



VIRGINIA'S FORESTRY BEST MANAGEMENT PRACTICES FOR WATER QUALITY

**Technical Manual
2011**

The publication of this document was supported by the Virginia Department of Conservation and Recreation, Division of Soil and Water, and was financed through a grant from the U.S. Environmental Protection Agency under the provisions of Section 319 of the Federal Water Pollution Control Act, as amended.

Virginia Department of Forestry
www.dof.virginia.gov

Virginia's Forestry Best Management Practices for Water Quality
Technical Manual
Fifth Edition
March 2011



VIRGINIA'S FORESTRY BEST MANAGEMENT PRACTICES FOR WATER QUALITY



Fifth Edition
March 2011

Acknowledgements



Acknowledgements

Thank you for your contribution to this Fifth Edition of Virginia's Forestry Best Management Practices for Water Quality:

Matt Poirot, Asst. Director of Forest Management - Water Quality Program, Virginia Department of Forestry

Bill Lakel, PhD, Water Quality Program Supervisor, Virginia Department of Forestry

Janet Muncy, Public Information Specialist, Virginia Department of Forestry

John Campbell, Director of Public Information, Virginia Department of Forestry

Thank you to the many people who were involved in the writing and development of the Fourth Edition of Virginia's Forestry Best Management Practices for Water Quality published in July 2002, from which this Fifth Edition was developed. Your input was invaluable to the success of this project.

Contents

Foreword	vii
CHAPTER 1 Introduction	1
Purpose.....	2
What is Nonpoint Source Pollution?	2
Why is Nonpoint Source Pollution Important to Us?	3
Best Management Practices – What are They and Why are They Important?	3
Using this Manual.....	3
Appendices	3
What Happens When Water Quality is Degraded?	4
CHAPTER 2 Watersheds	7
CHAPTER 3 Planning for Forestry Operations	11
Stream Types.....	13
Other Sensitive Areas	13
Benefits of Planning.....	14
Special Management Areas	14
Endangered Species	15
CHAPTER 4 Forest Roads	17
Specifications.....	18
Maintenance	21
CHAPTER 5 Timber Harvesting	23
Pre-Harvest Planning	24
Logging Systems for Effective BMP Implementation	29
Conclusion	35
Streamside Management Zones.....	35
SMZs for Trout	37
Salvage and Sanitation in the SMZ.....	38
Debris in Streams.....	39
Stream-Crossing Design and Construction	39
Temporary Bridges	40
Pole Bridges.....	41
Culverts.....	42
Fords.....	45
Skid Trails	46
Log Landings	48
Biomass Harvesting	49

Table of Contents

Equipment Maintenance and Litter.....	49
Harvest Closure.....	50
CHAPTER 6 Site Preparation and Reforestation	53
General Definition and Purpose	54
General Conditions Where Practice Applies	54
Reforestation/Regeneration Plan.....	55
Precautions.....	58
CHAPTER 7 Silvicultural Chemical Treatment	61
Fertilizer, Herbicides and Pesticides	62
General Conditions Where Practice Applies	62
Planning Considerations.....	63
CHAPTER 8 Fire Management	67
Wildfire.....	68
Incident Command Areas and Staging Areas	68
Wildfire Rehabilitation Plan.....	69
Prescribed Burning	69
BMPs for Prescribed Burning	70
Fireline Construction Methods	71
BMPs for Fireline Construction	71
CHAPTER 9 Wetlands	73
Description of Forested Wetland Types.....	74
Jurisdictional Wetlands	75
Site Preparation BMPs for Pine Plantation Management in Wetlands.....	77
When Using Chemicals in Wetlands	78
Wetlands Best Management Practices (State)	78
Wetland Access Systems.....	78
BMPs for Wet Weather Operations in Wetlands	81
Wildlife Habitat	81
Wetland Streamside Management Zones	81
Legal Requirements.....	82
Where to Go for Wetlands Assistance.....	82
CHAPTER 10 Regulations and Legislation	85
Federal Clean Water Act-Mandated Best Management Practices	86
Silvicultural Operations in Chesapeake Bay Preservation Areas.....	87
Silvicultural Water Quality Law	88
Debris in Streams Law	89

CHAPTER 11 Glossary of Forestry Terms	91
APPENDIX A BMP Specifications	99
1 – Forest Roads	100
2 – Skid Trails	101
3 – Wing (Lead Off) Ditches.....	102
4 – Culvert Sizes for Cross-Drainage of Roads	104
5 – Broad-Based Dip.....	105
6 – Rolling Dips.....	107
7 – Water Bars.....	108
8 – Temporary Fill Diversion	109
9 – Temporary Slope Drain.....	111
10 – Level Spreader	113
11 – Temporary Sediment Trap.....	115
12 – Rock Check Dams	117
13 – Mulching	120
14 – Soil Stabilization Blankets and Matting.....	124
15 – Straw Bale Barrier.....	126
16 – Silt Fence	128
17 – Brush Barriers	131
18 – Surface Roughening	133
19 – Geotextile	136
20 – Geo Web® Improved Ford	137
21 – Logging Entrance.....	138
APPENDIX B Planning Tools	141
Evaluating Slope.....	142
Evaluation of Aerial Photographs	143
Evaluation of Soil Maps.....	143
Evaluation of Topographic Maps	144
Evaluation of Drainage Area	145
APPENDIX C Road Surface Area	147
Determining Road Surface Area.....	148
Determining Road Surface Material.....	149
APPENDIX D Revegetation of Disturbed Areas	151
Revegetation of Bare Soil Areas.....	152
Critical Area Planting	153
The Use of Native Plants for Restoration	155
APPENDIX E Agency Listing	159

Tables

<i>Table 1 Streamside Management Zone (SMZ) Width.....</i>	15
<i>Table 2 Suggested Spacing for Cross-Drainage Culverts</i>	18
<i>Table 3 Suggested Spacing for Rolling Dips</i>	19
<i>Table 4 Suggested Spacing for Broad-Based Dips.....</i>	19
<i>Table 5 Suggested Spacing for Water Bars.....</i>	19
<i>Table 6 Logging System Application</i>	31
<i>Table 7 Swing System Application</i>	33
<i>Table 8 Streamside Management Zones (SMZs)</i>	37
<i>Table 9 Temporary Culvert Sizing (2-Year Event)</i>	42
<i>Table 10 Permanent Culvert Sizing (10-Year Event)</i>	43
<i>Table 11 Culvert Alternatives (diameter)</i>	43
<i>Table 12 Suggested Windrow Spacing</i>	56
<i>Table 13 Maximum Distance Between Wing Ditches/Turnouts</i>	103
<i>Table 14 Suggested Spacing for Cross-Drainage Culverts.....</i>	105
<i>Table 15 Suggested Spacing for Broad-Based Dips</i>	106
<i>Table 16 Suggested Spacing for Rolling Dips.....</i>	107
<i>Table 17 Suggested Spacing for Water Bars</i>	109
<i>Table 18 Guide for Area Estimation on a 7.5 Minute Topographic Map</i>	145
<i>Table 19 Guide for Determining Road Surface Area</i>	148
<i>Table 20 Surface Material Determination for Roads</i>	149
<i>Table 21 Seeding Mixtures and Guidelines for Revegetation of Critical Areas in Virginia</i>	154
<i>Table 22 Critical Planting Area</i>	155
<i>Table 23 Planting Rates</i>	156

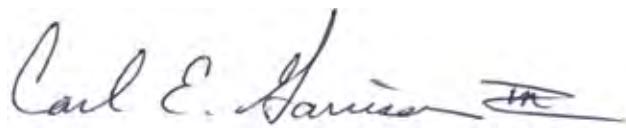


Foreword

The Virginia Department of Forestry – in cooperation with many of our associates with state and federal agencies, forest industry, forestry consultants and private non-profit groups – is pleased to present this Fifth Edition of our Forestry Best Management Practices for Water Quality Technical Manual. The original publication has served the forestry community well since 1978 and time has shown us more efficient and technically correct ways to install practices, as well as more instructive ways to present this information.

Continued effort by the forestry community is necessary to stay on top of Best Management Practices and water quality protection. The Virginia Department of Forestry remains committed to increased adoption of these practices by all who impact our forest resources. As the public becomes more aware of our collective practices on the land, we must be willing to instill the “Stewardship Ethic” and Sustainable Forestry Principles as we provide the raw material necessary for continued economic viability and the environmental amenities enjoyed by our citizens.

I trust this Fifth Edition is helpful and fosters the appropriate installation of Best Management Practices on Virginia's forestland.



NOTES

CHAPTER 1

INTRODUCTION



Introduction

Commercial forests occupy more than 61 percent or 15.4 million acres of land in Virginia. Forest ownership is dominated by non-industrial private ownership at 77 percent; forest industry owns 10 percent, and the remaining 13 percent is held by public agencies.

Forestry annually contributes more than \$27.5 billion to Virginia's economy. If Virginia is to thrive economically, the forests' ability to produce goods and services along with their harvestability must be sustained.

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.

Purpose

This manual is prepared to inform and educate forest landowners and the professional forest community on the proper Best Management Practices (BMP) use; its specific purpose, and technical specifications for installation. BMPs are proven methods used to protect water and site quality.

What is Nonpoint Source Pollution?

Nonpoint 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 man-made pollutants and deposits them into waterways, wetlands and ground water. Human activity can dramatically increase nonpoint source pollution potential.

There can be five types of water pollutants resulting from silvicultural activities. They are:

1. Sediment
2. Nutrients
3. Organics
4. Temperature
5. Chemicals

Silvicultural activities that have the greatest chance of causing nonpoint source pollution include:

1. Forest road construction, including stream crossings;
2. Forest harvesting activities, including skidding and processing timber;
3. Site preparation;
4. Pesticide application, and
5. Wildfire control lines and prescribed fire use.

Of all the listed silvicultural activities, road construction is generally considered to have the greatest potential to increase nonpoint source pollution and, subsequently, to degrade water quality. This potential impact is dependent on slope, soil type, area affected and intensity of activity.

Why is Nonpoint Source Pollution Important to Us?

Abundant clean water is important to all citizens of the Commonwealth. Excessive runoff can increase sedimentation to streams. Increased sedimentation raises filtering costs for drinking water; increases flood potential by filling up streambeds, and chokes irrigation systems. Fish habitats can be altered by improper management activities. Removing shade from critical riparian or streamside areas can increase water temperatures, thus affecting fish and other aquatic life. The entire food chain in and near streams can be affected and damaged by land management activity. Best Management Practices can reduce the impact from these management activities.

Best Management Practices – What are They and Why are They Important?

Best Management Practices are activities chosen to reduce soil erosion and prevent or control pollution resulting from forestry operations. BMPs have been in existence for many years in the areas of forestry, agriculture and urban development. Forestry BMPs are directed primarily at controlling erosion. Erosion can lead to sedimentation, which is the entry of soil into waterways. BMPs are proven methods to lessen the potential damage from land-disturbing activities.

Using this Manual

This technical manual is organized according to broad categories of forestry operations where the forest manager needs to recognize appropriate BMPs. The broad topics will describe useful BMPs and techniques to minimize pollution from the forestry operations. The back of the manual contains an appendix of standards and specifications for each BMP. The manual will not replace on-the-ground recommendations by a qualified professional forester or resource professional and should not be used as a substitute. Forest operators should always consult a professional for solutions to difficult on-the-ground problems. Alternative methods that achieve equal water quality protection are acceptable.

Appendices

Appendix A – BMP Specifications. Provides detailed information on each BMP, where it is to be used, design specifications and any planning considerations.

Appendix B – Planning Tools. Provides guidance on the use of various planning tools, such as slope determination; use of aerial photographs; use of soil maps; evaluation of topographic maps, and methods useful in determination of drainage areas.

Appendix C – Road Surface Area. Provides tables useful in determining road surface area; determining road surface material requirements, and the use of geotextile fabrics.

Appendix D – Revegetation of Disturbed Areas. Focuses on the stabilization of disturbed or bare soil areas following forestry operations.

Appendix E – Agency Listing. A listing of natural resources agencies that may provide technical assistance with any situations not provided for by this technical manual.

What Happens When Water Quality is Degraded?

If a silvicultural activity is negatively affecting water quality, the logger, landowner and timber buyer are all liable and each may be required to correct the problem. In July of 1993, the Virginia Department of Forestry was given the responsibility to inspect harvesting operations for water quality degradation. The Department, through this legislation, has the authority to do the following:

- 1.** Recommend corrective action;
- 2.** Stop harvesting, and
- 3.** Initiate civil penalties.

Forest industry and forest consultants who monitor compliance with this legislation have adopted the Department's inspection program. Any questions regarding this law should be directed to your local Department of Forestry office.

Please see Chapter 10, Regulations and Legislation Pertaining to Water Quality and Forestry in Virginia. (See "CHAPTER 10" on page 85.)

NOTES

NOTES

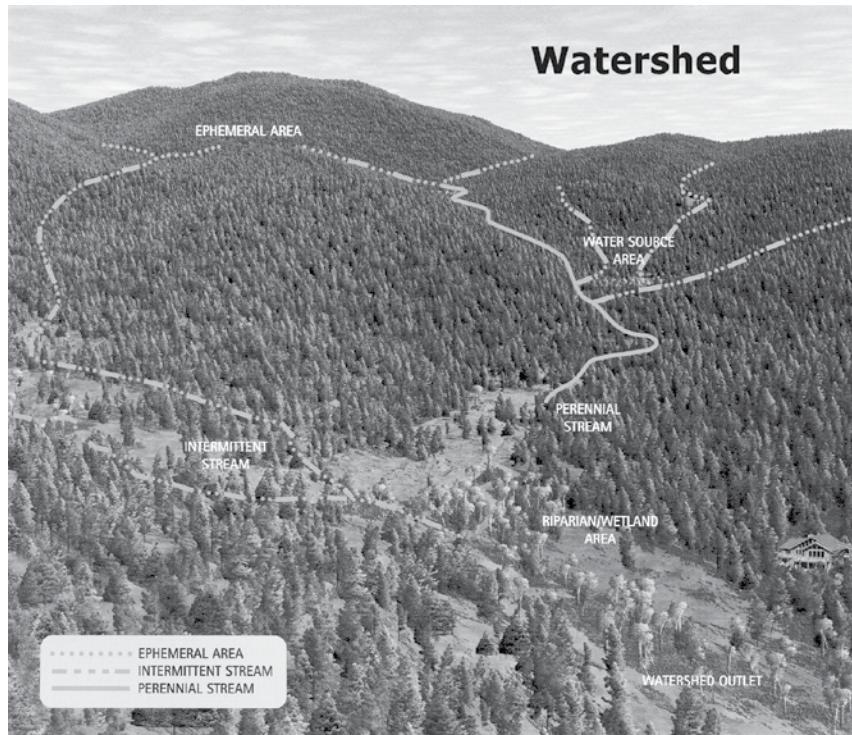
CHAPTER 2

WATERSHEDS



Watersheds

A watershed is a land area where precipitation collects and funnels to an outlet – usually a stream. The image below shows perennial streams, intermittent streams and wetland areas illustrated over a watershed.



An intermittent stream has water in it for only a portion of the year but has defined channels and banks, and evidence of scouring is apparent. A perennial stream has water in it all year and also has a well-defined channel and established banks. As the image depicts, most intermittent streams occur near the upper portion of the watershed while most perennial streams are near the lower portion of the watershed.

