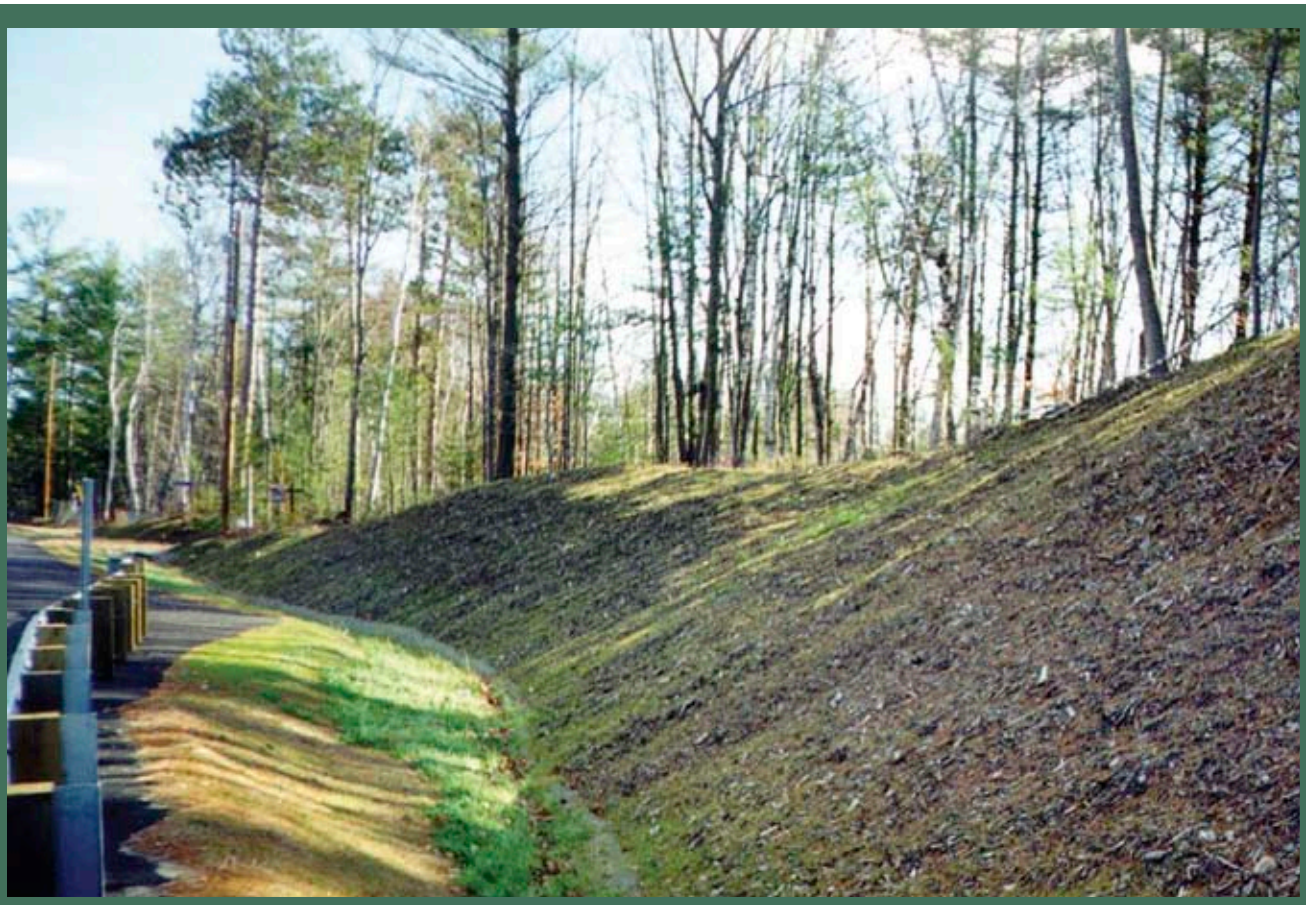


III. Best Management Practices

A. HOW TO USE THIS MANUAL

The BMPs in this manual are separated into sections focusing on the type of problem you are trying to address, making a distinction between the type of erosion occurring, i.e. sheet and rill vs. concentrated flow. It further distinguishes between erosion control practices and sedimentation control practices. This allows the writer of the SEWPCP to look at the site conditions and identify what conditions will be encountered during construction, and then go to the appropriate section of the manual to find specific BMPs to meet the needs of the project.

For other BMPs that are specific to the construction activity, see subsequent sections for In-Water Work and Miscellaneous.

This manual will also present some permanent BMPs that can be incorporated into the post construction stormwater management plan but does not give guidance in controlling post construction stormwater management.

- Sheet and Rill – Erosion Control (SR-EC)
- Sheet and Rill – Sedimentation Control (SR-SC)
- Concentrated Flow – Erosion Control (CF-EC)
- Concentrated Flow – Sedimentation Control (CF-SC)
- In-Water Work (IN-WATER)
- Miscellaneous (MISC)

B. Sheet and Rill Erosion Control (SR-EC)

B. SHEET AND RILL EROSION CONTROL (SR-EC)

Sheet and rill erosion, in combination with raindrop erosion, is the major source of suspended sediment on construction sites. This section contains the most effective BMPs in this manual. An ounce of prevention is worth a pound of cure.

Rainfall on bare soil will dislodge soil particles. If rain water cannot infiltrate the soil, it will begin to run off. This flowing water will begin to erode the unprotected soil. When this sheet run off concentrates into shallow concentrated flow, rill erosion begins. On MaineDOT projects most sheet and rill erosion occurs on inslopes and backslopes. Refer to the Introduction for a more detailed description of this process.

The sheet and rill erosion control practices in this section do one or a combination of the following:

- Protect the soil from rainfall impact and dislodgement, and increase the amount of infiltration of rainfall into the soil, therefore decreasing the volume of runoff and its power to erode.
- Roughen the soil surface which will decrease the velocity of runoff, and its power to erode.
- Decrease the watershed size by diverting water away from an exposed area until the area can be permanently stabilized. This will decrease both the volume and depth of water, and therefore its power to erode. This will also decrease the slope length to prevent the development of rill erosion further down the slope.

The mulching BMPs listed in this section are listed in order of their strength or ability to stay in place on the soil surface, from lowest to highest. Factors affecting this include wind, steepness of slope, and how quickly vegetation will grow (time of year, shade vs. sun, type of soil). Guidance is given in each specification.

BMP	Soil Protection	Roughening	Watershed Size
Hydraulic Mulch	X	X	
Hay and Straw Mulch	X	X	
Erosion Control Mix	X	X	
Erosion Control Blanket	X	X	
Turf Reinforced Matting	X	X	
Plastic Sheeting	X		
Riprap	X		
Seeding and Landscape Planting	X	X	
Surface Roughening		X	
Gradient Terrace			X
Hillside Diversion			X

1. HYDRAULIC MULCH

Definition and Purpose

Hydraulic mulch consists of a mixture of mulch and mulch binder that is sprayed onto unvegetated soil to protect it from raindrop erosion and, to a limited extent, the erosive forces of sheet flow. MaineDOT specifies paper fiber mulch or a combination of paper fiber mulch and cellulose (wood) fiber. The mulch binder is a chemical solution that holds the mulch together as it adheres to the soil surface after the binder cures.

