequent storms) can washout the check dams; erode the banks at the end of the check dams; or cause excessive scour at the outfall of the check dam.

Maintenance Requirements

Sediment that collects behind a check dam shall be removed before the sediment reaches 50% of the depth of the dam at the spillway. Check dams shall be inspected weekly and after every ½-inch or greater rainfall for repairs; erosion; and excessive sediment buildup. Any defects shall be repaired or replaced within 48 hours of being found.

Check dams constructed in permanent swales shall be removed when perennial grasses have become established, or immediately prior to the installation of a permanent, non-erodible lining. All of the rock and any accumulated sediment shall be removed. The area shall be dressed to match surrounding grades, then seeded and mulched, or otherwise stabilized.

Photograph 8. Example of a Rock Check Dam

Figure CS-13: Sandbag Check Dam Detail (Source: AHTD, 2001)

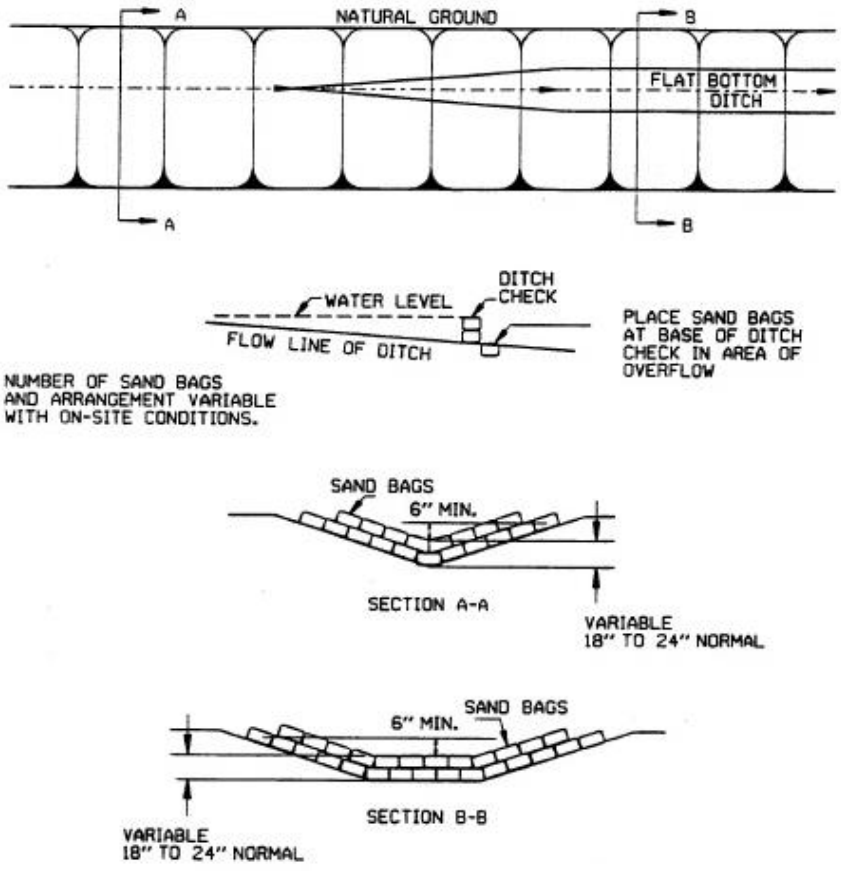
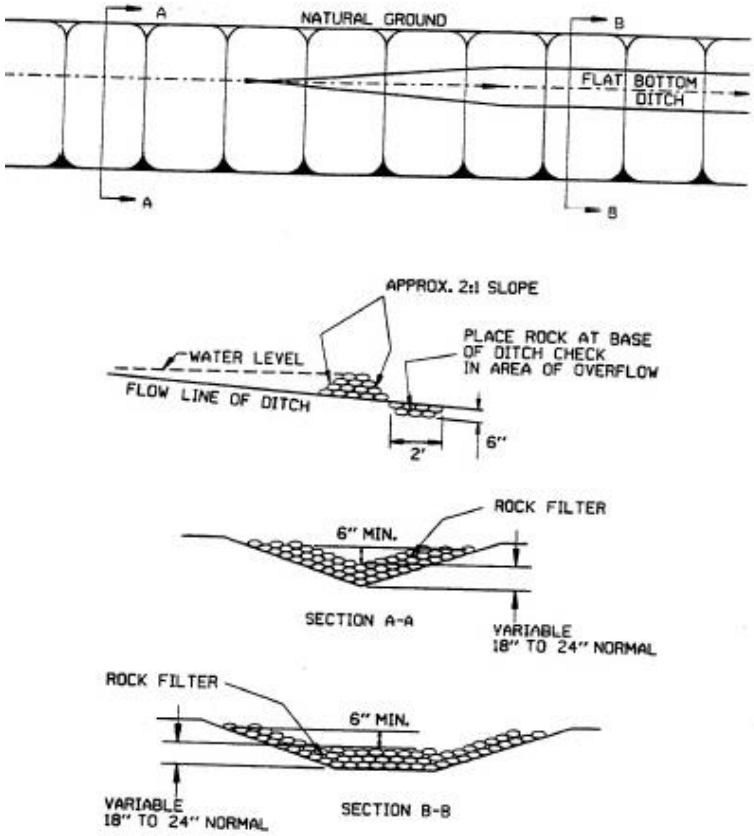