A comparison widely used is that of the roof on your home. Rain falls on the roof and moves by gravity toward the gutters, collecting debris and materials as it flows. The water eventually reaches the downspouts where it concentrates, picking up speed and additional debris. Different land uses affect watersheds differently. The effect of storms is dependent on slope, soil type and overall land use. For example, precipitation moves more slowly through a forested watershed than through an urban watershed because organic forest soils absorb the rainfall's energy more efficiently than rooftops and pavement in urban settings. Land-disturbing activities, such as road construction, timber skidding and site preparation, can greatly affect the movement of water and associated debris, including sediment, to a stream. One must be careful when conducting silvicultural operations so soil movement is minimized. Of particular importance are the intermittent streams that, despite not having water in them most of the year, can contribute to downstream water quality. The use of heavy equipment during timber harvesting can lead to altered and compacted soil causing downstream water quality problems if forest operators do not properly use BMPs.

Sensitive areas, such as wetlands, bogs, seeps and marshes, are found in all watersheds and should be treated with care and receive special protection. The Clean Water Act of 1972 (Public Law 92-500) and its amendments mandate water quality sufficient to provide “fishable” and “swimmable” waters. It requires that all “waters of the United States” will be protected from degradation. This includes, but is not limited to, headwater creeks, rich bottomland hardwood bogs, marshes and permanently flooded cypress-tupelo areas. The scope of the legal jurisdiction was expanded in 1977 by amendments redefining protection to include the “waters of the United States” and their “adjacent wetlands.” This protection, under Section 404, specifies that anyone engaging in activities impacting waters and wetlands is required to secure a permit before proceeding, unless exempted. In forested wetlands, the law provides an exemption from permitting under Section 404 for normal ongoing silvicultural operations provided that the “15 Federally-Mandated Best Management Practices” are followed. (See “CHAPTER 10” on page 85.)

NOTES

CHAPTER 3

PLANNING FOR FORESTRY OPERATIONS



Planning for Forestry Operations

Any forest management activity, regardless of potential impact on water quality, should be thoroughly planned. Whether the activity involves timber harvesting, site preparation and reforestation, chemical treatments, timber stand improvement or fire management, the planning process should consider the objectives of the proposed activity and potential impacts of all actions that disturb the soil surface or impact water quality. Planning should help identify sensitive areas and applicable BMPs to be used during timber sales, forest management activities, road construction, stream crossings, harvesting, site preparation, reforestation, fire management and silvicultural chemical applications. Planning should also identify terms and conditions of a written contract for any forestry practice. While BMPs do not specifically require written plans, it is generally a sound practice to maintain written records of any forest management activity on the land.

Plans should consider:

1. History of the site, including previous land use;
2. Sensitive areas, such as perennial and intermittent streams, lakes, ponds, wetlands, sinkholes, steep slopes, highly-erodic or hydric soil types, and active gully systems;
3. Regulations and/or permitting requirements, and
4. Location, type, timing and logistics of each activity.



Useful resources for planning forestry operations include U.S. Geological Survey (USGS) topographic maps, Natural Resource Conservation Service (NRCS) county soil survey maps with interpretations, aerial photographs and county tax maps. Additional tools include an area stand map and tract boundary survey map that can reveal tract boundaries and sensitive areas. Because no map is 100 percent accurate, they should be used as a reference to identify potentially sensitive areas that must then be verified and plotted during field reconnaissance to minimize impacts before silvicultural operations begin. Most of these maps, along with aerial photographs, are accessible at Department of Forestry area offices. The NRCS maintains soil maps at local field offices where field personnel are available to assist with map and resource information interpretation.



Water quality protection begins with the ability to recognize watercourses and water bodies. According to the Federal Clean Water Act, “waters of the U.S.” include lakes, rivers, perennial and intermittent streams, wetlands, sloughs or natural ponds. Identifying stream types (perennial or intermittent) is important in prescribing the level of protection through the implementation of BMPs listed in this manual. USGS topographic maps and NRCS county soil maps can be used as a reference to help identify stream types. Where available, they should be cross-referenced and field-verified.

Stream Types

Perennial streams flow in a well-defined channel throughout most of the year under normal climatic conditions. Some may dry up during drought periods or due to excessive upstream use. They are usually identified as solid blue lines on USGS topographic maps and as either solid black or black lines separated by one dot on NRCS soil maps. Aquatic organisms are normally present and easily found in these streams.

Intermittent streams flow in a well-defined channel during wet seasons of the year but not for the entire year. They generally exhibit signs of water velocity (scouring) sufficient to move soil material, litter and fine debris. They are usually identified as blue lines separated by three dots on USGS topographic maps and as black lines separated by two or more dots on NRCS soil maps. Aquatic organisms often are difficult to find or not present at all in these streams.

The landowner or manager may be familiar with a stream's flow characteristics and make the determination of stream type. In some cases, there may be uncertainty. In such situations, a qualified professional forester or other resource professional should be consulted.

Other Sensitive Areas

Some water bodies and upland areas have particular characteristics or regulatory requirements that require different management approaches. These include, but are not limited to, mountain trout streams, protected river corridors, water supply reservoirs/watersheds, cave entrances, ditches, canals, sloughs, wetlands, braided streams and gullied areas. In such situations, a qualified professional should be consulted. Forest health issues, such as fire management, integrated pest management and disease control, may also require a qualified professional to prescribe appropriate actions. Forest managers, landowners, foresters, timber buyers, logging contractors, site preparation contractors and reforestation contractors should clearly identify water bodies, sensitive areas and streamside management zones (SMZs) in the field and then decide which BMPs to apply and when and where to apply them to better design access roads, log decks and stream crossings. They should supervise these operations to ensure that BMPs are followed where necessary so that water quality is not compromised.

Benefits of Planning

The benefits of a well-written plan and/or written contract include better communications of expectations between the landowner and forestry professionals; 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; avoidance of fines or penalties, and enhancement of habitat for wildlife diversity. For information regarding sample contracts and management planning, contact the Virginia Department of Forestry. Planning for the protection of water quality just makes good sense.

Special Management Areas

Braided Streams – Streams that have multiple channels. Treat each channel individually, depending on whether the stream is perennial or intermittent. These unique and unstable streams require site-specific management planning and recommendations. Check with a qualified professional forester for management assistance.

Canals and Ditches – Provide minor drainage to **temporarily** lower the water level on a wetland site during road construction, timber harvesting and site preparation and is considered normal and exempt from Section 404 permitting if it does not result in the immediate or gradual conversion of a wetland to an upland or other land use. Minor drainage does not include the construction of a canal, dike or any other structure that continuously drains or significantly alters a wetland or other water body. If the ditches could potentially move sediment or other pollutants into the natural stream system and/or off-site, appropriate water protection techniques and devices should be used. Ditches should not empty directly into streams. New drainage ditches should not be located within the SMZ.

Gullies – Many old erosion gullies have healed and are not actively eroding. Care should be taken not to reactivate gully erosion. If the silvicultural activity leads to reactivation of flow, then the gullies may require stabilization.

Lakes, Ponds and Other Bodies of Flowing Water – Follow the BMPs recommended for perennial streams.

Seeps and Springs – Check with a local professional forester when seeps and springs are present to determine appropriate SMZ recommendations.

Sinkhole – A geologic feature typically found in karst geology, it usually provides a direct connection between land surface and groundwater. Cave entrances where active streams are present should be protected by an SMZ.

Slough – Sometimes referred to as an oxbow, treat as a perennial or intermittent stream if it could potentially move sediment or other pollutants off-site.

Water Supply Reservoir/Watershed – Requires wider buffer areas. Please refer to Table 1 for buffer width requirements.

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

Wetlands – For regulatory purposes, wetlands are defined by the presence or absence of specific plant communities, hydric soils and hydrologic conditions. Because of the generally wet soil conditions associated with forested wetlands, these areas are extremely sensitive to forestry activities. For example, bottomland hardwood sites and other swamps differ from upland forest types because their soils are wet most of the year. They are frequently connected directly to a larger aquatic system; often have overbank flow from nearby stream flooding, and may accumulate sediments and nutrients from upstream erosion and runoff.

To properly manage forested wetlands, plan for regeneration; consider the areas beyond the management boundary, and use special harvesting equipment and techniques to protect water quality. Any stream channels should be identified and protected by utilization of the appropriate SMZ.

For more information on harvesting and site preparation of wetlands, refer to Chapter 9 (“CHAPTER 9” on page 73).

Endangered Species

The Virginia Department of Game and Inland Fisheries, the Virginia Department of Conservation and Recreation – Division of Natural Heritage and the U.S. Fish and Wildlife Service have listings of endangered species and their known locations within Virginia. If you suspect the presence of an endangered species on the property where the silvicultural activity is to occur, consult one or more of these agencies for verification and management considerations. A listing of these agencies can be found in Appendix E (“APPENDIX E” on page 159).

NOTES

CHAPTER 4

FOREST ROADS



Forest Roads

Best Management Practices 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 forestland and water quality when removing forest products from the harvest site.

Studies have shown that most stream sedimentation that occurs during and after timber harvesting operations is the result of improperly constructed or maintained forest roads, skid trails or landings. Sediment may enter streams from these sources if BMPs are not properly installed to prevent soil erosion.

Well-drained and properly-surfaced forest roads not only prevent erosion but also allow better wet weather harvesting access. Properly constructed and maintained forest roads will save money in the long run by reducing down time and lowering equipment maintenance costs associated with wet weather operations.

Specifications

1. Roads should follow contour as much as possible with grades between two percent and 10 percent. Steep gradients that exceed these grades may be necessary when boundary lines or SMZs require such deviation. In these instances, additional BMP measures may be necessary to mitigate the disturbance. Vary road grades frequently to help reduce road surface erosion.
2. Forest roads should be out-sloped wherever road gradient and soil type will permit. Out-sloping allows surface water to drain off of the road quickly, reducing erosion potential.
3. Use in-sloping or ditch and culvert type of cross-section when constructing a road where road gradients are greater than 15 percent; toward sharp turns, or when constructed on clay and/or slippery soils. In such cases, the use of an under-road culvert positioned at a 30-degree angle to ensure proper inside road drainage is recommended (See Table 2 for spacing guidelines).



Table 2
Suggested Spacing
for Cross-Drainage Culverts

Road Grade (%)	Spacing Distance (ft.)
0 - 2	500 - 250
3 - 5	250 - 167
6 - 10	167 - 140
11 - 15	140 - 126
16 - 20	126 - 100
21 +	100

4. Good road drainage can be ensured through the use of properly constructed and spaced water turnouts, such as broad-based dips, rolling dips, culverts and lead-off ditches.
 - a. Use broad-based or rolling dips at appropriate intervals to channel water off the road (See Table 3 and 4 for spacing guidelines). The bottom of these structures should be out-sloped at approximately three percent to allow the removal of surface water. (See "APPENDIX A" on page 99.)
 - b. Locate and install water turnouts a minimum of 25 feet before stream crossings to disperse runoff water through undisturbed areas of the SMZ.
 - c. Use rip-rap or brush at the outlets of drainage structures to reduce water velocities and to avoid channelized flow as needed.
 - d. Use water bars when retiring temporary access roads. Water bars should be constructed at an angle of 30 to 45 degrees downslope with open ends to allow the removal of surface water (See Table 5 for spacing guidelines). (See "7 – Water Bars" on page 108.)
5. To help ensure proper road surface drainage, construct roads on the sides of ridges. New roads should not be constructed on the top of ridges where water tends to collect, resulting in poor drainage.
6. Locate new roads above flood plains and out of the lowest part of the terrain where surface water drainage can be difficult, such as the center of dry drainages.
7. Intermittent and perennial streams should be crossed using properly designed and constructed structures installed at right angles to the road. Structures should not impede fish passage or stream flow. (See "Stream-Crossing Design and Construction" on page 39.)
8. Minimize the number of stream crossings and choose stable stream crossing sites.
9. Approaches to stream crossings should be stabilized with gravel, mulch or other suitable material for a minimum distance of 50 feet on each side of the crossing, or to the top of the grade that is contributing sediment to the stream crossing.

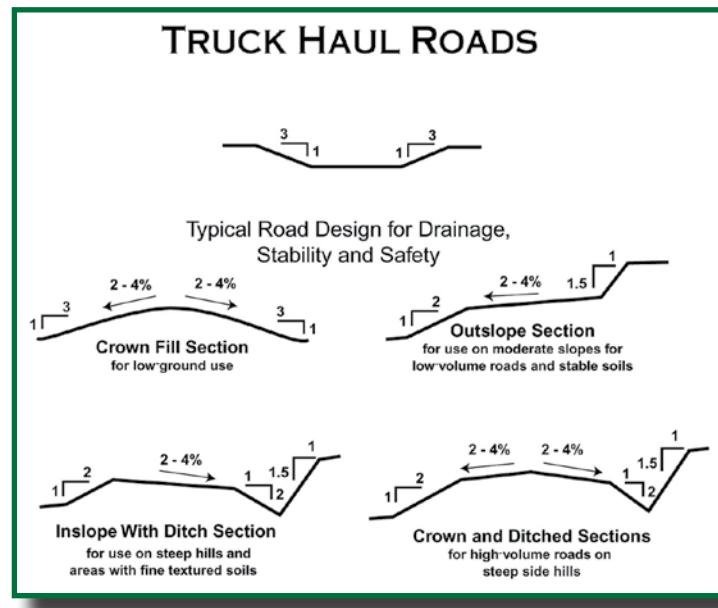
Table 3 Suggested Spacing for Rolling Dips	
Road Grade (%)	Spacing Distance (ft.)
2 - 5	180
6 - 10	150
11 - 15	135
16 +	120

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

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

4 | Forest Roads

10. Locate access roads outside the SMZ unless no other alternative exists.
11. If access roads have to be located within the SMZ due to right-of-way, boundary line restrictions or other physical features, such as rock outcroppings, additional measures must be taken to prevent erosion and/or water quality degradation. Carefully examine pre-existing roads when they are to be used for timber harvesting as drainage may be difficult.
 - a. Locate roads as far as practical from the stream channel and maintain an unbroken organic litter layer on the forest floor in the SMZ.
 - b. Roads within the SMZ should be surfaced with gravel, mulch or other suitable material to provide a non-erodible running surface.
 - c. Cut-banks and fill-slopes should be stabilized as soon as feasible to a non-erodible condition using vegetation, rock, geotextile material or other suitable material.
 - d. Install a properly constructed silt fence, staked-in straw bales or brush barriers at outlets of drainage structures within the SMZ. (See "APPENDIX A" on page 99.)
12. Roads should be "day-lighted" (shade removed) to aid in drying of the road surface.
13. Make road wide enough to accommodate traffic safely.
14. Minimize cuts and fills as much as possible during design and construction. Properly stabilize slopes exposed by road construction to prevent problems with erosion and runoff. Tall cut-slopes may require back-sloping to achieve stability and successful revegetation. Do not side-cast fill material if there is a chance that it will enter a stream, or if side slope exceeds 60 percent. Full bench construction with end hauling material to a suitable location is recommended when side slopes exceed 60 percent.
15. Restrict traffic on access roads during unfavorable conditions, such as saturated soil. Gravel, wooden mats or a combination of geotextile and gravel may be used to help facilitate operations during wet periods.



16. Skimming or removal of saturated soils from access roads should be avoided.
17. When access roads intersect public highways, use gravel, wooden mats or a combination of geotextile and gravel (or other means) to help keep mud off highway entrances.
18. Maintain road so that water can flow freely from the road surface.
19. Use existing roads where practical unless use of such roads would cause or aggravate an existing erosion problem.
20. Avoid slide-prone areas, which are characterized by steep side slopes with unstable soil.

Maintenance

1. Control access by using a locked gate to prevent unnecessary damage to the road surface.
2. Keep drainage systems open and working during and after logging operations.
3. Inspect the road at regular intervals to detect and correct maintenance problems.
4. When the timber harvest is complete and the road has been stabilized, control of access and road maintenance will be the responsibility of the landowner.