The type of hydraulic mulch that is applied (paper fiber or combination) depends on whether the area has been previously mulched with hay or straw. If hay or straw is present, a paper fiber mulch and binder is adequate to hold the hay or straw in place. In the absence of hay or straw mulch, a more durable hydraulic mulch consisting of paper fiber mulch, cellulose fiber mulch, and mulch binder is sprayed directly onto the soil surface.

Both types of hydraulic mulch can be applied with or without seed; see **Standard Specification 618 - Seeding**.

Appropriate Applications

- Seeded areas requiring temporary protection until permanent vegetation is established.
- As a tackifier for sites mulched with hay or straw that are subject to windy conditions or that have long slope lengths.
- As a permanent mulch for Seeding Method 1 and in areas subject to high winds; see **Standard Specification 618 - Seeding**.

Limitations

- Least effective mulch for erosion control when used alone. Most sites require temporary hay or straw mulch or other methods to minimize erosion.
- Mulch binder curing time before rainfall is normally a minimum of 24 hours. Low temperatures may slow curing (check with manufacturer's guidelines).
- Avoid application during windy days.

Standards and Specifications

- Hydraulic mulch materials and application shall comply with Standard Specification 619 – Mulch.
- Seeding Method 1 with hydraulic mulch shall use the cellulose fiber mulch mixture.
- Paper fiber mulch and mulch binder mixture can only be applied over existing hay or straw mulch.
- Hydraulic mulch shall be applied within one week of final grading. In some sensitive watersheds, daily application of hay or straw mulch may be required prior to hydraulic mulching.

- The selection of the appropriate hydraulic mulch mixture(s) should be based on the specific application and site conditions. Selection(s) made by the Contractor must be approved by the Resident.
- Avoid hydraulic mulch over-spray onto the traveled way, sidewalks, lined drainage channels, and existing vegetation.
- Hydraulic mulch shall be maintained until vegetative cover is acceptable according to Standard Specification 618 – Seeding.
- Advances in hydraulic mulch strength and durability are continuously being made. Their use must be pre-approved by the Resident.

Application Procedures

- Check the weather forecast to ensure that there is adequate curing time between the time of application and the next predicted rainfall, and that the temperature will be at, or above, the minimum curing temperature.
- Apply the paper fiber mulch mixture at a rate of 5 lbs/1,000 square feet or as directed by the product's manufacturer.
- Apply the cellulose fiber mulch mixture at a rate of not less than 40 lbs/1,000 square feet or as directed by the product's manufacturer. Higher rates of mulching should be used on areas subject to windy conditions (e.g., crests of ridges and banks) or heavy runoff (e.g., base of slopes).

Maintenance and Inspections

- The Contractor should inspect the mulched areas weekly and prior to, during, and after storm events to check for erosion. Additional Hydraulic mulch or hay or straw mulch shall be added, as necessary, to maintain the required coverage.
- If the cellulose fiber mulch mixture is used, any reseeding will require additional cellulose fiber mulch.

References

- Standard Specification 618 – Seeding
- Standard Specification 619 – Mulch
- Manufacturer's Guidelines and Specifications

2. HAY AND STRAW MULCH

Definition and Purpose

Hay is typically produced locally and contains a variety of grasses and reasonably few weeds. Hay is used as mulch on the majority of construction sites.

Straw is the stalks of cereal grain (barley, rye, oat, or wheat) after the grain has been harvested. It has very few seeds to contaminate the site and therefore is used on areas where the introduction of weed seed is unacceptable. Straw is considerably more expensive than hay and not as readily available.

Hay and straw mulching consists of placing a uniform layer of hay or straw over bare soil. It protects the soil from raindrop, sheet, and rill erosion until soils can be prepared for permanent vegetation. When applied over grass seed, it provides a favorable environment for seed germination. Depending on site conditions, the mulch may need to be secured to the soil surface by anchoring, punching, or applying a mulch binder.

Appropriate Applications

- Hay and straw mulch are used for temporary protection from raindrop, sheet, and rill erosion on disturbed areas until the site is prepared for permanent cover. If the disturbed area will not be fine graded within a 30-day period, temporary seed should be placed before it is mulched.
- In addition to erosion control, hay and straw mulch is used to enhance plant growth for permanent seedings - hay mulch for Seeding Method 2 or 3 of Standard Specification 618 - Seeding; straw mulch for Seeding Method 1 where introduction of weed seed is unacceptable.

Limitations

- Not to be used in areas of concentrated flow.
- Depending on site conditions (high wind, steep and/or long slopes), the mulch may need to be secured to the soil surface by anchoring with a hydraulic mulch binder, netting, or punching mulch into the soil.
- Application of hay and straw mulch is usually limited to slopes flatter than 2:1. Steeper slopes may require more aggressive mulch such as **erosion control blanket**. (If a steep slope is less than approximately 30 feet long with no contributing drainage area, hay and straw mulch may be adequate).
- Hay mulch has potential for introducing weed seed (unwanted plant material).
- When used as a temporary mulch, without seeding, hay and straw mulches only last 2 to 3 months and may require reapplication.

Standards and Specifications

- All material shall conform to Materials Specification 717.04 - Mulch
- Application rate should be a minimum of 2 tons/acre or 92 lb./1,000 ft^2 or as required in the project's special provisions. This will achieve coverage of 85 to 90 percent. Note: an average haybale weighs approximately 40 lbs. See Figure 1.

- Mulch is applied within one week of completed grading and prior to storm events. However, in sensitive watersheds it shall be applied daily.
- Hay and straw mulch must be anchored when exposed to high wind, when slopes are steep and long, or when grass growth is slow.
- The preferred anchoring method is a mulch binder. A paper fiber mulch binder is typically applied at a rate of 5 lb/1,000 $ft^{2;}$ see **Hydraulic Mulch**. Other binders may be used with the approval of the Resident.
- On small areas, or short steep slopes, hay or straw can also be anchored using netting. The netting is stapled to the soil surface according to manufacturer's recommendations. If plastic netting is used it must be removed when vegetation reaches 50% establishment. Biodegradable netting does not have to be removed.
- On slopes flatter than 3:1 hay or straw mulch may be punched or crimped into the soil using punch roller-type rollers, or track walking. Track walking shall only be used where other methods are impractical.
    - Punching mulch into the soil surface can be accomplished on small areas with a spade, shovel or other approved methods.
    - On slopes where soils are stable enough and the slope can safely support construction equipment mulch can be crimped into the ground using a knife-blade roller or a farm disc harrow with the coulters set straight.
- For application periods between November 1st and April 1st see **Winter Stabilization (MISC)**.

