COMMONWEALTH OF VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY

2025 Virginia Stormwater Management Handbook

Waterbar and Utility Access Road Advisory Committee Meeting #5

Tuesday December 2, 2025

Meeting Location:

Department of Environmental Quality Piedmont Regional Office

Winter Training Room

4949-A Cox Road, Glen Allen, VA 23060

Start – 1:00 PM, Estimated End – 3:00pm

Welcome and Introductions	DEQ Staff
FOIA Reminder	DEQ Staff
Utility Access Roads	All, Facilitated by DEQ Staff

- Review of draft sent by DEQ
- Discussion of Advisory Committee members comments and proposed revisions

Public Forum	All
Next Steps	DEQ Staff
Wrap Up	DEQ Staff

Draft Permanent Linear Utility Access Road (11-17-25)

1.0 Definition

A Permanent Linear Utility Access Road is the construction of a new permanent access road or the expansion and improvement of an existing impervious road for the operation and maintenance of a linear utility.

Commented [KA1]: This applies to all utilities not just electric and not just S&S as defined in the Virginia Utilities Act.

Commented [KA2R1]: Discuss at end of meeting - IMPORTANT NOTE - NO WHERE IN 9VAC25-875 OR 9VAC25-880 IS THERE A DEFINITION OF "UTILITY" ONLY EXAMPLES. Should we consider defining?

2.0 Purpose & Applicability of Best Management Practice

This specification applies to permanent access roads that are being developed to support the operation and/or maintenance of linear utility projects and support activities specifically associated with and directly adjacent to the linear utility under construction. This specification applies to development of new access roads on existing pervious surfaces, and the expansion or improvements of existing impervious roads. This specification does not supersede any restrictions or requirements for environmentally sensitive areas, including Resource Protection Areas (RPA).

This Best Management Practice (BMP) is used to:

1. Allow for permanent linear utility access roads that are designed and constructed such that they satisfy the water quantity requirements as outlined in this specification; however, water quality requirements must be addressed independently.

3.0 Planning and Considerations

Due to erosion and sedimentation concerns arising from access roads with a surface cover of exposed soil, this specification is written to address access roads constructed with an open graded gravel or stone surface. A properly maintained graveled or stone surface limits the potential for sediment-laden runoff, erosion and potential impacts to downstream properties.

Inadequately stabilized construction and maintenance of access roads are especially susceptible to erosion. The exposed soil surface is continually disturbed and recompacted with traffic, leaving little opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff along their surfaces. During wet weather, these exposed areas often become muddy and can generate significant quantities of sediment-laden runoff that may pollute downgradient streams or transport it offsite on the wheels of construction vehicles. Aggregate as a surface stabilization measure, when installed in accordance with this specification can promote infiltration and decrease runoff.

During construction and prior to restoration, areas within the limits of disturbance, including access roads, must be designed to meet DEQ requirements for erosion and sediment control established in 9VAC25-875-560. In circumstances where karst features are present, site specific considerations including but not limited to an engineered design may be required.

To avoid erosion, compaction, and potential runoff issues when siting a permanent utility access road, follow the planning steps recommended below:

1. Recommend coordination with resources agencies (e.g., Virginia Department of Conservation and Recreation, Virginia Department of Wildlife Resources, Virginia Department of Historic Resources) to

determine the appropriate areas for access routes, taking into consideration aquatic resources and sensitive areas including karst resources to minimize disruption.

2. Evaluate information from the Natural Resources Conservation Service (NRCS) Web Soil Survey, U.S. Geological Survey, National Wetlands Inventory, and other available resources to determine the most appropriate areas for access routes avoiding areas of highly erodible soils, karst topography, wet or rocky areas, and areas with seasonally high-water tables to the maximum extent practicable, to avoid challenging construction and maintenance.
3. Evaluate existing public and private roads, drives, and trails for possible project use (where feasible). If existing roads are to be utilized, consider and evaluate the following:
    a. Existing road infrastructure to confirm it is adequate for potential traffic conditions (turning radius, width, structural stability, grade, etc.).
    b. Existing culverts and ditch lines for function, sizing and stability.
    c. Potential BMPs necessary for project use and compatibility with current private road use.
    d. Existing land cover and potential changes that may occur during project use (short and long-term).
    e. Potential landowner requests for any/all road improvements to remain following project completion.
4. Evaluate the site topography to locate natural benches and flatter slopes, use these areas for access routes. Avoid long, steep road grades and narrow valleys.
5. Evaluate upslope watersheds that may contribute stormwater runoff onto the road surface which may warrant design measures to address potential run-on and conveying through drainage.
6. Evaluate aquatic resources in the area to minimize stream and/or wetland crossings. Where crossings are unavoidable, ensure appropriate permitting and consider the following:
    a. Cross at right angles to minimize the length of the crossing.
    b. Cross where the resource is narrowest and upland areas are most stable.
    c. Minimize the number of crossings to the maximum extent practicable.
    d. Span the resource without disturbing the bank on either side.
    e. Leave a buffer zone of undisturbed ground between the road and resource, where the road runs parallel to the resource.
    f. More stringent wetland permit requirements supersede the considerations listed above.
7. Where possible, use switchbacks to lessen the road grade on steeper sloped areas.
8. Locate roads on stable geology that includes well-drained soils and rock formations that tend to dip into the slope. Avoid slumps and slide-prone areas characterized by steep slopes, highly weathered bedrock, clay beds, concave slopes, hummocky topography, or rock layers that dip parallel to the slope.
9. Ridge tops can be good places for roads if proper drainage can be constructed. Be aware that conditions may change when constructing during the dry season. Be prepared to address stormwater concerns seasonally as hidden springs, seeps and streams may be more evident in the winter and spring (See 9VAC25-875-560).
10. If possible, build roads on the drier south- or west-facing slopes.
11. Implementation of construction and restoration best management practices and operational controls should be considered to mitigate fugitive dust emissions.
12. Roads often cross drainage patterns so controlling the flow and direction of runoff across the road is paramount. Adequately sized and stabilized ditches to catch minor hillside runoff should be considered when sheet flow across roads or broad based dips are not possible or create erosion or slope stability concerns.

The design goal is to maintain the existing hydrologic conditions and patterns to the maximum extent practicable and disperse runoff such that erosion and downstream flooding does not result.

4.0 Stormwater Performance Summary

MS-7: Cut and Fill Slopes – Cut and fill slopes will be designed and constructed in a manner that will minimize erosion. It is important that slopes are properly seeded and mulched to establish permanent vegetation so erosion by concentrated flow does not occur. Roughening the surface and other soil bed preparation actions can help decrease runoff by lowering the velocity of flow and increasing water retention, which leads to better seed germination and root bed health.

MS-19: Adequate Stormwater Conveyance to Adequate Stormwater Outfall – Permanent access roads designed and constructed in accordance with this specification that drain with sheet flow, not concentrated flow, are compliant with water quantity requirements; however, water quality requirements must be addressed independently.

9VAC25-875-560

Erosion Control Efficiency: MODERATE

Sediment Removal Efficiency: LOW

Water Quality Compliance:

The Virginia Stormwater Management Program Regulation requires the use of the Virginia Runoff Reduction Method (VRRM), or another equivalent methodology approved by DEQ, for compliance with the water quality criteria, 9VAC25-875-580. The VRRM requires that the post-development landcover conditions of a site be classified into one of four (4) landcover categories (i.e. Impervious, Managed Turf, Mixed/Open, or Forested) for nutrient load reduction requirement calculations.

- Compaction will be limited during construction through the use of low impact construction practices and void space inherent in the angular open graded aggregate (i.e. limited proof rolling, gravel topdressing, use of tracked equipment, etc.).
- Compaction will be limited post construction due to the infrequent vehicular traffic proposed.
- Water quality will be addressed with onsite post-construction BMPs or the purchase of nutrient credits.

5.0 Design Criteria

The permanent linear utility access road design should follow the contour of the natural terrain and limit the channelization of water to the maximum extent possible. Specifications have been provided below to encourage the design in this manner, while providing additional options for site specific conditions as the need arises. Virginia has unique physiography and characteristics change between the Appalachian Plateaus, Ridge and Valley Province, Blue Ridge, Piedmont, and Coastal Plain which affect utility installation practices and design strategies that should be addressed to ensure compliance with this specification.

Table C-SCM-14-1. Design Criteria for Permanent Linear Utility Access Roads

Design Criteria for Permanent Linear Utility Access Roads	
Road Cross-Sections	Five road cross-sections are typically used in road construction: (1) crowned fill; (2) crowned turnpike; (3) outslope; (4) inslope with ditch; and (5) crowned and ditched (Figure C-SCM-14-1).

Design Criteria for Permanent Linear Utility Access Roads	
	The choice of which cross-section to use depends on the drainage needed, soil stability, slope, and the expected volume of traffic on the road. The cross-sections can be used in combination as the terrain changes or as drainage issues are encountered. • **Crowned Fill Section:** Use on flat ground where water standing on a road surface may be a problem. • **Crowned Turnpike Section:** Use on low ground roads where fill is not available. • **Outslope:** Use on moderate slopes for low-volume roads and stable soils. Outsloping can be more dangerous in wet and snowy weather. • **Inslope with Ditch Section:** Use on steep hills, areas with fine-textured soils, and where drainage is necessary to prevent erosion and ensure slope stability. • **Crowned and Ditched Section:** Use on high-volume roads on steep side hills.
Road Width	Construct roadbeds to be a maximum of 14 feet wide and a maximum of 24 feet wide and 100 feet long for passing areas every 2000' or more on average as needed.
Alignment (Natural Resources Conservation Service 2021)	Adapt the gradient and horizontal alignment to reflect the intensity of use, the mode of travel, the type of equipment, loading, and the level of development. Frequent grade changes generally cause fewer erosion problems than long, continuous gradients. Design horizontal curves and switchbacks with sufficient radius for trucks and other large vehicles to negotiate easily. A radius of no less than 35 feet for standard vehicles and 50 feet for tractor-trailers is recommended unless site specific conditions demonstrate otherwise. Permanent linear utility access roads should not be constructed within sinkholes (as defined by a closed topographic depression) or over cave entrances.
Road Grade	Road grade is the single most important factor in planning a low-volume road. Where feasible, permanent linear utility access roads are intended to follow the contour of the existing terrain, keeping road grades to a minimum. If possible, do not exceed 10%. Exceeding these grades typically results in the transport of gravel from the roadbed and generally makes for poorly stabilized conditions on steeper road grades. Problematic conditions include ruts forming more easily and higher runoff velocities, which causes gullies and rill erosion along the roadbed and downstream areas. In conditions where gravel transport is possible, broad based dips or other means of collecting and directing surface water away from the roadbed to a stabilized area should be considered.
Road Embankment Side Slopes (Pennsylvania Department of Environmental Protection [PADEP] 2012)	Construct all cuts and fills to be 2H:1V or flatter to the extent possible. Slopes 2H:1V or steeper shall use Soil Stabilization Blankets and Matting (BMP C-SSM-05) to ensure final stabilization, among any other applicable VSMH practices. Minimize cuts and fills where possible. Long and/or high cut/fill slopes are often difficult to stabilize. In soils with low shear strength, these slopes also pose an increased potential for slope failures. Stabilize cut and fill slopes as soon as possible, but no more than seven (7) calendar days, after reaching final grade in accordance with Permanent Seeding (BMP Specification C-SSM-10) and Soil Stabilization Blankets and Matting (BMP_-C-SSM-05).
Drainage Ditches	Permanent linear utility access road designs promote diffuse flow patterns and limit the channelization of water to the maximum extent practicable by utilizing open graded

Commented [KA3]: Should we specifically mention sheet flow here?

Design Criteria for Permanent Linear Utility Access Roads	
	aggregate as defined in this specification. Where diffuse flow patterns cannot be achieved, drainage ditches may be needed. To minimize drainage areas and flows to each ditch, the maximum allowable depth shall be 1 foot. Drainage ditches may discharge through ditch turnouts, disconnects, plunge pools, and other approved energy dissipating devices to promote sheet flow and infiltration. Drainage ditches that discharge concentrated flow to a channels **shall discharge to an adequate and stabilized outfall in accordance 9VAC25-875-600**.
Stabilization	**Stone:** Apply a 6-inch course of clean open-graded angular aggregate, as defined in VDOT Road and Bridge Specifications, Section 203, Table II-3 with no component finer than the No. 8 Sieve or an equivalent mix, immediately after grading. A combination of different stone classifications found in Table II-3 may be used to withstand loading conditions and prevent footprint migration if specified in the approved plans. A geotextile may be applied to the roadbed surface before coarse aggregate placement. Design specifications for geotextile are provided in Temporary Stone Construction Entrance (BMP-C-SCM-03). In "heavy duty" traffic situations, place stone at an 8- to 10-inch depth to avoid excessive migration or maintenance needs. If a geogrid system is to be used follow manufacturer's material installation specifications and conditions in this specification, whichever is more stringent.
~~**Permanent Right-of-Way Diversion**~~	~~Permanent Right-of-Way Diversions shall be constructed in accordance with specification C-ECM-07. The minimum height of permanent right-of-way diversions will be reduced to 12-inches from the temporary specification, to better accommodate operations and maintenance vehicle traffic.~~
Broad Based Dips (BBDs)	Broad based dips (BBDs) collect flowing water from the road surface ~~and ditches~~ and direct it across the road to a stable outlet on road grades less than 10%. They are constructed as a gentle roll in the centerline profile of the road that is meant to be permanent as a self-maintaining water diversion structure with mild slopes that can be traversed by vehicles. ~~from the uphill ditch across the road to an outlet~~. A BBD can prevent accelerated aggregate loss and sediment generation by stopping drainage from flowing a long distance in wheel tracks or ruts. BBD's are the preferred low impact method for conveying water across utility access roads on gentle grades and dispersing the flow. CONSTRUCTION CONSIDERATIONS SPACING: Multiple BBDs can be used in sequence, to drain a long stretch of road. Suggested spacing is provided in Table C-SCM-14-4. Design spacing for BBDs depends on site-specific conditions including road slope, upslope drainage areas and flows, soil type and downstream conditions. SIZE & SHAPE: Size determination for BBDs will vary depending on road slopes and anticipated traffic. BBDs on flat roads may be relatively small, with slight elevation changes and short fill transitions. Whereas dips installed on steeper sections of road will need to be larger and will require longer approaches to ease the transition into and

Commented [KA4]: Is this reasonable? Intent is to break up the flows so they can easily return to sheet flow.

Commented [KA5]: How do we demonstrate this? Calcs? Max ditch depths and slope before calcs required? Matrix like waterbar spacing?

Commented [KA6]: If there is a combination do we want a cross section? Or leave it open for quarry flexibility?

Commented [KA7]: Does anyone use waterbars in access road construction? Do we even need this if we have broad based dips? Should this be the waterbar specification instead where it is reduced to 12" for traffic?

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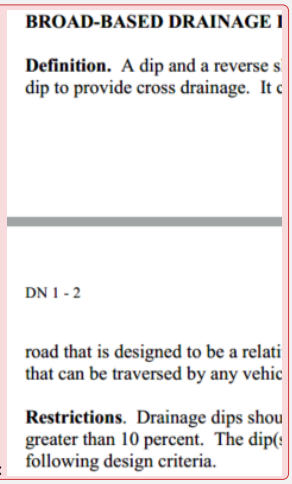


BROAD-BASED DRAINAGE I

Definition. A dip and a reverse s
dip to provide cross drainage. It c

DN 1 - 2

road that is designed to be a relati
that can be traversed by any vehic

Restrictions. Drainage dips shou
greater than 10 percent. The dip(s
following design criteria.