NOTES

CHAPTER 5

TIMBER HARVESTING



Timber Harvesting

Pre-Harvest Planning

Proper planning for timber harvesting is imperative to minimize the potential impact to soil and water quality. Incorporating BMPs into a logging operation while carrying out that operation in the most efficient manner requires planning.

There are two stages of harvest planning: preliminary pre-harvest planning and comprehensive harvest planning. A pre-harvest plan is a fairly simple plan commonly prepared for a forest landowner by a VDOF area forester, forestry consultant or procurement forester prior to conducting a timber sale. The plan will identify recommended streamside management zones as well as potential problem areas, such as fragile soils or steep slopes, that may require special treatment during the harvesting operation.

A comprehensive harvest plan is much more detailed. The plan is usually prepared by the logger or logging manager just prior to beginning the harvesting operation. The logging plan may include recommendations on logging roads, log decks, streamside management zones, stream crossings, skid trails and the schedule of activities. The logger must have the following information at his or her disposal:

1. **Type of cut** (clear-cut, row thinning, individual tree selection, etc.) – This could affect deck size and location, equipment restrictions or job layout.
2. **Terms of the timber sale contract** – For example, the length of time on the contract may dictate the time of year that the tract will be logged, which may impact the haul road construction standards.
3. **Tract topography** – In the mountains, topography will often limit the logger's options for road and deck location. In addition to slope, aspect and exposure should also be considered.
4. **Tract soil conditions** – Soils will affect road and deck location, especially in the Coastal Plain and Piedmont regions. Soils also impact equipment decisions and scheduling of activities.
5. **Tract hydrology** – Knowing how much water to expect in a stream after a big rain will dictate stream crossing structures.



6. **Tract boundaries, easements and rights-of-way** – This information is necessary to locate access points and haul roads and may be the limiting factors on accessibility for the site.
7. **Timber volume** – Timber volume to be removed by species and product, and the distribution of that volume across the tract. This information is vital for determining haul road standards, deck size, deck location and scheduling.
8. **Logging system and equipment spread**
– The planner must be intimately familiar with the characteristics of the logging operation, including any equipment limitations or operating constraints. For example, the type of log truck (tandem or tractor/trailer) will impact the haul road layout, acceptable curve radius and landing size.
9. **Applicable laws and regulations** – Laws affecting logging, including but not limited to the current non-regulatory BMPs, Silvicultural Water Quality Law, Chesapeake Bay Preservation Act and Clean Water Act. These could affect all aspects of the harvest plan.



There are several tools available to the harvest planner. Topographic maps, available from the U.S. Geological Survey, are a must in the Piedmont or Mountain regions. Soil survey maps are most important in the coastal plain regions, where soils impact logging operations much more than topography. Soil maps for most counties can be obtained from the Natural Resources Conservation Service. A detailed timber stand map can be of great assistance in planning log deck location and scheduling operations. Many landowners have these on file for their property, prepared by a VDOF area forester, forestry consultant or forest industry representative.

An accurate estimate of slope is necessary to maintain acceptable road grade, determine spacing between required water bars and to comply with various BMP recommendations. Plastic flagging of various colors is an important tool for the logging planner. Boundaries, log deck locations, "back-lines" for skidding zones, streamside management zones and designated skid trails can all be effectively marked and distinguished by flagging or paint of different colors. Plastic flagging, paint and slope-determining instruments can be purchased from any forestry or engineering supply company.

Steps to Prepare a Harvest Plan

The following 14 steps provide a framework for a comprehensive harvest plan:

- Step 1** Prior to but no later than three working days after commencement of an operation, the owner or operator shall notify VDOF by on-line website or by calling the toll-free number below.

This is a requirement of the law. Failure to notify can result in a Civil Penalty of \$250.00 for a first offense and up to \$1,000.00 for subsequent violations.

To notify of a timber harvest, you must obtain a notification identification number from VDOF. This is simply an assigned number that you will use to identify your company when you notify VDOF of timber harvests.

You will be asked for your phone number; when logging will begin; the county where it will occur; the location; the size of the operation, and contact information for the landowner. You will receive a confirmation number when you notify. Retain this confirmation number as proof of notification.

This information will be sent to the appropriate VDOF office.

The VDOF will assist with pre-harvest planning if requested. Pre-harvest planning guidance prior to moving equipment on the tract may lessen the chance of BMP or water quality problems later.

- Step 2** Study applicable maps and conduct an on-the-ground reconnaissance of the area to be logged. Note the slope, aspect, soils, timber, streams, wetlands, access, boundaries, old logging roads and "indicator" plants. Document as you proceed. A good method is to carry a large-scale topographic map covered with a sheet of acetate or mylar on a clipboard. Mark important details and locations on the acetate "map." Become familiar with all of the tract characteristics that will impact logging.

- Step 3** Identify and mark streamside management zones (SMZs). These are one of the most important and effective ways to reduce stream sedimentation in a harvested area, and should be implemented on all perennial and intermittent streams. (See "Streamside Management Zones" on page 35.)

- Step 4** Locate and flag log decks. These are critical decisions that will directly affect production. Log deck location is a trade-off between skidding distance and haul road construction. A log deck should be on a slightly sloped area (to facilitate drainage) with stable soils that do not easily rut.

- Step 5** Locate and mark logging road stream crossings. Generally the best rule regarding stream crossings is not to have any if at all possible. They can be expensive and a potential source of major environmental and water quality problems. However, if it is determined that a stream crossing is necessary,



choosing the proper location is critical. Look at the stream width; water depth; stability of the stream bottom and banks; the approaching topography and soils, and the normal high-water mark. Choose a location that will minimize the chance of stream sedimentation arising from logging and hauling operations. As much as possible, locate log roads and skid trails outside the SMZ.

Step 6 Locate and mark logging road entrance points from public roads. The law requires that a truck driver pulling onto the highway from a temporary log road be able to see clearly in either direction for a minimum of 200 feet. Contact your local VDOT office for specific concerns regarding your tract and any entrance permit requirements

Step 7 Locate any other logging road “control” points. These are points or locations that the logging road must either connect or avoid. Entrance points, stream crossing locations and the log deck locations are all “positive” control points for the haul road network. Examples of “negative” control points are rock outcrops or gumbo clay flats – areas through which the haul road cannot pass.



Step 8 Locate and flag the logging road gradeline (in the mountains) or centerline (in the coastal plain). A good procedure is to first attempt to plot the gradeline on a topo map, connecting the positive control points while keeping the road at an acceptable grade (recommend maximum 15 percent grade for no more than 200 feet at a time). Ideally, the grade should be kept at 10 percent or less. Locating a centerline on relatively flat coastal plain terrain is usually somewhat easier. Soils are often the main consideration. 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.

Step 9 Locate and flag designated skid trails, if necessary. In general, “bladed” designated skid trails should be avoided if at all possible as they greatly increase environmental impact through erosion and stream sedimentation.

Step 10 Specify logging road construction standards. There are generally three logging road standards:

1. The most common is a “branch” logging road. It is designed as a temporary road that will be “retired” immediately after logging is completed. A branch road is usually not much more than a 10- to 12-foot-wide trail where the surface organic material has been graded off. There is no surfacing, and drainage is handled through a few well-placed water turnouts or broad-based dips.
2. A “primary” logging or forest road is designed for permanent, all-weather use. It has a 20-foot-wide subsurface, permanent ditches, cross-culverts, stabilized banks and occasional crushed rock surfacing. A primary road is expensive and can be justified only on very large timber sales where the road will be used for several years.

5 | Timber Harvesting

3. A “secondary” logging road has a narrower subsurface than a primary road, with water control devices installed, but without surfacing. It is designed for all-weather use, and is a good choice for extended logging jobs that must operate year ‘round.

Consider the use and availability of temporary road stabilizing or surfacing options, such as crushed rock, geotextiles or mats (wooden, metal or rubber). These are best applied at potential “trouble spots” **before** a problem occurs.

- Step 11** Specify stream crossing structures. The common choices, from least to most expensive, are: a ford; a culvert with dirt fill; a “low-water” bridge, and an elevated timber bridge. The “best” choice depends upon the cost, the stream characteristics, the amount of use anticipated, the load-bearing requirements, the area of forestland drained by the stream, the previous “high-water” mark, the time of year the structure will be used and the environmental impact.

A proper stream crossing structure will minimize any disruption to the normal stream flow and pattern. Type and method of harvesting may influence culvert size. Refer to the section on stream crossings in this chapter for more details.



- Step 12** Determine the schedule of operations and harvest patterns. The most efficient schedule of operations depends on tract topography, time of year, current and anticipated weather conditions, road construction requirements, cash flow and other outside factors. Equipment maintenance, safety meetings and planned holidays or mill shutdowns should be included in scheduling. Scheduling should be constantly refined and updated as the operation progresses.

- Step 13** Specify tract “close-down” requirements. These primarily involve the implementation of BMPs that will minimize erosion and stream sedimentation on the tract in the period after harvesting has been completed. They include re-grading ruts; installing water bars on abandoned roads or designated skid trails; reseeding landings and roads; removing any temporary stream crossing structures; scattering brush; opening ditches or water turnouts, and any clean-up necessary to leave the tract in acceptable condition. Close and gate roads to unauthorized traffic.



Many of these operations can be scheduled during “slow” times as harvesting is completed on various parts of the tract, thereby avoiding a massive job at the end. It is important to make the landowner aware of his responsibility to maintain the tract in the environmentally-sound condition in which it is left after logging is completed and BMP compliance recorded.

- Step 14** Determine if permits are required and obtain them. The Virginia Marine Resources Commission has regulatory control over most of the stream bottoms of Virginia. Through mutual agreement between the Virginia Marine Resources Commission and the Virginia Department of Forestry, any stream crossing that has more than a five-square-mile watershed drainage area above the crossing will require a permit from the Virginia Marine Resources Commission. The permit application can be obtained from the Virginia Marine Resources Commission. (See “APPENDIX E” on page 159.) Any crossing on streams below the five-square-mile watershed threshold will have to adhere to the Best Management Practices for stream crossings as outlined in this manual.

Logging Systems for Effective BMP Implementation

A logging system is the combination of equipment and personnel used to harvest timber. Logging systems can be described in detail by all of the functions used to develop the harvest (felling, yarding, processing and loading).

For this general discussion on BMP implementation, logging systems will refer only to the primary method used to move the tree from the stump to the landing.

Logging systems, or tools to harvest timber, have evolved to be responsive to different harvesting conditions. As harvesting conditions change, so have the tools to harvest timber. Today, this evolution in logging systems results in a wide variety of specialized harvesting tools, each designed to effectively harvest timber in particular conditions. As public acceptability of harvesting’s adverse environmental impacts has decreased, logging systems have evolved to decrease these impacts.

As the utilization of the timber resource has pushed harvesting on increasingly difficult sites, logging systems have evolved to be effective in challenging timber and terrain. This evolution has resulted in a logging system toolbox, each tool being suited to a particular set of conditions. Proper application of logging systems means applying the tools to the set of conditions for which it was designed. Proper application of a logging system can result in both cost effectiveness and minimal adverse impact to the forest environment.



Improper application of a logging system usually results in increased harvesting costs and/or undesirable environmental impacts. Effective BMP implementation to mitigate harvesting impacts is dependent on the proper logging system application. The environmental impacts of improper logging system applications cannot usually be cost-effectively mitigated through BMP implementation, particularly on more challenging timber and terrain.

As a simple example, larger skidders were developed to skid larger timber. Small skidders and large skidders could represent two logging systems. When a large skidder is applied to a small timber tract, the result is increased costs as well as the potential for increased damage to the residual timber. Increased costs come through payloads lower than capacity (too many trees needed to get payload) and increased damage potential (choking stems) because of the reduced maneuverability of the larger skidder. Proper selection and application of a logging system, such as skidder size in this example, is key to minimizing harvesting costs as well as environmental impacts.



Logging System Descriptions

These are examples of some of the basic harvesting systems used today:

1. **Animal** – Horses or mules to pull logs or carts suspending logs. Animal weight, number of animals and species of animal vary to provide different skidding capacities.
2. **Tracks** – Use of track-laying tractors to pull logs or arches suspending logs. Tracks may be hard, as in dozers with rails, or soft, as in KMC skidders with torsion bar suspension. Tracked systems may have winches, grapples or swing-boom grapples. Track length, width and grouser patterns vary for differing weight and horsepower classes.
3. **Skidder** – Use of rubber-tired articulated tractors with integral arch to pull logs. Skidders may have winches, grapples, both or swing-boom grapples. Tire width and grouser pattern can vary for differing weight and horsepower classes.
4. **Shovel** – Use of hydraulic excavator-based loader/shovel to bail logs. Reach, track length, width and grouser patterns vary for differing weight and horsepower classes and may be combined with processing heads, grapples, grapple saws, felling heads, excavation buckets, live or dead heels and quick connections to transform into a multi-function machine.

5. **Forwarders** – Use of rubber-tired tractors equipped with log bunks and loader to transport logs free of the ground. The number of axles, tires, weight capacity and loader size vary for differing weight and horsepower classes.
6. **Cable** – Use of a cable yarder and carriage to yard logs, either with one end suspended or completely suspended by wire rope. A yarder is logging equipment combining winch drum and steel spars or towers. Cable yarders may be mounted on tracks, truck, trailer or sled. Tower height, number of winches, line size and line length vary by horsepower and weight class. A carriage is the device that moves in and out from the yarder to the timber and accommodates chokers or a grapple for hooking logs. Carriage characteristics are non-slack pulling or manual, mechanical, motorized slack pulling, radio, cycle or mechanically controlled, single or multiple span.
7. **Helicopter** – Use of helicopters to vertically lift timber from the stump and fly fully suspended to the landing. Helicopters used in logging have different lifting capacities.

Logging System Selection

The proper selection of a logging system involves consideration of many different conditions, such as slope, terrain shape, yarding distance, weather, soils, tree size, volume per acre, size of tract, cost of road construction, cost of logging and productivity goals. Table 6 lists the logging systems and the various characteristics of each system's niche. The niche, or place, for a logging system is the application where the harvesting costs and the environmental impacts are minimal when compared to other logging systems.



Table 6
Logging System Application

Logging System	Weather Sensitivity	Terrain Slope (%)	External Yarding Distance	Average Tree Size	Volume Per Acre	Volume Per Tract	Cost of Road	Terrain Shape & Length
Animal	Moderate	< 20	< 500 ft.	Small	Low	Small	Low	Flat Short
Tracks	Moderate	< 40	< 800 ft.	Large	Common	Small	Low	Moderate Short
Skidder	High	< 35	< 1,500 ft.	Medium	Common	Medium	Medium	Flat + Common
Shovel	Low	< 45	< 400 ft.	Medium	Common + Clear Cut	Small	Low	Moderate Broken
Forwarder	High	< 30	< 2,500 ft.	Medium	Low	Large	High	Gentle Long
Cable	Low	Any	< 1,500 ft.	Medium	Common +	Medium	High	Steep Concave Long
Helicopter	Low	Any	< 6,000 ft.	Large	High Sawtimber	Large	High	Any

Logging System Application

Animal – Using animals to skid timber is best applied in flat terrain, close to existing roads and in a publicly sensitive location. The sensitivity may be a recreation site, trail, road or residential viewshed. The system is limited by the weight of the animals and their ability to exert pull, and, in general, can be used in up to 20-inch timber on favorable slopes. Because of the low productivity and low move costs, small tracts can be harvested economically.

