



# Clear Creek County Best Management Practices Manual

## **BMP Manual Table of Contents**

Topic	Page
Revegetation .....	2-4
Mulching .....	5
Slope Netting/Erosion Control Blankets.....	6
Tree Protection .....	7
Surface Roughening .....	8
Berms and Ditches .....	9-10
Sediment Barriers .....	11-14
Driveway and Parking Area Stabilization .....	15-16
Infiltration Systems .....	17-19
Slope Stabilization .....	20-21
Inlet and Outlet Protection.....	22
Snow Removal .....	23
Sanding Procedures.....	24
Sediment Basins.....	25
Construction Fence .....	26-27
Paving .....	28
Appendix	
Managing Stormwater Around the House .....	29-30
Water Resources and Mountain Roads .....	30-31
Stormwater Management on Commercial Areas...	32-33

## **BMP: REVEGETATION**

**1. METHODS:** The primary purpose of revegetation is erosion control. Grass provides the best protection for the first few years. Grasses germinate and grow quickly and provide a fast and complete ground cover. Trees and shrubs are effective for long-term erosion control, but grasses are needed for initial soil protection until the slower growing trees and shrubs become well established. Decorative landscaping with trees and shrubs can be done later.

The harshness of the mountain climate, geologic conditions, and the steepness of the terrain make it difficult for plants to become established. The steeper the slope, the more difficult it is. You will have the greatest chance of success with revegetation if you keep the area and angle of disturbed slopes to a minimum.

Before you can revegetate an area, you must first roughen or loosen the soil surface so that seeds can get a foothold in it. Use a dirt rake or tiller. Broadcast the seed by hand or with a "belly grinder." Rake the soil after seeding to cover the seeds with ¼" - ½" of soil. The Site Development Inspector may require the addition of topsoil to sites having or which generate extremely rocky soils as a good seedbed is crucial to successful revegetation. Slope degree may require hydroseed/hydromulch as per the County's adopted revegetation policy below. Revegetation efforts shall provide for at least 70 percent coverage of the disturbed areas. The Site Development Inspector shall inspect the site periodically for two (2) years from the date revegetation work is completed to ensure compliance. If 70 percent coverage is not obtained, the property owner may be required to provide for additional revegetation.

The time of planting depends on whether or not you irrigate. If you choose to irrigate, you must continue irrigating until the grass is well established.

- If you do not irrigate:
  - (a) Plant seeds as late as possible in the fall but before the ground is frozen and before snowfall. October and November are generally good months to seed. Seeds planted too early in the fall may germinate with fall rains and the young seedlings can then be killed by frost.
  - Or,
  - (b) Plant seeds in April or May as soon as possible after snowmelt.
- If you are legally allowed to irrigate:
  - Plant seeds as soon as possible after grading is completed and the area can be closed to vehicle traffic. During the germination period

(at least the first 2 weeks), irrigate often enough to keep the seedbed moist. You may have to water more than once per day. Water with fine spray to avoid washing away seeds and soil. Water only long enough to moisten the first 2" of soil. You can discontinue irrigating when the grass is about 6" tall.

**2. MATERIALS:** The following grass seed mixtures are suggested for the three major habitats encountered in higher elevations of Colorado.

- Roadside Mix – Drought tolerant grasses for roadside stabilization consisting of tall and low growing bunchgrasses for rapid establishment and long term persistence.

<b><u>SEED</u></b>	<b><u>VARIETY</u></b>	<b><u>(LB per ¼ Acre)</u></b>
Slender wheat grass	San Luis, Revenue	2¼
Mountain Brome	Broman	2¼
Orchard grass	Paiute, Potomac	1
Hard Fescue	Durar	1
Sheep Fescue	Covar	1
		7½

- Landscape Mix – Low growing grasses comprised of bunchgrasses and sod formers giving a varied texture for transitional areas adjacent to buildings.

<b><u>SEED</u></b>	<b><u>VARIETY</u></b>	<b><u>(LB per ¼ Acre)</u></b>
Chewing Fescue	Shadow	2¼
Red Fescue	Pennlawn	2¼
Hard Fescue	Durar	1½
Sheep Fescue	Covar	1½
		7½

- Meadow Mix – For wetter sites adjacent to streams and in meadow areas where there is a high water table.

<b><u>SEED</u></b>	<b><u>VARIETY</u></b>	<b><u>(LB per ¼ Acre)</u></b>
Meadow Foxtail		¾
Smooth Brome	Manchar	1½
Tufted Hairgrass		½
Red Fescue	Pennlawn	¾
Timothy		½
Kentucky Bluegrass	Park	1
		5

**3. MAINTENANCE TIPS:** Fertilizing: Apply 5 lbs./1000 sq. ft. of 16-20-0 fertilizer with 15% sulfur (ammonium phosphate sulfate) at the

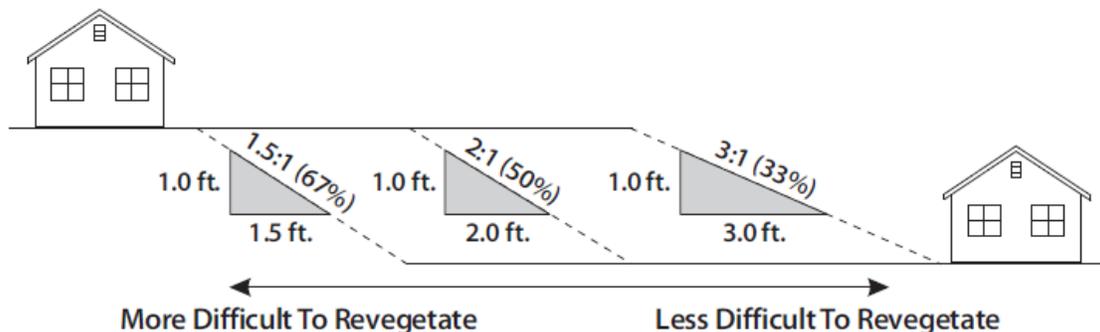
time of seeding. Reapply once per year in the spring until the soil is well protected with grass. Do not over fertilize. Excess fertilizer will wash away and can pollute downstream water resources.

**4. TEMPORARY OR PERMANENT USE:** Revegetation can be a temporary or permanent BMP.

***Clear Creek County's Re-vegetation requirement is: 1) Slopes constructed at >3:1 (horizontal to vertical) can be hand seeded and mulched. 2) Slopes constructed at 3:1 to 2:1 to must be hydroseeded/hydromulched. 3) Slopes constructed at 2:1 to 1½:1 must be hydroseeded/hydromulched and have slope netting/erosion control blankets installed (or equivalent erosion control measure with the approval of the Site Development Inspector). Slopes steeper than 1½:1 are not permitted or require retaining walls.***

***Permanent soil stabilization measures shall be installed within thirty days after final grade is reached. If construction is completed during winter months, planting should occur within the next window of opportunity. Silt fence or brush barrier to be installed on downhill side of excavation.***

#### ***Determining Steepness of Grade***



## **BMP: MULCHING**

**1. METHODS:** Mulch is essential for revegetation success. Mulch protects bare soil from erosion until new vegetation grows large enough to do the job. It also holds seed and fertilizer in place, keeps soil moist and shades seedlings, helping them to become established.