Figure CS-14: Rock Check Dam Detail (Source: AHTD, 2001)



8.32 BMP RC-2 Triangular Silt Dike

See also the City of Bella Vista's 2010 BMP Manual Section 322

Description

A triangular silt dike is a triangular-shaped foam block or perforated plastic form covered with geo-textile fabric. When laid in a channel and placed perpendicular to the flow of water, it provides an area for sediment to settle out of the water.

A triangular silt dike is a reusable alternative to rock check dams. It can be shaped to conform to curves and rough terrain.

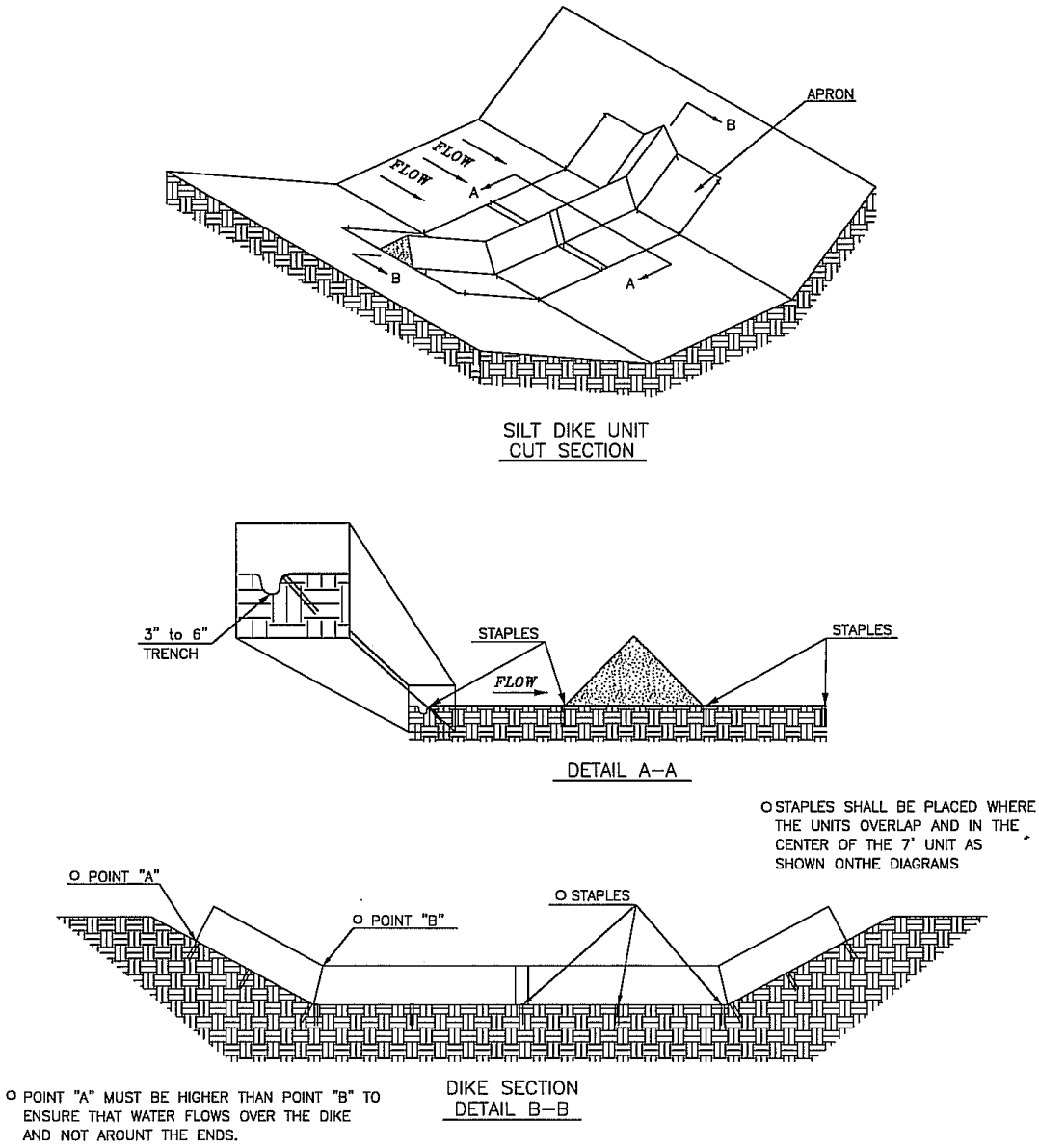
Applications

Any channel where vegetative protection has not developed. Steeper slopes are more subject to erosion than flatter slopes.

Triangular silt dikes can also be used as diversion dikes and as inlet protection.

In certain conditions, the dikes can also be used on paved surfaces if the manufacturer allows.

Figure CS-15: Triangular Silt Dike Detail (Source: ACF Environmental)



Design Criteria

Place ditch checks such that the top of the downstream check is at the same elevation as the bottom of the next upstream check.

A protective apron shall be installed on both sides of the dike to prevent erosion and failure. The dike should be secured using U-shaped wire staples or other manufacturer-approved fastener.

A trench shall be excavated that is approximately 3- to 6-inches deep on the upslope side of the dike, unless the manufacturer's specifications state otherwise. The trench shall then be backfilled and the soil compacted over the textile.

Limitations

If improperly constructed, water will flow around the triangular silt dike and erode the banks of the channel. Large flows (less frequent storms) can washout the triangular silt dike; erode the banks at the end of the check dams; or cause excessive scour at the outfall of the check dam.

Maintenance Requirements