Design Criteria for Permanent Linear Utility Access Roads	
	out of the structure. Be sure to take anticipated traffic, including the type and amount, into account. A relatively wide channel in the dip bottom is recommended to disperse flows as well as easing vehicle transitions. The upslope end of the dip should be tied into the uphill bank to ensure water does not bypass the structure. ANGLE: BBDs should be angled across the road at approximately 20-40 degrees and not placed perpendicular to the road like a speed bump. The angle will facilitate the flow of water across the road. SLOPE: Similar to a cross pipe, the bottom of a BBD should have a continuous elevation drop towards the downstream end for positive drainage. The slope is usually dictated by the grade of the road and the angle of the dip but should be mild in nature to prevent erosive velocities. DIP REINFORCEMENT: Because a BBD is designed to convey flow on the surface of the road, reinforcement of the BBD bottom is recommended, especially on steeper slopes. Open graded aggregate larger than the road surface can be used to reinforce the bottom of the dip to resist erosion if needed. OUTLET REINFORCEMENT: BBDs will be discharged to a permanently stabilized ~~outlet~~ area, preferably a vegetated buffer strip area similar in nature to a Sheet Flow to a Filter Strip or Conserved Open Space (See P-FIL-07). Depending on the flow volume and velocity, additional stabilization methods, such as rock armoring, may be required. MAINTENANCE: A properly constructed BBD will function with minimal maintenance and shall not require perpetual maintenance agreements but will be inspected in accordance with required permits and for maintenance needs along with the utility line itself.
Turnouts and Ditch Disconnects	Turnouts and ditch disconnects are broad flat swales that drain water away from roads or roadside ditches into well-vegetated areas. Turnouts are typically located along crowned roadways while ditch disconnects are located at the terminus of roadside ditches along in-slope or crowned with ditch roadways to return runoff to sheet flow where it may collect due to topography. Locate turnouts and ditch disconnects to take advantage of natural drainage courses or buffer areas where possible. Grade the approach to a turnout on a 2% to 3% slope to allow positive drainage. Ensure that the spoil from turnout construction is not allowed to form a dam at the end of the turnout. Do not discharge water from a turnout or ditch disconnect directly into a stream or waterbody. An excavated sump at the end of the feature can effectively pond and settle out sediment before discharging to an area with characteristics similar to a vegetated filter strip (See P-FIL-07). Where a suitable vegetative filter strip is not available to remove sediment, install a compost filter sock, rock filter or other sediment removal device found in the current VSMH at the outlet of the turnout. Design discharges from a turnout or ditch disconnect to minimize erosion by minimizing the contributing drainage area, breaking up long and/or steep slopes and minimizing or flattening slopes to reduce velocities. ~~Consult Outlet Protection (Specification BMP-C-ECM-14) for design guidance.~~

Commented [KA9]: Does referring to a P-BMP infer that a BMP maintenance agreement is needed? Not the intent.

Commented [KA10]: OP dissipates energy, not trying to infer it is concentrated flow.

Design Criteria for Permanent Linear Utility Access Roads	
	Stabilize outlet as soon as possible after grading in accordance with Permanent Seeding (Specification BMP-C-SSM-10) and Soil Stabilization Blankets and Matting (Specification BMP-C-SSM-05).
Stream or Wetland Crossing	Permanent stream and wetland crossings should be designed on a site-specific basis. Crossings should be designed as close to perpendicular as possible. Observe locality design requirements if more stringent. Ensure all applicable permits are in place prior to installation of stream and wetland crossings.

Source: Technical Bulletin 2/2019, Broad Base Dips, Penn State Center for Dirt and Gravel Road Studies.

6.0 Construction Specifications

Commented [KA11]: This section needs a lot of work. We need to discuss how specific we want to be and do we want it as a numbered process like others.

Before permanent access road construction, install the appropriate erosion and sediment controls downgradient of the construction activity in accordance with the approved plans. Measures may include Compost Filter Socks (BMP-C-PCM-05), Silt Fence (BMP-C-PCM-04), Temporary Sediment Trap (BMP-C-SCM-11), Temporary Sediment Basin (BMP-C-SCM-12), and other structures. Upland disturbance should only commence after proper installation of perimeter controls.

Clear the roadbed of all vegetation, roots, and other objectionable material as necessary.

Upon completion of roadway grading, immediately stabilize cut and fill slopes.

ADD TEMP TO PERM CONVERSION

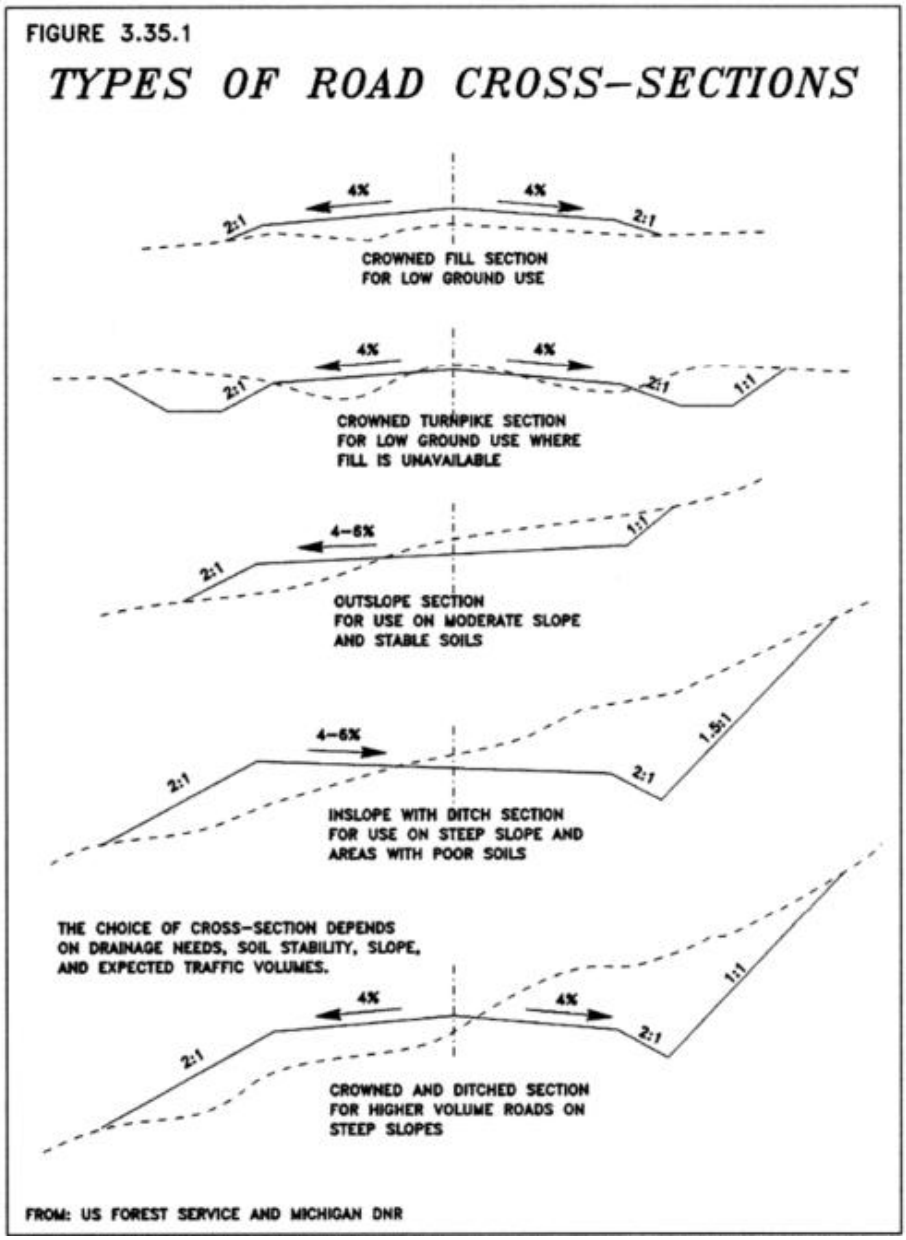


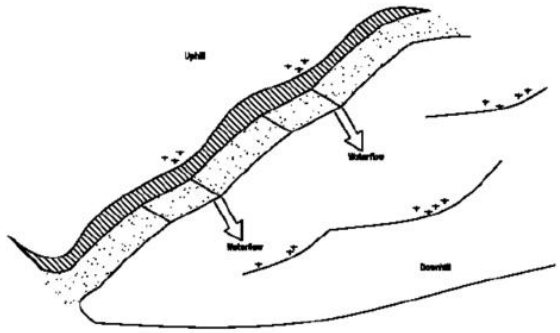
Figure C-SCM-14-2. Types of Cross Road Sections
West Virginia BMP 3.35 – Access Road/Low Volume Road/Driveway, p.3.35-9.

126 *INSERT FIGURES FOR BROAD BASED DIPS, USDA AND FOREST SERVICE EXAMPLES BELOW*

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.



NRCS, VA
October 2014

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Figure 2. Broad-based drainage dips – dimensions.

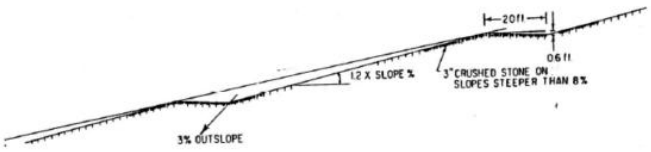

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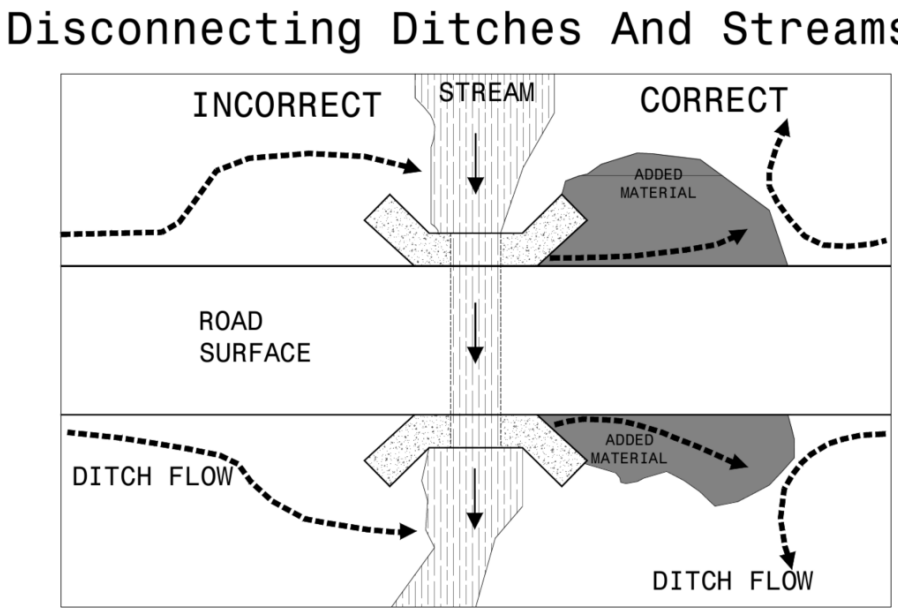
Table C-SCM-14-4 – Suggested Spacing for Broad Based Dips

Suggested Spacing for Broad-Based Dips	
Road Grade (%)	**Distance (ft.)**
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135

Source: Virginia's Forestry Best Management Practices for Water Quality Field Guide October 2019

Commented [KA12]: Revise to Table C-ECM-08-4 or C-ECM-17 for waterbar spacing? Perm WB is by slope, temp WB by drainage area and slope.

Commented [KA13]: What other details do we need? Ditch turnout?



* Aerial depiction of road-stream crossing. The left side of the diagram shows the traditional practice of discharging water to the stream. The right side of the diagram shows material added to redirect ditch flow and outlet water away from the stream.

7.0 Operations and Maintenance Considerations

At a minimum, inspections should occur in accordance with 9VAC25-880-70 Part II G~~, the approved S&S~~ or at a more stringent frequency established by the authority, whichever is more restrictive.

Monitor roadways and cut/fill slopes for gully and rill erosion and sloughing or scour in the ditches. Ensure that the measures have been maintained and are sufficient to capture road surface runoff. If runoff overruns these measures, repair immediately. Inspect culverts, roadside ditches, and outlets and restore flow capacity as needed. If erosion results, additional measures or modifications may be necessary.

Example of Poorly Maintained Vehicular Route Stabilization

Ensure that the proper road cross-section is available, and ~~outlets~~ adjacent areas are adequately stabilized to receive runoff. Repair or replace surface materials, including travel treads, as needed in accordance with this specification to maintain runoff characteristics.

Monitor roads and drainage structures to ensure that the measures do not become clogged with silt or other debris. Remove accumulated debris as necessary to maintain flow capacity. Stabilize disturbed areas immediately following maintenance activities in accordance with 9VAC-875 and~~/or approved S & S and~~ VSMH Specifications.

Monitor seeded areas adjacent to the roads to ensure that vegetation is mature and maintained.

Commented [KA14]: Since S&S agreements now reflect VSMH can we remove?

In certain situations (landowner or land management entity request, etc.), improvements made to pre-existing access roads may be left as the permanent condition by complying with the road criteria in this specification, such that the permanent condition is stable and not eroding. Note conversion from a temporary access road cross-section to the permanent ones defined herein may be necessary.

After completion of construction and permanent stabilization of the disturbed area associated with the linear utility access roads, the roads should function with minimal maintenance. During operation, the roads will be inspected periodically along with typical maintenance and inspection of the utility. If a permanent BMP is not required to meet the water quality or quantity standards per the VSMH then a permanent maintenance agreement is not required.

8.0 References

Dominion Energy. 2019. Erosion and Sedimentation Control and Stormwater Management Control Standards and Specifications for Dominion Energy Electric Distribution. March. Available online at: https://www.deq.virginia.gov/our-programs/water/stormwater/stormwater-construction/bmp-design-specifications.

Natural Resources Conservation Service. 2020. Conservation Practice Standard: Access Road, Code 560. National Standard 560-CPS-1. United States Department of Agriculture, Natural Resources Conservation Service. September. Available online at: https://www.nrcs.usda.gov/resources/guides-and-instructions/access-road-ft-560-conservation-practice-standard.

PADEP. 2012. Erosion and Sediment Pollution Control Program Manual. Final. Technical Guidance Number 363-2134-008. March. Available online at: http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=4680.

Virginia Department of Environmental Quality. 1992. Virginia Erosion and Sediment Control Handbook. Third ed. Available online at: https://www.deq.virginia.gov/our-programs/water/stormwater/stormwater-construction/handbooks.

Wetland Studies and Solutions, Inc. 2020. Erosion and Sediment Control Standards for Wetland and Stream Bank Construction Projects. WSSI #21698.01. Revised September 17. Available online at: https://www.deq.virginia.gov/our-programs/water/stormwater/stormwater-construction/bmp-design-specifications.

Penn State Center for Dirt and Gravel Road Studies. 2019 Technical Bulletin, Broad Base Dips

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.