Straw is the best mulch material. Apply 1 bale of straw per 1,000 sq. ft. Distribute the straw evenly so that it forms a layer 1" to 2" thick. Soil should still be visible through the straw mat. If you apply too much mulch, it may produce a mat too dense for seedlings to penetrate.

Anchor the straw by punching it into the soil every 1' to 2' with a dull, round-nosed shovel (to avoid cutting the straw) or by covering it with netting (jute, plastic mesh, woven paper, or chicken wire). Fasten the netting to the ground with wire staples. Because the soils in many areas are quite hard, you may have to use netting to anchor the straw.

Wood fibers, wood chips, and pine needles are other usable mulch materials. Wood fiber mulch is applied hydraulically in a slurry that also contains the seed and fertilizer. It is suitable for use on steep slopes or large areas and must be applied by a contractor. (The application rate for wood fiber mulch is 3,000 lbs/acre.) Wood chips and pine needles can protect the soil from erosion, but they also inhibit plant growth. They can only be used where a grass cover is not desired. Apply wood chips so that the soil is completely covered. Apply pine needles in a layer 2" to 3" thick. You can save the pine needles from graded areas on your property to use as a mulch later, but you will probably have to supplement them with wood chips to achieve an adequate ground cover.

**2. MATERIALS:**

- Straw, wood fibers, wood chips, or pine needles.

**3. MAINTENANCE TIPS:**

- Replace as required.

**4. TEMPORARY OR PERMANENT USE:** Mulching is a temporary BMP.

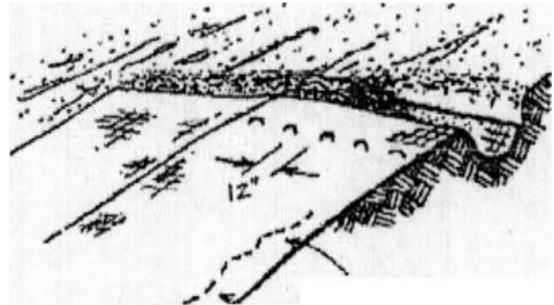
## **BMP: SLOPE NETTING/EROSION CONTROL BLANKETS**

**1. METHODS:** Netting or erosion control blankets are often used to hold mulch in place on steeper slopes. Netting can be used by itself to protect seeds and soils from washing away during watering or rain storms. The following installation procedures should be used.

- A. Starting above the mulched area, bury top end of strip of netting material in a trench at least 4" deep.
- B. Fill trench with soil and tamp firmly. Fasten with a row of staples 12" apart.
- C. Overlap lower end of uphill strip over next strip at least 12" and secure with staples 12" apart.
- D. Continue adding strips of material until entire mulched area is covered. Overlap sides of strip at least 4" and staple as shown.

**2. MATERIALS:**

- Jute, excelsior, fiberglass, or plastic netting. (Do not use plastic sheeting or filter fabric.)
- Wire staples, no.11 gauge or heavier, 6" to 10" long. (Use longer staples on loose soils.)



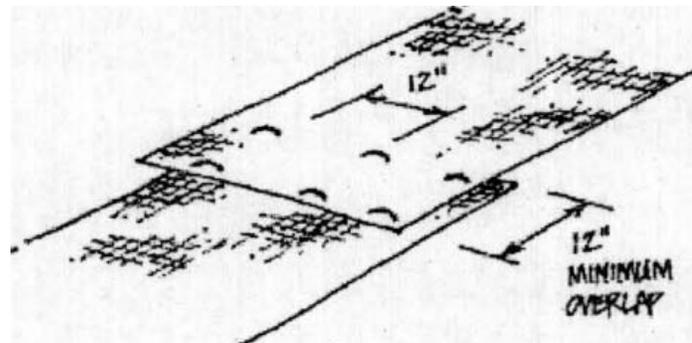
*Outermost edge of mulched area*

**3. MAINTENANCE TIPS:**

- Inspect and repair as needed.

**4. TEMPORARY OR PERMANENT USE:**

- Slope netting is a temporary BMP. Remove non-biodegradable netting and staples when vegetation is stabilized.



## BMP: TREE PROTECTION

**1. METHODS:** Trees and other native vegetation must be protected against construction damage. Protect vegetation by following these guidelines:

- A. Do not nail boards, filter fabric, or anything else to trees.
- B. Grading, paving, or placing fill within a tree's drip line are not allowed except when all of the following are met:
  - encroachment is only on one side of tree;  
encroachment is no closer than 5' from the trunk or no more than  $\frac{1}{2}$  the distance between the drip line and the trunk;
  - a drainage system that allows air and water to circulate through the root zone is placed under all fills over 1' deep within the drip line; and
  - care is taken not to cut tree roots unnecessarily or to compact the soil around them.
- C. Remove low tree limbs that are likely to be broken by construction activities. Cut the limb flush to the trunk or main branch. Paint cut or damaged limbs, trunks or roots with a good grade of tree paint.
- D. When planting new vegetation, water frequently and protect from adverse weather conditions.

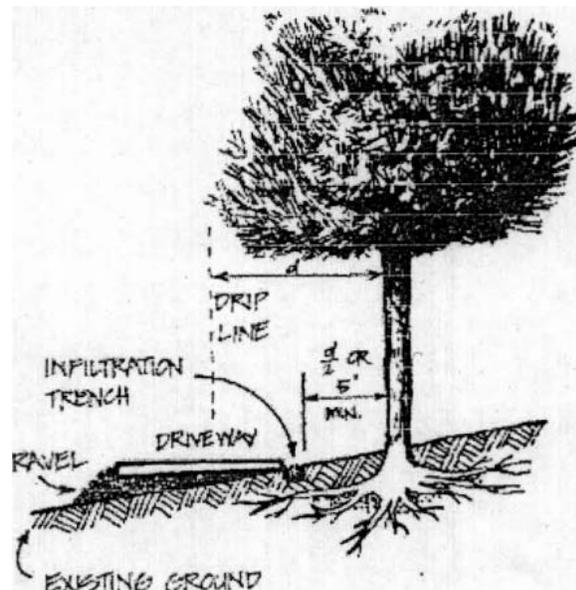
**2. MATERIALS:**

None required but materials such as plastic construction fence or silt fence could be used to delineate the area of non-disturbance.

**3. MAINTENANCE TIPS:**

Water as required and wrap if necessary.

- 4. TEMPORARY OR PERMANENT USE:** Tree protection can be a temporary or permanent BMP.



## BMP: SURFACE ROUGHENING

**1. METHODS:** Surface roughening involves roughening previously disturbed soils. Surface roughening is used to reduce the speed of runoff, increase infiltration, reduce erosion, trap sediment and prepare the soil for seeding by capturing moisture for the seed. The soil surface is considered roughened if depressions are created 2 to 4 inches deep and spaced approximately 4 to 6 inches apart. Revegetation is required within 30 days of surface roughening or the next window of opportunity.