Application Procedures

- The mulch must be evenly distributed on the soil surface, by machine or by hand.
- Anchor mulch as necessary.

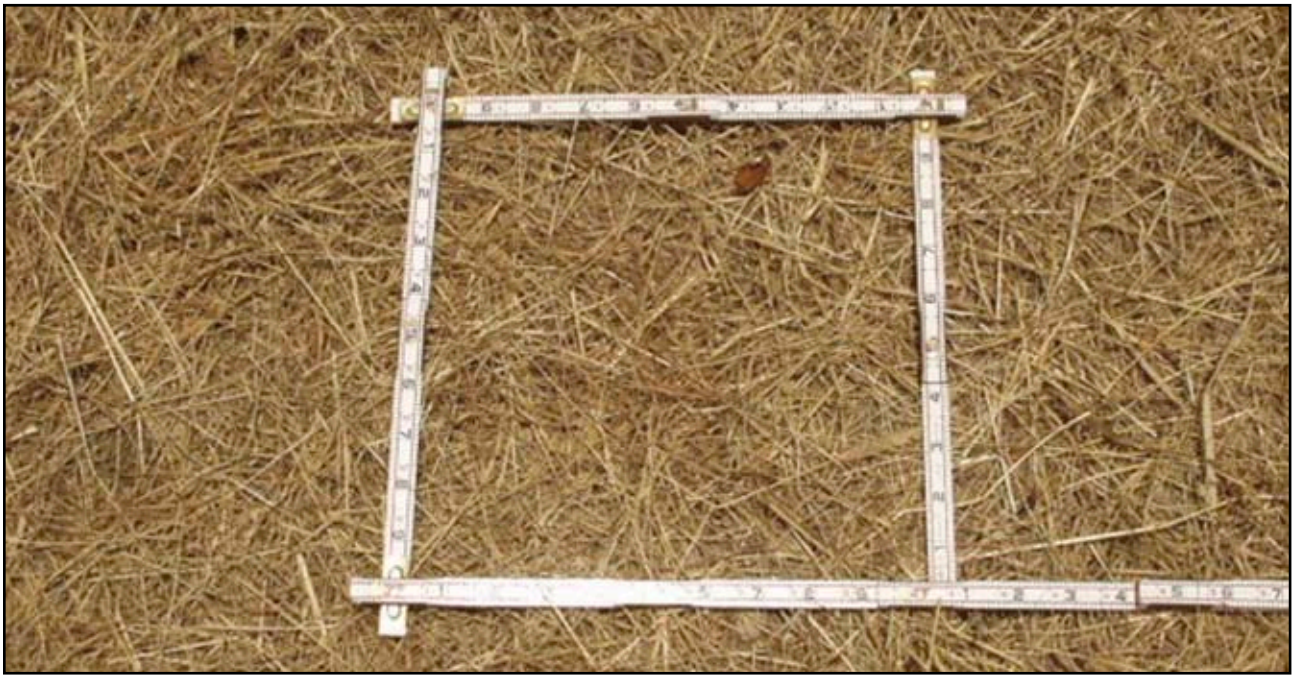


Figure 1. Hay Mulch - Adequate Application Rate

Maintenance and Inspections

- Hay and straw mulch shall be inspected weekly and before, during, and after storm events. Repairs shall be made immediately to ensure specified coverage.
- Reapplication of mulch, mulch binder, or additional anchoring may be required to maintain effective soil stabilization over disturbed areas and slopes.
- Vegetation is not considered established until a ground cover is achieved which is mature enough to control soil erosion and to survive severe weather conditions.

References

- Standard Specification 619 - Mulch

3. EROSION CONTROL MIX

Definition and Purpose

Erosion control mix is a dense, processed mixture of intertwining wood fragments and grit that form a stable, long lasting mulch. Common sources include paper mill flume grit, stump grindings, and aged wood waste.

Erosion control mix can be used as temporary mulch where hay and straw mulch will not be able to resist the erosive forces of wind or water. It is typically used as permanent mulch when there are poor site conditions for growing grass as a final cover. The same material is also used a sediment barrier, see **Erosion Control Mix Berm (SR- SC)**.

Erosion control mix can be seeded with Seeding Method 3 or left to vegetate naturally; see **Standard Specification 618 - Seeding**.

Appropriate Applications

- Slopes 2:1 or flatter where long-term stabilization is required. May be used on steeper slopes at the approval of the Resident.
- Slopes with unfavorable growing conditions for grass, e.g., heavy shade, or sandy, clay, or rocky soils.
- Sites with high wind conditions.
- Used for winter mulch between November 1st and April 1st. Unlike straw or hay mulch, erosion control mix will last through the winter if applied in the fall. On projects that are active through the winter, erosion control mix can be used for daily or weekly mulching on frozen ground.

Limitations

- Subject to failure in areas of concentrated flow, periodic groundwater seepage, or on slopes steeper than 2:1.
- During decomposition, erosion control mix can deprive soils of nitrogen needed for plant growth.
- May have to be removed prior to permanent seeding or other preferred methods of permanent soil stabilization.
- Erosion control mix is more expensive than hay and straw mulching, due to material and labor costs.
- Unless seeded with Method 3 or well maintained, ‘volunteer’ plants will begin to colonize and may have an objectionable appearance in residential settings.

Standards and Specifications

- Erosion control mix materials and application shall comply with Standard Specification 619 – Mulch. Wood chips, ground construction debris, reprocessed wood products or bark chips will not be acceptable as the organic component of the mix.

- Erosion control mix shall be applied within one week of completed grading. In sensitive watersheds, daily mulching may be required.
- Erosion control mix shall be evenly distributed and shall provide 100 percent coverage.
- A minimum thickness of 4 inches of Erosion control mix shall be applied. On slopes steeper than 3:1, the thickness shall increase according to the following:

    - Slope length greater than 60 feet ------ 5 inches
    - Slope length greater than 100 feet------6 inches

- Seeding of erosion control mix is limited to Seeding Method 3, crown vetch (Standard Specification 618 – Seeding), or specialty mixes as provided by the Landscape Unit).
- When used between November 1st and April 1st, see **Winter Stabilization.**

Application Procedures

- Roughen slope, as needed, for better adhesion between the soil and the erosion control mix; see **Surface Roughening**.
- Distribute erosion control mix with a hydraulic bucket, pneumatic blower, or by hand ensuring the underlying soil is well covered.
- Erosion control mix shall be evenly distributed across the soil surface to the minimum depth specified.
- If used as temporary mulch, all erosion control mix must be removed prior to final stabilization of slopes by vegetation or other methods, e.g., riprap.