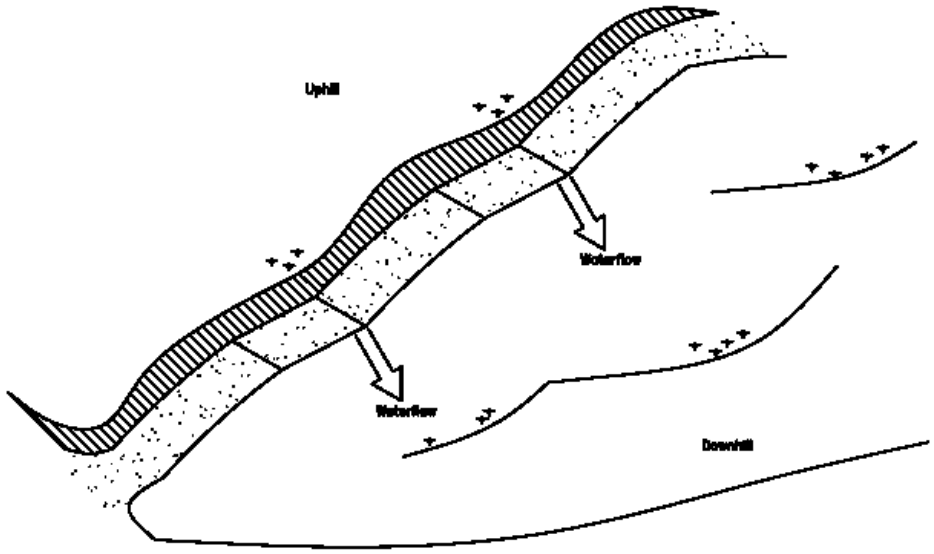
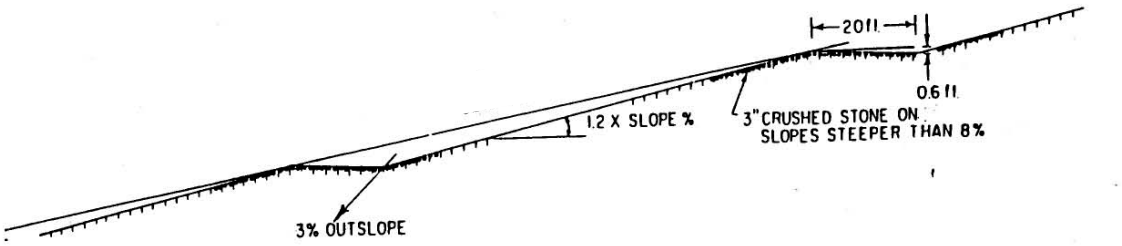


Figure 2. Broad-based drainage dips – dimensions.



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.

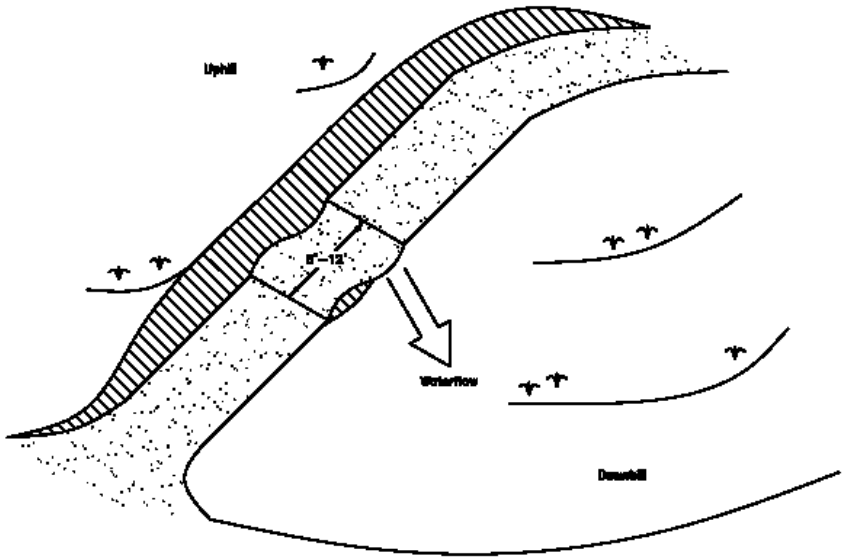
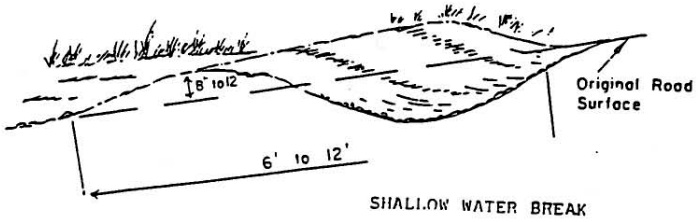


Figure 4. Narrow-based Water Break – dimensions.



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.

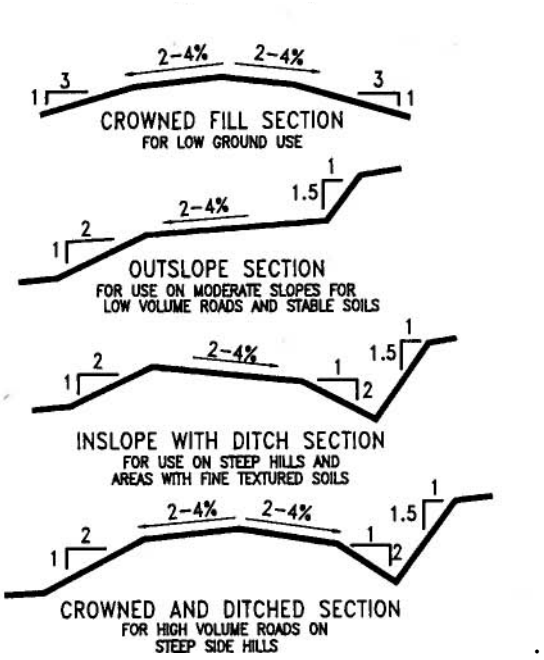
Crowned Road Surface. A crowned road surface is a combination of an outsloped and insloped surface with the high point (crown) at the center of the road. The crowned road provides drainage to both sides of the roadway.

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.

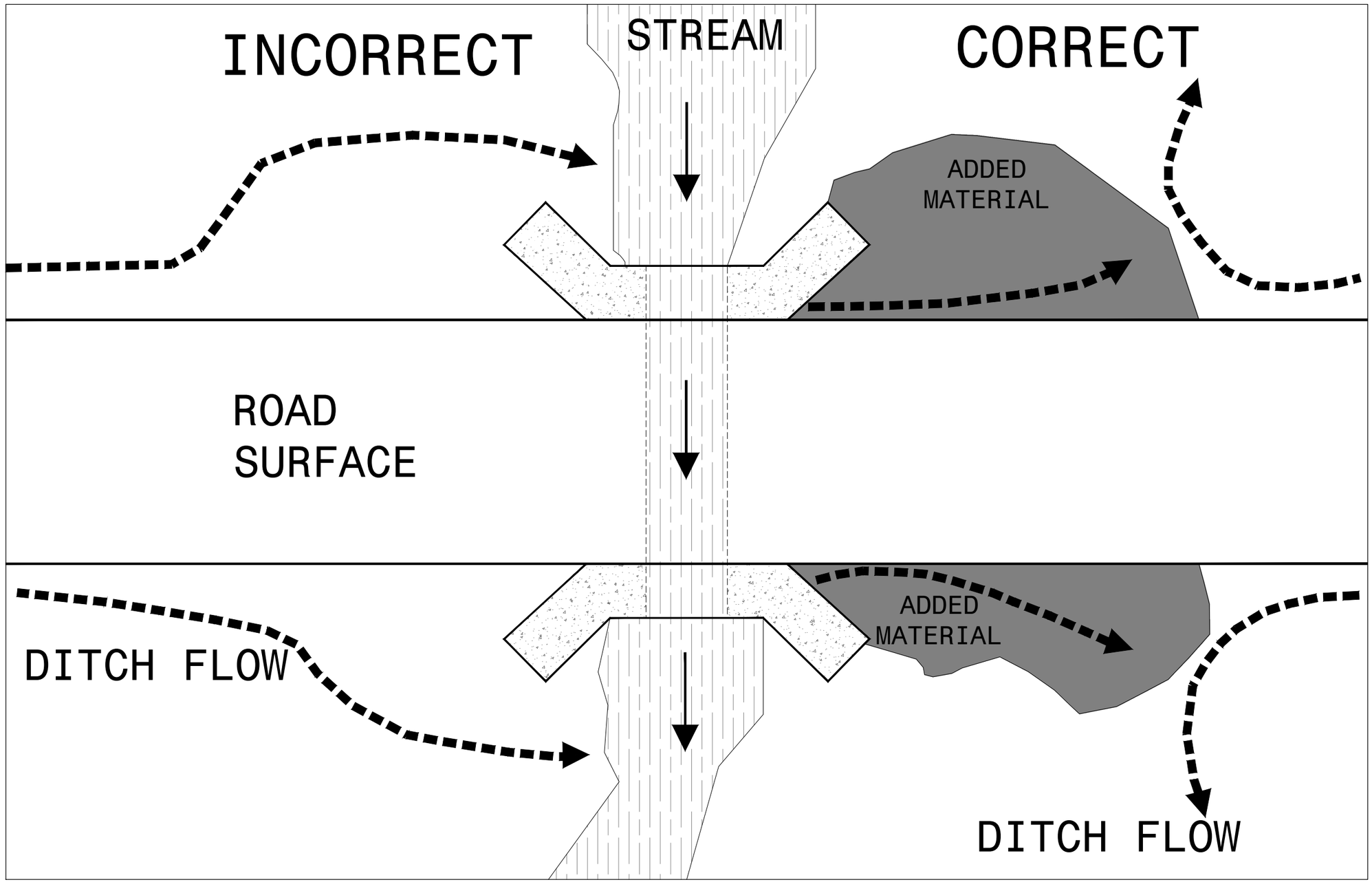
Pennsylvania Conservation Practice Standard *Animal Trails and Walkways (Code 575),* June 2003.

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.

Disconnecting Ditches And Streams



* Aerial depiction of road-stream crossing. The left side of the diagram shows the traditional practice of discharging water to the stream. The right side of the diagram shows material added to redirect ditch flow and outlet water away from the stream.

LUCK STONE

Technical Data

Weight percentages passed through screens

Screen Size VDOT / AASHTO / ASTM	90 mm 3½"	75 mm 3"	63 mm 2½"	50 mm 2"	37 mm 1½"	25 mm 1"	19 mm ¾"	12 mm ½"	9.5 mm ⅜"	4.75 mm #4	2.36 mm #8	2.00 mm #10	1.18 mm #16	850 mm #20	600 mm #30	425 mm #40	300 mm #50	250 mm #60	150 mm #100	75 mm #200
1	90-100		25-60		0-15		0-5													
2		100	90-100	35-70	0-15		0-5													
3			100	90-100	35-70	0-15		0-5												
Rail Ballast			100	90-100	60-90	10-30	0-10		0-1											
5					100	90-100	20-55	0-10	0-5											
357			100	95-100		35-70		10-30		0-5										
56					100	90-100	40-85	10-40	0-15	0-5										
57					100	95-100		25-60		0-10	0-5									
67						100	90-100		20-55	0-10	0-5									
68						100	90-100		30-65	5-25	0-10		0-5							
7							100	90-100	40-70	0-15	0-5									
78							100	90-100	40-75	5-25	0-10		0-5							
8								100	85-100	10-30	0-10		0-5							
8P								100	75-100	5-30	0-5									
9									100	85-100	10-40		0-10				0-5			
10									100	85-100									10-30	
B Slurry Seal									100	90-100	65-90		45-70		30-50		18-33		10-21	5-15
C Slurry Seal									100	70-95	45-70		32-54		23-38		16-29		9-20	5-12
A-Sand									100	95-100	80-100		50-85		25-60		5-30		0-10	
B-Sand									100	94-100									0-10	
21A*				100					63-72			32-41				14-24				6-12
21B*				100					50-69			20-36				9-19				4-7
25					100	90-100				14-50										
26						100	90-100			16-60										
Gabion 4"-8"						85-95														
Rip Rap																				

** Not applicable to North Carolina specifications.
*Grading data provided is a guide only, as each plant has a unique job mix.

D-4-2 STANDARDS AND SPECIFICATIONS

FOR

PLUNGE POOL

Definition

An excavated depression lined with riprap and placed at the outfall of a culvert.

Purpose

To dissipate the energy of a discharge and prevent scour at a pipe outfall.

Conditions Where Practice Applies

Where discharge velocity and energy at a pipe outlet is sufficient to erode the downstream channel reach. This applies to outlets of all types such as road culverts, sediment basins, and stormwater management facilities. Plunge pools are an alternative to rock outlet protection and are preferable in locations where space constraints exist. A plunge pool may be temporary or permanent, based on design.

Design Criteria

1. Select type of plunge pool (larger stone required for Type 1):

   Type I: Plunge pool is depressed ½ the size of the culvert rise.
   Type II: Plunge pool is depressed the full height of the culvert rise.

2. Determine the riprap (d_{50}) stone size for the plunge pool type and design storm flow.

   Type I: $d_{50} = (0.0125d^2/Tw) \times (Q/d^{2.5})^{4/3}$
   Type II: $d_{50} = (0.0082d^2/Tw) \times (Q/d^{2.5})^{4/3}$

3. Determine plunge pool dimensions.

   $C = (3 \times d) + (6 \times F)$
   $B = (2 \times d) + (6 \times F)$

   Where: d_{50} = the median stone size in feet (refer to Table H.2: Stone Size)
   d = the culvert diameter or span in feet
   Tw = the tailwater depth in feet
   Q = the design flow for the culvert, minimum 10-year, 24-hour storm, in cfs
   B = the plunge pool width in feet
   C = the plunge pool length in feet
   D = $2 \times d_{50}$ = riprap thickness in feet
   E = the culvert diameter or span in feet equal to d
   3E = the plunge pool bottom length in feet
   2E = the plunge pool bottom width in feet
   F = plunge pool depth in feet = d (for Type II) or 0.5 d (for Type I)

4. For permanent uses, provide a toewall at the downstream end at a depth twice the (D) dimension and at a width equal to the (D) dimension, on nonwoven geotextile. Extend the rip-rap a minimum of 18 inches under the outlet pipe if the outlet does not have a footer or headwall.

5. Provide an underdrain to a suitable outfall if standing water in the plunge pool is an issue or as required by the appropriate approval authority.

6. Provide the design values on the plans for the following dimensions: B, C, D, E, and F.

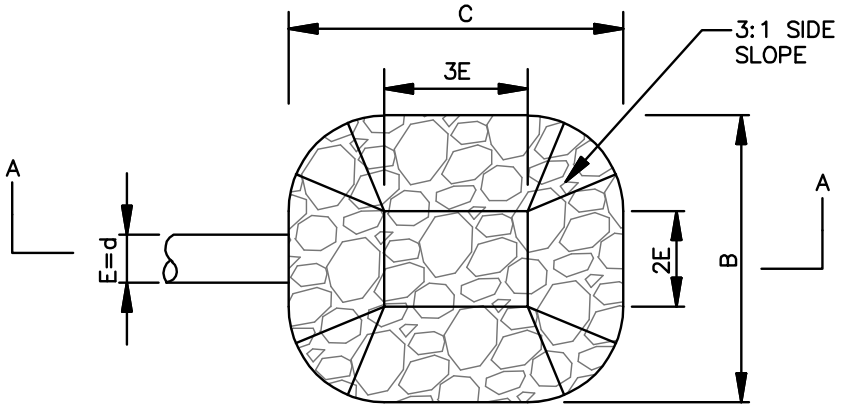
Maintenance

Maintenance needs are generally low for plunge pools. The line, grade, and cross section must be maintained, and the outlet must be kept free of erosion. After high flows inspect for scour and dislodged riprap. Repairs must be made immediately. Accumulated sediment and debris must be removed.