**2. MATERIALS:**

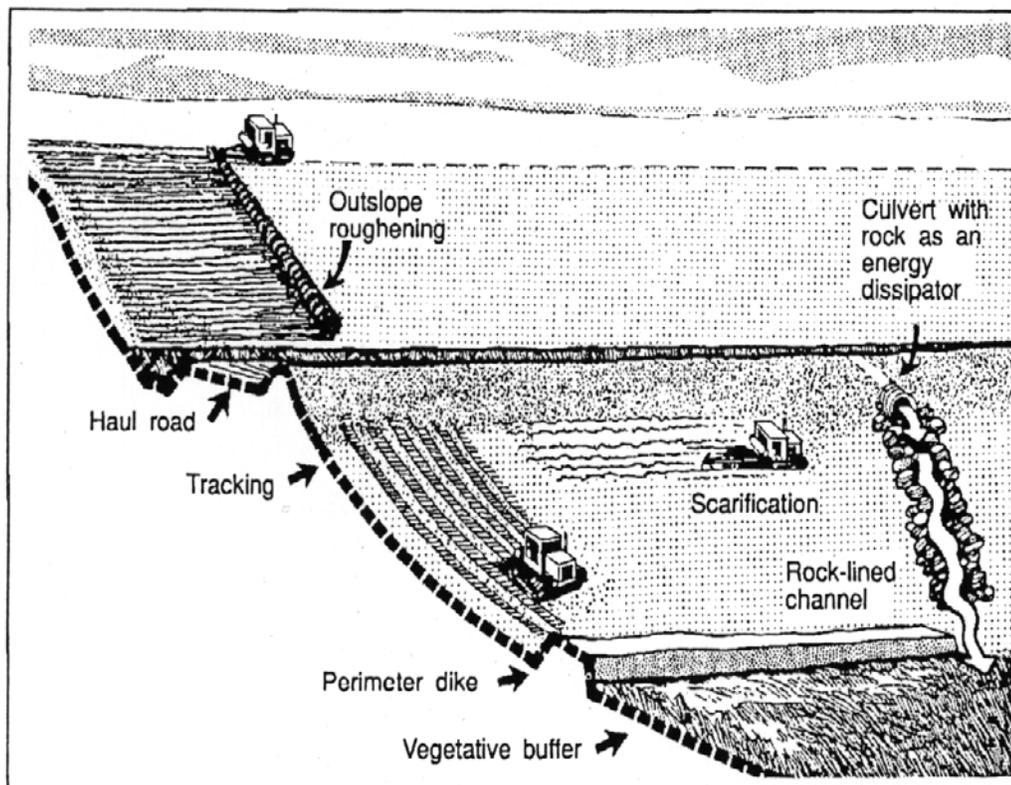
- Dozer, tracked machine or tiller.
- Seed, mulch and/or erosion control blankets.

**3. MAINTENANCE TIPS:**

- Do not drive over areas that have been treated.
- Revegetation must occur within 30 days or next window of opportunity.

**4. TEMPORARY OR PERMANENT USE:**

- Surface roughening is a temporary BMP until revegetation occurs.



## BMP: BERMS AND DITCHES

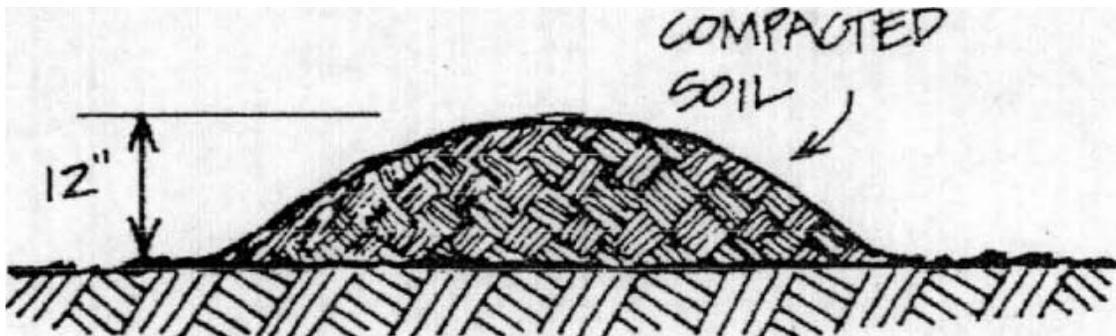
**1. METHODS:** A berm is a ridge of compacted soil. A ditch is a small drainageway. Both of these structures have similar purposes. Berms and ditches should be used:

- Above disturbed slopes
- Around graded areas (to keep clean runoff out and to contain sediment-laden runoff within)
- Along slope benches
- Above leach fields when required.

The most common use of berms and ditches is to divert upland runoff away from exposed soil to a protected outlet (such as an infiltration trench, storm drain, or stable channel). When a berm or ditch is used to contain runoff from a disturbed area, you must route the sediment-laden water to a sediment trapping device (see section on sediment basins).

The following method should be used to construct a berm:

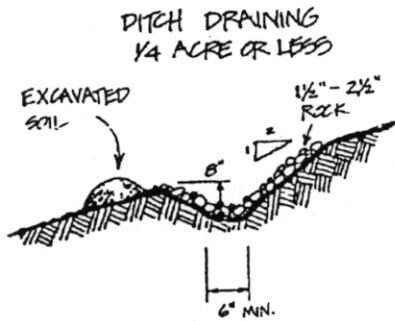
- A. Deposit a ridge of soil about 18" high with a shovel or backhoe.
- B. Compact the soil by rolling or tamping until it has the dimensions shown.
- C. Vegetate permanent berms with installation of an erosion control blanket.



The following method should be used to construct a ditch:

- A. If the drainage area to the ditch is  $\frac{1}{4}$  acre or less, dig the channel 8" deep. If the drainage area is  $\frac{1}{4}$  to 2 acres, dig the channel 12" deep. Deposit the excavated soil where it will not wash into a drainage way (such as on the downhill side of the ditch).

B. Compact the channel by tamping or rolling.



C. Line temporary ditches with rock, filter fabric, plastic sheeting or jute netting. Do not construct a temporary ditch at a slope exceeding 15%.

D. Line permanent ditches with rock, asphalt or concrete. Install a rock lining as shown here. Do not install a rock lining on a ditch steeper than 15% slope.

E. Install an outlet protector or infiltration system at the end of the ditch.

**2. MATERIALS:**

- Use rock, filter fabric, plastic sheeting or jute netting for temporary ditches.
- Use rock, asphalt or concrete for permanent ditches.

**3. MAINTENANCE TIPS:**

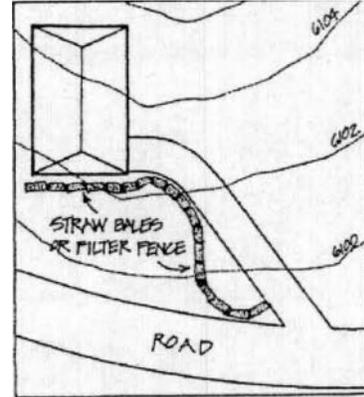
- Clean out upstream side of berms after snowmelt or storm event.
- Inspect dikes and ditches after each storm.
- Re-compact any loose soil on berms and ditches periodically.
- Fill gaps and low spots (such as tire tracks across a dike).
- If an unlined channel is eroding, line it with a suitable material.
- Repair damaged linings immediately.