Tracks – Tracks are best used where short, steeper slopes prohibit overland rubber-tired skidding. Because of the slower travel speeds, yarding distance is limited and roads should be either existing or inexpensive to construct. Soft tracks, or high-speed torsion bar suspended tracks, can extend the efficient skidding distance and operate on somewhat steeper slopes than traditional hard tracks. Swing-boom grapple-tracked machines can be effective in larger timber on steeper slopes at short distances. These can be used on wetter sites or in moderately inclement weather.

Skidder – Rubber-tired skidders have application in the broadest range of logging conditions of any logging system. This is why skidders are the conventional logging system in Virginia. Skidders are a flat-ground system, but with winches can be effectively used on flat to moderate slopes. Skidding is the default logging system selection except when: 1) logging is necessary in inclement weather; 2) skidding distances are longer than 1,500 feet due to the cost of road construction, or 3) a dozed road is necessary for the skidder because slope is excessive. Under these conditions, other logging systems should be considered. Tire widths can be increased to operate over land on steeper slopes and on wetter sites.

Shovel – Shovel logging is limited to clear-cutting when it is necessary to pick up and swing the timber toward the road (bail). Shovels can work in adverse weather, in wet areas and on steeper slopes because they are not dependent on tractive effort to move the timber. Shovels are best applied in common + timber volumes clear-cut per acre; logging in adverse weather, or on steeper slopes where yarding distance is generally less than 400 feet and roads are either existing or inexpensive to build due to the shorter yarding distance.

Forwarder – Forwarders are best applied where longer yarding distances in fairly gentle terrain is needed to avoid expensive truck road construction, or where the volume to be harvested per acre is low and does not justify truck road construction. Scattered pieces can be picked up and forwarded. It is suited to larger tracts with existing trails that can be used as is without the need for truck road construction and for yard distances of 1,500 feet up to 2,500 feet.

Cable – Cable logging systems are best applied where, due to excessive slope, ground-based systems require excavated skid roads to operate; when harvesting in adverse weather is necessary, or where compaction due to ground-based systems is unacceptable. Logging uphill up to 1,500 feet is most efficient, however downhill and cross-canyon cable systems can also be used effectively. Terrain features control the landing, cable corridor pattern and the acres that can be harvested from a setting. Because there must be a sufficient volume of timber on each setting to make it economically efficient, higher-than-common timber volumes and value are generally needed.



Helicopter – Helicopter logging is best applied when road costs are high; large volumes must be moved in a short period (salvage or keep the mill running); sawtimber only is planned for harvest; harvest in adverse weather is needed, or when the landowner's objective is to minimize the environmental impacts of harvesting. This harvesting option, due to the expense, should be considered when other options are unsatisfactory. Maximum flight distances should be less than 6,000 feet to maintain an average of 2,500 feet or less per turn. Flight paths can be uphill or downhill but are limited by powerlines, roads, houses and other improvements. Maximum log size is limited by the lift capacity of the helicopter used. Helicopter logging will stop when visual contact between the pilot and ground crew cannot be maintained (fog); when the wind is >30 mph, or when icing conditions (jet intake 30°F to 34°F) are present. Due to the high productivity, 80 million to 100 million board feet per day, extensive landing and trucking support is required.

Swing System – Swing systems are combinations of logging systems to move the timber from stump to a full-service landing. They may or may not involve a swing landing, which is a concentration point between the logging systems employed. The combination of logging systems allows each system to operate in the terrain on which it is most efficient. For example, since tracks can operate on steeper slopes than skidders, yet are limited in the distance to which they can pull, combining tracks with grapple skidders allows for logging on steeper slopes at greater distance than either tracks or skidders alone. If the distance is even greater, combining tracks with a forwarder would be efficient. Another good option for steeper slopes at longer distances is a shovel-skidder swing; however, it is applicable only to clear-cutting operations.

Table 7
Swing System Application

Swing System	Application
Tracks to Skidder	Short, Steep Slopes to Flat Ridge or Flat Bottom
Shovel to Skidder	Short, Steeper Slopes to Flat Ridge or Flat Bottom
Skidder to Forwarder	Moderately Steep Slopes to Long Flat Ridge or Bottom
Skidder to Cable	Flat Slopes/Bottom to Steep Slopes (up a cliff, across a river)
Cable to Skidder	Steep Slope to Moderately Steep Ridge

Logging System Planning

The successful implementation of any specialized logging system is dependent upon successful planning. With a specialized logging system, it is possible to do a more efficient job under particular conditions. The key to logging planning is to keep the specialized logging system working in its particular niche. If the logging system is applied in conditions for which it is not suited, harvesting costs and adverse environmental impacts will likely be high. An example is the application of mechanical felling. It is well known that mechanical felling is safer, more productive and less expensive than manual felling; however, there are certain slope and tree size limitations to mechanical felling equipment. As an example: a logger buys a mechanized feller but can use it only 50 percent of the time because the tracts are too steep or the timber too large. The costs are effectively doubled because the risk of accident is high and productivity suffers when the machine is pushed on slopes beyond its effective working range to increase utilization. As a rule, mechanical felling is better than manual felling – in its niche.

5 | Timber Harvesting

Keeping the specialized tool in its niche is what logging planning is all about – knowing well ahead of the scheduled harvest what logging system is needed and if there is enough timber to keep it utilized. Logging plans are done at different scales, to serve different purposes, and are typically referred to as **strategic** and **tactical** logging plans.

Strategic Logging Plans – These involve large areas on numerous tracts and are based heavily on topographic maps with field work verifying only critical items. A paper logging plan is designed, showing landing locations, road locations, logging systems and yarding patterns. This paper plan is then reviewed in the woods to verify questionable locations, such as access points and major road locations, and is adjusted accordingly. In this fashion, different logging systems can be evaluated for their environmental impacts and cost of harvesting. An example of such evaluations is comparing the conventional cable skidder to cable logging on steep ground. The results of this comparison might reveal that the impacts and costs of building extensive skid road networks for the skidder would create more impacts and cost more than cable logging. Additionally, the capacity of the cable system would be identified, such as how much uphill, sidehill and downhill yarding is required. How far will the cable system need to yard? On what type carrier should the yarder be to negotiate the landing settings? What size lines should the yarder run, and how tall a tower is needed? Following strategic logging planning that represents the variety of timber and terrain being harvested, patterns develop and lead to logging system equipment selection.

Tactical Logging Plans – These involve specific tracts with specific logging systems and are field verified to the extent that the plan can be implemented as designed with acceptable environmental impacts, and within the harvesting cost budgeted for the tract. This is the plan that the selected logging contractor can take to the woods, with his or her particular equipment, and build the roads where shown and log with the patterns shown, at the cost that has been planned. Having an accurate logging plan enables the contractor to schedule the work efficiently and avoid unknown surprises. As logging system specialization occurs, tracts will need to be subdivided for the logging contractor who has the system to fit the timber and the terrain. This could mean, for example, reserving a strip of selective harvest along a residential development for a horse-logging contractor (or small selective-cut contractor), while the remainder of the tract is reserved for a fully mechanized, high-production, clear-cutting contractor. In the mountains, it will mean separating the tract between the specialized cable logger from a conventional skidder logger. **By tactically identifying each logging system's niche and planning to fit the specialized system to the timber and terrain, a reduction in both the harvesting costs and environmental impacts can be achieved.**



Conclusion

Effective BMP implementation for timber harvesting operations needs to consider appropriate logging systems selection and logging plans. The utilization of specialized logging systems can result in lower costs and lower environmental impacts when compared to a one-size-fits-all harvesting operation. Logging planning is essential to the successful implementation of specialized logging systems and the effective implementation of BMPs.

Streamside Management Zones

Streamside Management Zones (SMZs) are areas adjacent to streams that protect water quality. They may have other names, such as riparian areas or buffer strips. Whatever the name, these areas are extremely important to the protection of water quality. An effective SMZ will filter sediment and nutrients; maintain desirable water temperatures, and provide many of the essential requirements of forest stream ecosystems.

On all harvest operations that take place in Tidewater Virginia, all necessary 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 the specifications in this section. If a proper SMZ is not left, it is considered a violation of the Chesapeake Bay Preservation Act. The enforcement procedure is outlined in Chapter 10.

The first step in delineating SMZs is to identify the perennial and intermittent streams on the property. Other significant waters, such as lakes, ponds, natural springs and municipal water supplies, will also merit an SMZ. A perennial stream is one that holds water throughout the year except during periods of extreme drought. An intermittent stream is one that holds water during seasonally wet times of the year.

A 1:24,000 USGS topographic map is a good starting point for identifying the major perennial and intermittent streams. Perennial streams are designated as a solid blue line. Intermittent streams are shown with a dotted blue line. It must be remembered that many intermittent streams that are not shown on the topographic map merit an SMZ. Identifying characteristics of an intermittent stream include a defined channel, evidence of streambed scouring and bare soil or rock showing on the streambed bottom.

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.

Tidal streams are unique in that they often encompass wide areas of adjacent grasslands. For the purposes of establishing SMZ width, measure from the edge of the grassland/woodland area.

Some streams in Virginia flow into caves in areas where karst geology exists. It is important to treat these cave entrances with an appropriate 50-foot SMZ.



5 | Timber Harvesting

The photo to the right shows a proper SMZ. Please notice the continuity of the SMZ up and down the stream channel. Partial clear-cutting of the SMZ should be avoided. It is not desirable to have large fluctuations in SMZ width in an attempt to reach the average of the desired width.



Harvesting within the SMZ should minimize disturbance. The forest floor should remain essentially undisturbed. Manual felling, directional felling and mechanized felling can be effectively used providing minimal disturbance of the forest floor results. Drainage structures, such as ditches, water bars, broad-based dips and culverts, should be used on skid trails and haul roads prior to entrance to the SMZ. Locate all decks and sawmill sites outside the SMZ. On tracts where this is not possible, additional practices may be necessary to protect water quality.

Steep slopes, cold-water fisheries and municipal water supplies all need wide SMZs to protect water quality. Table 8 lists the widths for streamside management zones for streams in conjunction with different stream types.

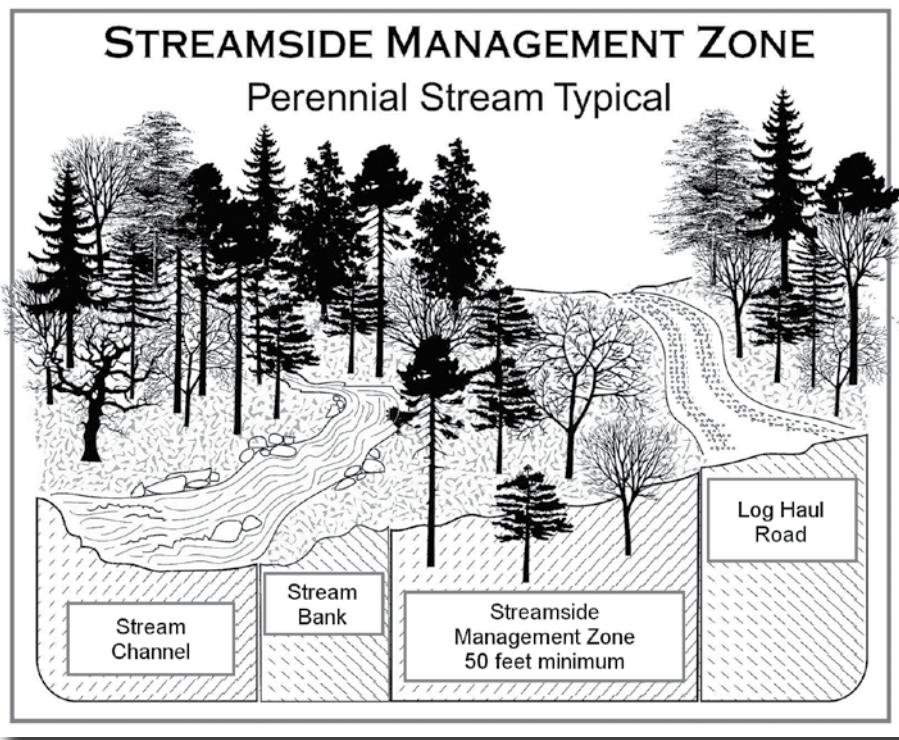


Table 8 Streamside Management Zones (SMZs)			
Percent Slope of Adjacent Lands (%)	SMZ Width (ft.)		
	Warm Water Fisheries (all other waters including wetlands)	Cold Water Fisheries (Trout)	Municipal Water Supplies (Streams or Lakes)
0 - 10	50	66	100
11 - 20	50	75	150
21 - 45	50	100	150
46 +	50	120	200

SMZs for Trout

It should be noted in the previous table that cold water fisheries (trout) require a wider SMZ than warm water fisheries. A wider SMZ is more effective at reducing sedimentation; maintaining lower water temperatures through shading, and introducing food, such as leaves and insects, into the food chain. Ninety percent of the food in forested streams comes from bordering vegetation.

Wild trout populations require cold, well-oxygenated water, a clean stream bottom and good fish cover. An overhead cover, such as undercut banks, large rocks or submerged logs, is required. When such cover is removed, the trout leave. Lack of suitable cover limits the number of large trout a stream can support. In Virginia, most trout habitat losses occur through increased stream temperature, siltation and stream channel alteration.

Water temperature may be the most critical factor facing Virginia's trout populations. Most shaded mountain streams do not exceed 70°F during the summer, which is suitable for trout. Aquatic habitat and suitable water temperature can be maintained even during logging operations when streamside vegetation is left intact. In most cases, maximum stream temperatures in the low 70s are within the tolerable range for trout, but such temperatures improve the habitat for other stream fishes against which trout cannot compete.

Silted stream bottoms decrease the stream's insect population, an important source of food for trout. Siltation also makes trout reproduction difficult. Trout lay eggs in stream gravel and clean gravel is necessary to ensure movement of oxygenated water over the eggs. As little as a quarter-inch of silt over trout eggs can result in 100 percent mortality.

The Department of Game and Inland Fisheries' trout stream inventory identifies more than 2,300 miles of wild trout streams in Virginia. Biologists are encouraged to find that brook trout – the only trout species native to Virginia – still account for 80 percent of the wild trout resource in the state.



Salvage and Sanitation in the SMZ

The necessity to remove and utilize forest products that have been damaged by insects, disease or other factors is important to the health of adjacent timberlands. Factors that need to be considered for salvage and sanitation within the SMZ are: 1) potential threat to neighboring forest resources, and 2) alternatives for insect and disease control strategies that may be more economical with less potential for site damage.

It is important to weigh all factors related to the salvage and sanitation operation and to minimize the potential impact to water quality when operating within the SMZ. This can be accomplished by:

1. Locating haul roads and skid trails outside the SMZ.
2. Harvesting of areas adjacent to the SMZ to remove potential brood trees, susceptible species, low-vigor trees and high-quality stems at or near maturity.
3. Removal of harvested timber in the SMZ should be done so that the forest floor remains virtually undisturbed. If disturbance does occur, a permanent vegetative cover should be established on exposed soil within the SMZ.
4. Equipment should not be operated in or adjacent to the SMZ for salvage and sanitation purposes when soils are saturated.
5. When more than 50 percent of the basal area is removed, evaluate the density of the understory and importance of stream temperature to determine the need for revegetation or reforestation.
6. Small spots of damage – less than one acre – may be completely harvested.



When a salvage/sanitation harvest within the SMZ occurs within an area of the state that falls within the guidance of The Chesapeake Bay Preservation Act (CBPA), notify the locality and the local contact for Virginia Department of Conservation and Recreation Division of Chesapeake Bay Local Assistance of the intent to harvest a portion of the SMZ. The reason should be documented as salvage/sanitation for forest health.