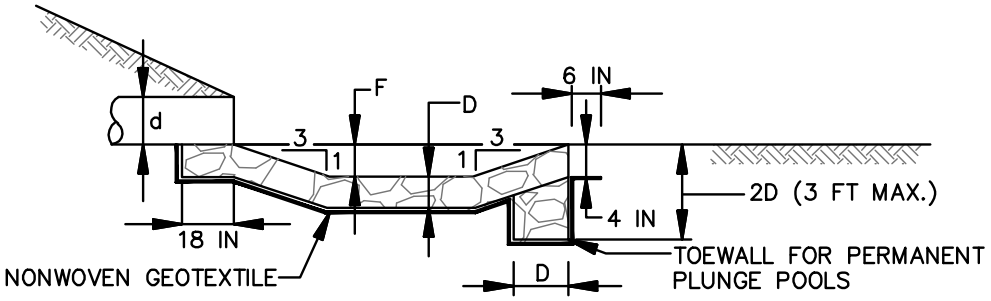
DETAIL D-4-2 PLUNGE POOL

STANDARD SYMBOL

PP



PLAN VIEW



SECTION A–A

CONSTRUCTION SPECIFICATIONS

1. USE SPECIFIED CLASS OF RIPRAP.
2. USE NONWOVEN GEOTEXTILE AS SPECIFIED IN SECTION H–1 MATERIALS, AND PROTECT FROM PUNCHING, CUTTING, OR TEARING. REPAIR ANY DAMAGE OTHER THAN AN OCCASIONAL SMALL HOLE BY PLACING ANOTHER PIECE OF GEOTEXTILE OVER THE DAMAGED PART OR BY COMPLETELY REPLACING THE GEOTEXTILE. PROVIDE A MINIMUM OF ONE FOOT OVERLAP FOR ALL REPAIRS AND FOR JOINING TWO PIECES OF GEOTEXTILE.
3. PREPARE THE SUBGRADE FOR THE PLUNGE POOL TO THE REQUIRED LINES AND GRADES. COMPACT ANY FILL REQUIRED IN THE SUBGRADE TO A DENSITY OF APPROXIMATELY THAT OF THE SURROUNDING UNDISTURBED MATERIAL.
4. EMBED THE GEOTEXTILE A MINIMUM OF 4 INCHES AND EXTEND THE GEOTEXTILE A MINIMUM OF 6 INCHES BEYOND THE EDGE OF THE SCOUR HOLE.
5. STONE FOR THE PLUNGE POOL MAY BE PLACED BY EQUIPMENT. CONSTRUCT TO THE FULL COURSE THICKNESS IN ONE OPERATION AND IN SUCH A MANNER AS TO AVOID DISPLACEMENT OF UNDERLYING MATERIALS. DELIVER AND PLACE THE STONE FOR THE PLUNGE POOL IN A MANNER THAT WILL ENSURE THAT IT IS REASONABLY HOMOGENEOUS WITH THE SMALLER STONES AND SPALLS FILLING THE VOIDS BETWEEN THE LARGER STONES. PLACE STONE FOR THE PLUNGE POOL IN A MANNER TO PREVENT DAMAGE TO THE GEOTEXTILE. HAND PLACE TO THE EXTENT NECESSARY.
6. AT THE PLUNGE POOL OUTLET, PLACE THE STONE SO THAT IT MEETS THE EXISTING GRADE.
7. MAINTAIN LINE, GRADE, AND CROSS SECTION. KEEP OUTLET FREE OF EROSION. REMOVE ACCUMULATED SEDIMENT AND DEBRIS. AFTER HIGH FLOWS INSPECT FOR SCOUR AND DISLODGED RIPRAP. MAKE NECESSARY REPAIRS IMMEDIATELY.

Plunge Pool Design

Project Name: Test Site
Computed by: Me
Date: 4/7/2010

IaPlungePool.xls Ver 1.2
Checked by: _____
Date: _____

	(Inputs)			*(Outputs)*
1) Determine Minimum Riprap Size				
Pipe design discharge (CFS)	42	Q		
Pipe diameter (Ft)	2	D	Minimum Riprap size, d50 (Ft)	0.02
2) Determine Minimum Basin Dimensions				
Selected Riprap Size, d50 (Ft)	0.7	d_50		Riprap size=OK
Conduit Outlet Invert Elevation (Ft)	1061			
Top of Riprap Elevation (Ft)	1061		Minimum Depth (below tailwater) (Ft)	4.9
Tailwater Elevation (Ft)	1060		Min. Bottom Length (Ft)	4.8
Outlet Channel Elevation (Ft)	1059		Min. Bottom Width (Ft)	4.2
Slope Of Conduit Outlet (Ft/ft)	0.0385	S	Pipe Outlet to CL Basin (Xm) (Ft)	11.1
Specific Gravity Of Riprap E.g. 2.65	2.65	Ps	Minimum Riprap thickness (Normal) (Ft)	1.75
3) Select Basin Size, Slopes				
Plunge Pool Depth (below tailwater) (Ft)	5			Depth=OK
			Basin Bottom Elevation (Ft)	1055
Bottom Length (Ft)	5		zl Minimum value (Max Steepness)	1.88
Bottom Width (Ft)	5		zw Minimum value (Max Steepness)	1.58
				Bottom size=OK
Upstream/Downstream slopes (Z:1)	2			Basin Length=OK
Perpendicular Side slopes (Z:1)	2			Basin Width=OK
4) Select Lining Depths				
Lining Depth Method	Vertical Thickness		Vertical/Normal Thickness Multiplier	1.12
			Minimum Riprap thickness (Vertical) (Ft)	1.96
Riprap Thickness (Ft)	2			Riprap thickness=OK
Coarse Filter Thickness (Ft)	0.75			
Fine Filter Thickness (Ft)	0.75		Subgrade Elevation (Ft)	1051.5
Tie In Slope (Z:1)	1		Quantity: Riprap/Coarse/Fine (Cu Yds)	154.04
			Overall Length (US/DS) (Ft)	39
			Overall Width (Ft)	43
5) Determine Stationing of Plunge Pool				
Adjacent slope of dam (Z:1)	3		US edge of Top RR station (Ft)	57+23.3
Elevation of point on DS dam slope (Ft)	1095.1		CL PP Station (Ft)	57+44.8
Station of point on DS dam slope (Ft)	56+21.0		Pipe Outlet Station (Ft)	57+33.7

Miscellaneous Calculations (NRCS Design Note 6)

Vo	13.36901522	Z1	6.13409263		
Vh	13.35912324	Z2	5.547292376		
Vv	11.35151103	Zp/D	0.5		
Vp	17.53062966	Zm	6.13409263		
Xp	4.501774521	Le	11.87812036	Lr Actual	12.5
Fd	2.876394854	We	10.40578058	Wr Actual	12.5

Basic Layout Results

IaPlungePool.xls Ver 1.2

Project Name: Test Site
Computed by: Me
Date: 4/7/2010

Checked by: _____
Date: _____

Inputs needed for *Plunge Pool Layout* CAD Macro

Size & Shape

Top of Riprap Elevation, Ft	1061
Outlet Channel Elevation, Ft	1059
Basin Bottom Elevation, Ft	1055
Basin Bottom Length Ft	5
Basin Bottom Width, Ft	5
Upstream/Downstream Slope, Z:1	2
Perpendicular Side Slope, Z:1	2
Riprap Thickness, Ft	2
Coarse Bedding Thickness, Ft	0.75
Fine Bedding Thickness, Ft	0.75
Riprap Tie In Slope, Z:1	1

Position

Distance from Pipe Outlet to CL of Basin, Ft	11.1

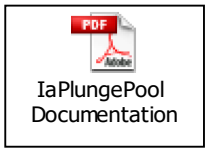
IaPlungePool.xls Ver 1.2
April 7, 2010

Program support:

USDA Natural Resources Conservation Service
693 Federal Bldg
210 Walnut St
Des Moines, Iowa 50309

Calculates the size of a riprap lined plunge pool for energy dissipation from a cantilever outlet pipe.

Double Click Here
to View the Documentation
Adobe Reader is require to open this.



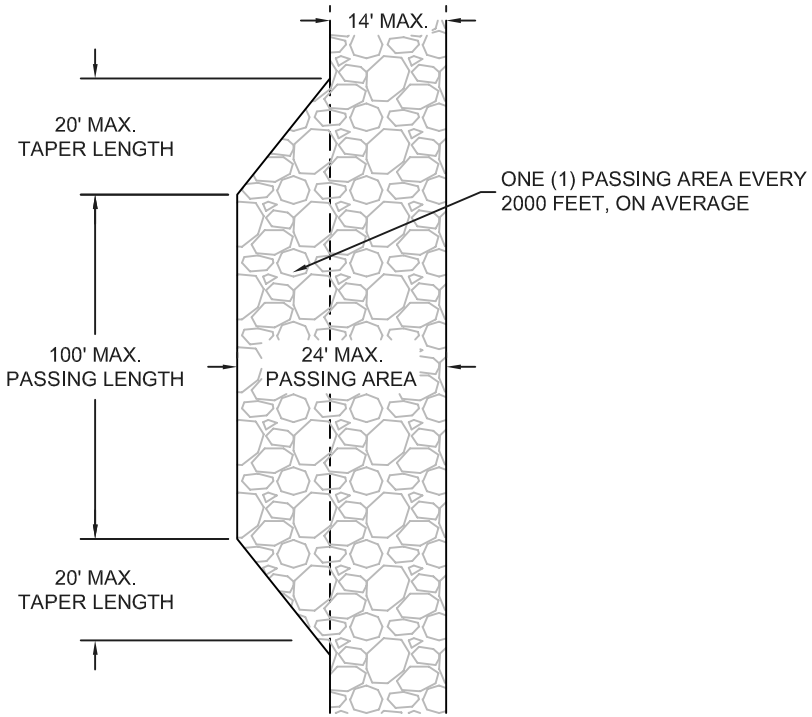
Revisions

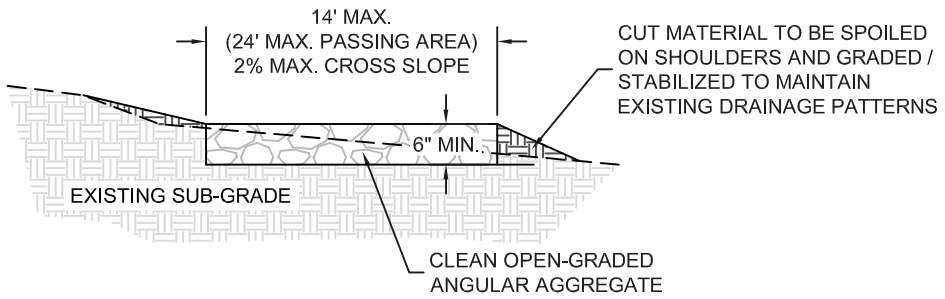
Version 1.2 - April 7, 2010
Checks for overwriting of file prior to data export.

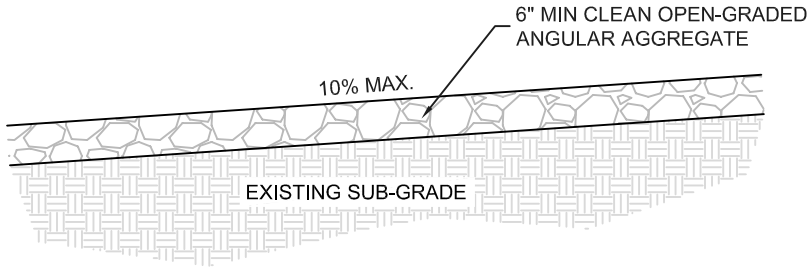
Version 1.1 - August 2, 2006
Corrects the calculation for the Stationing of the Centerline of the Plunge Pool.

Version 1.0 - February 27, 2006
Provides a total quantity of riprap, coarse drainfill, and fine drainfill to the top of the riprap. The previous version gave quantities for each but only to the outlet channel elevation
Vertical thickness is an alternative to normal thickness for ease of construction staking & Output is formatted for use with PlungePoolLayout macro in AutoCAD. That macro draws lines into CAD for creating surface models and final quantity calculations.

Renamed spreadsheet from PlungePool.xls.







NOTES:

1. THE MAXIMUM WIDTH OF THE PERMANENT GRAVEL ACCESS ROAD SHALL BE NO MORE THAN 14 FEET WITH PASSING AREAS NOT MORE THAN 100 FEET IN LENGTH AND 24 FEET IN WIDTH EVERY 2,000 FEET, ON AVERAGE;
2. THE PERMANENT GRAVEL ACCESS ROAD SHOULD FOLLOW THE CONTOUR OF THE NATURAL TERRAIN TO THE EXTENT POSSIBLE AND SLOPES SHOULD NOT EXCEED 10 PERCENT
   - 2.1. FOR PLANNING AND DESIGN PURPOSES, SLOPES WILL GENERALLY BE AVERAGED OVER 500 LINEAR FOOT ROAD SEGMENTS OR AS BEST DETERMINED BY ENGINEERING JUDGEMENT. AVERAGE SLOPES OVER 10% WILL REQUIRE ADDITIONAL CONSIDERATION AND COORDINATION.
3. THE PERMANENT GRAVEL ACCESS ROAD SHALL BE CONSTRUCTED USING CLEAN, OPEN-GRADED, ANGULAR AGGREGATE AT A DEPTH OF NO LESS THAN SIX INCHES
   - 3.1. FOR THE PURPOSES OF THIS SPECIFICATION OPEN-GRADED, ANGULAR AGGREGATE SHALL INCLUDE WASHED STONES THAT MEET THE VDOT / AASHTO / ATM SIZES: 1, 2, 3, RAIL BALLAST, 357, 5, 56, 57, 67, 68, 7, 78, 8, 8P, 9 OR A COMBINATION OF THOSE LISTED.
   - 3.2. SHOULD FINE AGGREGATE, ROUNDED AND/OR UNWASHED STONE BE UTILIZED DURING CONSTRUCTION, ALL MATERIAL SHALL BE REMOVED FROM PRIOR TO PERMIT CLOSEOUT AND THE ROAD SHALL BE RESTORED TO MEET THE CLEAN, OPEN-GRADED, ANGULAR AGGREGATE DEFINED ABOVE.
4. THE FOLLOWING CONDITIONS ALSO NEED TO BE MET:
   - 4.1. THE PROJECT IS MANAGED SO THAT DURING CONSTRUCTION OF THE PERMANENT GRAVEL ACCESS ROAD THE AREA OF LAND-DISTURBING ACTIVITY IS LESS THAN ONE ACRE;
   - 4.2. THE AREA WHERE LAND-DISTURBING ACTIVITY HAS BEEN COMPLETED IS ADEQUATELY STABILIZED PRIOR TO INITIATING CONSTRUCTION OF THE GRAVEL ACCESS ROAD ON THE NEXT AREA SUBJECT TO LAND-DISTURBING ACTIVITY. "ADEQUATELY STABILIZED" MEANS COMPLIANCE WITH STANDARD AND SPECIFICATION 3.36 IN THE 1992 VIRGINIA EROSION AND SEDIMENT CONTROL HANDBOOK;
   - 4.3. THE ENVIRONMENT IS PROTECTED FROM EROSION AND SEDIMENTATION DAMAGE ASSOCIATED WITH THE LAND-DISTURBING ACTIVITY; AND
   - 4.4. THE PROJECT OWNER OR CONSTRUCTION ACTIVITY OPERATOR DESIGNS, INSTALLS, IMPLEMENTS, AND MAINTAINS POLLUTION PREVENTION MEASURES TO (I) MINIMIZE THE DISCHARGE OF POLLUTANTS FROM EQUIPMENT AND VEHICLE WASH WATER, WHEEL WASH WATER, AND OTHER WASH WATERS; (II) MINIMIZE THE EXPOSURE OF BUILDING MATERIALS, BUILDING PRODUCTS, CONSTRUCTION WASTE, TRASH, LANDSCAPE MATERIALS, FERTILIZERS, PESTICIDES, HERBICIDES, DETERGENTS, SANITARY WASTE, AND OTHER MATERIALS PRESENT ON SITE TO PRECIPITATION AND TO STORMWATER; (III) MINIMIZE THE DISCHARGE OF POLLUTANTS FROM SPILLS AND LEAKS AND IMPLEMENT CHEMICAL SPILL AND LEAK PREVENTION AND RESPONSE PROCEDURES; (IV) PROHIBIT THE DISCHARGE OF WASTEWATER FROM THE WASHOUT OF CONCRETE; (V) PROHIBIT THE DISCHARGE OF WASTEWATER FROM THE WASHOUT AND CLEANOUT OF STUCCO, PAINT, FORM RELEASE OILS, CURING COMPOUNDS, AND OTHER CONSTRUCTION MATERIALS; AND (VI) PROHIBIT THE DISCHARGE OF FUELS, OILS, OR OTHER POLLUTANTS USED IN VEHICLE AND EQUIPMENT OPERATION AND MAINTENANCE.