**4. TEMPORARY OR PERMANENT USE:** Berms and ditches can be temporary or permanent BMPs.

## BMP: SEDIMENT BARRIERS

**1. METHODS:** Sediment barriers are temporary structures that slow runoff and trap small amounts of sediment. Sediment barriers can be built with:

- Straw bales
- Silt fence or filter fabric attached to a wire fence or to straw bales
- Erosion Control Log/wattle
- Native Erosion Control Log, or
- Sandbags

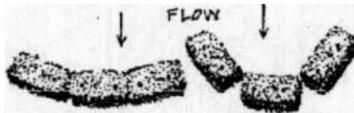


Sediment barriers should be used:

- Below small disturbed areas;
- At the base of exposed slopes;
- Along streets, curbs, and property lines (below disturbed areas).

The following method should be used to install straw bales:

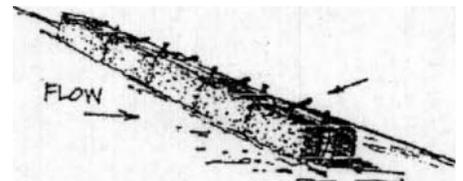
- A. Dig a 6-inch deep by 2-foot wide trench. Align trench along contour but curved slightly uphill so runoff cannot escape around the end bales.
- B. Place bales in trench with ends tightly abutted.



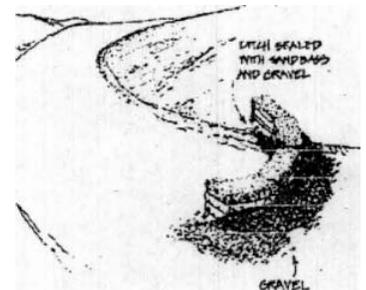
*InCorrect*

- C. Anchor each bale with 2 re-bars or wood stakes hammered 1½ to 2 feet into the ground. Angle first stake in each bale toward the previously laid bale.

- D. Wedge loose straw between bales. Backfill and compact the excavated soil against the uphill side of the barrier.



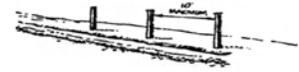
- E. When installing bales on pavement, you can pile gravel or rock behind the bales to hold them in place.



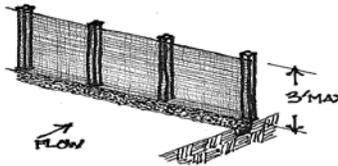
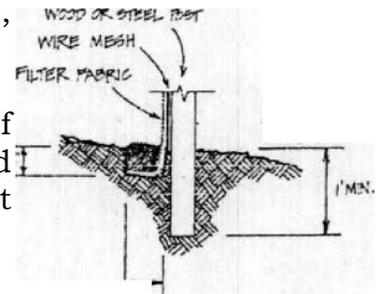
**SILT FENCE:** Silt fence is required when excavation occurs next to any watercourse and must be installed prior to any earthwork.

The following method should be used to install silt fence or filter fence:

A. Space posts no more than 10' apart and drive them at least 1' into the ground, align the fence along the slope of the contour, curving it slightly uphill to avoid end runs.



B. The fabric should not extend more than 3' above the ground. Cut filter fabric from a continuous roll to avoid having joints. Where joints are necessary, splice the fabric only at a post, with at least a 6" overlap, and fasten both ends securely to the post.



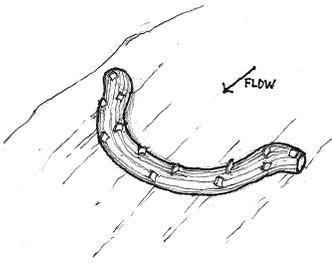
C. Fasten mesh to uphill side of posts with staples or wire, extend mesh to bottom of trench. (Do not attach mesh or fabric to trees.)

D. Dig a 4" x 4" trench on the uphill side of the fence.

E. Backfill trench and compact the soil.

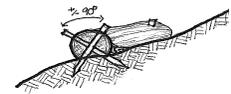
**Note:** Silt fences will not withstand high-volume of water, snow loading and high wind environments and often require higher maintenance.

The following method should be used to install an erosion control log:



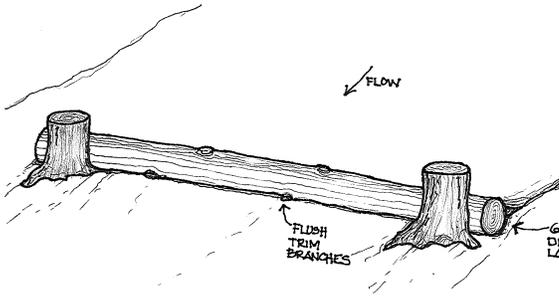
A. Erosion control logs should conform to the slope and must maintain contact with the ground the entire length of the log. When installed in series as a wattle, ends should be tightly fastened together with plastic ties.

B. Install using 1 1/2" x 1 1/2" x min. 24" wood stakes. Locate stakes at all ends or joints, otherwise on 24" centers. Alternate orientation throughout the length of the erosion control log. Proper staking is essential for erosion control log function.



The following method should be used to install a native erosion control log:

- A. Cut a native log to length, allowing for some overlap past each of the supporting tree stumps. Flush trim the branches.



- B. Dig a shallow trench, slightly wider and longer than the log, on the uphill side of the tree stumps. Set the log into trench and against the supporting tree stumps.

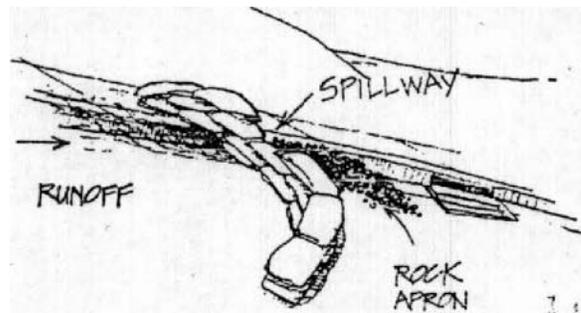
- C. Backfill and compact the excavated soil along uphill side of the log barrier.

The following method should be used to install a sandbag sediment barrier:

- A. Place a row of sandbags from the top of the curb to at least 3' into the driveway. Curve the barrier so the ends point uphill.

- B. Place a second layer of bags overlapping the first. Press the bags tightly together to eliminate any spaces between the bags.

- C. Place a third layer of bags on top leaving a 6" wide spill way near the center of the row.



- D. If the driveway is unpaved, construct a rock apron below the downhill side of the spillway (see section on outlet protectors).

- E. Add 1 or 2 more layers of bags, if necessary, to accommodate higher flow. If using more than 3 layers, place a second row of bags behind the first for reinforcement. Leave a gap in the top layer as a spillway.