Debris in Streams

Significant logging debris should be kept out of streams. Logging debris can change the flow of water and cause stream bank erosion. A large amount of green logging debris in a stream can cause oxygen depletion and kill fish. Trash, logging debris, tree limbs or tops cannot block the passage of fish or boats. The Department of Forestry has been given the responsibility for enforcement of the Debris in Streams Law, Section 62.1-194.2, *Code of Virginia*. A copy of this regulation may be found in Chapter 10.



Stream-Crossing Design and Construction

Stream crossings are the point at which the haul road or skid trail intersects a stream channel. The manner and construction of a road or skid trail crossing a stream is extremely important and is where most logging water quality problems occur. Stream crossings have the potential to adversely affect water quality by exposing soil at or near a stream channel. Stream crossings should be avoided whenever possible through proper pre-harvest planning. Permits may be required from the Virginia Marine Resources Commission, local government and/or the Army Corps of Engineers for permanent culvert installations.

If a stream crossing is necessary through pre-harvest planning, one must consider three basic types of crossings: bridges, culverts and fords.



Temporary 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, making them more cost-effective than culverts. Furthermore, bridges have less effect on fisheries than other stream-crossing methods. Pole bridges may also be used for temporary crossings under certain conditions. **Any bridge installed for use by the general public for public transport should be designed by a licensed civil engineer.**

Temporary Bridge Specifications

1. Temporary bridges should be installed at right angles to the stream.
2. 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 depending on bridge design).
3. 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 soil conditions.
4. As with culverts, the approaches should be stable. Stabilize approaches with rock (in the case of haul roads), brush, corduroy with poles (in the case of skid trails) or other non-erodible surface extending at least 50 feet from both sides of the stream edge. Ideally, the non-erodible surface would extend to the top of the hill on each side of the stream approach.
5. Bridge approaches should be straight to limit safety hazards and prevent logs, soil and other debris from being deposited into the stream by the sliding movement of logs over the edge of the bridge. As with temporary culverts, remove temporary bridges when logging is completed. Stabilize approaches and stream edges by installing the appropriate number of water control structures, and establish vegetation to prevent soil delivery to stream. The use of tree tops, limbs and debris incorporated into the skid trail during use is an excellent soil stabilizer.



Prompt stabilization after removal of the bridge will be most critical to the protection of water quality.

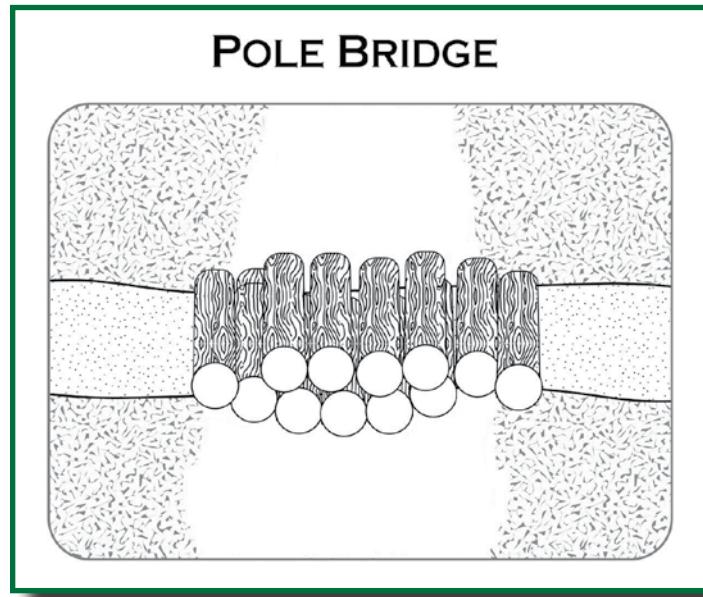
Pole Bridges

Pole bridges may be used when crossing a stream channel where no water is present. Pole bridges are wood logs of no less than 10 inches in diameter packed in a stream channel creating a solid foundation on which to skid. This structure may incorporate the use of heavy gauge steel pipe (no specific diameter requirement) 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 the skidder tire.

Pole bridges can be used in dry, intermittent stream channels for a short period of time. Pole bridges should be removed immediately following their use.

Pole Bridge Specifications

1. Pole bridges should be packed sufficiently so as not to allow the skidder to dip below the streambank edge and cause erosion.
2. A heavy-gauge steel pipe incorporated in the channel with the logs will help in the event an unforeseen rainfall event occurs while the structure is in place.
3. Pole bridges should not have any dirt or debris associated with the logs. Pole bridges must be removed following logging. As with temporary culverts, pole bridges are considered a water quality problem if not removed.
4. Stabilize the approaches to the pole bridge location following logging with the appropriate number and type of water control structures and establish rooted vegetation.



Culverts

Culverts may be either temporary or permanent installations. Temporary culverts are those that are installed and used for less than 30 consecutive months. Culvert sizing will increase if the culvert is considered a permanent installation. Permanent installations are those remaining following logging at the request of the timber buyer or landowner (proper permitting may be required). The purpose and duration of time for a culvert's use are determining factors in selection of culvert diameter. If circumstances dictate that a culvert sized with the intention of being temporary will in fact remain as a permanent structure, the culvert should be replaced with a culvert sized to permanent specifications. Since culvert replacement and size upgrade is expensive, it is important that the logger and landowner are clear on the long-term use of forest roads, stream crossings and culverts.



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

Temporary Culvert Specifications

Table 9 lists culvert diameters for temporary culvert sizes and is intended to be used as a guide. **No guarantees are given or implied by the use of this table. The Virginia Department of Forestry retains no liability for the failure of pipes.**

- ◆ Drainage basins larger than five square miles require a permit from the Virginia Marine Resources Commission.
- ◆ Based on N.R.C.S. 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.
- ◆ Coastal Plain: Areas East of Interstate 95.
- ◆ Piedmont: Areas East of Route 29 and West of Interstate 95.
- ◆ Mountains: Areas West of Route 29.
- ◆ Calculations for specific situations will provide a more accurate culvert size.

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

- ◆ Culvert-crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation, or other options considered.

Permanent Culvert Specifications

Table 10 lists culvert diameters for permanent culvert sizes. **This table is intended to be used as a guide. No guarantees are given or implied by the use of this table. The Virginia Department of Forestry retains no liability for the failure of pipes.**

- ◆ Drainage basins larger than five square miles require a permit from the Virginia Marine Resources Commission.
- ◆ Based on N.R.C.S. TR-55 Method, modified for a 10-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.
- ◆ Coastal Plain: Areas East of Interstate 95.
- ◆ Piedmont: Areas East of Route 29 and West of Interstate 95.
- ◆ Mountains: Areas West of Route 29.
- ◆ Calculations for specific situations will provide a more accurate culvert size.
- ◆ Culvert crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation, or other options considered.

If it is preferable to place either two or three smaller culverts instead of one larger one, Table 11 shows the required diameters. For example, the 66-inch permanent culvert could be replaced with three 42-inch culverts installed side by side.

**Table 10
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

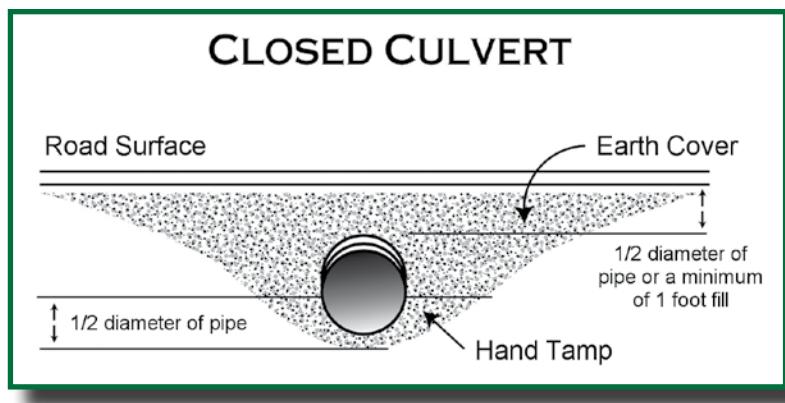
**Table 11
Culvert Alternatives (diameter)**

Required Culvert Diameter (in.)	2-Culvert Alternative (in.)	3-Culvert Alternative (in.)
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.

1. The culvert should be placed on the same grade as the natural stream bottom.
2. Crossings should be installed at as close to right angles to the stream as possible. Erosion protection measures will need to be used to minimize soil movement. Rip-rap; filter cloth; seeding and mulching, and non-erodible surfaces may be necessary in any culvert installation. This is important at both the inlet and outlet end of the pipe where scour can occur.
3. 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, a non-erodible energy absorbing structure should be placed at the outlet.
4. Culverts require periodic maintenance and inspection to avoid plugging with leaves and debris.
5. If a culvert is to be installed in soft or sandy material, use of small crushed stone as a stable base under the pipe will cause minimal settling of the pipe. When the logging is completed and a temporary pipe will be removed, remove all material used during construction and any debris generated following construction from the stream channel and re-establish its natural dimension and profile. Earth cover over pipes should be half the culvert diameter but not less than one foot.
6. 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 Mountains areas. They may have some limited use in portions of the Coastal Plain as well. **In some cases, they may be the most acceptable of the stream crossing types because of the reduced amount of continued stream disturbance.** When fords are used, strembeds should have a firm rock base.

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. Any changes made to improve an existing ford or create a new ford on streams with less than a five-square-mile drainage area will have to adhere to forestry BMPs.

In some cases, the temporary use of wooden mats in a stream channel may be allowable to increase the carrying capacity of the ford. These mats must be removed following use. The addition of crushed limestone rock might be allowable in certain situations to level the stream bottom for truck traffic. Care should be taken to minimize the addition of stone for this purpose so as not to restrict the natural flow of the stream. Geo Web® material may be allowed to create a “hardened” stream bottom in certain situations. (See “20 – Geo Web® Improved Ford” on page 137.) Use of the ford should be temporary and be restricted to low-traffic volumes. The water depth should be no more than an average two feet deep for that section of stream being crossed. Crossing should be made at right angles to the stream. Locate fords where stream banks are low and with stable approaches. To avoid sediment delivery to the stream, stabilize approaches with rock a minimum of 50 feet from the water’s edge on both sides of the stream and maintain a clean layer of rock at all times.

Equipment crossing the stream should have no leaks of hydraulic oil, engine oil, fuel or any other foreign substance.

Rock approaches should be underlined with geotextile fabric where necessary.



Installation of a Geo-Web® hardened ford.

Skid Trails

A skid trail by definition is an unsurfaced travelway, usually a single lane trail or narrow road typically narrower and sometimes steeper than a haul road. Skid trails are generally temporary pathways over forest soils where logs, trees or roundwood products are dragged, resulting in ground disturbance.

The skid trail is used to move logs, tree lengths or roundwood products from the stump to the log landing.



Skid Trail Specifications

Locate log landings first and lay out road approach with grades less than 15 percent. Major skid trails should have planned locations to minimize damage to the residual stand; reduce erosion and sedimentation, and provide the most economical method for skidding products. Planning is needed for efficient skid trail operation in the woods.

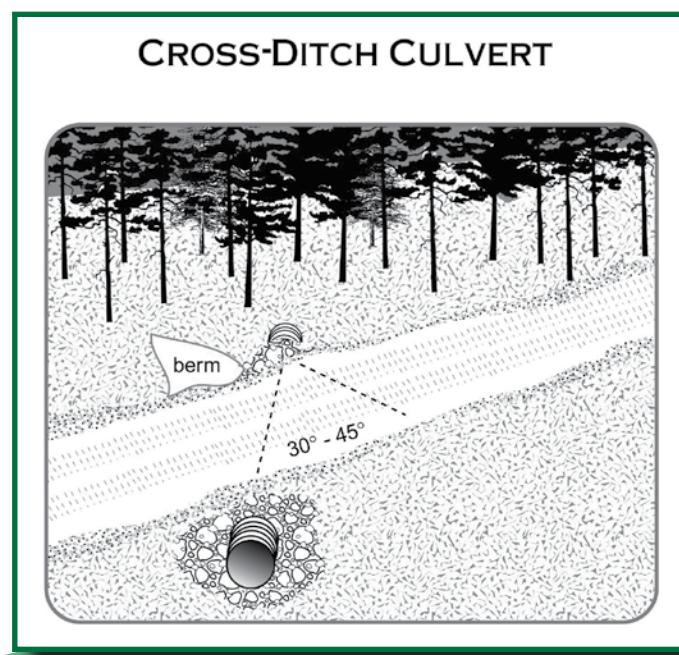
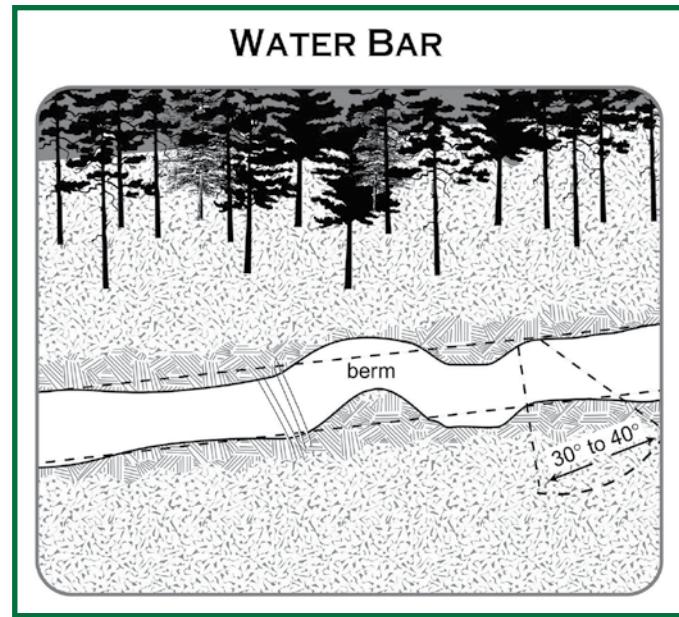
1. Bladed or dozed skid trail grades should not exceed 25 percent. However, steeper segments may be required to avoid boundary lines, sensitive areas or other areas not accessible using skid trails of lesser grades. Allowances for skid trail grades of up to 35 percent for short segments can be acceptable. If steeper grades are necessary, practices must be used to prevent concentrated water flow that causes gullying. Skid trails should not be constructed on sideslopes exceeding 60 percent. If it is impossible to limit exposure of mineral soil, alternate systems, such as extra cable length or cable yarding, should be considered.
2. Overland and dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
3. Skid trails should be located outside the SMZ.
4. Any skid trails that must cross a perennial stream, intermittent stream or drainage ditch should use a bridge or culvert of acceptable design. (See "Stream-Crossing Design and Construction" on page 39.)

Logs shall not be dragged through an intermittent or perennial stream.

Approaches to stream crossings should be as close to right angles to the stream direction as possible.

5. Install water turnouts 25 feet prior to a stream crossing to direct surface runoff into undisturbed areas of the SMZ.
 6. 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.
 7. Climb upslope on a slant or zigzag pattern to avoid long, continuous grades.

