

NATURAL RESOURCES CONSERVATION SERVICE
VIRGINIA ENGINEERING DESIGN NOTE 1 (DN-1)
ROAD DRAINAGE PRACTICES

INTRODUCTION

Proper construction of a road, trail, or walkway will minimize disturbance to waterflow over the landscape and ensure the longevity and stability of the structure. Culverts, surface cross drains, and road profile grading are practices that can be used to provide drainage on access roads and on trails and walkways. For the purposes of this Design Note, the word “road” will encompass all travel-ways constructed using Virginia NRCS Conservation Practice Standards (CPS) *Access Road (Code 560)* and *Trails and Walkways (Code 575)*.

GENERAL CRITERIA

Install surface drainage controls at intervals that remove storm water from the roadbed before the flow gains enough volume and velocity to erode the surface. Avoid discharge onto fill slopes unless the fill slope has been adequately protected. Avoid draining surface water from roads and ditches directly into streams, ponds, lakes, or wetlands. Instead, drain the water into a filter strip or other vegetated area. This is particularly important for manure-contaminated trail or walkway runoff. All structures should convey runoff water to stable outlets at velocities that are non-erosive.

Proper installation of these practices will reduce the amount of sediment entering the water. Improperly installed practices often contribute more sediment to the streams than if the practice were not installed at all. The design of these practices should include selecting the appropriate practice, calculating the minimum spacing needed, routing the road drainage through adequate filtration zones, maintaining the structures, and evaluating the need for energy dissipaters.

The following recommendations should be used to minimize erosion:

1. Control the flow of surface water on roads by using a combination of the appropriate road cross-section and water diversion structures within the roadbed itself.
2. Install cross drains and diversion ditches to avoid carrying water long distances in roadside ditches. Road cross drains may include pipe culverts, broad-based dips, or water bars. A 15” pipe culvert is the minimum recommended size for cross drainage. Smaller culverts can clog with debris and require frequent maintenance.
3. A graveled road surface or a grassed strip on the edge of the driving surface can reduce total loss of sediment from roads by up to 60 percent over a standard graded road surface.

BROAD-BASED DRAINAGE DIPS

Definition. A dip and a reverse slope in the trail or walkway surface with a cross slope in the dip to provide cross drainage. It can be described as a gentle roll in the centerline profile of the

road that is designed to be a relatively permanent and self-maintaining water diversion structure that can be traversed by any vehicle.

Restrictions. Drainage dips should not be used on a road, trail or walkway that has a grade greater than 10 percent. The dip(s) should be installed during initial construction using the following design criteria.

Installation Guide

1. Construct a twenty (20) foot long, three (3) percent reverse grade in the trail or walkway by cutting from upgrade of the dip location and using cut material for the reverse grade.
2. Use Figure 1 in Virginia NRCS CPS *Access Road (Code 560)* for spacing.
3. The cross drain slope will be 3% (approximately 1 inch in 3 feet) in the direction of water flow. Install the cross drain at an angle across the road or trail of 5-30 degrees, as measured from a line perpendicular to the road. The drain should also flair out at about a 30 degree angle. See Figures 1 and 2.
4. The dip and reverse grade section may require bedding with gravel for stability.
5. Outlet dips onto undisturbed or stable areas. Where this is not practical, install an energy absorber such as riprap or, in some cases, a level area where the water can spread, at the outfall of the dip to reduce water velocity.

Figure 1. Broad-based drainage dips – example of usage.

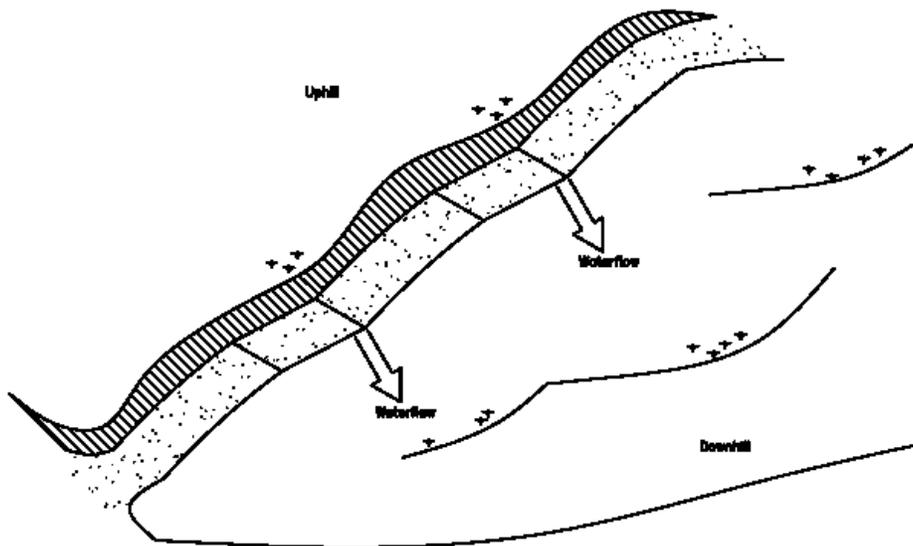
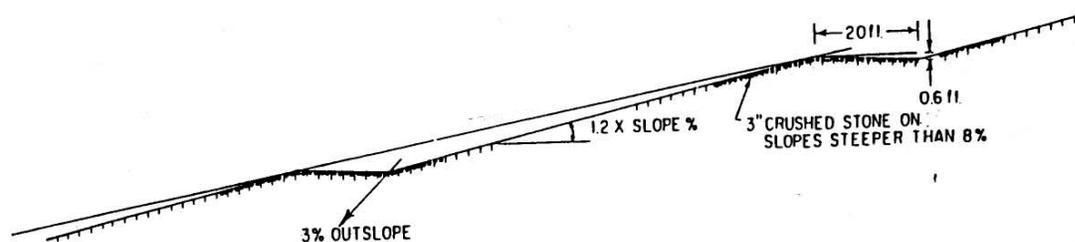