TYPICAL PERMANENT GRAVEL ACCESS ROAD

Virginia's Forestry Best Management Practices for Water Quality

Field Guide

Virginia Department of Forestry
www.dof.virginia.gov

Virginia's Forestry Best Management Practices for Water Quality

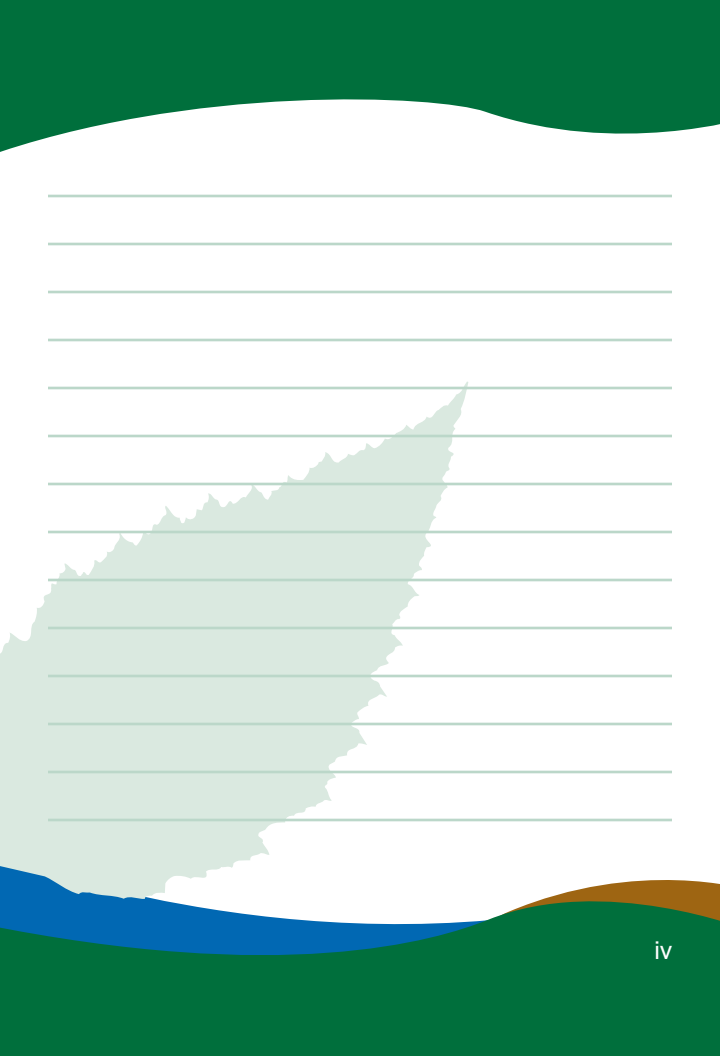
Field Guide

October 2019

Virginia's Forestry Best Management Practices for Water Quality

Field Guide

October 2019



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Introduction

Protecting water quality and the forest and soil resources on the land are among the most important aspects of a successful and environmentally sustainable timber harvest. Studies have shown that while timber harvesting is not a major cause of water quality problems, skid trails, haul roads and landings have the potential to be sources of sedimentation, erosion and siltation of streams and other water bodies. Forest management programs and operations should incorporate

adequate measures to provide for proper soil and water conservation. Most streams originating in or flowing through our timberlands are sources for water supplies, recreation and a wealth of other uses.

The key to success is proper planning and the use of forestry best management practices (BMPs). These are practices chosen to reduce erosion and prevent or control pollution resulting from forestry operations. Forestry BMPs are directed primarily at controlling erosion.

This field guide is intended to be a practical tool for timber harvesters, forest managers and landowners. It presents suggestions, guidelines and technical references on a range of timber harvesting BMPs.

The guide is not meant to replace on-the-ground recommendations by a qualified professional forester or resource professional and should not be used as a substitute.

The ultimate goal is to have an economically viable timber harvest that protects the soil, water and other forest resources from loss or degradation. BMPs can help attain this goal. *Alternative methods that achieve equal water quality protection are acceptable.*

Introduction

Non-point source pollution is generated from land runoff resulting from precipitation. As the runoff moves over the land surface, it picks up and carries away natural and manmade pollutants and deposits them into waterways, wetlands and groundwater, damaging fish habitats and spawning areas, and making the water unsuitable for other uses downstream.

Planning is the Key

It is almost always more economical to plan timber harvesting activities in advance and to take preventive measures than it is to try to "fix" problems after they occur. It is intended that the suggestions outlined in this field guide, if followed, will minimize the impact from timber harvesting on the waters of the Commonwealth and will provide a viable forest resource for the future of all Virginians.

Introduction

Planning for Forestry Operations

Planning

Timber harvesting activities should follow a well-designed plan with the ultimate outcome being an efficient operation that provides protection of soil and water resources. A forestry professional should be consulted for planning assistance.

Planning should help identify sensitive areas and applicable BMPs to be used during the silvicultural activity. A variety of tools can help in the evaluation of the property and the development of the plan. These tools include aerial photographs, soil survey maps, topographic maps, property or survey maps and timber stand maps.

A field reconnaissance to identify areas of special concern, such as streams, ponds, lakes, wetland sites, boundary restrictions, rock outcrops and nesting sites, should always be conducted to ensure an efficient operation.

Planning not only considers how the timber will be accessed, but also when the timber will be cut. Timing of harvest is one of the more important BMPs.

Failing to Plan is Planning to Fail

Planning for Forestry Operations

The benefits of a well-developed plan and/or written contract include:

- better communication of expectations between the landowner and timber operator
- maximum return from the harvest
- potential long-term benefits in site productivity
- better infrastructure
- economic efficiency
- minimal environmental impacts
- compliance with federal, state and local laws
- enhancement of habitat for wildlife diversity

Planning for Forestry Operations

Endangered Species

It is the responsibility of the operator to determine if endangered species are present on the harvest property where the forestry activity is to occur. If you suspect the presence of endangered species, contact one of the following:

- Virginia Department of Game and Inland Fisheries
- Virginia Department of Conservation and Recreation, Division of Natural Heritage
- U.S. Fish and Wildlife Service

These agencies should be able to assist with verification and management considerations. A listing of these agencies can be found in the back of this field guide.

Planning

Once a site evaluation has been conducted, follow these recommendations to plan forest harvesting activities:

Notify the Virginia Department of Forestry on-line or by calling the toll-free logging notification number:

www.dof.virginia.gov
1-800-939-LOGS (1-800-939-5647)

This is a requirement of the law. Violators will be subject to a civil penalty for failure to notify.

- Things to note in the site evaluation:
  - Slope, aspect, soils, timber, streams, wetlands, access, boundaries, old roads and indicator plants.
  - Become familiar with all of the tract characteristics that will impact logging.
- Identify and mark on the ground the Streamside Management Zones (SMZs) on all perennial and intermittent streams.
  - A 1:24,000 USGS topographic map is a good starting point for identifying major perennial and intermittent streams. Perennial streams are identified as a solid blue line, and intermittent streams are shown as a dotted blue line. It must be remembered that many intermittent streams that do not show up on a topographic map may merit an

SMZ. Identifying characteristics of an intermittent stream include a defined stream channel, evidence of streambed scouring, and bare soil or rock showing on the bottom of the streambed.

- Locate and flag logging decks (landings). These should be on stable soils with a slight sloping for drainage.
- Locate and mark any logging road stream crossings, if necessary. Avoid them if possible, and if they are necessary, consideration should be given to the type of crossing to be used.
- Locate and mark logging road entrance points from public roads, providing for good traffic visibility in all directions at the entrance.

- Locate any other logging road "control" points. These are points at which the logging road must either connect or avoid. Examples: entrance points, stream crossing points, rock outcrops and wetland areas.
- Locate and flag the logging road gradeline (in the mountains) or centerline (coastal plain). Ideally, the gradeline should be kept at 10 percent or less. Try to locate the haul road on well-drained, stable soils with good load-bearing capacity, such as clay or sandy-clay loams with a solid base.
- Locate and flag designated skid trails, if necessary.
- Specify stream-crossing structures and period of time required of the crossing:
  - Ford
  - Modified Geoweb® improved ford
  - Culvert
  - Bridge
- Determine the schedule of operations and the harvest pattern. Some of the factors involved in this decision will be tract topography, time of year, anticipated weather conditions, road construction requirements, cash flow and marketing allowances (generally determined by the mill).

Planning for Forestry Operations

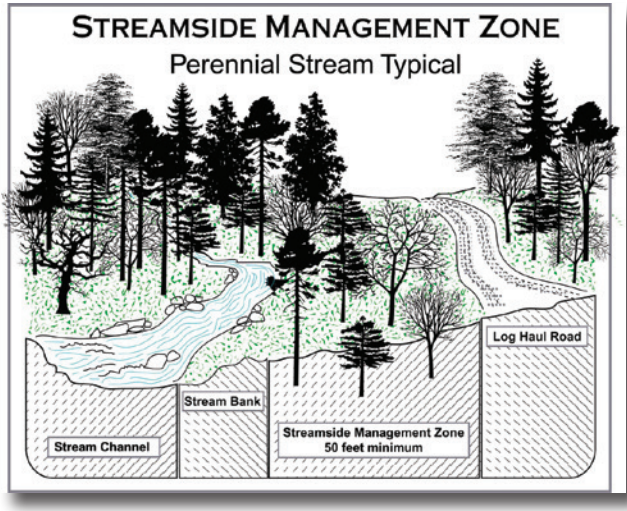
- Specify tract "close-down" requirements. These generally involve implementation of BMPs to minimize erosion and stream sedimentation on the site after harvesting is completed. They include:
  - Re-grading ruts
  - Installing water bars on roads and skid trails
  - Reseeding landings and roads
  - Removing any temporary stream crossing structures
  - Scattering brush
  - Opening ditches and turnouts
- Close and gate the road to unauthorized traffic.
- Determine the need for permits and obtain them, if necessary. Check with the local field office of the Virginia Department of Forestry for other agency permit requirements.

Streamside Management Zones (SMZs)

Streamside Management Zones are areas adjacent to streams that protect water quality. An effective SMZ will filter sediment and nutrients, maintain desirable water temperature, and provide many of the essential requirements of forest stream ecosystems.

In Tidewater Virginia, all Forestry BMPs must be implemented properly according to the Chesapeake Bay Preservation Act. The SMZ is one such BMP and must be left according to specifications in this section, or it will be considered a violation of this Act.

SMZs should be left on perennial and intermittent streams, as well as lakes, ponds, natural springs, municipal water supplies, and in areas of karst geology where flowing streams enter caves.



A 1:24,000 USGS topographic map is a good starting point for identifying major perennial and intermittent streams. Perennial streams are identified as a solid blue line, and intermittent streams are shown as a dotted blue line. It must be remembered that many intermittent streams that do not show up on a topographic map may merit an SMZ. Identifying characteristics of an intermittent stream include a defined stream channel,

evidence of streambed scouring, and bare soil or rock showing on the bottom of the streambed.

It is recommended that all SMZs be a minimum of 50 feet in width, measured from the top of the stream bank. This 50-foot SMZ is a managed forest; within this managed area, up to 50 percent of the basal area or up to 50 percent of the forest canopy can be harvested.

In areas adjacent to tidal marshes, the SMZ will begin at the marsh grass/forest edge and 50 feet inland.

- Harvesting within the SMZ should minimize disturbance. The forest floor should remain virtually undisturbed.
- Manual felling, directional felling and mechanized felling can be effectively used provided minimal disturbance of the forest floor results.
- Water bars, broad-based dips and culverts should be used on skid trails and haul roads prior to entrance into the SMZ.
- All roads, trails, decks and sawmill sites should be located outside of the SMZ where possible. If necessary, additional practices may be required to protect water quality.
- Steep slopes, cold-water fisheries and municipal water supplies all need wider SMZs to protect water quality.

The following table lists those widths:

Table 1
Streamside Management Zone (SMZ) Width

Percent Slope of Adjacent Lands (%)	SMZ Width Per Side (ft.)		
	Warm Water Fisheries (all other waters including wetlands)	Cold Water Fisheries (Trout)	Municipal Water Supplies (Streams or Lakes)
0 - 10	50	66	100
11 - 20	50	75	150
21 - 45	50	100	150
46 +	50	125	200

Planning Tools

- Aerial Photographs
- County Soil Survey Maps or Web Soil Survey
- USGS Topographic Maps
- Wetland Inventory Maps
- Natural Heritage database maps (for T & E species)

Logging System Selection

A logging system is the combination of equipment and personnel used to harvest timber. Matching the right harvesting system to the specific harvesting conditions can result in minimizing the impact to the harvest site. Effective BMP implementation to mitigate harvesting impacts is dependent on the proper logging system application. Application of the proper logging system to the specific site will also result in higher productivity and lower harvesting costs.

Logging System Application

- *Animal* – Animals are best used to skid timber on flat terrain close to existing roads. The system is limited by the weight of the animals and their ability to pull and, in general, can be used to move up to 20-inch-diameter timber on favorable slopes.
- *Tracks* – Track machines are best used where short, steeper slopes prohibit overland rubber-tired skidding. Yarding distance is limited and these machines generally can be used on slightly wetter sites.

- *Skidder* – Rubber-tired skidders have application in the broadest range of logging conditions in Virginia. Skidders are a flat ground system but, with winches, can be effectively used on flat to moderate slopes. This skidding system has limitations when:
  - Weather conditions are unfavorable
  - Skidding distances exceed 1,500 feet due to the cost of road construction
  - Steep Slopes

- *Shovel* – Shovel logging is limited to clear cutting when it is necessary to pick up and swing the timber toward the road. Shovels can work in adverse weather, in wet areas and on steep slopes.

- *Forwarder* – Forwarders are best applied where longer yarding distances in fairly gentle terrain are needed to avoid expensive truck road construction.
- *Cable* – Cable logging systems are best applied where excessive slope would require ground-based systems to build an excessive number of excavated skid trails.
  - Requires excessive slopes to operate efficiently
  - Yarding distances of up to 1,500 feet are not uncommon
  - Can operate under adverse weather conditions

- *Helicopter* – Best applied when road costs are high; large volumes must be moved in a short period of time; sawtimber only is planned for the harvest; the ability to harvest in adverse weather is needed, or when the landowner's objective is to minimize the environmental impacts of harvesting. Maximum yarding distance is 6,000 feet.