Triangular silt dikes shall be inspected weekly and after every ½-inch or greater rainfalls for holes; repairs; erosion; and excessive sediment buildup. Any damage shall be repaired within 48 hours of being found. Sediment must be removed when it reaches 6 inches of depth on the dike, or as the manufacturer specifies. If the geo-textile has deteriorated, the entire device shall be replaced.

Triangular silt dikes constructed in permanent swales shall be removed when perennial grasses have become established or immediately prior to installation of a non-erodible lining. All of the accumulated sediment shall be removed prior to the dike's removal. The area shall be dressed to match surrounding grades, then seeded and mulched, or otherwise stabilized.

8.33 BMP RC-3 Grass-Lined Channels

See also the City of Bella Vista's 2010 BMP Manual Sections 301, 302, 303 & 304

Description

A grass-lined or sod-lined channel conveys stormwater runoff through a stable conduit. Vegetation lining the channel reduces the velocity of concentrated runoff and provides water quality benefits through filtration and infiltration. Because grassed channels are not usually designed to control peak runoff loads by themselves, they are often used with other BMPs. Examples include subsurface drains, riprap, and other permeable liners that can be placed under or over grass and/or sod.

Where moderately steep slopes require drainage, grassed channels can include excavated depressions or check dams to enhance runoff storage; decrease flow rates; improve pollutant removal; and control where drainage channels are located. Peak discharges can be reduced by temporarily holding them in the channel. Pollutants can be removed from stormwater by filtration through vegetation; by deposition; or by infiltration of soluble nutrients into the soil. The degree of pollutant removal in a channel depends on how long the water stays in the channel and the amount of contact between vegetation and the soil surface. Local soil conditions can affect the removal efficiency of this BMP.