Figure 2. Broad-based drainage dips – dimensions.



NARROW-BASED WATER BARS (BREAKS)

Definition. A combined shallow trench and ridge made of earth, rocks, or logs constructed diagonally across a trail or walkway to remove and disperse surface runoff from the trail or walkway. A water bar can be used to divert water from an inside (uphill) ditch. Typical length of structure is 6-12 feet.

Installation Guide

1. Dig a shallow trench 6" to 12" deep at an angle of approximately 30-45 degrees down-slope to turn surface water off the road.
2. The outflow end of the bar should be fully open and extend far enough beyond the edge of the road to safely convey runoff water away from the road surface. Protect the outflow area of the water bar with a buffer or filter zone to clean the sediment out of the water and prevent erosion.
3. Tie the uphill end of the bar into the cut bank of the road or trail, or into the upper bank of the side ditch to fully intercept any ditch flows. Use the spacing guidance from Figure 1 in Virginia NRCS CPS *Access Road (Code 560)*. Figures 3 and 4 show locations and dimensions.

Figure 3. Narrow-based Water Break – example of usage.

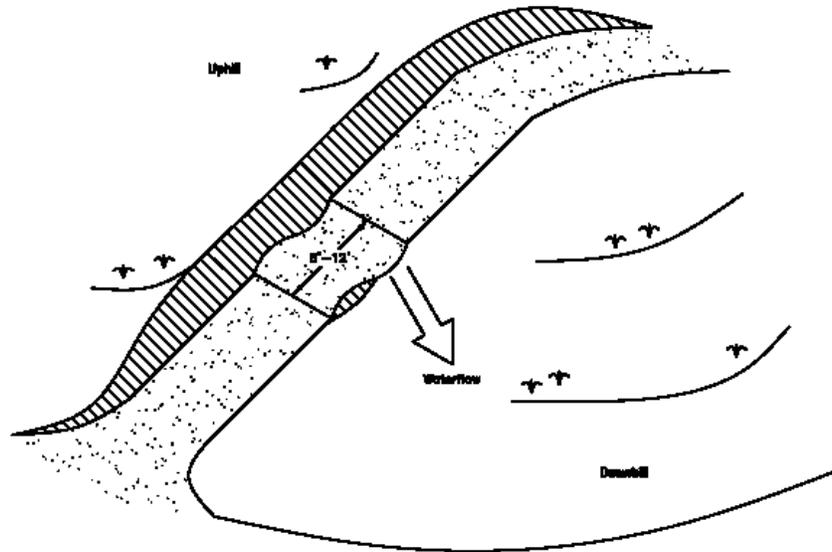
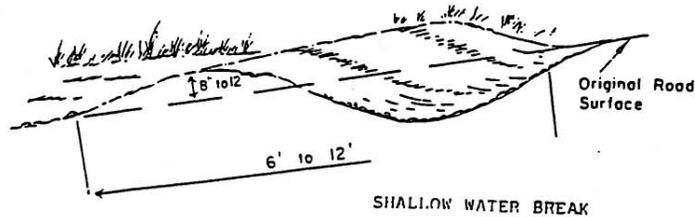


Figure 4. Narrow-based Water Break – dimensions.



CROSS DITCH OR RELIEF CULVERTS

Definition. Pipe made of metal, plastic, or other suitable material installed under road to transmit water from an inside ditch to the outside edge of a road for dispersion. Use Virginia NRCS CPS Structure for Water Control (Code 587).

Installation Guide

1. Both ends of the pipe will extend at least one foot beyond the side slope of the fill material.

2. Place the culvert on a 1%-2% downgrade to prevent clogging. Lay the pipe so the bottom of the culvert is as close as possible to the natural grade of the ground or drain.
3. Angle the culvert across the road at a downslope angle of 30-45 degrees, as measured from a line perpendicular to the road.
4. Protect the inlet and outlet from erosion. This protection can be in the form of headwalls, riprap, geotextile filter fabric, large stone, or prefabricated outflow and inflow devices.
5. On the upstream side of the culvert, a small berm may be installed in the ditch at a point slightly downstream of the inlet to direct water into the culvert.
6. The distance between pipes in a multiple culvert application should be a minimum of half the pipe diameter.
7. Use Figure 1 in the Virginia Conservation Practice Standard *Access Road (Code 560)* to determine the distance between culverts.
8. Refer to the EPA publication *National Management Measures to control Nonpoint Source Pollution from Forestry* for additional information.