## **2. MATERIALS:**

- For a straw bale sediment barrier, use straw bales (bound with wire or twine) and wood or steel stakes, minimum 4-foot long (2" X 2" wood, re-bars or steel pickets), 2 stakes per bale.
- For a filter fence, use filter fabric (42 inches wide, tensile strength = 120 lbs., equivalent opening size 70); posts, minimum 5 feet long (4" X 4" wood or 1.3 lbs/ft steel); wire mesh (42 inches wide, 6 inch mesh maximum, 14-gauge wire minimum); staples for wood posts (heavy duty, 1 inch long minimum); and wire for steel posts. Note: Some types of filter fence have stakes included and do not require all the above materials.
- For an erosion control log sediment barrier, use 9 to 18 inch diameter tubular mesh encased straw, coir or excelsior erosion logs, and 1 ½" x 1 ½" wood or rebar stakes, minimum 24 inches long, placed every 24 inches along length.
- For a natural erosion control log sediment barrier, use a minimum 6 to 8 inch diameter site harvested log with all branches trimmed flush to trunk.
- For a sandbag barrier, use sandbags and add rocks if needed.

## **3. MAINTENANCE:**

- Inspect periodically and after each storm, and before the winter season.
- Replace damaged bales or logs; re-anchor displaced ones.
- Clean out accumulated sediment before it reaches the top of the bales or logs.
- Deposit the sediment where it will not enter a drainage way.
- To winterize a site adequately, all loose fill material should be protected from erosion. Cover fill material necessary for backfilling during the next grading season with sheeting of straw and install a sediment barrier around it. Remove loose material and rocks from the road and from drainage ditches or gutters. Gravel or pave driveways and access roads before the grading season ends. Where slope stabilization is necessary as a permanent erosion control measure, it should be installed before the winter season to prevent undue erosion.

## **4. TEMPORARY OR PERMANENT USE:** Sediment barriers are temporary BMPs.

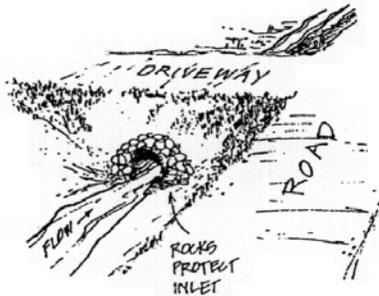
## BMP: DRIVEWAY AND PARKING AREA STABILIZATION

**1. METHODS:** As soon as driveways and parking areas are graded, pave them or cover them with gravel to prevent soil erosion. Spread a 4" layer of  $\frac{1}{2}$ " to  $\frac{3}{4}$ " gravel over these areas. Size culverts to handle the peak flow during a heavy storm. Generally, the Site Development Department, Road and Bridge Department or private engineer will size the culvert necessary for installation in roadside ditches along public roads. Where sizing requirements are not provided, as a rule-of-thumb, use a culvert with twice the cross-sectional area of the channel draining into it. The extra capacity is needed because of flow efficiency loss at the culvert's inlet.

Erosion frequently occurs at culvert entrances. It is best to install a culvert with its inlet flush to the embankment. The edge of the pipe should be rounded or flared to improve flow into it. Place rocks or sandbags around the inlet to prevent scour. As flow volumes and velocities increase, outlet protection is usually needed. An outlet protector, such as a rock apron, is a device for absorbing the energy of water discharging from a pipe or channel. Outlet protectors should be used:

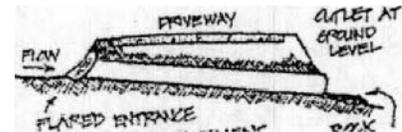
- Below culverts.
- Below sediment trap outlets.
- Where a steep or paved channel drains into an unlined or natural drainageway.

**2. MATERIALS:** The following method should be used to construct a rock apron outlet protector. (Note: The following description applies to a ditch or culvert discharging at the side of a drainageway.) The ditch or culvert should end at the top of the bank of this drainageway if you are constructing a driveway and culvert across a natural drainageway.



sideways for each 2' of length until the apron is 5 times the width of the ditch or culvert.

Good



Poor

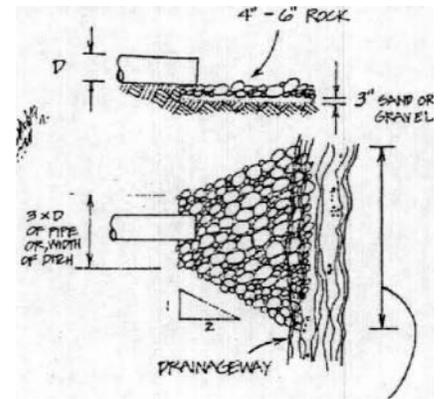
A. Place a 3" layer of sand or gravel in a trapezoidal-shaped apron from the ditch or culvert to the middle of the drainageway. The apron width at a ditch should be as wide as the ditch. The apron width at a culvert should be 3 times the culvert's diameter. The apron should flare out at a ratio of 1'

- B. Place a layer of 4" to 6" rock on the top of the apron. The top of the finished apron should be at the same level as the inflowing ditch or culvert and should slope at the existing grade.

**3. MAINTENANCE:**

- Inspect inlets and outlets during and after each storm.
- Replace dislodged stones with larger ones.
- Enlarge the apron if erosion is occurring around its edges.

- 4. TEMPORARY OR PERMANENT USE:** Driveway and parking area stabilization can be temporary or permanent BMPs.



## BMP: INFILTRATION SYSTEMS

**1. METHODS:** An infiltration system is a device used to percolate runoff into the soil. A typical system is a rock-filled trench/basin (called a dry well) or Infiltrator Chambers. Both mechanisms are similar to a septic system's leach field. The rock-filled trench is limited in storage capacity compared to the Infiltrator Chamber. You should infiltrate runoff from all impervious surfaces, including roof tops, driveways, and areas where the soil has been packed down.

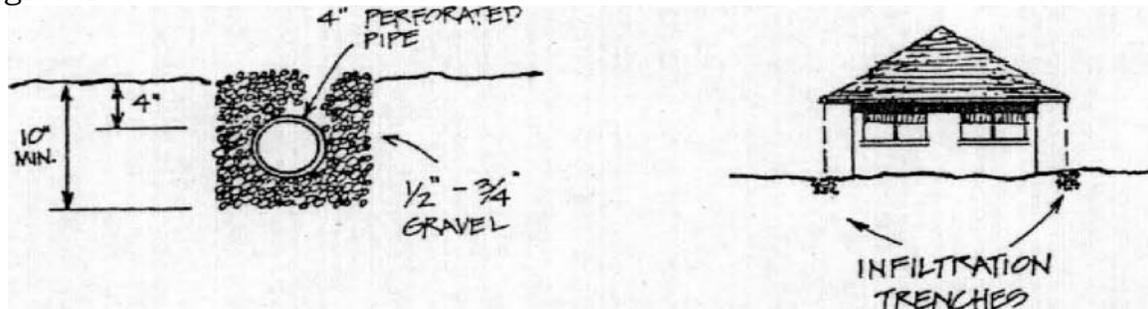
An infiltration system should be used:

- Below roof drip lines;
- In conjunction with downspouts/gutters;
- Along driveways and walkways;
- Along dikes and ditches;
- Below sediment trap outlets; and
- On flat or gently-sloping ground.