Planning for Forestry Operations

Effective BMP implementation for timber harvesting operations needs to consider appropriate logging system selection and harvest planning. Use of the proper logging system for the specific logging conditions can result in lower costs and lower environmental impacts.

Proper planning, from the location of the roads and decks to the type of logging system used, is essential to reducing the impact of the operation on the property.

Forest Roads

Proper road construction will minimize disturbance to waterflow over the landscape and ensure the longevity and stability of the road. Forest roads provide a simple road structure of adequate strength to support heavy vehicle traffic while providing adequate drainage to allow water to pass through the road corridor.

BMPs for forest roads are designed to provide greater opportunities for safe, efficient and profitable operations. A well-planned and properly-constructed forest road is necessary to effectively protect the forest land and water quality when removing forest products from the harvest site.

Site characteristics and the value of the resource being served will influence choices regarding road construction standards and maintenance activities. Culverts and ditches may be necessary in many situations.

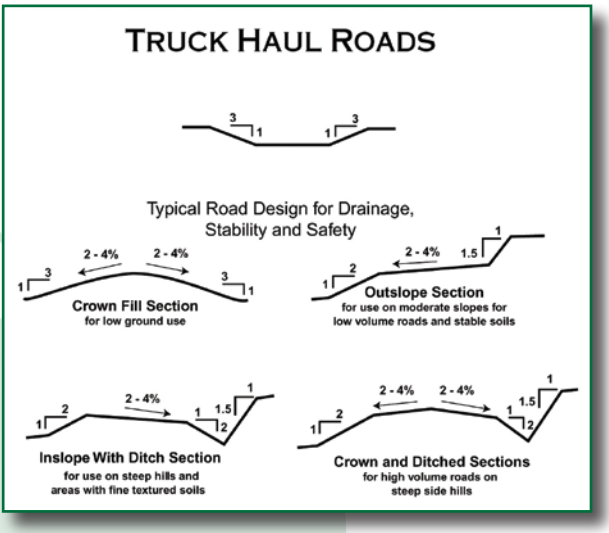
Well-drained and properly surfaced forest roads prevent erosion and provide better wet weather harvesting access. This will, in-turn, provide more operating days for the logging contractor.

Road Alignment and Location

The proper alignment and location of roads will reduce the potential for non-point source pollution. The following recommendations should be incorporated in the road design:

- Roads should follow contour as much as possible with grades between two percent and 10 percent. Steeper gradients may be necessary due to boundary lines or SMZ restrictions; in these cases, additional BMP measures may be required.
- Forest roads should be out-sloped wherever road gradient and soil type will permit.
- Use in-sloping or ditch-and-culvert type of cross-section when constructing a road where road gradients exceed 15

percent, toward sharp turns, or when constructed on clay and/or slippery soils. Cross-drainage culverts should be incorporated in this instance.



Road Drainage

Water flowing along or onto the road should be diverted before gaining sufficient volume or velocity to cause significant erosion of the road and ditch. The following recommendations should be used to minimize erosion:

- 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.
- Install cross drains and diversion ditches to avoid carrying water long distances in roadside ditches.
- Road cross drains may include pipe culverts, rolling dips or broad-based dips.
- A 15-inch pipe culvert is the minimum recommended size for cross drainage. Smaller culverts can clog with debris and require frequent maintenance.
- Spacing for cross drainage is critical as slope increases. (See table on page 28.)
- Size stream-crossing culverts and other drainage structures large enough to minimize impact on water flow and water quality. For more details, see *Stream Crossing Section* starting on page 43.

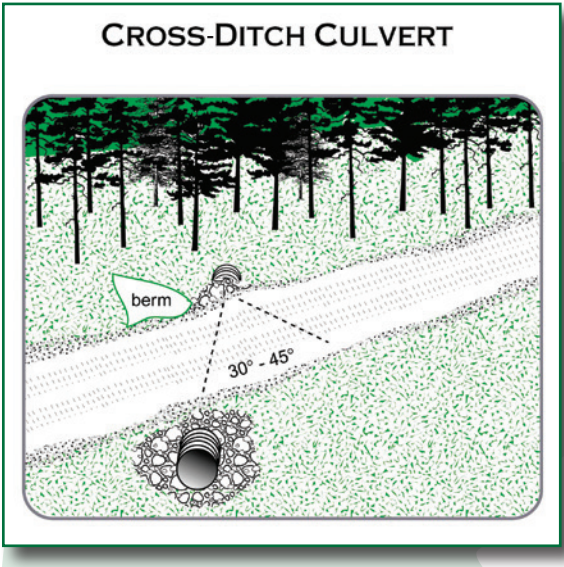
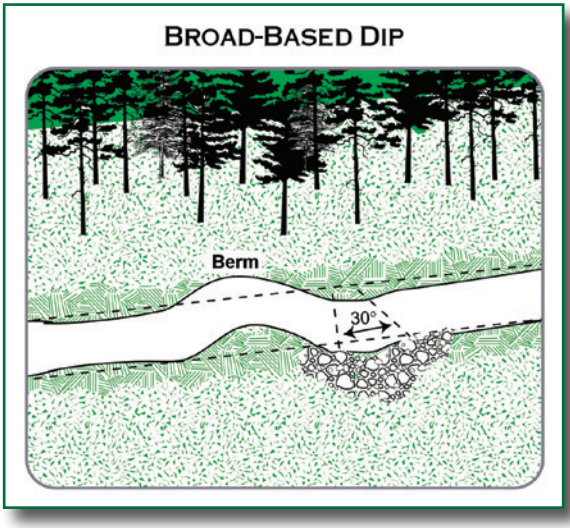

CROSS-DITCH CULVERT
berm
30° - 45°

Table 2 Suggested Spacing for Cross-Drainage Culverts	
Cross-Drainage Road Grade (%)	**Culvert Spacing Distance (ft.)**
0 - 2	500 - 300
3 - 4	250 - 180
6 - 10	167 - 140
11 - 15	140 - 136
16 - 20	126 - 120
21 +	100

Table 3 Suggested Spacing for Rolling Dips	
Road Grade (%)	**Distance (ft.)**
2 - 5	180
5 - 10	150
10 - 15	135
15 +	120

Forest Roads



- Avoid draining surface water from roads and ditches directly into streams, ponds, lakes or wetlands. Instead, drain the water into the filter strip or other vegetated area.
- Build a sediment trap into the ditch to catch debris as it travels down the ditch.

Table 4 Suggested Spacing for Broad-Based Dips	
Road Grade (%)	**Distance (ft.)**
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135

Constructing Forest Roads

Proper construction of roads is a vital step in preventing erosion. The following are some practices that may lessen the potential for problems to develop.

Clearing widths will vary depending on the needs of both the owner and the user of the road. Consideration should be given to the necessity for roadway drying and to safety and cost of various widths of road right-of-ways.

Excavation

- Minimize cuts and fills as much as possible during design and construction.
- Tall cut slopes may require back-sloping to achieve stability and successful revegetation. Slopes of 1:1 or flatter are preferred if the terrain permits.
- Do not side cast material if there is a chance it will enter a stream channel or if side slope exceeds 60 percent. (Full bench construction with removal of fill material offsite may be necessary in this situation.)
- Locate access roads outside of SMZ unless no other alternative exists.

- Deposit excess material in stable locations away from streams, ponds, lakes and wetlands.
- Avoid placing excavated material in SMZs.
- Limit the area excavated to that which can be shaped and stabilized within a day, with provisions made for storm drainage and sedimentation control.

Construction

Site drainage and cross-drainage are important for controlling sedimentation. Proper handling of water during construction will minimize potential impacts on water quality. These recommendations should be followed to reduce possible impacts:

- Provide adequate drainage for road grades during construction to minimize erosion of unconsolidated materials.
- Install drainage structures as construction proceeds.

Forest Roads

- Avoid locating roads with grades in excess of 10 percent. On highly erodible soils, as identified on soil survey maps, a grade of less than eight percent is recommended.
- Minimize down-road flow and ponding by constructing roads with a slight outsloping of one or two percent. Install broad-based dips. Install rolling dips on roads with steeper grades.

- Crown the road surface and excavate ditches where necessary.
- Compact fill firmly around culverts, paying special attention to the sides and lower portion. Cover the top of the culverts with fill to a depth of one-half the pipe diameter or 12 inches, whichever is greater.
- Use riprap or large boulders to stabilize culvert inlets and outlets to reduce bank and channel erosion and sedimentation.

- Provide temporary cross-drainage structures, such as water bars, during construction where needed to drain water off road surfaces.
- Install siltation barriers, such as silt fences and straw bales, during construction on sites where roads and water have close contact for long periods.

Soil Protection

Disturbed areas should be shaped, stabilized and, if necessary, seeded as soon as possible to minimize the potential for erosion. The greatest potential for soil erosion occurs immediately after construction.

The following measures are recommended:

- Vegetative cover is recommended along all forest roads. To prevent erosion before vegetation takes hold, mulch with hay, straw, bark or native vegetation. Hay or straw mulch should be applied at the approximate rate of 80 bales per acre.
- Inspect and repair erosion control measures on a regular basis to ensure that they remain functional.

Designing Wetland Forest Roads

Timber operators are strongly advised to use the services of a professional forester to design wetland forest roads. This professional assistance is particularly important when constructing permanent all-season roads.

The following general recommendations apply when planning the design of all roads across wetlands:

- Avoid crossing wetlands if possible.
- Minimize total wetland road mileage when wetlands must be crossed.
- Determine the type and depth of wetland subsoil to ensure proper design and construction.

Forest Roads

- Minimize width of roads consistent with maintaining safety and road design considerations. This typically would be a running surface of 12 feet in width for straight sections, and the curved road running surface would be no wider than 16 feet.
- Design approaches to wetlands so that surface runoff carrying potential sediment is diverted before entering the wetland.
- Plan to remove temporary fills and structures to the extent practical when use is complete.
- Provide adequate cross-drainage by employing one or both of the following techniques:
  - Use construction methods that allow free water flow throughout the entire roadbed, or
  - Place 24-inch culverts or other cross-drain structures at regular intervals across the fill material throughout the wetland road. These culverts should have one-half their diameter placed below ground level to handle sub-surface flow.

Constructing Wetland Forest Roads

Choosing the appropriate road construction technique will depend on knowledge of water table position, zone of water flow, type of wetland soils and the strength of wetland soils.

With any road construction technique, culverts or ditches (or both) may be necessary.

Follow these recommendations when constructing ditches on wetland roads:

- Construct all road embankments with clean fill and other suitable materials.
- Construct ditches in wetland crossings, where necessary, to intercept and carry surface and subsurface water (the top 12 inches) to, through and away from culverts.
- Avoid having ditches create outlets that will result in drainage of the wetland.

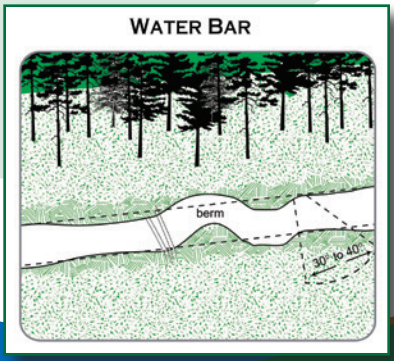
Employ sediment control techniques, such as straw bales and silt fencing, to prevent movement to open water when placing fill during construction.

Skid Trails

- Use existing trails if they provide the best long-term access. Consider relocating existing trails if both access and environmental impact can be improved.
- Consider the topography in the location of skid trails and avoid steep slopes whenever possible.
- Where possible, keep bladed or dozed skid trail grades to less than 25 percent. Where steep grades are unavoidable, frequent grade breaks are recommended. Install drainage structures and use soil stabilization practices where needed to minimize runoff and erosion.
- Overland or dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
- Skid trails should be located outside the SMZ.
- Any skid trail that must cross a perennial stream, intermittent stream or drainage ditch should use a bridge or culvert of acceptable design (see Stream Crossing Section). *Logs shall not be dragged through an intermittent or perennial stream at any time.*

Skid Trails

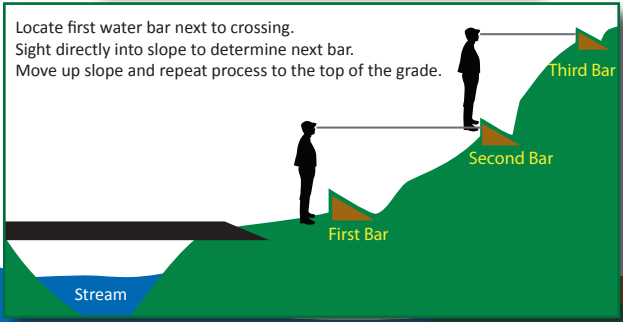
- Lay out skid trails to use low-value trees as "bumper trees" at turns to reduce residual tree damage.
- Install water turnouts 25 feet prior to a stream crossing to direct surface runoff into undisturbed areas of the SMZ.
- A brush mat of logging slash can be used to stabilize skid trails on stream crossing approaches. This alleviates rutting and firms up the running surface.
- Rutting should be avoided whenever possible and especially where it causes channelized erosion. If rutting is unavoidable, concentrated skidding may be used to reduce the amount of disturbance, *but in no instance may channelized erosion be allowed to direct sediment into a stream channel.*



Skid Trails

- Upon completion of skidding activity, water bars should be installed immediately in areas subject to erosion.

Table 5. Water Bar Spacing	
Road Grade (%)	**Distance Between Water Bars (ft.)**
2	250
5	135
10	80
15	60
20	45
30	35



Skid Trails

- Watch the weather forecast and plan ahead for severe storms.
- All woods roads and skid trails should be repaired, smoothed and seeded after logging, and be left in a stable condition to resist erosion.

Stream Crossings

Stream-crossing structures are installed across intermittent or perennial streams to provide access for logging equipment. When properly located and constructed, stream-crossing structures can prevent damage to the bed and banks of streams and can control the movement of sediment into the water.

Stream-crossing structures that are poorly located or constructed can result in disturbance of the banks and bottoms of streams, increasing the chance for erosion and sedimentation to occur.

A forestry professional or Department of Forestry forest engineer can assist in planning the stream-crossing structure best suited to the site.

Locating Stream Crossings

- Use stream crossings only when absolutely necessary.
- Keep the number of stream crossings to a minimum.
- Cross streams by the most direct route and at a right angle to the flow of the stream, if possible.

Stream Crossings

- Whenever possible, find stream-crossing sites that have low, stable banks, a firm stream bottom, minimal surface runoff and gentle slopes along the approaches.
- Stabilize the soil around all culverts and bridges immediately after installation.

A permit is required from the Virginia Marine Resources Commission for all stream-crossing structures that cross a stream that has a drainage area of greater than five square miles or 3,200 acres.

Stream-Crossing Design

Operating equipment in or near perennial or intermittent stream channels may add sediment directly to streams.

As roads approach a stream crossing, proper road drainage is critical to avoiding sedimentation in streams. Three common stream-crossing structures are bridges, culverts and fords.

Bridges

Bridges are the preferred method of crossing streams because they require little or no in-stream work to install. They typically require less time to install and can be used many times, thus making them more cost-effective than culverts. Because they cause little disturbance to the stream banks or channel, they also have less effect on fisheries than any other crossing method.

Any bridge installed for use by the general public for public transport should be designed by a licensed civil engineer.

Bridge Installation

- Temporary bridges should be installed at right angles to the stream.
- Bridges should be of sufficient length to maintain at least five feet of bridge/ground contact on each side of the stream (this will vary by bridge design).
- Mud sills consisting of rough sawn hardwood beams 16 inches wide, three inches thick and 16 feet long can be used to provide additional load bearing capacity in soft soils.
- Approaches should be stabilized with rock, corduroy, brush or other non-erodible surface for a distance of 50 feet on either side of the bridge.
- Prompt stabilization after removal of the bridge will be most critical to the protection of stream water quality.