Applications

The first choice of lining should be grass or sod because this reduces runoff velocity while providing water quality benefits through filtration and infiltration. If the velocity in the channel can erode the grass or sod, additional stabilizing BMPS should be used. Geo-textile materials can be used in conjunction with either

grass or riprap linings to provide additional protection at the soil-lining interface.

Grassed channels should be used where erosion-resistant conveyances are needed, but should be limited to areas without highly erodible soils and on moderately steep slopes (though less than 5%). Install them only where space is available for a relatively large cross section.

Grassed channels have a limited ability to control runoff from large storms, so do not use them in areas where flow rates exceed 5 fps.

Implementations

Locate grass-lined channels so that they coordinate with the site's natural drainage system. The channel should not receive direct sedimentation from disturbed areas. It should be sited only on the perimeter of a construction site to convey relatively clean stormwater runoff. To reduce sediment loads, separate the channel from all disturbed areas by using a vegetated buffer or other BMP.

Consider using Geo-textiles to stabilize vegetation until it is fully established. Consider covering the bare soil with sod; mulches with netting; or geo-textiles to provide reinforced stormwater conveyance immediately.

Use triangular channels with low velocities and small quantities of runoff; use parabolic grass channels for larger flows. Where space is available; use trapezoidal channels with large, low-velocity flows (low slope).

Install outlet stabilization structures if the runoff volume or velocity might exceed the capacity of the receiving area.

Limitations

If grassed channels are not properly installed, they can change the natural flow of surface water and adversely affect downstream waters. And if the design capacity is exceeded by a large storm event, the vegetation might not be adequate to prevent erosion and the channel might be destroyed. The effectiveness of grass-lined channels clogged with sediment and debris reduces stormwater conveyance.

Grassed channels have a limited ability to control runoff from large storms, so do not use them in areas where flow rates exceed 5 feet per second.

Maintenance

The maintenance requirements for grass channels are relatively minimal. While vegetation is being established, inspect the channels after every rainfall. After vegetation is established, mow it; remove litter; and perform spot vegetation repair. The most important objective in grassed channel maintenance is to maintain a dense and vigorous growth of turf.

The grass needs to be maintained at a height that is not too short to encourage root growth but not so tall that it becomes on eyesore or health hazard. Preferable height should fall between 3" and 8" so depressions can be found.

Periodically clean the vegetation and soil buildup in curb cuts so that water flow into the channel is unobstructed.

During the growing season, cut the channel grass no shorter than the level of the design flow.

(Source: US Environmental Protection Agency)

8.34 BMP RC-4 Interceptor and Diversion Dikes and Swales

See also the City of Bella Vista's 2010 BMP Manual Sections 301, 302, 303 & 304

Description

Water running onto the site will increase erosion and can be a nuisance to construction activities. Additionally, runoff from the construction site can have excessive amounts of sediment that can end up in local streams.

Interceptor and Diversion Swales and Dikes are diversion systems used to divert upstream run-on around a site or to direct runoff from a site to a pond in order to settle out sediment prior to discharge from the site.

Applicability

Any area that that is subject to runoff from uphill drainage areas.

Design Criteria

There are two types of temporary slope diversion dikes:

1. A diversion dike located at the top of a slope to divert upland run-on before it reaches the disturbed area. This runoff may be directed by dikes to a permanent channel or temporary diversion channel.
2. A diversion dike located at the base or mid-slope of a disturbed area to divert sediment-laden water to a sediment basin. The discharge intercepted by these diversion dikes may be directed to a temporary slope drain and/or sediment basin.