Infiltration systems are required on all BMP Permits and for all development where the roof square footage area is greater than 1,750 square feet.

The capacity of infiltration trenches decreases as the slope of the trench increases. Don't build infiltration trenches with drain slopes steeper than 15%. Where a roof drip line or driveway exceeds 15% slope, install a lined ditch to convey the runoff to a dry well or lateral infiltration trench located along a slope contour.

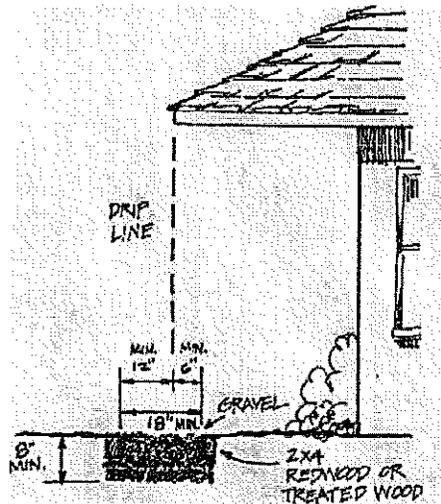
A french drain is a trench containing a perforated pipe surrounded by gravel.



Where water dripping from a roof will fall on a slope above a house's foundation, install a french drain to convey the roof drip to an infiltration system away from the house. The french drain will prevent water from seeping under the foundation and weakening it.

Where an infiltration system is located below a disturbed area, install a sediment barrier to remove the soil before it reaches the system.

Removing sediment from the runoff will increase the efficiency of the infiltration system and reduce maintenance costs.



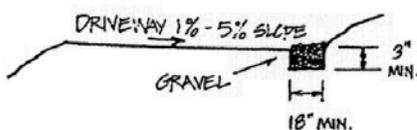
The size of the infiltration system depends on soil permeability, runoff area and is sized according to storm events. The system must be able to infiltrate at a minimum 0.5" of precipitation per hour, which is 90% of the precipitation from storm events. A more effective system would be designed for 1" of precipitation which is 95% of the annual storm events. If you have hired an architect or engineer to prepare the plans for your house, he or she can calculate the size of the infiltration system needed.

The following method should be used to construct a roof drip line infiltration trench:

- A. Dig a trench of the required size along the roof drip line as shown. Allow 3" extra width for the border boards.
- B. Add the border boards (which are optional) and gravel to fill the trench to ground level.
- C. Downspout/gutter infiltration devices are designed per project. Either an engineer, contractor or the County's Site Development Department can assist on a design. See diagrams for examples of these devices.

The following method should be used to construct a driveway infiltration trench when the driveway surface is paved or non-erodible:

- A. Grade the driveway with a 1%-5% slope towards the trench.
- B. If the driveway slope is less than 15%, size and construct a trench along the low side of the driveway as described above.
- C. If driveway slope is 15% or more, install a paved ditch or trench drain along the low side of the driveway and route the runoff to lateral infiltration trenches located along slope contours or to dry wells located in more level areas.



Install a 2' long water bar between each section of ditch to prevent runoff from continuing down slope.

continuing down slope.

- D. Do not install lateral infiltration trenches on fill slopes steeper than 4 horizontal to 1 vertical (4:1). Do not locate a driveway on top of an infiltration trench. Avoid placing infiltration trenches where their construction will damage tree roots.

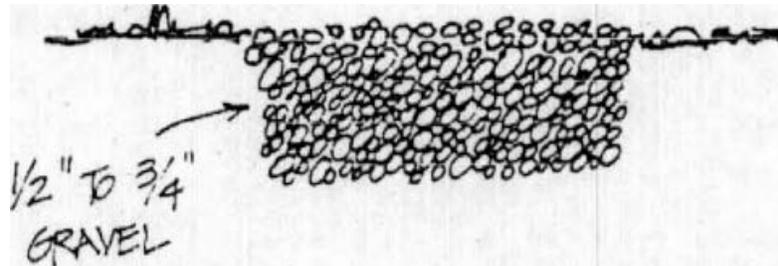
The following method should be used to construct a dry well:

- A. Determine the required dry well size.
- B. Dig a basin of the required size and fill it with gravel. You may want to cover the top of the dry well with a shallow layer of sand or wood chips to create a more pleasing appearance.

Lateral Infiltration  
Trenches

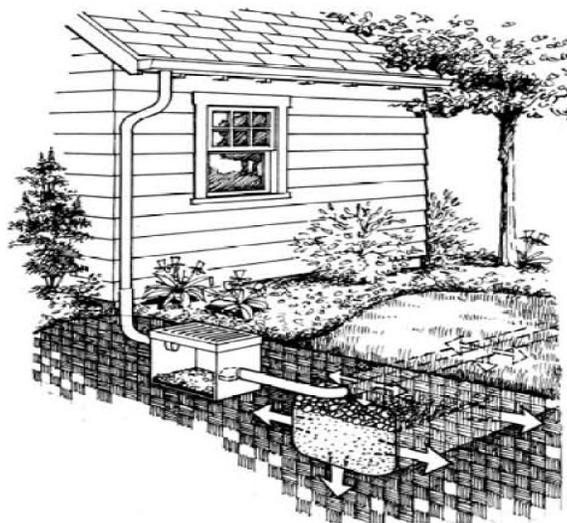
**2. MATERIALS:**

- Catch basin
- Perforated pipe
- Gravel
- Wood, cinderblock, etc.



- 3. MAINTENANCE:** Clean out accumulated sediment and debris when the dry well fails to infiltrate storm runoff.

- 4. TEMPORARY OR PERMANENT USE:** Infiltration systems are permanent BMP's.



Dry Well (seepage pit)

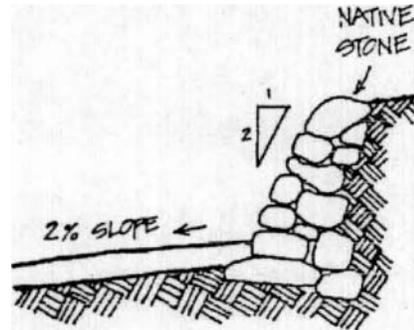
## BMP: SLOPE STABILIZATION

**1. METHODS:** Rip rapping is the use of cobble-size rock, generally 6"- 10" in size, placed closely together on disturbed soils to prevent erosion. Rock riprap is generally the most effective erosion control device for slopes greater than 30%. It can also be used on less steep slopes and works well with seeding. Concrete can be used to fill in between the rocks to hold the riprap securely in place, a common practice on steep slopes.

Slopes that are cut for building or driveway construction are sometimes so steep that vegetation or rip rapping alone cannot adequately protect them. Runoff from these over-steepened slopes often erodes the toe of the slope, causing continued slope slippage. Retaining walls prevent toe erosion and slope slippage.

The following method should be used to construct a native rock retaining wall. (Note: Any retaining wall over 4' high shall be designed by a licensed Colorado engineer and require a retaining wall permit.