Pole Bridges

Pole bridges may be used when crossing a stream channel where no water is present. Pole bridges are constructed by laying wooden logs of no less than 10 inches in diameter in a stream channel, creating a solid foundation on which to skid. This structure may incorporate the use of heavy gauge steel pipe with the logs to allow for short periods of flow should it rain.

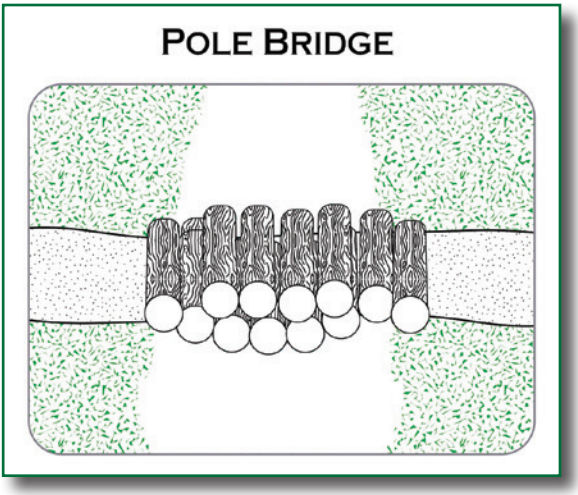
Pole bridges should not be used on channels greater in width or depth than the diameter of a skidder tire.

Pole bridges can be used in dry, intermittent stream channels for a short period of time.

Pole Bridge Installation

- Pole bridges should be packed sufficiently so as not to allow the skidder to dip below the streambank edge and cause erosion of the bank.
- A heavy-gauge steel pipe incorporated in the structure will help in the event of an unforeseen rainfall event while the structure is in place.
- Pole bridges should not have any dirt associated with the logs.

- Pole bridges must be removed following use of the crossing.
- Stabilize the approaches with the appropriate water diversion structures and vegetation following removal of the structure.



Culverts

Culverts may be either temporary or permanent installations. Temporary culverts are those that are installed and used for fewer than 30 consecutive months.

Permanent culverts are those remaining after the logging operation at the request of the timber buyer or landowner. (Proper permitting may be required for this situation. Check with the VDOF forest engineer prior to installation of a permanent culvert.)

Most culvert installations for harvesting purposes are considered to be temporary and must be removed. A reduced-sized culvert is permitted for temporary installations.

Temporary Culvert Chart

The table on the next page lists culvert diameters for temporary culvert sizes. *This chart is intended to be used as a guide. No guarantees are given nor are any implied by its use.*

Table 6 Temporary Culvert Sizing (2-Year Event)			
Culvert Size (in.)	Watershed (acres)		
	Coastal	Piedmont	Mountains
15	Up to 65	Up to 35	Up to 15
18	65 - 90	35 - 65	15 - 25
24	90 - 200	65 - 110	25 - 40
30	200 - 400	110 - 210	40 - 60
36	400 - 700	210 - 420	60 - 135
42	–	–	135 - 230

- Based on the NRCS TR-55 Method modified for a two-year frequency storm event.
- Assumes B soils; a CN-55, and sheet and shallow concentrated flows only for averages of four watersheds for each physiographic region of the state.
- Culvert-crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation.

Permanent Culvert Chart

Table 7 lists culvert diameters for permanent culvert sizes. *This chart is intended to be used as a guide. No guarantees are given nor are any implied by its use.*

Table information based on the NRCS TR-55 Method, modified for a 10-year frequency storm event. All assumptions are the same as the temporary chart.

Table 7 Permanent Culvert Sizing (10-Year Event)			
Culvert Size (in.)	**Watershed (acres)**		
	Coastal	**Piedmont**	**Mountains**
15	Up to 8	Up to 7	Up to 4
18	8 - 12	7 - 10	4 - 7
24	12 - 25	10 - 20	7 - 12
30	25 - 35	20 - 30	12 - 15
36	35 - 70	30 - 50	15 - 25
42	70 - 100	50 - 75	25 - 35
48	100 - 150	75 - 110	35 - 55
54	150 - 240	110 - 170	55 - 75
60	240 - 360	170 - 240	75 - 100
66	360 - 550	240 - 350	100 - 135
72	–	–	135 - 200

If it is preferable to place multiple smaller culverts instead of one large one, the following table shows the required diameters of multiple pipes to replace one larger one.

Table 8
Culvert Alternatives (diameter in inches)

Required Culvert Diameter (in.)	2-Culvert Alternative	3-Culvert Alternative
15	–	–
18	15, 15	–
24	15, 18	15, 15, 15
30	18, 24	18, 18, 18
36	24, 30	18, 24, 24
42	30, 30	24, 24, 30
48	36, 36	30, 30, 30
54	36, 42	30, 36, 36
60	42, 48	36, 36, 42
66	42, 54	42, 42, 42
72	48, 60	48, 48, 48
84	60, 66	48, 54, 54

Culvert Installation

- The pipe length will extend one foot beyond the edge of the fill material on each side of the culvert.
- The culvert should be placed on the same grade as the natural stream bottom.
- Culverts should be installed with 10 percent of its diameter below the streambed. This will minimize undercutting at the inlet or outlet. If the outlet is more than six inches above the natural stream channel, an energy absorbing structure should be placed at the outlet.
- Culverts require periodic maintenance and inspection to avoid blockage.
- Culvert pipes less than 15 inches in diameter are not recommended for stream crossings.

Fords

Natural rock fords are an acceptable crossing method in portions of the piedmont and mountain areas. They may also prove useful with improvements to portions of the coastal plain. In certain situations, they may be the most acceptable of the stream crossing types because of the reduced amount of continued stream disturbance.

Any changes made to stream bottoms – including the addition of foreign material or unnatural material into a stream that has a drainage area in excess of five square miles – require a permit from the Virginia Marine Resources Commission.

Construction of a Ford

- Locate fords where stream banks are low.
- The stream should have a firm rock or gravel base; otherwise, install stabilizing material, such as reinforced concrete planks, rubber or wooden mats or Geoweb®, for improvement of streambed stabilization.

Log Landings

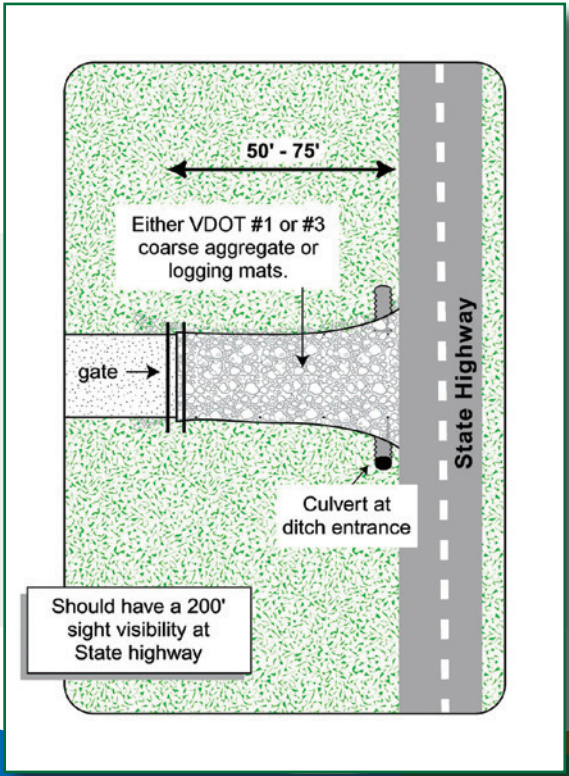
Landings are one of the most visible parts of any timber harvest. If possible, locate the landing out of sight of the public. Log landings are the areas where logs are concentrated, processed, sorted and loaded prior to shipping. Care should be taken to locate the landing in an area that is well-drained to reduce the chance for erosion or sedimentation. Landings are subject to severe compaction. Additional effort may be required to establish a vegetative cover on these compacted areas.

Log-Landing Construction

The following recommendations should be considered when planning, locating and constructing landings and roads to and from the landings:

- Use existing landings if possible. Close existing landings next to streams and water bodies unless construction of new landings would cause greater harm to water quality than using existing landings.
- Log landings should be located at least 50 feet from the Streamside Management Zone. If closer placement is necessary, additional BMP measures should be considered (such as straw bales or silt fence).
- Locate landings on firm, well-drained soil that is slightly out-sloped to promote efficient drainage.
- Size all landings to the minimum necessary for the acreage to be harvested, yet with enough room for efficient equipment operation and product sorting and removal.
- Locate residue piles, such as slash, sawdust and chips, away from drainages where runoff may wash residue into streams, lakes or wetlands.
- Locate diversions, such as water bars, on skid trails leading into the landing. Construct skid trails to prevent water from flowing into the landing and ponding, where

Log Landings



compaction from the machinery has occurred.

- Locate diversions, such as water bars and broad-based dips, on the truck haul road leading out from the landing to prevent water and sediment from flowing out onto the public highway.
- Place coarse rock or stone to shake mud off vehicles before entering public highways.
- Remove all mud tracked onto public roads immediately.
- During muddy conditions, use coarse rock over geotextile to keep the rock in place.

Landing Maintenance

- Check fittings and hoses regularly to prevent leaks of lubricants and hydraulic oil. Repair all leaks immediately.
- Have oil-absorbent mats or material on landing in the event of fuel oil, hydraulic fluid or lubricant spills.
- Remove all unnatural debris, such as cans, paper, discarded tires, cables and chains, etc., on a daily basis.
- Scatter all woody debris to improve drainage and appearance of the site.
- If necessary, soil should be stabilized by seeding and mulching at the end of the operation.

Post-Harvest Closure

The “close-down” of the timber harvest operation is one of the most important considerations to the protection of water quality. The installation of the appropriate BMPs at this time will minimize erosion and stream sedimentation following the timber harvest. If the harvest has been effectively planned, the requirements for “close-down” will be minimal. The necessary BMPs should be installed throughout the operation as various portions of the site are harvested.

Post-Harvest Closure

Upon completion of the harvest operation:

- All road surfaces should be crowned, outsloped, insloped or water-barred. Remove berms from the outside edge of the road or trail where water can be channeled.
- Abandoned roads should be left in a condition that provides adequate drainage without further maintenance.
- Do not allow closed roads to become stream channels. Divert channelized flow of water off the road surface.

- Temporary bridges, abutments, culvert pipes or other crossing structures should be removed prior to road closure. All stream channels should be restored to their natural condition.

Post-Harvest Closure

- Cut and fill slopes should be reshaped to a stable gradient and vegetation established on all bare soil areas with a slope greater than five percent.
- All unnatural debris, such as cans, paper, discarded tires and metal parts, etc., must be removed from landings.
- Exposed soils prone to erosion should be seeded and mulched at the end of the operation.
- Fill in ruts and install water bars and erosion barriers to prevent or minimize erosion and sedimentation from roads, skid trails and landings.
- Inspect erosion control measures periodically and maintain or remove as needed.

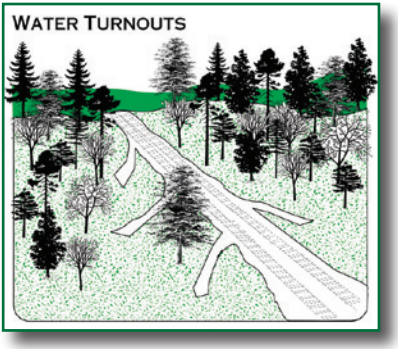
Traffic barriers should be placed where appropriate to prevent off-road vehicles from disturbing the recently stabilized areas. Barriers should be visible and well marked, and should not present a safety hazard.

Post-Harvest Closure

Erosion Control Measures

Wing (Lead-Off) Ditches

A lead-off ditch is a diversion ditch that is constructed to turn water away from the road and out of the side ditch into adjacent, undisturbed areas.



Lead-off ditches should:

- Intersect the roadside ditch at the same depth and be outsloped to a maximum grade of two percent.
- Not feed directly into adjacent drainages, gullies or channels.

- Be installed or cut solidly into the soil and wide enough to allow for maintenance.

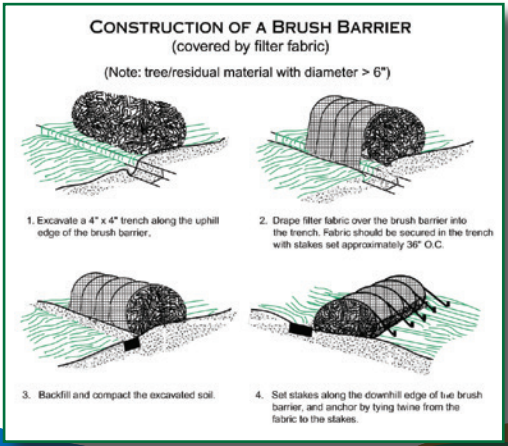
Table 9
Maximum Distance Between Lead-Off Ditches

Slope	Slope (%)	Distance (ft.)
Flat	2	250
	3	220
	4	190
	5	160
Moderate	6	144
	7	128
	8	112
	9	96
Steep	10	80
	11	60

On sloping roads, the lead-off ditch should leave the road ditch at a 30 to 45 degree angle to the roadbed and downsloped less than two percent.

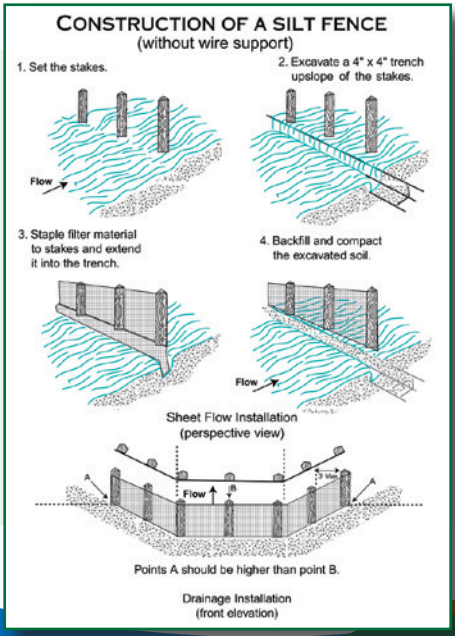
Brush Barrier

A brush barrier is a temporary sediment barrier constructed at the perimeter of a disturbed area, such as log decks adjacent to the SMZ or skid trails in the bottom of swales. The purpose of the brush barrier is to intercept and retain sediment from disturbed areas to prevent sediment from leaving the site.



Silt Fence

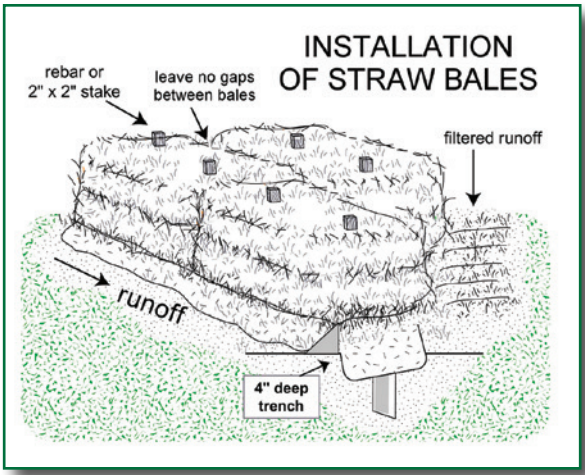
A temporary sediment barrier consisting of a synthetic filter fabric stretched across and attached to supporting posts and entrenched to a depth of four inches.



Straw Bale Barrier

A temporary sediment barrier consisting of entrenched and anchored straw bales.