Temporary diversion dikes **shall** be provided whenever:

S^2L > 2.5 for **undisturbed** tributary areas:

S^2L > 1.0 for **disturbed** tributary areas:

S^2L > 0.25 for **impervious** tributary areas:

where: S = slope of the upstream tributary area (in feet/foot); and,

L = length of the upstream slope (in feet).

and

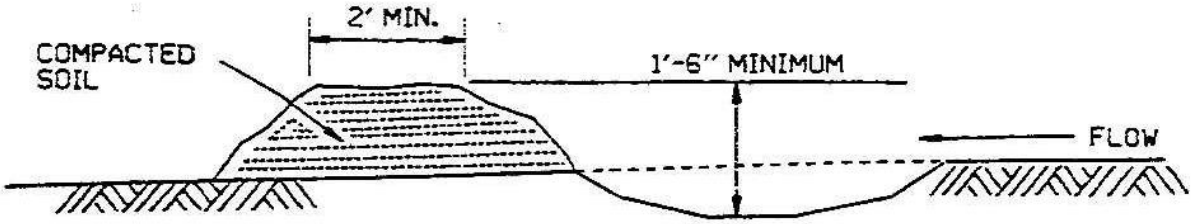
Undisturbed Tributary Area = area tributary to the temporary diversion dike that is, and will remain, in a natural condition undisturbed by development activities.

Disturbed Tributary Area = area tributary to the temporary diversion dike that will be disturbed by development activities, including removal of native vegetation and/or compaction of native soils.

Impervious Tributary Area = area tributary to the temporary diversion dike that is largely comprised of impervious surfaces, such as buildings and pavement.

The interceptor swale (channel) or dike should be situated to capture run-on from upstream of the work area with a vegetative buffer uphill of the swale to remove sediment before it enters the swale. The stabilized swale and ditch should be in-place prior to all other earth work on the project. The channel shall be designed to handle the 10-year storm, with the bottom and sides protected for the anticipated water velocity. Typically, the ditch will be 2 feet wide at the bottom and 6 feet wide at the top. Maximum water velocity in the swale shall not exceed 4 fps. Side slopes shall be no steeper than 3:1 (horizontal:vertical). Energy dissipation shall be provided at the exit from the swale as needed.

Figure CS-16: Swale configuration detail (Source: AHTD, 2001)



Limitations

Interceptor swales and diverter ditches below disturbed areas need to meet the same design criteria as those above it, but should also address erosion and sedimentation in the swale. These should either discharge to a sediment trap, basin, or other device to remove sediment and other pollution before leaving the site.

Excessive flow rates can cause scour in the swale; therefore requiring a sediment control pond at the end of the swale.

In the event that the dike over flows during larger storm events, the site can be damaged and excessive erosion and sediment transport can occur.

Maintenance Requirements

The swale shall be cleared of debris and excessive vegetation as required.

8.35 BMP RC-5 Rough-Cut Street Control

Description

These controls include dirt berms; sandbag dikes; or gravel-filled geo-textiles socks used to prevent rill; channel; and gully erosion in rough-cut street areas.

Rough cut street controls are barriers that are constructed at intervals down an unpaved or future road. These barriers are installed perpendicular to the longitudinal slope from the outer edge of the roadside swale to the crown of the road. The barriers are positioned alternately from the right and left side of the road to allow construction traffic to pass in the lane not barred. Refer to the rough-cut street control detail that follows.

Applicability

Rough-cut street controls shall be considered for roadways that are not paved; are expected to remain that way for 30 days; has only partially reach final grading; and/or have not received an application of road base or other suitable, approved subbase materials.

Maintenance

Rough-cut street controls shall be inspected immediately following the initial installation; once a week while the site is under active construction; and immediately following every storm event.

Accumulated sediment shall be removed when the sediment depth is a 25% of the height of the control.

Street controls shall be repaired immediately following any sign of wear or alteration of the original shape and dimensions.

Controls shall be kept in place and maintained until subgrade preparation begins for final paving. This may require multiple removals and reinstallations as the layers of the final pavement section are created.