- A. Remove all large rocks from the eroding slope and stockpile on site.
- B. Dig a footing trench along the toe of the slope.
- C. Place the largest rocks in the trench with their longest axes perpendicular to the slope.
- D. The face of the wall may vary from vertical to a 1:2 slope.
- E. Fill the space behind the rock wall with leftover soil excavated from the site.
- F. Slope the ground at the base of the wall at a 2% grade away from the wall and stabilize it with vegetation or mulch. If a driveway is located at the base of the wall, pave it up to the wall or install a curb.



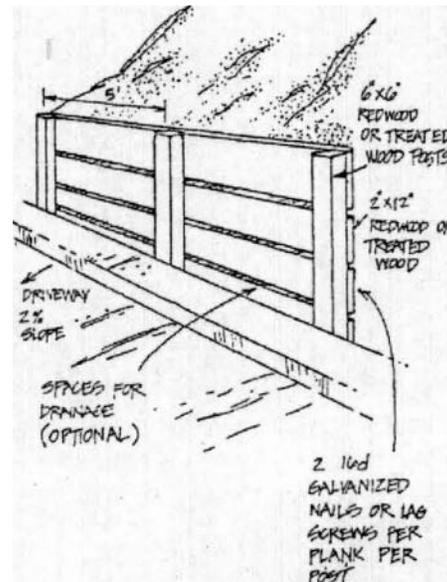
The following method should be used to construct a wood retaining wall. Note: Any retaining wall over 4' high and shall be designed by a licensed Colorado engineer and require a retaining wall.

- A. Set 6" x 6" wood posts into concrete foundations at least 2' into ground. Space the posts 5' apart.

- B. Nail 2" x 12" wood planks to the upslope side of posts. Leave a small vertical space between planks to allow drainage at the base of the wall and between planks. You may want to backfill the space behind the wall with surplus soil from excavations.
- C. Slope the ground at base of the wall at a 2% grade away from the wall and stabilize it with vegetation or mulch. If a driveway is located at the base of the wall, pave it up to the wall or install a curb.

**2. MATERIALS:**

- Rocks
- Redwood, cedar, or treated wood
- Rock-filled baskets (gabions)
- Railroad ties
- Concrete
- Steel

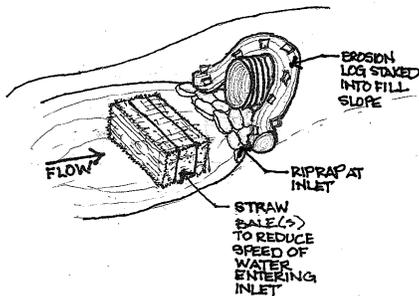


**3. MAINTENANCE:** Inspect periodically for erosion, slippage, sloughing, or other damage. Repair as needed.

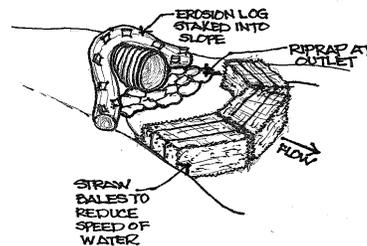
**4. TEMPORARY OR PERMANENT USE:** Slope stabilization can be a temporary or permanent BMP.

## BMP: INLET AND OUTLET PROTECTION

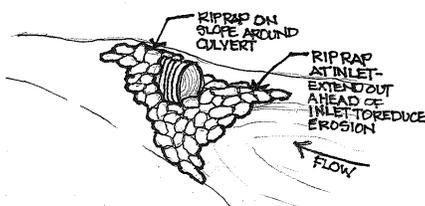
- 1. METHODS:** The primary function of stormwater inlet protection is to decrease sedimentation/siltation impacts to these devices, which increases their functionality and longevity. Outlet protection, such as rip-raping drainage ways, reduces channelization and decreases erosion. Once a stormwater device is installed, protection to both inlets and outlets should then also be installed.
- 2. MATERIALS:**
  - Straw bales, erosion control logs, silt fence, sand bags and rip-rap.
- 3. MAINTENANCE:**
  - Silt and sediment must be removed on a regular basis.
  - Devices installed should be inspected after each storm event.
- 4. TEMPORARY OR PERMANENT USE:** Inlet and outlet protection can be a temporary or permanent BMP.



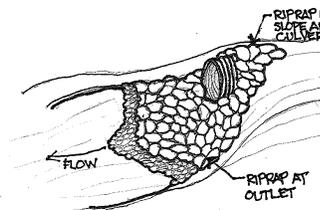
Temporary  
Inlet Protection



Temporary  
Outlet Protection



Permanent Inlet  
Protection



Permanent Outlet  
Protection

## **BMP: SNOW REMOVAL**

**1. METHODS:** Snow removal is essential for the safe and efficient operation of roads, parking areas and driveways. In rural areas and along highways, snow is usually plowed to the sides of roads and allowed to melt there. In more densely developed areas, particularly in commercial areas and parking lots, snow must be removed and transported by truck to separate storage areas. Because of the concentration of petroleum products (from oil and gasoline) and salt in snow on roads and parking areas, the runoff from stockpiled snow can have significant impacts on water quality. Suggested methods for minimizing these impacts are:

- Where conditions permit, plow snow to the center of roadways and parking areas prior to removal by truck. This reduces the clogging of storm drains and reduces damage to curbing and other structures.
- Create a snow storage area that prevents contaminated snowmelt from reaching stream channels and groundwater. The size of the area will vary with the needs of the municipality, but in general should be of sufficient size to allow evaporation. The area should be lined and bermed to prevent runoff, and incorporate a settling pond if necessary.
- If snow storage area is located near a waterway it should be surrounded by a sand berm for the snowmelt to percolate through.
- Do not dump or plow snow into or adjacent to stream channels, storm drains or other drainage ways.
- Remove plowed snow as soon as possible following storm to minimize on-site runoff.

**2. MATERIALS:** Silt fence, berms, hay bales, riprap, see other BMP's.

**3. MAINTENANCE:** Storage area(s) should be checked annually, and any necessary repairs to liners, berms or settling ponds. Sand and other foreign materials should periodically be removed as needed.

**4. TEMPORARY OR PERMANENT USE:** Permanent installation recommended.

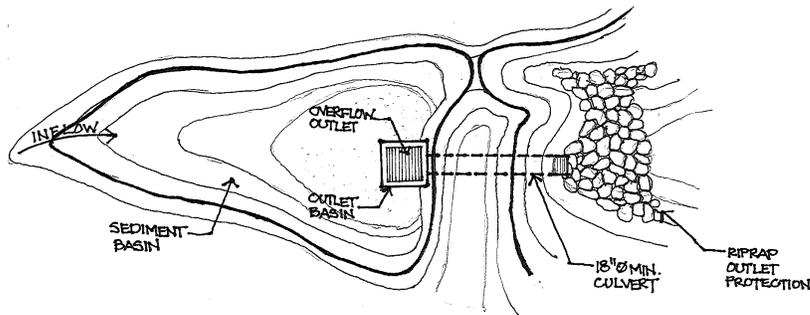
## **BMP: SANDING PROCEDURES**

- 1. METHODS:** Wintertime sanding during storms is a necessity for roads and driveways in the upper Clear Creek watershed. Since road sand typically contains some percentage of salt (5 to 20%), snow melt can have negative effects on water quality. Recommended methods include:

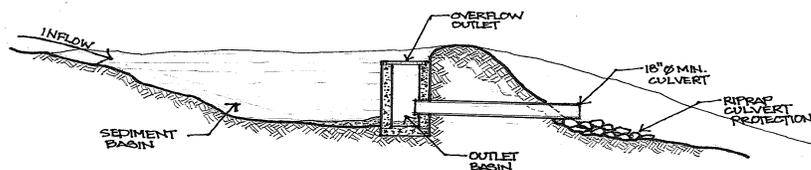
  - Use the minimum amount of sand needed to accomplish the job.
  - Use the lowest feasible content of salt.
  - Sweep sand from paved roads as soon as possible following storm.
  - Recycle sand if feasible.
  - Store sand on lined, curbed or bermed site and under shelter if possible.
- 2. MATERIALS:** Sand with salt. Alternate materials to reduce fugitive dust and reduce the need for salt are being evaluated by various municipalities and the Department of Transportation. Contact CDOT for more information.
- 3. MAINTENANCE:** Sand should be removed from paved streets as soon as feasible following storm.
- 4. TEMPORARY OR PERMANENT USE:** This is a permanent BMP.

## BMP: SEDIMENT BASINS

- 1. METHODS:** Sediment basins are small impoundments that allow sediment to settle out of stormwater runoff. The outlet from the sediment basin should be designed to empty its volume over an extended period of time.
- 2. MATERIALS:** Inlet structure and pipe, riprap and compacted earth.
- 3. MAINTENANCE:** Remove sediment as required.
- 4. TEMPORARY OR PERMANENT USE:** Permanent.



Sediment Basin



Sediment Basin Section

## **BMP: CONSTRUCTION FENCE**

**1. METHOD:** Construction fence is required on slopes greater than 20° when adjacent to a public/private road, adjacent to any structures or if determined it is needed to provide for the health, safety or welfare of the general public.

There are several types of construction fence that can be used. They vary in strength and integrity. On steeper, rockier slopes, a chain link fence and metal post will be required. Gentler, less rocky slopes can use the welded wire fence and in some cases, the orange plastic construction fence will be required.

Brush barriers are also a mechanism that can be used in place of a construction fence. A brush barrier is the tree material removed from the site and placed on the downside of all excavation, relatively close to the ground. Trees are a great tool for decreasing rock fall from the property and should be used where appropriate.

**2. MATERIALS:**

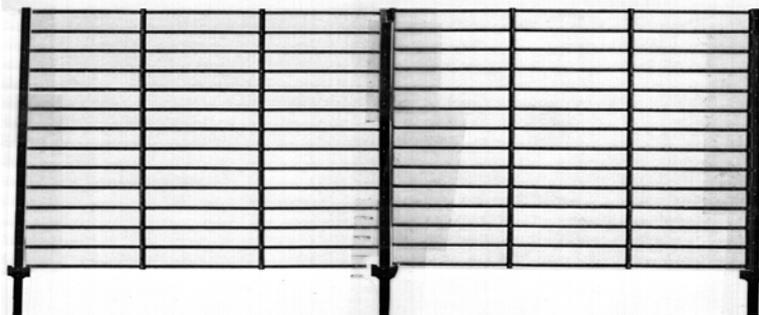
- 4' - 2"x4" Welded Wire Fence and standard 6' Fence Posts
- 4' or 6' Chain Link Fence with Steel Posts
- Native tree material used from site for a Brush Barrier

The individual permit will specify what type of safety barrier to use. These devices must be installed prior to any excavation.

**3. MAINTENANCE TIPS:**

- Repair or replace fence as needed
- Repair or replace any fence posts
- Inspect daily after excavation
- Add additional tree material when needed

**4. TEMPORARY OF PERMANENT USE:** The fence or brush barrier is a temporary BMP. The fence or brush barrier can be removed after excavation is completed and the slope has been stabilize.



2" X 4" Welded Wire Fence with 6' High Poles



## BMP: PAVING

**1. METHODS:** Paving is required on private roads, driveways and parking areas when they are accessed by a paved road. Parking areas and drives must be paved with a minimum of 6 inches of road base compacted to 95% modified Proctor and 3 inches of asphalt, see figure. Paved parking areas for all other development shall be designed in accordance with Section 2.43. C, with TI equaling 6.0, as per Clear Creek County's Roadway Design and Construction Manual.

The County may also require pavement that drains, or porous pavement. This requirement will be contingent upon any land use case stipulation/condition and will be designed by a Colorado licensed engineer.

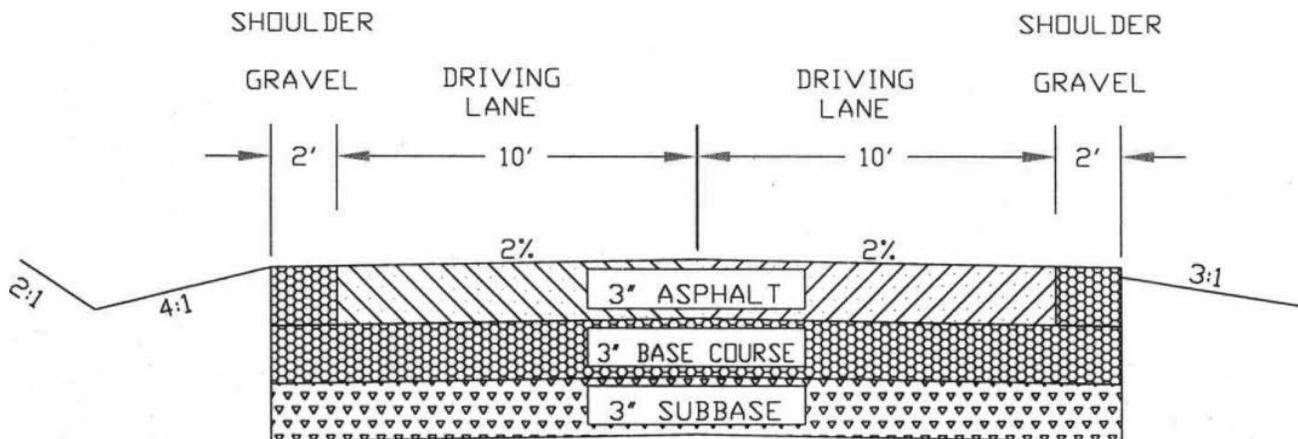
**2. MATERIALS:**

- 3" asphalt, 3" base course, 3" subbase, as per figure 6, Clear Creek County's Roadway Design and Construction Manual.

**3. MAINTENANCE TIPS:**

- Replace/repair as required.

**4. TEMPORARY OR PERMANENT USE:** Paving is a temporary and Permanent BMP.



*Typical Cross Section for a Primitive Status Road*

- The Primitive Road Standard can be either one (1) or two (2) lanes as per Clear Creek County Roadway Design and Construction Manual .
- Parking areas are required to meet the same criteria as above (3" Asphalt, 3" Base Course and 3" Sub Base) with a maximum of 4% grade.