8. Skidding should be restrained when soils are saturated to prevent excessive soil compaction and channelized erosion. The skimming of saturated soils from skid trails should be avoided.
9. 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. Site preparation should be used to ameliorate excessively compacted or rutted sites.
10. Upon completion of skidding, water bars should be installed immediately in the areas subject to erosion. The primary need is drainage of surface water from the skid road and exposed soils by establishing water bars at the recommended intervals. (See "7 – Water Bars" on page 108.)
11. Water bars should be installed at a 30 to 45 degree angle downslope, with ends open to prevent water accumulation behind them. A permanent vegetative cover should be established upon exposed roads, trails and soils that are greater than or equal to five percent slope when subject to erosion. (See "APPENDIX D" on page 151.) Scattered logging slash or other ground cover on the trails or exposed soils may enhance soil stability but should not be substituted for appropriate water bars and seeding.
12. Water turnouts should be installed on main skid roads. Cross drainage should be installed immediately above extra steep pitches in skid roads and below bank seepage spots.
13. Identify bumper trees and/or install fender logs on the outside edge of skid roads on steep slopes and at turns and switchbacks to prevent logs from rolling off the skid road and to protect adjacent standing timber from damage.
14. Maintenance of skid roads during periods of use is usually confined to keeping the surface water drained off.
15. Where skid roads cross streams or intermittent water courses, the stream beds should be cleaned of fill material and slash and be restored to their natural shape and grade provided the action taken does not cause greater likelihood of sedimentation and erosion.



16. Temporary closeout of skid trails should be considered if the skid trail becomes inactive for periods longer than seven days or if a storm event is anticipated.

Log Landings

Log landings are the areas where logs are concentrated, processed, sorted and loaded prior to shipping. Care should be taken to properly locate landings to minimize the chances of erosion or sedimentation. Like skid trails, landings are subject to severe compaction.

Runoff from these sites must be addressed in the pre-harvest plan and on the ground both during and after the operation is completed. Soil compaction at landing sites may require extra effort to establish an adequate vegetative cover following harvest.

Properly located and constructed log landing sites are essential for profitable and environmentally friendly timber harvesting operations. Log landings that have been properly re-vegetated at the conclusion of a harvest can provide an excellent food source for wildlife.



Log Landing Specifications

1. Locate sites for log landings in advance of road construction. These sites should be located in areas that will help minimize skid trail and haul road distances.
2. Where possible, log landings should be constructed on well-drained, gently sloping sites of no more than five percent. On areas greater than five percent, additional soil protection measures may be necessary.
3. Haul roads and skid trails that terminate at the landing area should be properly drained to prevent run-off water from entering the landing.
4. Log landings should be located at least 50 feet from the SMZ. If closer placement is necessary, additional BMP measures should be considered.
5. A diversion ditch around the uphill side of landings can intercept the flow of water and direct it away from the landing.
6. Prevent stormwater runoff from landings from entering stream channels.
7. In areas where run-off water from the landing may reach a stream channel, install a silt fence, and stake in straw bales and/or brush and debris barriers to filter sediment. (See "APPENDIX A" on page 99.)
8. Construct log landing no larger than is necessary to handle loading and merchandizing activities.

9. Do not drain engine fluids onto the ground when servicing equipment. Maintain equipment to control leakage of hydraulic fluids, antifreeze and similar substances. Provide proper storage and removal for fuel and other used oils. A secondary containment structure, such as earthen berms or straw bales, should be placed around stationary fuel tanks.
10. Keep site clean and free of trash. Do not leave trash at the site following harvest completion.
11. Disturbed areas should be reshaped to provide adequate surface drainage. Revegetate landings following completion of harvesting operations using appropriate methods and materials. (See "APPENDIX D" on page 151.)

Biomass Harvesting

Whole-tree harvesting with careful logging practices is no more of an erosion risk than conventional logging systems (Martin and Hornbeck, 1994). In general, the research suggests that biomass harvesting will not contribute to or create additional physical impacts on soil productivity as compared to conventional harvesting as long as best management practices (BMPs) are followed and harvest rotations are not shortened.

Biomass Harvesting Considerations

- ◆ It is important that some ground cover be left on site to protect the soil from raindrop erosion and to lessen the possibility for increased soil displacement during rain events.
- ◆ It is critical that the forest floor, including leaf litter, pine straw, grasses, forbs, root mats and fine woody material, be retained as a well-distributed ground cover as much as possible.
- ◆ Sites that are harvested for biomass should be regenerated with planted or natural regeneration as quickly as possible. It may become necessary to forgo early weed control treatments to protect the soil resource.
- ◆ It may become important to find a way to retain some tree tops and limbs on site, regardless of biomass needs, to protect the integrity of the soil resource and ultimately to protect water quality from soil impact.
- ◆ Harvesting following leaf fall will help retain the forest floor and vital site nutrients necessary to promote revegetation of the site.

Equipment Maintenance and Litter

- ◆ Perform all maintenance away from riparian areas.
- ◆ Capture all coolants, oils, fuels, etc., and dispose of waste properly.
- ◆ Repair equipment leaks immediately.
- ◆ Properly dispose of all trash associated with harvesting. Do not burn or bury.
- ◆ Consider the use of biodegradable fluids, such as modified vegetable oil, as hydraulic fluid.

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 after harvesting is completed. If the harvest has been effectively planned, the requirements for “close-down” will be minimal. The necessary BMPs should be installed on the site as various portions of the site have had harvesting completed. These include: regrading of ruts to prevent channelized water flow; installation of water bars on abandoned roads and trails used for the harvest; revegetation of landings, roads and bare soil areas with greater than five percent slope; removal of any temporary stream-crossing structures, and the opening of any ditches or water turnouts.

The type of future access should be a consideration in the degree of closure that is desired. Is the road system going to be used for continuous or periodic access? Will haul roads and skid trails be abandoned until the next rotation of timber is ready to harvest? These are the type of decisions that need to be made in the harvest planning phase of the operation, as they will influence the design characteristics of the various roads and trails and reduce maintenance costs associated with retention of an access road.



Upon completion of the harvest operation:

1. 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. **This may not apply if the area is under a mining permit, or the timber sale contract specifies.**
2. Abandoned roads should be left in a condition that provides adequate drainage without further maintenance. These roads should be closed to traffic; scarified if required, and reseeded. The drainage system of closed roads needs careful thought and attention – water still runs on closed roads.
3. Do not allow closed roads to become stream channels. Outslope closed roads where possible, or divert channelized flow off the road surface.
4. Temporary bridges, abutments, culvert pipes or other crossing structures should be removed prior to road closure.
5. If the decision is to remove bridges and “pull” all culverts, it is also necessary to restore all drainage features to their natural condition. This includes reseeding road surfaces and all cut and fill slopes.
6. Cut and fill slopes should be reshaped to a stable gradient.

Traffic control on forest roads can be an effective way to reduce road maintenance costs and provide protection of other forest resources. Traffic control may include full road closure; temporary or seasonal closure, or require restrictions of light use only.

Any degree of control requires inspection for maintenance needs.

The unauthorized use of traffic-controlled roads is a problem for forest landowners. Damage to road surfaces can occur as easily by a pickup truck as by a logging truck. Any access that is granted voluntarily by the forest landowner or the timber operator must be done in a manner that does not compromise the stabilization effort.

In many cases, physically blocking the access to roads may be necessary. Gates are used because they can provide temporary closure along with quick access if needed. Alternatives to gates include large berms or trenches, logs, stumps or boulders. To prevent removal by vandals, gates and other barriers need to be well anchored. For safety reasons, it is advisable to provide good visibility and signage for road closure, and adequate space for turn-around.



NOTES

CHAPTER 6

SITE PREPARATION AND REFORESTATION



Site Preparation and Reforestation

General Definition and Purpose

Site preparation and reforestation refers to those methods used to prepare harvested areas for the establishment of desirable trees and to control undesirable vegetation.

The purpose of site preparation and reforestation work is to:

- ◆ Enhance forest establishment;
- ◆ Improve environmental protection of the woodlands, and
- ◆ Reduce the regeneration gap or the time to start a new forest.

Important concepts of site preparation are to:

- ◆ Enhance forest establishment;
- ◆ Occur only once in a forest rotation, and
- ◆ Ensure that the duration of risk of soil erosion lasts only until the site revegetates naturally, which is a short period of time in the forest life cycle.



General Conditions Where Practice Applies

These reforestation practices can be used where it is desirable to prepare areas for artificial or natural regeneration or to control undesirable vegetation.

Although soil erosion may result from site preparation, it typically presents a much smaller erosion problem than construction projects or the annual cultivation of agricultural crops. As with other practices, the guiding principle is to expose as little soil as possible to accomplish the intended purposes. The land manager should carefully analyze site conditions and prescribe the treatment or treatments that will adequately remove competing vegetation with a minimum of site disturbance. Some site conditions that can influence treatment selection are:



Topography – Slope should be a major consideration in determining treatment intensity. Some treatments acceptable to the Piedmont and Coastal Plain Regions may be unsuited to the Mountains.

Soil – Inherent soil erodibility characteristics should be evaluated. Upland soils showing evidence of accelerated erosion from past field cropping should receive special attention to avoid removing all litter from the forest floor.

Residual Vegetation – The species, size and amount of vegetation on the site will be a major determinant of treatment intensity. The greater the volume, the greater will be the need for intensive preparation with attendant risks of erosion. Every effort should be made to remove as much volume as possible through good utilization at the time of logging to avoid the need for extreme site preparation treatments.

Reforestation/Regeneration Plan

Purpose/Application

Pre-harvest planning often includes site preparation activities. If not, then a Regeneration Plan should be made prior to starting site preparation action. This plan should address the condition of the tract, adjacent property and environmental concerns, including water quality. Potential problems should be identified and mitigating measures noted to prevent water quality problems. The plan could indicate, for example, that in some situations a light burn through the SMZ would do less damage than constructing a fireline adjacent to the SMZ. The land manager should carefully analyze site conditions and prescribe the treatment or treatments that will adequately remove competing vegetation and prepare the site for planting with a minimum of site disturbance.

General Specifications

1. Site preparation intensity will be confined to the minimum soil disturbance required to achieve the planned results.
2. Chemicals, fire and hand-logging – as opposed to the use of heavy machinery – will be favored on steep terrain and/or fragile soils.
3. Because it is less site disturbing, it is preferable to use a shear (KG) blade than to use a straight blade. Shearing and drum chopping are more preferable than disking. In general, disk should be avoided unless site conditions dictate no other management alternative.
4. An SMZ with undisturbed forest floor and ground cover of adequate width will be maintained adjacent to all intermittent and perennial streams. Soil disturbance along perennial and intermittent streams are subject to Virginia's Silvicultural Water Quality Law.
5. No debris or soil that might impede water flow or cause stream bank degradation will be placed in intermittent or perennial streams.

Individual Site Preparation Specifications

1. **Prescribed Burning** – Refer to Chapter 8, Fire Management, for specific BMPs for Prescribed Burning.
2. **Drum Chopping** – to knock down and crush residual trees, thereby providing available fuel for a prescribed burn. Limited mineral soil is exposed by drum chopping. On slopes in excess of 10 percent, the direction of travel should be based on safe equipment operations.
3. **Disking** – reduces unwanted vegetation by incorporating organic matter; reduces soil compaction, and improves the site for planting.
 - a. Disk parallel to contour lines.
 - b. Schedule operations during favorable soil moisture conditions. When soil moisture is favorable, a ball can be formed but will break apart readily when lightly squeezed between two fingers.
 - c. Do not disk within SMZs or near streams.
4. **Bulldozing** – (straight, root rake and KG blade) to remove residual trees and pile debris.
 - a. If an erosion potential exists – and whenever possible – topsoil, including root mat, should be left in place to preserve site quality and minimize water quality impact. Stumps should be left in place. Keep dozer blade a minimum of three inches above ground surface. Do not expose more than 50 percent of the mineral soil.
 - b. Normally bulldozing must not be attempted on slopes greater than 45 percent due to operator safety, increased risk of erosion, inefficient equipment operation and greater clearing cost.
 - c. Do not bulldoze the surface within SMZs or near streams.
 - d. Windrow Construction
 - 1) Windrows should be constructed along contour lines, as free of soil and as narrow as possible. Windrows are effective sediment traps.
 - 2) All standing vegetation should be pushed or sheared prior to windrow construction. Standing live trees should not be left in windrows.
 - 3) Slope, soil type and the amount of vegetation to be sheared or pushed will determine the distance between windrows. As the slope increases, the distance between windrows (slope length) should decrease. Reducing the slope length by spacing windrows as shown on Table 12 will reduce the potential for sheet and rill erosion.



Table 12
Suggested Windrow Spacing

Slope (%)	Maximum Spacing Distance (ft.)
10	200
20	150
30	100
40	60

- 4) For the purpose of forest wildfire access and wildlife passage, windrows should have openings of at least 20 feet in width for each 600 feet of length. Windrows, regardless of length, shall have a minimum opening of at least 20 feet between each end of the windrow and the boundary lines or SMZ of the tract being sheared or pushed. On steep terrain, openings within windrows must be offset in down-slope alignment to reduce the potential for water and sediment to move straight down hill and form gullies.
 - 5) Windrows can cross or occupy small gullies (less than three feet deep) where they will trap sediment. Larger gullies require surface water management to rehabilitate the eroded area.
- e. Raking and Piling
- 1) Raking and piling in combination with shearing should be done very carefully when working on steep slope and fragile soil areas.
 - 2) Toothed-type root rakes will be favored over straight and KG blades for raking and piling.
 - 3) Care should be exercised in raking to avoid gouging and penetrating the soil with the blade.
 - 4) When a sloping site is raked, the debris will be pushed into windrows placed on the contour to act as a trap or filter for any surface runoff. Where old gullies are present, debris (without soil attached) may be placed in the gullies to break the velocity of water flow during storm events.
 - 5) The presence of considerable soil in the windrows is a sign of improper equipment operation when raking. Frequent checks are needed to prevent this from occurring.
5. **Bedding** – to mound soil in rows to overcome poor soil conditions for seedling establishment.
- a. Bedding should be on the contour if slope is discernible.
 - b. Bedding rows should not be “tied in” to any drainage. Avoid channeling runoff and sediment into streams and ditches.
6. **Furrowing, Scalping and Ripping** – to create a shallow furrow, removing sod competition (and sometimes sub-soiling to improve water infiltration and root penetration) to improve the site for tree planting and seedling survival.
- a. Furrowing and scalping work should be done as shallow as possible and should be less than 6 inches deep.
 - b. The furrowing and scalping rows should follow the contours. Where the equipment cannot follow the contours, the plow or blade shall be picked up periodically to leave undisturbed strips to check erosion.
 - c. Sub-soiling or ripping of at least 12 inches in depth should follow contours.
 - d. Furrowing, scalping and sub-soiling rows should not channel water into any drainage.

7. **Hand Tools and Equipment** – the use of hand tools or other small equipment to destroy or reduce competing vegetation for the purpose of site preparation or timber stand improvement. Hand tools and equipment should be favored on steep slopes, fragile soils and in sensitive areas, such as Streamside Management Zones.

8. **Machine Planting** – to establish tree seedlings and have the effect of sub-soiling to break up plow layers, hard pans or compacted soil.



- a. Machine planting and sub-soiling should be done along contour lines. Steep slopes should be hand planted.
- b. Site conditions must be suitable for machine planting operation.

9. **Pesticides/Herbicides** – Chemicals used in the forest consist almost entirely of herbicides used for the removal of unwanted vegetation and insecticides or fungicides used to control insects and diseases. Minor use is made of rodenticides and animal repellents for specialized purposes. For further information see Chapter 7 Silvicultural Chemical Treatment. (“CHAPTER 7” on page 61.)

Precautions

- ◆ Avoid excessive soil compaction.
- ◆ Soil disturbance should be kept to a practical minimum.
- ◆ Minimize disturbance on slopes with extremely erodible soils.
- ◆ Wherever possible, mechanical site preparation should follow the contour.
- ◆ Wherever possible, discharge water from site-prepared areas onto vegetated surfaces.
- ◆ Operations should be planned to minimize disturbance in filter strips.
- ◆ No chemical containers or equipment should be washed in any stream.