Maintenance and Inspections

- The Contractor should inspect erosion control mix weekly and prior to, during, and after storm events to check for erosion and movement of the mulch. Any failures shall be repaired immediately with the addition of mulch or other stabilization methods, as necessary.

References

- Standard Specification 619 – Mulch

4. EROSION CONTROL BLANKET

Definition and Purpose

Erosion control blanket is a machine produced rolled blanket of biodegradable organic fibers, evenly distributed with a consistent thickness, sewn into a biodegradable mesh on the top and bottom surface. The types of organic fibers used vary but include jute, excelsior wood fiber, coconut fiber, and straw.

Erosion control blanket is used where hay and straw mulch will not be able to resist the erosive power of wind or water.

When applied over grass seed, it provides a favorable environment for seed germination.

Appropriate Applications

- Steep slopes, generally 2:1 or steeper.
- Long slopes - greater than 20 feet; or where water flows from a contributing drainage area.
- Sites where erosion hazard is high.
- Areas that are slow to vegetate (such as slopes with poor soils or slopes that are shaded).
- Ditches and drainage swales.
- As an option for winter stabilization between November 1st and April 1st.

Limitations

- Seed must be applied before installation of the erosion control blanket.
- Erosion control blankets must be anchored with staples or pegs and are generally not suitable for excessively rocky sites or very shallow soils.
- Erosion control blanket can be more expensive than other types of erosion control measures, due to material and labor costs.

Standards and Specifications

- Refer to Standard Detail Drawing.
- Install within one week of completed grading. In sensitive watersheds, daily application of temporary mulching may be required prior to installation of erosion control blanket.
- Spacing of anchors shall be placed at a maximum spacing of 3 feet on center or as required by the manufacturer, whichever is closer.
- Seed shall be sown under erosion control blanket, regardless of whether or not permanent seeding will occur later in the project schedule.

Application Procedures

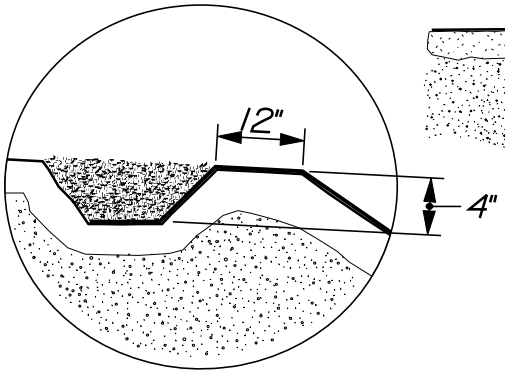
- The soil should be fine graded, and rocks and vegetation removed so that the erosion control blanket will have direct contact with the soil.
- General installation instructions
    - Dimensions listed below and in the Standard Detail Drawing are a minimum. Always consult the manufacturer's recommendations prior to installation.
        - Begin at the top of the slope and anchor the erosion control blanket in a 6 in deep trench. Backfill trench and tamp earth firmly.
        - Unroll erosion control blanket.
        - Overlap the edges of parallel rolls a minimum of 3 inches Anchor every 3 feet along the overlap.
        - Overlap the ends of rolls shingle style a minimum of 3 inches Anchor every 3 feet along the overlap.
        - Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
        - Anchor erosion control blanket sufficiently to maintain contact with the soil. Anchors shall be placed down the center and staggered along the edges. Maximum spacing shall be 3 feet on center or as required by the manufacturer, whichever is closer.

Maintenance and Inspections

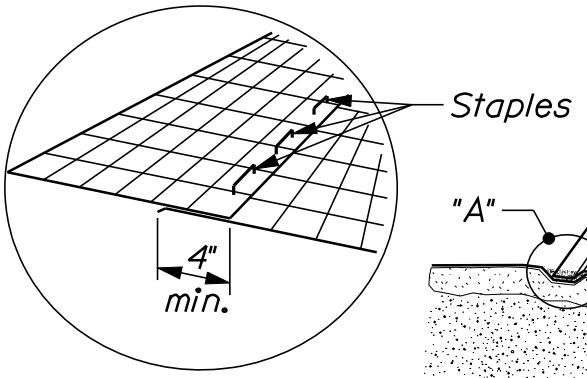
- The Contractor should inspect erosion control blanket weekly, and prior to, during, and after storm events to check for erosion and undermining. Any failures shall be repaired immediately.
- Place additional anchors, as necessary, to prevent movement of the erosion control blanket and to maintain continuous contact with the soil surface.
- Continue inspection and maintenance until new vegetation covers 90% of the soil surface. Vegetation is not considered established until ground cover is mature enough to control erosion and to survive severe weather conditions.

References

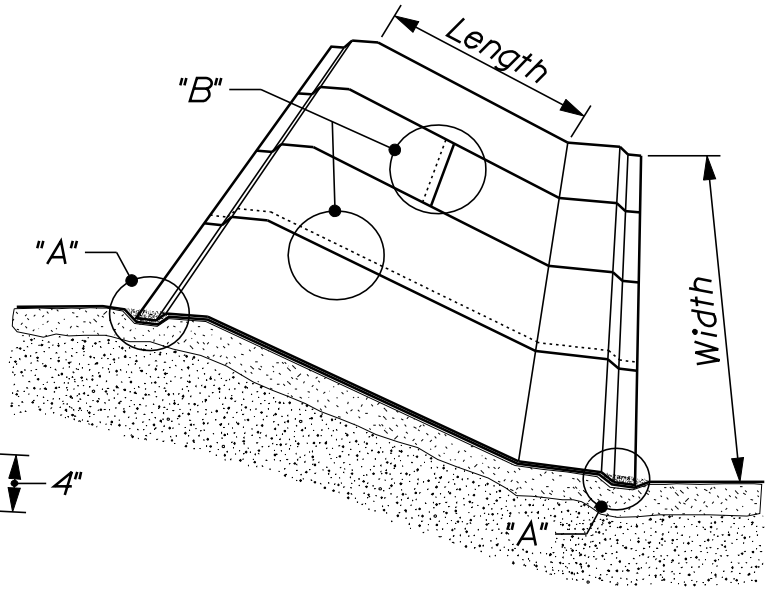
- MaineDOT Approved Product List: www.maine.gov/mdot/transportation-research/qpl.php
- Standard Specification 613 – Erosion Control Blankets