8.36 BMP RC-6 Water Bars

Description

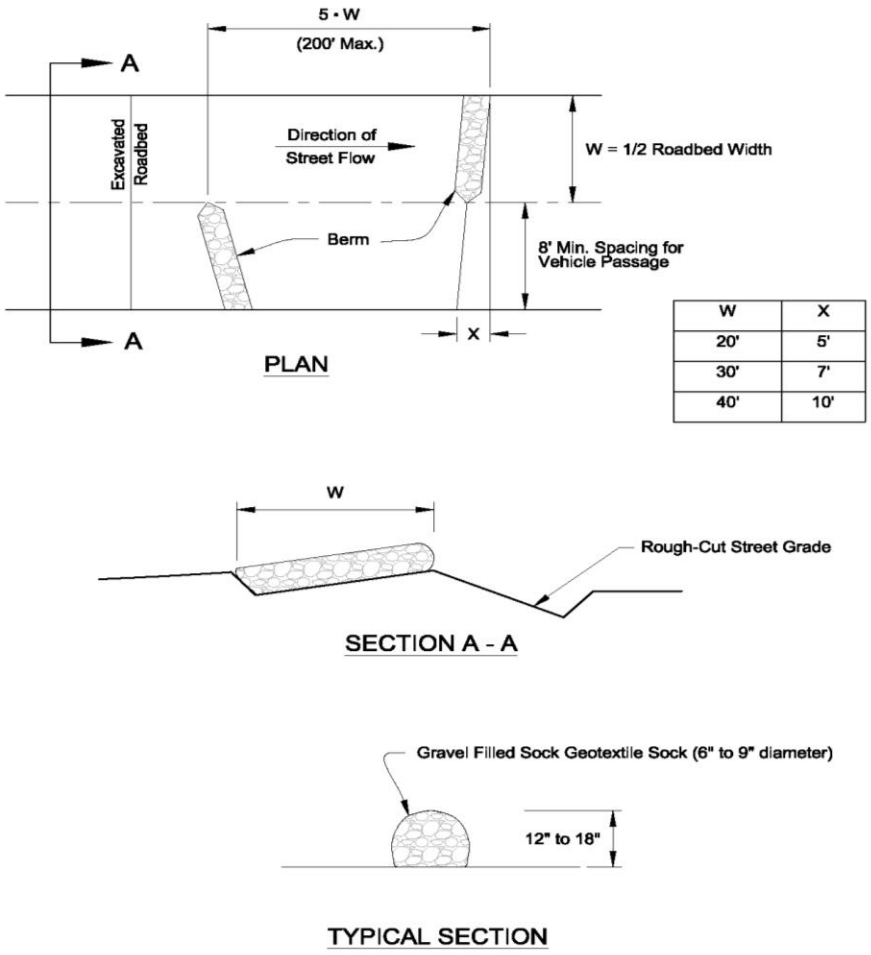
A water bar is a ridge of compacted soil, loose rock, or gravel constructed diagonally across disturbed rights-of-way and similar sloping areas. The height and side slopes of the water bar are designed to divert water while allowing vehicles to cross. Water bars are used to shorten the flow length within a long sloping right-of-way by reducing the erosion potential by diverting storm runoff to a stabilized outlet or sediment trapping device.

Applications

Water bars can be used in areas where earthen diversions are applicable and where there will be little or no construction traffic within the right-of-way. Gravel or rock structures are more applicable to roads and

rights-of way which accommodate vehicular traffic.

Figure CS-17: Rough-Cut Street Control (Source: Orange County, California)



W	X
20'	5'
30'	7'
40'	10'

Implementations

Construction of utility lines and roads often requires the clearing of long strips of easements or rights-of-way over sloping terrain. The volume and velocity of stormwater runoff tends to increase in these cleared strips which results in increased potentials for erosion since the vegetative cover is greatly diminished or removed. To compensate for the loss of vegetation, it is usually a good practice to reduce the flow length within the cleared strip so that runoff does not have an opportunity to concentrate and cause erosion. At proper spacing intervals, water bars can significantly lessen the amount of erosion which will occur until the area is permanently stabilized.

Limitations

Water bars should not be used for drainage areas less than 1 acre, but must be close enough to dissipate water flow energy.

Water bars can be used where there will be little or no construction traffic within the easement or right-of-

way. Gravel structures are more applicable to roads, rights-of way, and other areas which accommodate vehicular traffic.

Maintenance

Water bars shall be inspected after every rainfall and repairs made if necessary. Approximately once every week, whether a storm has occurred or not, the device should be inspected and repairs made if needed. Materials that are subjected to damage by vehicular traffic shall be reshaped at the end of each working day.

(Source: NRCS Planning and Design Manual)

Figure CS-18: Water Bar installation (Source: Minnesota – DNR 1998)