NOTES

NOTES

CHAPTER 7

SILVICULTURAL CHEMICAL TREATMENT



Silvicultural Chemical Treatment

Fertilizer, Herbicides and Pesticides

Chemicals are used to control or prevent damage by insects, disease, unwanted vegetation, rodents or birds to a forest or to individual trees within a forest. The target pests to be controlled will vary with stand age, species, site conditions, stand density or market goals for the stand. The purpose for including a section on chemicals is to prevent the contamination of surface waters or ground water by pesticides that are used for forestry purposes.

General Conditions Where Practice Applies

Pesticides are used to protect the landowner's investment from loss due to pests. Herbicides are used to selectively remove certain plants from competition with those designated for the site.

The conditions for the appropriate handling of forest chemicals to protect water quality are the focal concerns of this chapter.

Pesticides/Herbicides may be used with different goals throughout the life of a stand. The following are possible applications of forest pesticides/herbicides:

1. The control of insects or grubs that will attack seedlings.
2. Pesticides may be applied to seeds used for direct seeding to repel insects, mammals and birds.
3. Seedlings may be dipped in pesticides to repel insects and herbivores that might attack the seedlings.
4. Sapling stands may be treated with pesticides when they are short-rotation, high-value stands, such as Christmas trees, or to control an infestation that is likely to spread.
5. Both immature and mature trees may be treated with pesticides to reduce the effects of outbreaks of insect damage beyond the levels normal to the forest. High-value trees may be individually treated to preserve their potential value.
6. Dead or dying trees may be treated with pesticides to stop the spread of the insect or disease.
7. Herbicides may be used when a change in the composition of the existing forest is desired and herbicides will be less expensive or easier to apply than other measures, and their use will safely achieve the desired results.



8. Herbicides can be used for site preparation with or without the use of fire and can duplicate or surpass mechanical site preparation results with less water quality impact. Soil is undisturbed so slope is not the limiting factor as it is with mechanical site preparation.
9. Herbicides may also be used to control unwanted vegetation in established stands.

Planning Considerations

Pesticides and herbicides can be liquid, granular or powder and can be applied aerially or by ground equipment. Water quality considerations include measures taken to keep pesticides and herbicides from reaching streams whether by direct application or through runoff of surface water. Applications must follow manufacturers' label instructions, EPA guidelines, regulations pursuant to the Virginia Pesticide Control Act and VDOF aerial spray guidelines (when spraying under a VDOF aerial spraying contract).

Pesticides and herbicides vary widely in toxicity and persistence. Caution in their use is always essential. Excessive applications and misuse are the most immediate problems. Expert advice is available from the Department of Forestry.

Pesticides and herbicides that have been designated "Restricted Use" by the Environmental Protection Agency require application by or under the supervision of applicators certified by the Virginia Department of Agriculture Pesticide Board. Information on the certification process is available from the Virginia Department of Agriculture and Consumer Services.

1. Proper Application of Pesticides

Many pesticides and herbicides must be used by or under the direct supervision of a State Certified Pesticide Applicator.

Potential for adverse water quality impact varies widely from one chemical to another and depends primarily on: 1) the chemical's mobility; 2) its persistence, and 3) the accuracy of its placement. Water quality can be protected by knowledge of the chemical being used and adherence to the manufacturer's specification and directions. The label contains information regarding the safety of the applicator; target species for which the chemical is registered; the pesticide/herbicide application rate or concentration; appropriate weather conditions during application; environmental impact, and proper container disposal. Material Safety Data Sheets provide toxicological data and are available from the chemical manufacturer.

Each pesticide or herbicide application project will have its own unique considerations, but the following are general guidelines that should be followed:

- a. Pesticide and herbicide applications should be scheduled when atmospheric conditions will assure that the pesticide/herbicide reaches the target species. Application in advance of and during unstable and unpredictable changing weather patterns should be avoided.
- b. Aerial Applications will not be made when surface wind speeds exceed five miles per hour or when there is danger that the pesticide/herbicide will be displaced by wind. **In no case shall application be made under windy or gusty conditions.**

7 | Silvicultural Chemical Treatment

- c. Filter and buffer strips must conform to federal and state regulations and any label requirements. The use of aerial or broadcast application of herbicides is not allowed in any SMZ adjacent to perennial streams. (See “Streamside Management Zones” on page 35.) Buffers and filter strips should be considered next to agricultural crops, farm animals, orchards, apiaries, horticultural crops, etc.
- d. The use of persistent, bioaccumulating pesticides should be avoided as much as possible. Virginia Department of Forestry personnel can assist in determining the optimum chemical to use.
- e. The use of granular pesticides and herbicides, preplant treatments and injection methods are preferred because of the reduced likelihood of water pollution. Pesticides and herbicides with low solubility in water are less likely to cause water pollution through drainage and runoff than pesticides/herbicides with high water solubility. Pesticides and herbicides with low solubility often adhere strongly to sediment particles, and the loss of these pesticides/herbicides can be greatly reduced by preventing erosion.
- f. Pesticides and herbicides should not be mixed, and application equipment should not be filled, emptied or repaired where spilled chemicals can drain or be washed into streams, lakes or other bodies of water.
- g. Equipment and techniques that are designed to assure maximum control of the spray swath with minimum drift will be used.
- h. Under no circumstances will silvicultural pesticides, herbicides or fertilizers be applied to the surface of lakes, ponds or streams as part of a practice to establish stands of trees.
- i. Transportation regulations for pesticides and herbicides must be followed. Accidents that result in spillage must be reported promptly to the proper authorities.

2. Proper Disposal of Pesticides and Herbicides

A careful evaluation of pesticide/herbicide needs should be made in advance and purchases limited to a one-year or one-season supply. This will reduce carryover, damaged containers and diminished effectiveness of the pesticide or herbicide. Another consideration should be to mix only the amount of pesticide/herbicide needed for the job at hand to end the application with an empty tank or hopper. Unwanted pesticides/herbicides should never be disposed of in a manner inconsistent with the product label.

3. Proper Disposal of Containers

No pesticide/herbicide container is ever truly empty – all contain residues. Disposal of pesticide and herbicide containers must be in accordance with label directions.

Containers should be allowed to drain in a vertical position for 30 seconds after normal emptying. The container should then be rinsed three times with water or other diluting material, allowing 30 seconds for draining after each rinse. A good rule of thumb is to refill the container 1/4 to 1/5 full for each rinse; e.g., use one quart of water or diluting material for each gallon container; one gallon for five-gallon containers, and five gallons for 30- or 55-gallon drums. Each rinse should be drained into the spray tank.

Pesticide and herbicide containers should not be reused even after the triple rinse procedure has been completed.

Any specific disposal directions or procedures on the product labels must be carefully followed. Disposal of containers should be supervised by someone qualified and licensed for the application and handling of pesticides/herbicides. The disposal of the containers is as much a part of proper handling as is the application of the chemical to the target area.

4. Forest Fertilization

The application of nitrogen, phosphorus or other elements by conventional ground equipment, helicopter or fixed wing aircraft is to enhance the growth of tree species. Ammonium nitrate is known to be toxic to fish and shellfish, and phosphorus is known to be responsible for the acceleration of the oxygen depletion process in water bodies.

- a. Fertilizer may be broadcast no closer than 100 feet from open water or perennial streams.
- b. Application of fertilizer mixtures should be at rates reflecting tree species and soil needs.
- c. Application must be made according to the manufacturer's label instructions.
- d. Loading and unloading operations should occur away from ditches and water bodies.



5. Sources of Advice

Landowners should consult the Virginia Department of Forestry. Technical advice on pesticide use is available from the Virginia Cooperative Extension Service, the Environmental Protection Agency (EPA) and the chemical manufacturer. Advice on the disposal of pesticides/herbicides and containers is available from the same sources and from the Virginia Department of Health and the Virginia Department of Agriculture and Consumer Services (VDACS). VDACS administers the examination and certification of applicators.

NOTES

CHAPTER 8

FIRE MANAGEMENT



Fire Management

Wildfire

The first and foremost concerns in wildfire control are the safety of personnel and the prevention of damage to property. During wildfire suppression, fireline BMPs that slow containment efforts must take a lower priority than fire suppression. Potential effects of firelines should be dealt with at a later time.

Stabilize all areas that have significantly increased erosion potential or drainage patterns altered by fire suppression activities.

Treatments for damage include, but are not limited to:

1. Installing water bars and other drainage diversions in fire roads, firelines and other clear areas.
2. Seeding, planting and fertilization to provide vegetative cover.
3. Spreading slash or mulch to protect bare soil.
4. Repairing damaged road-drainage structures.
5. Clearing stream channels of debris deposited by excessively burned soils.
6. Scarification may be necessary to encourage percolation on excessively burned soils.



Incident Command Areas and Staging Areas

1. Protect surface and subsurface water resources from nutrients, bacteria and chemicals associated with solid waste and sewage disposal.
2. Locate these sites away from active streams.
3. Garbage and other solid waste is also a concern, and these materials should be collected and disposed of at a properly designated, operated and permitted landfill.



Wildfire Rehabilitation Plan

Minimize soil and site productivity loss; threats to life and property, and deterioration of water quality both on and off the site by:

1. Seeding grasses or other vegetation to provide a protective cover as soon as possible on steeper grades;
2. Fertilizing;
3. Stabilizing actively eroding gullies, when possible;
4. Ensuring that all road surfaces are stabilized and protected;
5. Fencing, where necessary, to protect new vegetation, and
6. Clearing all debris from the wildfire from stream channels.

Prescribed Burning

Prescribed fire is an important and useful silvicultural tool. It can be used to prepare a site for planting by reducing logging debris or to prepare a seedbed for seed fall. Prescribed fire can also be used in established stands for silvicultural purposes, wildlife habitat improvement and hazard reduction. A concern in the use of fire for any of these management purposes is the effect of the prescribed fire on surface runoff and soil erosion.

Studies have shown that properly planned and conducted prescribed burning has a minimal impact on water quality in the South. Most problems associated with prescribed burning can be minimized with proper planning, awareness of changing weather conditions and by following the guidance of a certified prescribed burn manager who has been through the Virginia Department of Forestry's **Certified Burn Manager Program**.



BMPs for Prescribed Burning

1. Site preparation burns on steep slopes or highly erodible soils should be conducted only when they are absolutely necessary and should be of low intensity.
2. A significant amount of soil movement can occur when preparing for prescribed burns. Firebreaks should have water control structures to minimize erosion. Locate firelines on contours as much as possible. Water bars should be constructed in firelines at frequent intervals to slow surface runoff in areas subject to accelerated erosion, such as steep grades or highly erodible sloping firelines. (See “7 – Water Bars” on page 108.)
3. Site preparation burning creates the potential for soil movement. All efforts should be made to keep high-intensity site prep burns out of SMZs.
4. Use hand tools when necessary to connect firelines into stream channels.
5. Avoid burning when conditions will cause a fire to burn too hot and expose mineral soil to erosion.
6. Avoid allowing high-intensity fire to enter SMZs.
7. Avoid burning on severely eroded forest soils when the average duff layer is less than one-half inch.



Fireline Construction Methods

Fireline construction is an essential part of forest management and wildfire control. A number of erosion control practices can be implemented during fireline construction to prevent unnecessary erosion.

BMPs for Fireline Construction

1. Firelines should be constructed along the perimeter of the burn area and, when prescribed, along the boundary of the SMZ. The purpose of protecting the SMZ from fire is to safeguard the filtering effects of the leaf litter and organic material. If a fireline along the SMZ boundary is not prescribed, allowance should be made for a low-intensity backing fire within the SMZ.
2. Firelines should follow the guidelines established for skid trails with respect to water bars and wing ditches and should be only as wide and as deep as necessary to permit safe prescribed burns.
3. Firelines that approach a drainage should be turned parallel to the stream or include the construction of a wing ditch or other structure that diverts concentrated runoff into the woods prior to entry into the stream channel.
4. Firelines on highly-erodible sites should be inspected periodically to correct any developing erosion problems before they become too serious.
5. Avoid disturbing existing gullies where possible.
6. Avoid disturbing any more soil surface than necessary.
7. Avoid plowing straight up and down a slope, where possible.
8. Revegetate bare soil areas with slopes greater than five percent, where practical.



NOTES

CHAPTER 9

WETLANDS



Wetlands

The Army Corps of Engineers defines “wetlands” in their delineation manual as follows: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.



Description of Forested Wetland Types

Red River Bottoms – These wetlands are usually located in the floodplain of major rivers with the headwaters originating in the Piedmont or Mountain regions. These areas are parallel and immediately adjacent to the drainage system, sloughs and oxbows. If large enough, they may be classified separately as muck swamps. This wetland type is characterized by turbid, sediment-bearing water flowing in well-defined channels and sloughs with overland flow during seasonal floods. Water tupelo, cypress, red maple, swamp black gum and others are found along these sloughs. Beyond the sloughs and oxbows are found first bottoms that flood periodically, however, drainage is fairly rapid because of higher elevation. Species include sweetgum, green ash, water oak, sycamore, red maple, river birch, elms and willow. At still higher elevations, second bottoms and terraces are found; flooding is infrequent and species found include cherrybark, swamp chesnut and white oaks, hickories, beech and yellow poplar.

Black River Bottoms – These wetlands are usually located in floodplains of major rivers with headwaters in the large swamps of the Lower Coastal Plain. The river banks and first terraces flood periodically during the wet season. The low sediment load of blackwater rivers allows less development of complex terrace systems than alluvial rivers. It is characterized by darkly colored and generally low-turbidity water flowing in well-defined channels. Species of trees found are similar to red river bottoms.

Branch Bottom Swamps – Relatively flat, alluvial land along minor drainage systems. They are dominated by constant seepage of spring-fed water with minor flooding during the wet season. On wetter portions with heavier soils, the predominant species are willow and water oaks, swamp black gum, sweetgum, red maple and ash. The lighter soils of the terrace support cherrybark, swamp chestnut and white oaks, sweetgum, hickory, yellow poplar and loblolly pine.

Cypress Strand – These elongated or linear sequences of depressions occur infrequently in the flatwoods. The waters are slowly draining through multiple braided channels or by sheetflow into blackwater rivers. The forest vegetation is dominated by bald cypress interspersed with sweetbay and redbay, swamp black gum and, sometimes, Atlantic white cedar.

Muck Swamp – This wetland type is characterized by slow moving to standing water during the dry seasons but more rapid sheetflow during annual flood stages. They are semi-permanently flooded during the growing season and are characterized by heavy accumulation of organic matter. Soils range from silt loam to clay. Water tupelo and bald cypress are common in deeply-flooded areas and swamp black gum predominates toward the fringes.

Wet Flat – Similar to peat swamps and pocosins, they lie in broad interstream areas where drainage systems are poorly developed. However, wet flats are better drained than their associates because of higher elevation. The non-alluvial soils may possess some accumulation of organic material, but fertility is superior to peat swamps and pocosins because of superior parent material. Species generally encountered are sweetgum, red maple, oaks, ashes, loblolly pine and elms.

Peat Swamp – These are located at the headwaters of most blackwater drainages. The areas consist of large concave depressions behind natural impounding levees or ridges. Peat swamps mainly impound rainwater and may recharge groundwater of the surrounding area when the water table is low during the dry season. The swamps are poorly drained with heavy accumulations of raw organic matter. Soils resemble those of muck swamps but in general are heavier and of better quality. Swamp black gum and red maple predominate with a mixture of many other hardwood species along with loblolly and pond pines and some Atlantic white cedar.

Cypress Pond – These occur infrequently and are irregular or circular swamps formed by depressions and sink holes and are often connected by cypress stands. They are characterized by standing or very slowly flowing water during the wet season if connected to a channel or outlet. Cypress ponds mainly impound rainwater and may recharge groundwater of the surrounding area when the water table is low during the dry season. The site is dominated by bald or pond cypress.