ROAD PROFILE GRADING

Definition. Shaping the surface of the road to allow drainage. The road or trail profile can influence the drainage and stability characteristics of the road. Outsloping, insloping, crowning, and grading can be used to minimize water accumulation on roads. Figure 5 shows the possible configurations and the optimum location for use.

Outsloping. Outsloping involves grading a road so that the entire width of the road slopes away from the road cut, and it is appropriate when fill slopes are stable and drainage will not flow directly into stream channels. Outsloping the roadbed keeps water from flowing next to and undermining the cut bank and it is intended to spill water off the road in small volumes along its length. The effectiveness of outsloping is limited by roadbed rutting during wet conditions.

Installation Guide – Outsloping

1. Provide a 2 to 3 percent outslope for the entire width of the road.
2. Construct a drainage dip to turn water off the surface.
3. Providing a berm on the outside of an outsloped fill during construction, and until loose fill material is protected by vegetation, can eliminate erosion of the fill. (A continuous berm along a roadside can reduce total sediment loss by an average of 99 percent over a standard graded soil road surface. Berms need to have openings provided to allow water to drain off the road surface at appropriate locations where a

suitable infiltration or sediment trap site is reached. Natural berms that form along the road over time should be cut at appropriate locations to provide drainage.

Insloping. Insloped roads carry road surface water to a ditch along the cut bank.

Installation Guide – Insloping

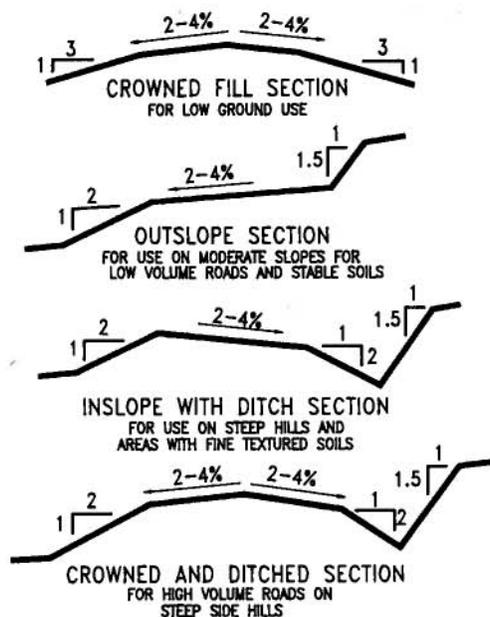
1. Ditch gradients of between 2 and 8 percent usually perform best. Slopes greater than 8 percent give runoff waters too much momentum and enough erosive force to carry excessive sediment and debris for long distances. Slopes of less than 2 percent tend to cause water to drain too slowly and do not provide the runoff with enough energy to move accumulated debris. The ditch grade also depends on the soil type: Use a slope closer to 2 percent on less stable soils and nearer to 8 percent on stable soils.
2. Use Virginia NRCS CPS *Structure for Water Control (Code 587)*, *Lined Waterway or Outlet (Code 468)*, or *Grade Stabilization Structure (Code 410)* as needed to install the ditch.

Crowned Road Surface. A crowned road surface is a combination of an outsloped and insloped surface with the high point (crown) at the center of the road. The crowned road provides drainage to both sides of the roadway.

Installation Guide – Crowned road surface

1. From the crown, slope the road at a grade of 2-4% to the edges.
2. Place a drainage ditch or water control structure next to the road on the insloped side. Direct the runoff to an appropriate grassed buffer, detention basin, or other sediment control structure. Use Virginia NRCS CPS *Structure for Water Control (Code 587)*, *Lined Waterway or Outlet (Code 468)*, or *Grade Stabilization Structure (Code 410)* as needed to install the ditch.

Figure 5. Typical Road Design for Drainage, Stability, and Safety. (From Virginia DOF)



REFERENCES

- Best Management Practices (BMP) Field Guide.* Virginia Department of Forestry. July 2002.
- National Management Measures to Control Nonpoint Source Pollution from Forestry.* EPA 841-B-05-001. U. S. Environmental Protection Agency. May 2005.
- Pennsylvania Conservation Practice Standard *Animal Trails and Walkways (Code 575)*, June 2003.
- Tennessee Conservation Practice Standard *Animal Trails and Walkways (Code 575)*, May 2003.
- Virginia's Forestry Best Management Practices for Water Quality.* Virginia Department of Forestry. July 2002.
- Woodlands of the Northeast, *Erosion and Sediment Control Guides.* Prepared by USDA Soil Conservation Service, Northeast Technical Center, Broomall, PA and USDA Forest Service, Northeastern Area State and Private Forestry, Upper Darby, PA. 1977.