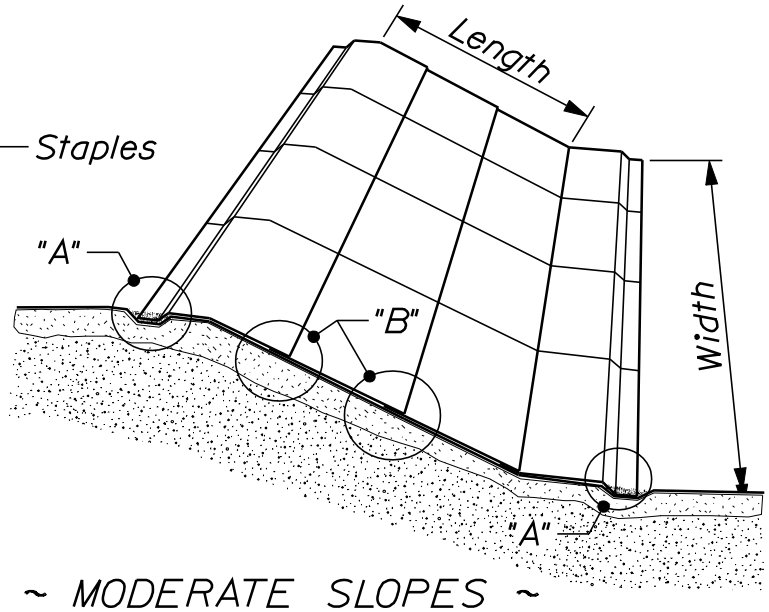
~ DETAIL "A" ~
Anchor Trench



~ DETAIL "B" ~
Lap Joint



~ STEEP SLOPES ~
(Greater than or equal to 2:1)



~ MODERATE SLOPES ~
(Less than 2:1)

NOTES:
1. Width may vary depending on type of material chosen.
2. Follow Manufacturer's recommendations for anchoring blanket ends, overlaps, and staple spacing. Dimensions for theses activities are to be used as a minimum.
3. Staples may be as provided or biodegradable staples according to the Qualified Products List*
4. See section 717.0611 of the MaineDOT Standard Specification or MaineDOT Qualified Products List*
*http://www.maine.gov/mdot/transportation-research/qpl.php

EROSION CONTROL BLANKET SLOPE APPLICATION

802(01)

5. TURF REINFORCED MATTING (GEOTEXTILES)

Definition and Purpose

Turf reinforced matting is a permanent vegetation reinforcement of permeable, synthetic, three-dimensional geotextile products that provides permanent increased strength to the surface layer of the soil and the vegetative cover.

Appropriate Applications

- On slopes steeper than 3:1 where erosion hazard is high.
- In areas that would normally require riprap but where machine access is limited or where a permanent vegetative cover is desired.
- It is also used as a channel liner; see **Channel Linings (CF-EC).**

Limitations

- Material cost are usually more expensive than other permanent covers.
- Turf reinforced matting are designed to work with vegetation; and vegetation must be maintained for the life of the project.

Standards and Specifications

- Permanent stabilization with turf reinforced matting shall be designed under the guidance of a professional engineer.
- Must follow manufactures recommendations and be approved by the Resident.

Application Procedures

- Follow Manufacturer's Guidelines and Specifications.

Maintenance and Inspections

- The Contractor shall inspect installation of turf reinforced matting weekly and before, during, and after storm events until vegetative cover is established. Any failures shall be repaired immediately.
- Long term management of the vegetative cover is required.

6. PLASTIC SHEETING

Definition and Purpose

Plastic sheeting is used for short duration protection of exposed soils or temporary cover of soil stockpiles. Woven and non-woven geotextile fabric may also be used.

Appropriate Applications

- For temporary stabilization on soil stockpiles or small areas of exposed soil for short periods of time, such as a sudden thunderstorm, until planned measures can be applied.

Limitations

- Plastic sheeting results in 100% runoff, which may cause serious erosion problems in unstable areas receiving the increased flow.
- Woven and non-woven geotextiles are an expensive option and if damaged in this application may be unusable for their intended applications.
- If not properly anchored, plastic sheeting and geotextile fabrics are susceptible to wind and if dislodged can be a safety hazard, especially to the traveling public.
- Plastic sheeting is easily vandalized, cut, or torn.

Standards and Specifications

- Plastic sheeting shall be polyethylene sheeting and shall have a minimum thickness of 4 mils.
- Plastic sheeting may be reused if approved by the Resident.
- All woven and non-woven geotextile fabric may be used for this practice.
- Overlap the sides of parallel rolls by 1 to 2 feet, upwind roll overlapping downwind roll.
- Overlap the ends of rolls by 1 to 2 feet, uphill end over downhill end.
- All seams shall be taped, staked, or weighted down their entire length.
- Material shall be properly anchored at edges, especially on the upwind side. Whenever possible, additional anchors should be evenly placed no more than 10 feet apart over entire surface to prevent ballooning of the surface.

Application Procedures

- The soil surface should be relatively smooth and free of protruding rocks and debris that can puncture and tear the sheeting.
- On slopes, unroll plastic sheeting down slope in the direction of runoff.
- Anchor edges and seems as they are placed.

Maintenance and Inspections

- The Contractor should inspect plastic sheeting used on stockpiles weekly and prior to, during, and after storm events. Place additional anchors, as necessary, to prevent movement of plastic sheeting.
- If used for a single rainstorm event that includes high winds, maintain constant inspection against dislodgement.

7. RIPRAP

Definition and Purpose

Riprap is the designed placement of rock to protect the soil from all forms of erosion and geotechnical failure. It is used in the most severe conditions where other forms of stabilization are inadequate.

Appropriate Applications

- On slopes steeper than 2:1.
- On slopes that can not be stabilized with vegetative cover due to slope length, contributing watershed, groundwater seepage, or poor soil conditions.
- Areas where soil is subject to high energy water flow with high erosive power such as stream banks, shorelines, ditch centers, culvert inlets and outlets.

Limitations

- It is a permanent erosion control treatment and not typically used for temporary erosion control.
- Material cost and site accessibility.
- When riprap is placed on the shore of a waterbody, vegetation to shade the water will be difficult to establish. This may cause an increase in water temperature.

Standards and Specifications

- Permanent stabilization with riprap shall be designed under the guidance of an engineer.
- Riprap and stone ditch protection shall meet the requirements of Materials Specification 703- Aggregates.
- Riprap should be well graded, having a range of rock sizes to fill the void spaces when placed.
- Unless approved by an engineer, a filter material must be placed between the existing soil and riprap to maintain separation from the underlying soil. The most common filter is a non-woven geotextile fabric. Refer to Materials Specification 722 - Geotextile (Erosion Control Geotextile). A fine aggregate or gravel filter can also be used if properly sized.
- As a general rule, riprap thickness should be at least 1.5 times the D_{50} of the design rock gradation (D_{50} indicates the rock size whereby 50% by weight of the sample is smaller than the specified diameter.)

Application Procedures

- Site should be graded smooth and free from all organic material.
- Place filter material (geotextile or aggregate) and secure.
- Place riprap with machinery, building from the bottom of the slope to the top.
- Riprap should not be end-dumped from a truck or dropped for more than six feet, to prevent separation of sizes.

- If placed in a watercourse, the bottom should be keyed into the bottom of the channel at least one and a half times the normal thickness of the riprap and installed flush with the surrounding slopes.

Maintenance and Inspections

- Riprap should be periodically inspected for slumping or bulging of the surface.