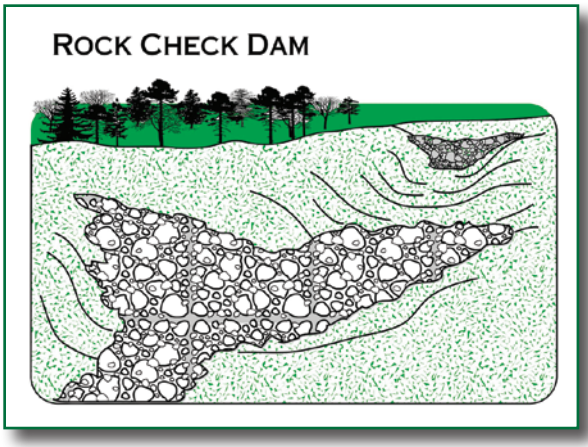
- Decreases the velocity of sheet flows.
- Intercepts small amounts of sediment from disturbed areas.



Rock Check Dams

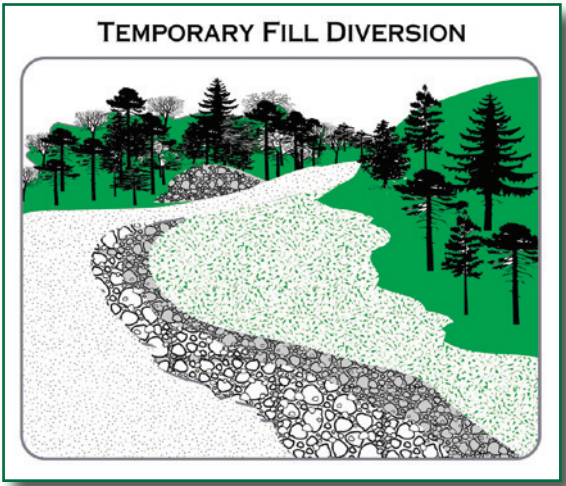
Small temporary stone dams constructed across a swale or drainage ditch.

- Effective in reducing the velocity of water moving in a drainage ditch, thereby reducing the erosive potential of the water in the ditch.
- An aid in sediment trapping for forestry operations.



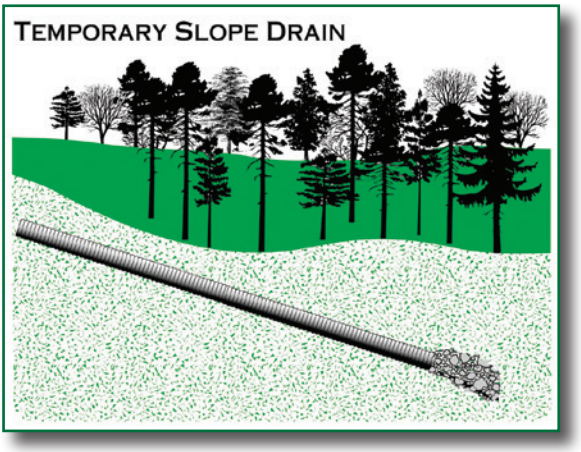
Temporary Fill Diversion

Usually found along the edge of a road where an "active fill" is present directly below the road edge. This diversion will keep drainage from the road surface from crossing the exposed fill and eroding it down-slope. Generally, the water from such a fill diversion is directed to a temporary slope drain, or a vegetated or rock-lined ditch.



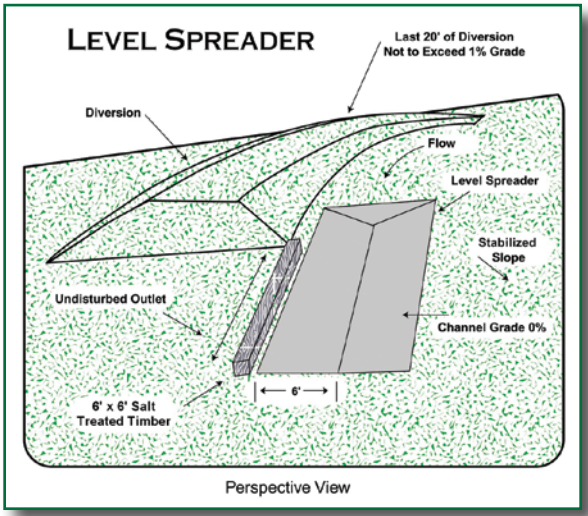
Temporary Slope Drain

A flexible tubing or conduit used to direct water from a road surface to the bottom of a fill slope. This will prevent erosion of the fill slope. This will also allow for the stabilization with vegetation of the fill slope.



Level Spreader

An outlet for drainage structures and diversions consisting of an excavated depression constructed at zero grade across a slope.



Erosion Control Measures

The level spreader will release directed flow from a drainage structure, such as a lead-off ditch, to a zero grade and release it into the undisturbed forest area as sheet flow.

The following additional BMP measures can be found in the full manual, *Virginia's Forestry Best Management Practices for Water Quality Technical Manual*:

- Sediment Traps
- Geoweb® improved stream crossings
- Geotextile
- Mulching
- Erosion Control Blankets
- Surface Roughening

Revegetation

Soil stabilization practices are necessary where soil is exposed and is likely to erode to adjacent streams. Stabilization through revegetation is recommended on all bare soil areas that exceed five percent slope or on highly erodible soils. Bare soil areas should be stabilized immediately following harvest by using the recommended specifications and seeding tables that follow. For further assistance, contact the Department of Forestry; Soil and Water Conservation Districts, or the Department of Game and Inland Fisheries.

Specifications for Revegetation

- Select a seed mix appropriate for the conditions and the season of the year to ensure success.
- Install all necessary water control structures prior to seeding.
- Adequate seed bed preparation is essential to the successful germination of the seed. Surface roughening may be required.
- An application of mulch during the dry summer months and in the fall can help in the establishment of the vegetation.

Revegetation

- Lime and fertilizer is generally required. It is recommended that a soil test be done to determine the correct quantities. In general, in areas with acidic soils, 1.5 tons of lime per acre and 600 pounds of 10-10-10 fertilizer will assist germination and survival.

Please refer to the following tables for:

Seeding Mixtures and Guidelines for Revegetation of Critical Areas in Virginia

Choose a mixture of Main Crop, Legumes and Grains/Grasses to equal a total of 100 to 150 pounds per acre seeding rate.

Main Crop

Choose one of the following or a combination:

Table 10. Main Crop Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Perennial Ryegrass K-31 Fescue	Total 60 - 70 lbs. /acre	Feb. 15 - May 15	Feb. 1 - Apr. 15
		Aug. 15 - Nov. 15	Sep. 15 - Nov. 15

Choose one rye, perennial rye and/or fescue as a main crop grass. A combination can also be used in fall plantings.

Use of annual rye outside peak seeding times is beneficial as a quick, temporary cover.

Legume

Choose one of the following or a combination:

Table 11. Legumes Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Kobe orrean L. Koespediza	15 lbs./acre	N/A	Mar. 1 - May 15
Hairy or Woodford	15 lbs./acre	N/A	Feb. 1 - May 15
Bigflower	15 lbs./acre	Feb. 15 - May 1	N/A
Lathco Flatpea Alfalfa	25 lbs./acre	Sep. 1 - Nov. 1	N/A

A legume will provide wildlife food and cover and add nitrogen to the soil. Choose one or a combination in addition to your main crop.

Grains and Grasses

Choose one of the following or a combination:

Table 12. Grains and Grasses Seeding Rates and Times

Seeding Mixture	Rate/Acre	N. Piedmont, Mountains, Valley	S. Piedmont, Coastal Plain
Weeping Lovegrass	20 lbs./acre	Mar. 15 - May 15	N/A
Foxtail Millet	20 lbs./acre	May 15 - Aug. 15	May 1 - Sep. 1
Hybrid Bermudagrass	15 lbs./acre	N/A	Mar. 1 - May 15

Adding additional grains and grasses ensures plant diversity if the main crop does not successfully seed. Many of these grasses produce grain seeds critical to game birds. Use weeping lovegrass on steep slopes when seeding in warm seasons.

Critical Planting Area

Mulching should always occur for critical area planting at rates of two to four tons of mulch per acre. If this type of planting occurs in mid-winter, consider mulch only until the spring seeding period occurs.

Table 13. Seeding Mixtures and Rates

Seeding Mixture		
Late Winter/Spring	**Rate/1,000 sq. ft.**	**Rate/acre**
Oats	2 lbs.	95 lbs.
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats & Ryegrass	½ lb. - 1 lb.	45 - 60 lbs.
Oats & Korean Lespedeza	½ lb. - 1 lb.	45 - 60 lbs.
Summer	**Rate/1,000 sq. ft.**	**Rate/acre**
Sundangrass	1 lb.	35 - 45 lbs.
Browntop Millet	1 lb.	30 - 40 lbs.
Weeping Lovegrass	5 lbs.	25 lbs.
Late Summer/Early Winter	**Rate/1,000 sq. ft.**	**Rate/acre**
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats (before Oct. 1)	2 lbs.	90 lbs.
Barley (before Oct. 15)	3 lbs.	140 lbs.
Wheat (after Oct. 1)	3 lbs.	140 lbs.

Regulations

Federal Clean Water Act – Mandated Road BMPs for Wetlands

1. Roads and trails for forestry in U.S. waters must be minimal in number and area, consistent with silvicultural operations and topographic and climate conditions.
2. All roads must be far enough from streams or water bodies (except those crossing these waterways) to minimize dredge/fill discharge in U.S. waters.
3. Road fill must be bridged, culverted or otherwise designed to prevent the restriction of expected high flows.
4. The fill must be properly stabilized and maintained during and following construction to prevent erosion.
5. Discharges of dredge/fill material into U.S. waters to construct road fill must be done so as to minimize the encroachment of trucks, tractors, bulldozers or other heavy equipment within (into) U.S. waters and wetlands that lie outside the lateral boundaries of the fill.
6. In designing, construction and maintaining roads, negative disturbance in U.S. waters must be kept to a minimum.

7. The design, construction and maintenance of the road crossing must not disrupt the movements of aquatic species living in the water body.
8. Borrow material must be taken from upland sites when feasible.
9. Discharges must not take, jeopardize, adversely modify or destroy the critical habitat of threatened or endangered species as defined under the Endangered Species Act.
10. Discharges into wetlands and into breeding, nesting and spawning areas for waterfowl must be avoided if less harmful alternatives exist.
11. Discharges must not be located in the proximity of a public water supply intake.
12. Discharges must not occur in areas of concentrated shellfish production.
13. Discharges must not occur in part of the National Wild and Scenic Rivers System.
14. Discharges must not contain toxic pollutants in toxic amounts.
15. Temporary fills must be entirely removed and the area restored to its original elevation.

Silvicultural Operations in Chesapeake Bay Preservation Areas

Silvicultural activities in Chesapeake Bay Preservation Areas are exempt from [the] regulations provided that [the] silvicultural operations adhere to water quality protection procedures prescribed by the Department of Forestry in its full manual, *Virginia's Forestry Best Management Practices for Water Quality Technical Manual.*

Check with the local Department of Forestry Office, local government zoning officer, or Virginia Department of Environmental Quality Chesapeake Bay Local Assistance Office for further information regarding this Law.

Silvicultural Water Quality Law

This section of the *Code of Virginia* (§10.1-1181.1 through 10.1-1181.7) refers to the Silvicultural Water Quality Law. This law gives the State Forester legal authority to protect water quality from excessive sedimentation originating from silvicultural operations on any stream in Virginia.

This law allows the State Forester to issue Special Orders or Emergency Special Orders that will require implementation of corrective measures, and to impose civil penalties of up to

$5,000 per violation, with each day of a continuing violation being considered a separate violation. These orders and penalties involve all owners and operators involved in the silvicultural activity.

The law also requires that operators notify the State Forester prior to the start of a silvicultural activity.

Please refer to the *Code of Virginia* for specific language regarding this law, or contact your local Department of Forestry field office for specific information regarding this law.

Debris in Streams Law

§ 62.1-194.2. Throwing trash, etc., into or obstructing river, creek, stream or swamp.

It shall be unlawful for any person to throw or otherwise dispose of trash, debris, tree laps, logs, or fell timber or make or cause to be made any obstruction which exists for more than a week (excepting a lawfully constructed dam) in, under, over or across any river, creek, stream, or swamp, so as to obstruct the free passage of boats, canoes, or other floating vessels, or fish in such waters. The provisions of this section shall be enforceable by duly authorized state and local law-enforcement officials and by conservation police officers whose general police power under § 29.1-205 and forest wardens whose

general police powers under § 10.1-1135 shall be deemed to include enforcement of the provisions of this section. Violations of this section shall be punishable as a misdemeanor under § 18.2-12; and each day for which any violation continues without removal of such obstruction, on and after the tenth day following service of process on the violator in accordance with § 19.2-75, shall constitute a separate offense punishable as a misdemeanor under § 18.2-12.

Regulations

Agency Listing

Virginia Department of Forestry

Notification of Logging Operations Line
www.dof.virginia.gov
1-800-939-LOGS (1-800-939-5647)

For information and assistance in the areas of Harvest Planning, Water Quality Law and/or general assistance, contact:

Virginia Department of Forestry
900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903
Phone: (434) 977-6555

Or contact one of the regional offices listed below:

Western Region	Salem	(540) 387-5461
Central Region	Charlottesville	(434) 977-5193
Eastern Region	Providence Forge	(804) 966-5092

Virginia Marine Resources Commission

For information and assistance on stream-crossing permits for drainage areas more than 3,200 acres:

Virginia Marine Resources Commission
2600 Washington Avenue
Newport News, Virginia 23607-0756
Phone: (757) 247-2200

Virginia Department of Game and Inland Fisheries

For information and assistance on wildlife and habitat protection:

Virginia Department of Game and Inland Fisheries
7870 Villa Park Drive, Suite 400
Henrico, Virginia 23228
Phone: (804) 367-1000

Virginia Department of Conservation and Recreation - Division of Natural Heritage

For information regarding rare, threatened or endangered species:

DCR – Division of Natural Heritage
600 East Main Street, 24th Floor
Richmond, Virginia 23219
Phone: (804) 786-7951

Agency Listing

DCR Division of Chesapeake Bay Local Assistance

For information and assistance on whether your harvest area lies within the Chesapeake Bay Resource Protection Area, you may contact CBLAD at the following address and phone number; your local county zoning official, or VDOF.

Chesapeake Bay Local Assistance Division
PO Box 1105, 1111 East Main Street, Suite 1400
Richmond, Virginia 23219
Phone: (804) 698-4000 or (800) 592-5482

Virginia Department of Environmental Quality

For information and assistance regarding oil spills:

Virginia Department of Environmental Quality
PO Box 1105, 1111 East Main Street, Suite 1400
Richmond, Virginia 23219
Phone: (804) 698-4000 or (800) 592-5482

Department of Mines, Minerals and Energy

To purchase topographic maps for harvest planning:

Department of Mines, Minerals and Energy
Division of Geology and Mineral Resources
900 Natural Resources Drive, Suite 500
Charlottesville, Virginia 22903-0667
Phone: (434) 951-6340

U. S. Army Corps of Engineers

For information and assistance on wetlands and permitting:

U. S. Army Corps of Engineers
Norfolk District Office
803 Front Street
Norfolk, Virginia 23510-1096
Phone: (757) 201-7655

You will be put in touch with the correct field office.

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www.diannejohnson.com

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This is a requirement of the law. Violators will be subject to a civil penalty for failure to notify.

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Charlottesville, Virginia 22903
Phone: (434) 977-6555
www.dof.virginia.gov

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