References

- Standard Specification 610 – Stone Fill, Riprap, Stone Blanket, and Stone Ditch Protection
- Standard Specification 620 – Geotextiles
- Materials Specification 703.27 – Plain and Hand Laid Riprap
- Materials Specification 703.28 – Heavy Riprap
- Materials Specification 722.03 – Erosion Control Geotextile

8. SEEDING AND LANDSCAPE PLANTINGS

Definition and Purpose

Seeding provides a vegetative cover for temporary erosion control during construction or as a permanent measure to prevent sheet and rill erosion in the long term. Landscape plantings of trees, shrubs and other vegetation provide an immediately effective option for revegetation of a site. Seeding and landscape plantings also provide habitat and food for wildlife and shading of streams which benefits fisheries.

Appropriate Applications

- Apply temporary seed to disturbed areas which will not be completed for more than 30 days.
- Apply permanent seed to all areas where long term vegetative cover is desired.
- Use landscape plantings in areas where foot traffic is causing damage and needs to be discouraged.
- Use landscape plantings to quickly re-establish mature vegetation damaged or removed during construction, especially when located in a sensitive watershed or adjacent to a water resource.
- Use landscape plantings on areas where grasses may not be successful, such as steep or rocky slopes or shaded areas.

Limitations

- Seeded areas are vulnerable to erosion during the initial germination and establishment period.
- Seeding and landscape plantings are susceptible to changing weather conditions (especially susceptible to drought) and are not applicable or effective during winter construction.

Standards and Specifications

- Seeding shall be applied weekly unless otherwise indicated by Special Provision.
- Refer to Standard Specification 618 - Seeding, or 621 - Landscaping.

Application Procedures

- Seeding shall be done in compliance with Standard Specification 618 - Seeding.
- Landscape plantings shall be coordinated through the MaineDOT Landscape Unit and shall be in compliance with Standard Specification 621 Landscaping.

Maintenance and Inspection

- Seeded areas shall be inspected weekly and before, during, and after each storm event to check for erosion. If necessary, additional mulch and/or seed shall be applied (mulch to cover 100% of disturbed soils, seed to achieve 90% coverage). Watering may be needed during the germination and the establishment period.
- Inspection and maintenance of landscape plantings shall be as specified under Standard Specification 621 - Landscaping.

References

- Standard Specification 618 - Seeding
- Standard Specification 621- Landscaping

9. SURFACE ROUGHENING

Definition and Purpose

Surface roughening is the practice of providing a rough soil surface with horizontal depressions for the purpose of reducing runoff velocity and encouraging infiltration. This will reduce the volume and depth of runoff and therefore the erosive power of the runoff.

There are two types of soil roughening methods:

- Tracking – is accomplished by tracked equipment traveling up and down the slope leaving cleat marks parallel to the contour (see figure 1).
- Grooving – is the process of tilling, disking, or harrowing across the slope leaving small ridges parallel to the contour (see figure 2).

Appropriate Application

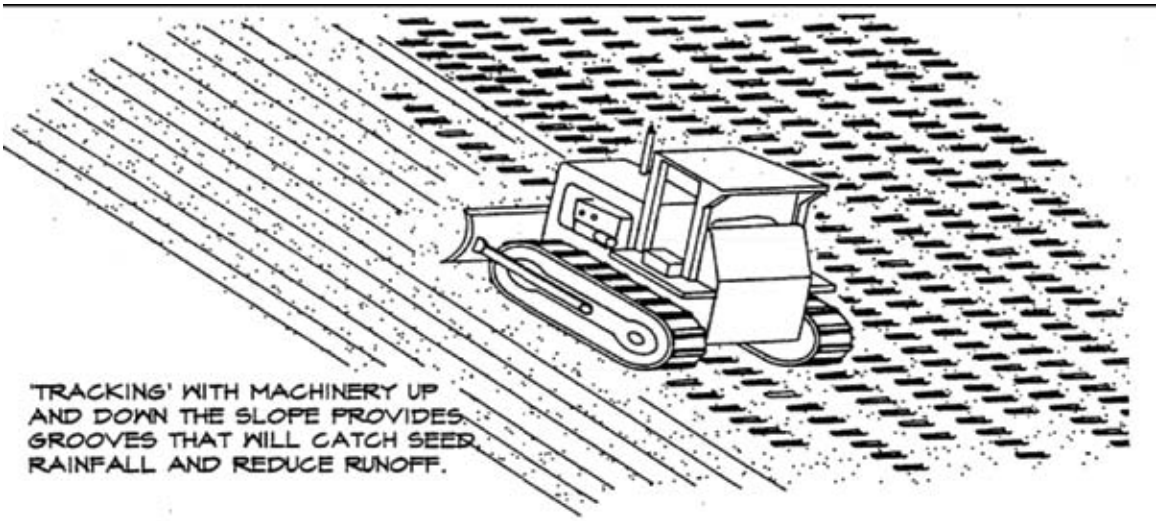
- It should be used on constructed slopes where seeding, planting, or mulching are planned as the permanent cover and on graded areas with smooth, hard surfaces and a potential for erosion.

Limitations

- Surface roughening may not be acceptable on slopes that will be mowed frequently.
- Grooving should be limited to slopes flatter than 3:1 (H:V). Tracking is acceptable on slopes 2:1(H:V) and flatter.
- On soils with high clay content tracking can cause excessive surface compaction restricting growing conditions for grass and landscape plantings.
- Surface roughening is not intended to be used as a stand alone BMP. Other forms of erosion and sediment control must be used in conjunction with this BMP.

Standards and Specifications and Application Procedures

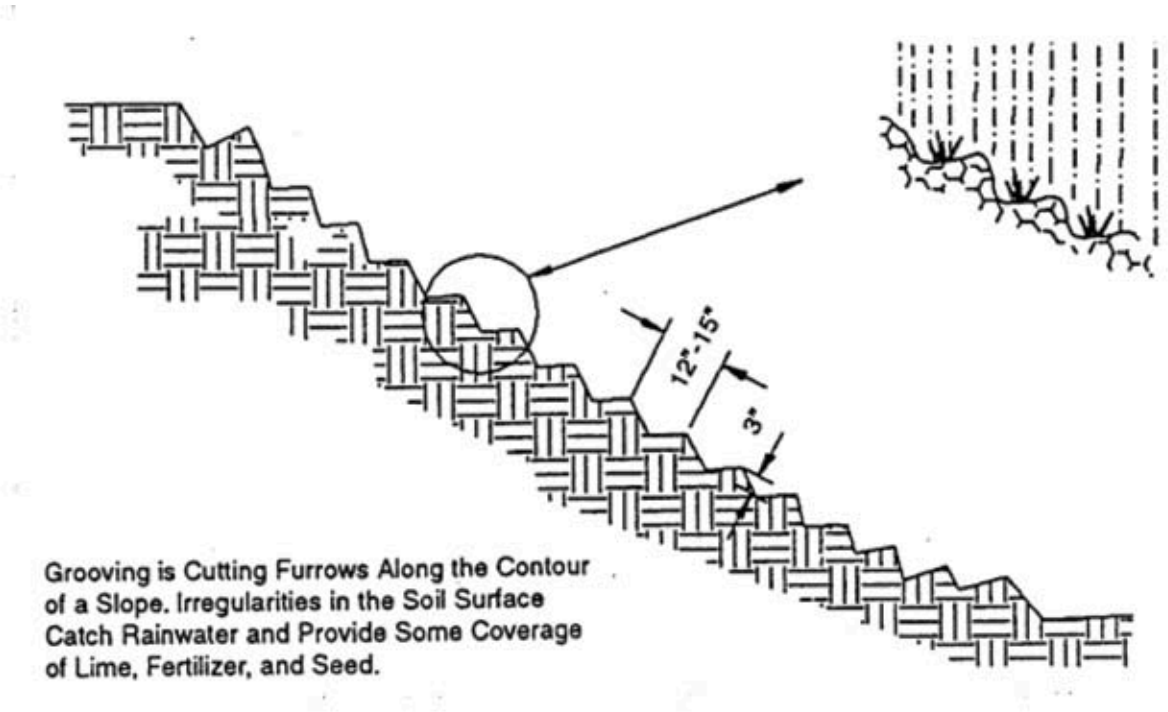
- Tracking - each pass of the equipment should overlap the previous pass, by the width of one track, such that the entire sloped area is roughened. Cleat indents must run perpendicular the slope.
- Grooving - accomplished by cutting furrows perpendicular to the slope. Typical applications include using agricultural equipment such as tillers, or disk harrows. If slope is not to be mowed, grooves should no more than 15 inches apart and not less than 3 inches deep.



TRACKING

Knoxville BMP Manual

Figure 1



Pennsylvania BMP Manual

Figure 2

Maintenance and Inspections

- During construction, slopes shall be inspected weekly and before, during, and after any storm event. Since wet slopes should not be accessed by equipment, eroded areas resulting from precipitation should be stabilized with other BMPs. Make any repairs within 24 hours.

10. GRADIENT TERRACE

Definition and Purpose

Gradient terraces are benches constructed into long slopes to interrupt surface runoff. By doing so it shortens the flow length over the slope and promotes infiltration. This will reduce the volume and depth of runoff and therefore the erosive power of the runoff.

Gradient terraces divert runoff from the slope face to a stable outlet.

They are intended as a permanent practice to protect a slope from slumping, sloughing, or excess ice build-up during winter months, but also help protect newly constructed vegetated slopes until vegetation is established.

Appropriate Applications

- Gradient terraces are suitable for any slope that is susceptible to erosion.
- Gradient terraces are an excellent BMP for slopes that are designed to be vegetated but are constructed from late summer into the fall and will not have adequate time to establish vegetative root development before the end of the growing season.

Limitations

- Gradient terracing is not intended to be used as a stand alone BMP. Other forms of erosion and sediment control must be used in conjunction with this BMP.
- Site conditions such as right-of-way limitations, ledge, or design restrictions may limit the potential for altering slopes.

Standards and Specifications

- Each terrace must be sufficiently stabilized with an appropriate channel lining to handle concentrated flows. Terraces must also discharge to a stabilized area capable of handling flows without eroding.
- Terraces shall be a minimum of eight feet wide to provide for ease of maintenance.
- Terraces shall be designed with a reverse slope of 6:1 or flatter to the toe of the upper slope and with a minimum depth of one foot, providing a shallow ditch for conveyance of water runoff.
- Terraces shall have a minimum longitudinal slope of 0.5% and maximum of 2.0% for drainage purposes, and shall convey runoff to a stable channel or outlet area such as a temporary slope drain or riprap downspout.
- Terraces shall be installed to the maximum vertical spacing shown in Table 1.

Terrace Spacing Slope (H:V)	Maximum Vertical Spacing Between Terraces (feet)	Maximum Slope Length Between Terraces (feet)
2:1	20	45
3:1	30	95
4:1	40	165

Table 1

- Terrace length across slope shall not exceed 800’ of flow in one direction.

Application Procedures

- Gradient terraces shall be designed by a professional engineer.
- Install gradient terraces as designed, beginning at a stable outlet and proceeding across the slope.

Maintenance and Inspections

- The contractor should inspect gradient terraces weekly and before, during, and after storm events until final vegetative cover is established.
- Make any repairs within 24 hours.

11. HILLSIDE DIVERSION

Definition and Purpose

Hillside diversions are constructed channels across the top of a slope with a supporting berm on the downhill side which is used to divert surface runoff away from the slope face, decreasing the watershed and therefore minimizing the depth of runoff and the erosive power of the runoff.

They can be temporary practices until vegetation is established or as permanent practices for long term stabilization. Temporary hillside diversions are installed during construction to provide added protection to a seeded slope until the required percent vegetative cover has been established. Permanent hillside diversions are intended to provide a long term reduction in runoff volume. They are usually used where additional surface runoff volumes will hinder vegetation growth, or cause slope slumping, sloughing, or excess ice build-up during winter months.

Appropriate Applications

- Hillside diversions are suitable for any slope that is susceptible to excess runoff from a contributing watershed.
- The primary application is to intercept sheet and shallow concentrated runoff, but if properly designed they may be used to divert concentrated flow.

Limitations

- Temporary hillside diversions are not intended to be used as a stand alone erosion control BMP. Other forms of erosion and sediment control must be used in conjunction with it.
- Site conditions such as right-of-way limitations, ledge, or design restrictions may limit access to the top of the slope.

Standards and Specifications

- Temporary Hillside Diversions
  - Refer to Standard Detail Drawing.
  - Location should be determined by considering the outlet conditions, topography, land use, soil type, length of slope, groundwater seepage, (place below seeps and springs) and the project scope.
  - A non-erosive channel lining (riprap, erosion control blanket, sheet plastic) shall be installed.
  - The outlet shall be stable and non-erosive, typically a temporary slope drain.
  - Design must be approved by the Resident.

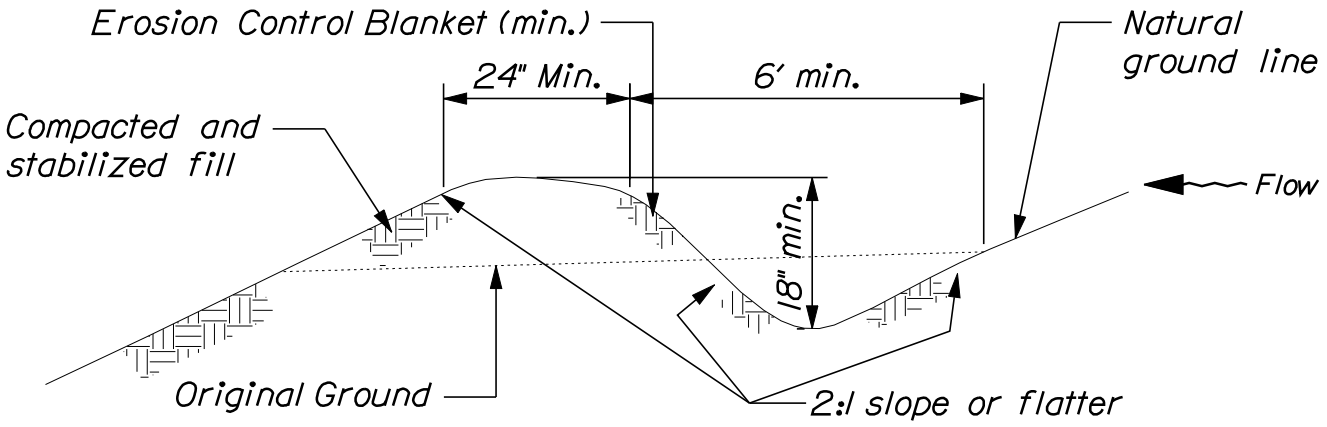
- Permanent Hillside Diversions
    - Shall be designed by an engineer.
    - Shall be designed to carry a minimum of the 10 year, 24 hour flow with a minimum freeboard of six inches.
    - If failure of the diversion may cause property damage it shall be designed to carry a higher frequency storm event.
    - The channel lining should be vegetated. If site conditions will not support vegetation, riprap is acceptable.
    - The outlet shall be stable and non-erosive, typically a riprap downspout.
    - Cross sectional areas may be constructed by cut and fill. See standard drawing.

Application Procedures

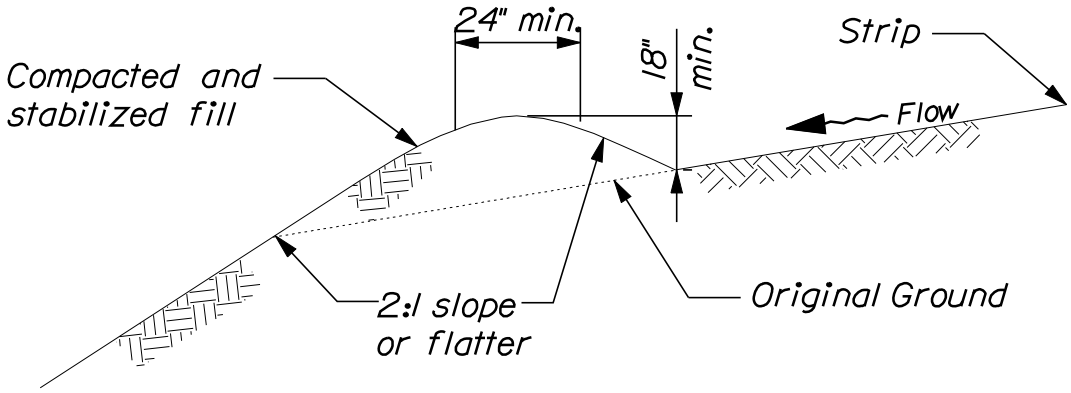
- Install hillside diversion as designed, beginning at a stable outlet and proceeding up hill.
- The diversion shall be excavated or shaped to line, grade, and cross-section as required meeting the criteria specified, free of irregularities which will impede flow.
- Fills shall be compacted by equipment to prevent unequal settlement that may cause damage in the completed diversion.
- All earth removed and not needed in construction shall be reused or disposed of and stabilized so that it will not interfere with the functioning of the diversion.
- All constructed channel sections shall be stabilized by the end of the work day.

Maintenance and Inspections

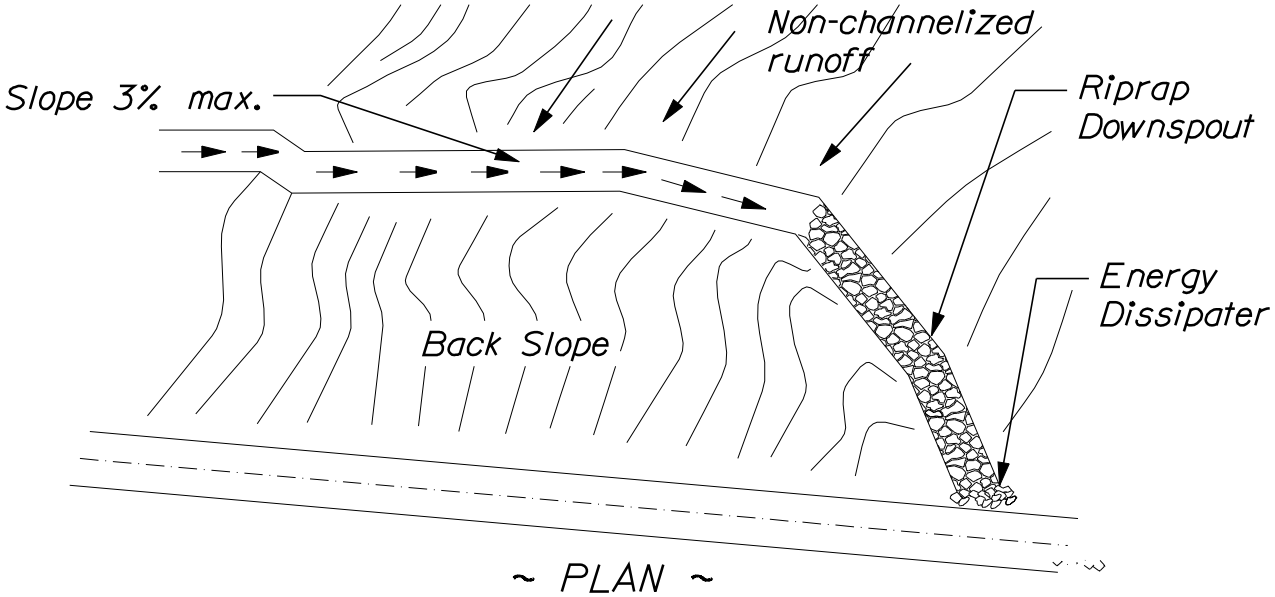
- Temporary hillside diversions shall be inspected weekly and before, during, and after storm events throughout the life of the practice.
- Permanent hillside diversions shall be inspected weekly and before, during, and after storm events until final cover is established.
- Special care should be taken in areas where there is a change in channel grade.
- Make repairs within 24 hours.



~ EXCAVATED DIVERSION ~



~ FILL PLACED DIVERSION ~



~ PLAN ~

NOTE: Dimensions shown are for a temporary hillside diversion; if used as a permanent practice, it must be designed by a professional engineer.

HILLSIDE DIVERSIONS

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