Jurisdictional Wetlands

Jurisdictional wetlands require three criteria:

1. **Hydrophytic vegetation** – plants that have the ability to grow, effectively compete, reproduce and/or persist in anaerobic soil conditions.
2. **Hydric soils** – soils that are saturated, flooded or ponded long enough during the growing season for anaerobic conditions to develop.
3. **Wetland hydrology** – inundated by water sufficient to support hydrophytic vegetation and develop hydric soils.

All three must be present under normal circumstances for an area to be identified as a jurisdictional wetland.

Many sites classified as bottomlands may be wetland-like, but are not necessarily “wetlands” in the strictest legal or jurisdictional sense. Jurisdictional wetlands are found throughout the state and are not limited to flooded or open marsh areas.

Maintaining ecological productivity for wetland and wetland-like sites often calls for the same management techniques. These wetland BMPs work well in both types of sensitive land types.

Although wetlands are federally regulated, normal forestry operations in wetlands – including but not limited to site preparation, harvesting and minor drainage – are exempt from permit requirements under Section 404 of the Clean Water Act Amendments of 1977, as long as the activity:

- ◆ Qualifies as normal silviculture;
- ◆ Is part of an established silvicultural operation;
- ◆ Does not support the purpose of converting a water of the United States to a use to which it was not previously subject;
- ◆ Follows the 15 mandatory BMPs for road construction, and the six mandatory BMPs for site preparation, and
- ◆ Contains no toxic pollutant listed under Section 307 of the Clean Water Act in discharge of dredge or fill materials into waters of the United States.

A forestry activity will require a Section 404 permit if it results in the conversion of a wetland to a non-wetland. Individuals who wish to change land use, or whose activity may change the land use, or who are uncertain about permit exemption status of a forestry activity, should contact the U.S. Army Corps of Engineers. If the activity is on a farmed wetland or on agricultural land, the Natural Resources Conservation Service is the appropriate initial contact.

Minor drainage refers to installation of ditches or other water control facilities for temporary de-watering of an area. Minor drainage is considered a normal silvicultural activity in wetlands to temporarily lower the water level and minimize adverse impacts on a wetland site during road construction, timber harvesting and reforestation activities. **Minor drainage does not include construction of a canal, dike or any other structure that continuously drains or significantly modifies a wetland or other aquatic area.**

Minor drainage is exempt from needing an individual 404 permit if it is part of an ongoing silvicultural operation and does not result in the immediate or gradual conversion of a wetland to an upland or other uses. Any artificial drainage on a site must be managed. Once the silvicultural activity has been completed, the hydrology that existed prior to the activity should be restored by closing drainage channels.

Normal silvicultural activities conducted as part of “established, ongoing” silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Normal activities include but are not limited to road construction, timber harvesting, site preparation, reforestation, timber stand improvement and minor drainage. Best Management Practices listed in the Virginia Technical Guide are not necessary for exemption from Section 404 Corps of Engineers permit requirements, but they are strongly recommended to minimize nonpoint source pollution of waters of the Commonwealth and/or waters of the United States. Their utilization will also help prevent violations of the Virginia Silvicultural Water Quality Law.

Established silvicultural operations are included in a management system (not necessarily written) that is planned over conventional rotation cycles for a property or introduced as part of an established operation. An activity need not itself have been ongoing as long as it is introduced as part of an ongoing operation.

Evidence of use of the property may be used to determine whether an operation is ongoing. Examples of such evidence may include, but are not limited to:

- ◆ A history of harvesting with either natural or artificial regeneration;
- ◆ A history of fire, insect and disease control to protect maturing timber;
- ◆ The presence of stumps, logging roads, landings or other indications of established silvicultural operations that will continue on the site;
- ◆ Explicit treatment of the land as commercial timberlands by government agencies under zoning, tax, subsidy and regulatory programs;
- ◆ Certified plan under the National Tree Farm System, Stewardship Program or NRCS, or
- ◆ Ownership and management by a timber company or individual whose purpose is timber production.

For federal wetland BMPs required for exemption from Section 404 permit requirements, refer to Chapter 10, Federal Clean Water Act, Mandated Best Management Practices for Road Construction and Maintenance BMPs.

Site Preparation BMPs for Pine Plantation Management in Wetlands

1. **Minimize soil disturbance.** Position shear-blades or rakes at or near the soil surface and windrow or pile and otherwise move logs and logging debris by methods that minimize dragging or pushing through the soil to minimize soil disturbance associated with shearing, raking and moving trees, stumps, brush and other unwanted vegetation.
2. **Avoid soil compaction.** Conduct activities in a manner to avoid excessive soil compaction and maintain soil tilth.
3. **Limit erosion and runoff.** Arrange windrows in a manner to limit erosion, overland flow and runoff.
4. **Keep logging debris out of SMZs.** Prevent disposal or storage of logs or logging debris in streamside management zones to protect water quality.
5. **Maintain natural contour and drainage.** Maintain the natural contour of the site and ensure that activities do not immediately or gradually convert the wetland to a non-wetland.
6. **Exercise water management.** Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.



When Using Chemicals in Wetlands

1. Follow **all** label instructions. Some chemicals are approved for wetlands; others are not.
2. Conduct applications by skilled and licensed applicators.
3. Identify and establish buffer areas for moving surface waters, especially for aerial applications.

Wetlands Best Management Practices (State)

Planning is a critical BMP when working in wetland areas. At all times, three primary considerations should be maintained:

1. Consider the relative importance of the wetland in relation to the total property to be managed. Perhaps the wetland should be left undisturbed.
2. Protect the environment. Do not alter the hydrology of the wetland by:
 - ◆ Restricting the inflow or outflow of surface, sub-surface or groundwater;
 - ◆ Reducing residence time of waters;
 - ◆ Introducing toxic substances, or
 - ◆ Changing the temperature regime.
3. Protect wildlife habitat.

Identify and comply with local, state and federal regulations.

Identify control points – those places within the areas to be managed that should be accessed; those that should be avoided, or those that need special consideration.

Identify and mark Streamside Management Zones.

Locate access system components, such as roads, landings, skid trails and maintenance areas, outside filter strips and streamside management zones.

Wetland Access Systems

Wetland Forest Roads

Roads provide access for timber removal, fire protection, routine forest management activities and other multiple-use objectives. When properly constructed and maintained, roads will have minimal impact on water quality, hydrology and other wetland functions.

Permanent roads are constructed to provide multiple-season access for silvicultural activities and are maintained regularly. Construction of permanent roads in wetlands and wetland-like areas should be minimized.

Road drainage designs in wetlands must provide cross drainage of the wetland during both flooded and low-water situations.

Methods of cross drainage in fills for wetlands:

1. Space 24-inch culverts at regular intervals along the fill throughout the wetland. These culverts should have one-half their diameter placed below ground level to handle sub-surface flow. The fills around all culverts should be stabilized.
2. Install a 12-inch-thick porous layer of material aligned in elevation with the porous surface soil layer. A layer of geotextile cloth should separate the layers of this type road.

Use drainage techniques, such as crowning, insloping, outsloping and two percent minimum grades, as well as surface gravel and maintenance, to ensure adequate drainage and discourage rutting and associated erosion and sedimentation.

All road outflows from road ditches should be discharged before entering wetlands and riparian areas to minimize the introduction of sediment and other pollutants. Road width should be kept to the minimum necessary to achieve silvicultural operational success. Typically, on straight road sections, the running surface should be no more than 12 feet wide. Curved road running surfaces should be no more than 16 feet wide.

Use geotextile fabric during construction to minimize disturbance, fill requirements and maintenance costs.

Ditches parallel to the road center line should be constructed along the toe of the fill to collect surface and subsurface water; carry it through the cross drainage structure, and redistribute the water on the other side of the road.

All fills in wetlands should consist of free-draining granular material.

Build roads in advance of harvesting to allow them to settle and harden.

Favor temporary roads that will be “closed” after the silvicultural operation is completed.



Wetland Skid Trails

Choose the best harvesting system to remove the timber. The choice should minimize equipment entry into the wetland areas.

Where equipment entry into wetlands is unavoidable, minimize the area disturbed and practice dispersed skidding.

Use specialized equipment that exerts very low ground pressure to traverse wetland areas. The use of such equipment on areas that are marginally operable with conventional equipment results in minimum impact.

Schedule the harvest during dry seasons of the year or during times when the ground is completely frozen.

Minimize the crossing of perennial or intermittent streams and waterways. Use portable bridges, pole bridges (in dry channels) and corduroy approaches to minimize bank disturbance and sedimentation.

Cross streams at right angles and use bumper trees to keep logs on the trail or bridge.

Do not skid through vernal ponds, spring seeps or stream channels.



Wetland skid trail



Shovel logging

Wetland Log Landings (Decks)

Keep the number and size of landings to the minimum necessary to accomplish the operation.

Locate landings on well-drained areas that are not located near streams, seeps or other water-conveying channels.

Geotextile fabric is recommended in wetlands and on soils with low weight-bearing strength.

BMPs for Wet Weather Operations in Wetlands

1. Avoid heavy equipment operations, especially skidding, during flooded or wet soil conditions.
2. Do not operate heavy equipment, especially skidders, in floodplains when they are flooded or during conditions of flowing or standing floodwater.
3. Minimize skidder and other heavy equipment operation during wet conditions to avoid widespread excessive soil rutting. Although some minor rutting may occur in a typical wetland harvesting operation, skidders and other heavy equipment operation should be planned for dry periods as much as possible.



Poor wetland logging practice

Wildlife Habitat

Wetlands provide habitat to many sensitive endangered or threatened species. Consult with VDOF, DGIF or other professionals if your tract could be home to threatened or endangered species.

When planning operations, be cognizant that these areas are very important for amphibians and other species. Be sure to incorporate elements of preserving critical habitat during the planning stage.

Wetland Streamside Management Zones

Wetland areas tend to have multiple stream channels, oxbow lakes, vernal pools, sloughs and other unique features that do not show on topographic maps. These areas deserve special protection, and a minimum buffer of 50 feet should be left around them. Like SMZs on streams, 50 percent of the basal area should be retained or up to 50 percent of the crown cover can be removed. Crossing these features should be avoided if possible. If they must be crossed, temporary bridges, roads or skid trails (e.g., corduroy roads) or alternate logging systems (e.g., helicopter logging) should be considered. These man-made features should be removed after the operation is completed.

Both fresh- and saltwater marshes require the SMZ to start at the boundary between the marsh and the woodland. Up to 50 percent of the crown cover or 50 percent of the basal area can be removed during harvesting, but the forest floor must remain undisturbed. Also, any debris from the harvesting operation must be removed from the marsh boundaries.

Legal Requirements

Federal requirements have been discussed earlier in this chapter. There are also several state laws that affect harvesting operations in wetlands.

Virginia Silvicultural Water Quality Law – states that it is illegal to conduct silvicultural operations in any manner that allows sediment or the likelihood for sediment to enter the waters of the Commonwealth.

Debris in Streams Law – states that it is illegal to impede the navigation of man or fish in any navigable stream with debris from a silvicultural operation.

Submerged Aquatic Lands Law – states that a permit is required from VMRC to cross any drainage channel that drains more than five square miles, as well as any crossing of a tidal stream or marsh.

There may be additional local ordinances governing operations in wetland areas. Check with local authorities before beginning any operation.

Where to Go for Wetlands Assistance

Contact the Department of Forestry for assistance in forest management on both uplands and wetlands. However, forest management activities on wetlands are subject to special regulations. (See “APPENDIX E” on page 159.)

The District Office of the U.S. Army Corps of Engineers has the authority to determine which lands are subject to wetland regulations.



NOTES

NOTES

CHAPTER 10

REGULATIONS AND LEGISLATION



Regulations and Legislation for Water Quality and Forestry in Virginia

Federal Clean Water Act-Mandated Best Management Practices

As published, Section 404(f) affords an exemption for normal and established silvicultural activities in wetlands. However, landowners should be aware that even though a state may have a nonregulatory BMP program for forestry, as is true for most Southern states, the 15 BMPs below for road construction and maintenance are mandatory in jurisdictional wetlands. These are enforceable by federal agencies and these agencies are increasingly penalizing those who fail to comply.

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, constructing 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

Regulatory Requirements

The Chesapeake Bay Preservation Act, §10.1-2100 et seq., required “that all localities within Tidewater Virginia incorporate general water quality protection measures into their comprehensive plans, zoning ordinances and subdivision programs, in accordance with criteria established by the Commonwealth, that define and protect certain lands called Chesapeake Bay Preservation Areas.”

Subsequently, the Chesapeake Bay Preservation Area Designation and Management Regulations, 9VAC10-20 et seq., charge the VDOF with the responsibility to oversee and document the installation of silvicultural best management practices. Section 9VAC10-20-120.10 states that:

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 ‘Forestry Best Management Practices Handbook for Water Quality in Virginia.’

In other words, silvicultural operations within Chesapeake Bay Preservation Areas must implement all necessary Forestry BMPs.

- ◆ Before beginning a silvicultural operation, the landowner or harvester should contact the local government to determine if the proposed timber harvest site is within a Chesapeake Bay Preservation Area.
- ◆ Pursuant to a Memorandum of Understanding between the Department of Forestry (VDOF) and DCR’s Division of Chesapeake Bay Local Assistance, the VDOF will conduct harvest inspections on all known silvicultural activities within Chesapeake Bay Preservation Areas to determine impacts on water quality.
- ◆ The VDOF will notify the local government and DCR when it is determined that the Streamside Management Zone (SMZ) has not been maintained during the silvicultural activity, as recommended in this manual. Even if VDOF determines that an SMZ violation may not pose an immediate threat to water quality, the SMZ violation is still considered a violation of the Chesapeake Bay Preservation Act and requires an enforcement action by the local government.
- ◆ Failure to properly install or maintain any of the forestry BMPs within a CBPA would automatically eliminate the silvicultural exemption status under the Regulations. For example, clear-cutting or partially clear-cutting within an SMZ would constitute an illegal clearing of vegetation in the RPA and would be subject to local CBPA enforcement procedures. Landowners are legally and financially responsible for all such violations and any penalty or corrective measures required by the enforcement action.
- ◆ Please contact DCR’s Division of Chesapeake Bay Local Assistance at (800) CHES-BAY for more information about the Chesapeake Bay Preservation Act and Regulations.

Silvicultural Water Quality Law

Title 10.1 – Conservation

Chapter 11 – Forest Resources and the Department of Forestry

Article 12 – Silvicultural Activities Affecting Water Quality

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 owners and operators notify the State Forester prior to the start of a silvicultural activity. Failure to do so will result in a civil penalty of \$250 for a first offense and up to \$1,000 for subsequent offenses.

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

§62.1-194.1. Obstructing or contaminating state waters.

Except as otherwise permitted by law, it shall be unlawful for any person to dump, place or put, or cause to be dumped, placed or put into, upon the banks of or into the channels of any state waters any object or substance, noxious or otherwise, which may reasonably be expected to endanger, obstruct, impede, contaminate or substantially impair the lawful use or enjoyment of such waters and their environs by others. Any person who violates any provision of this law shall be guilty of a misdemeanor and upon conviction be punished by a fine of not less than \$100 nor more than \$500 or by confinement in jail not more than 12 months or both such fine and imprisonment. Each day that any of said materials or substances so dumped, placed or put, or caused to be dumped, placed or put into, upon the banks of or into the channels of, said streams shall constitute a separate offense and be punished as such.

In addition to the foregoing penalties for violation of this law, the judge of the circuit court of the county or corporation court of the city wherein any such violation occurs, whether there be a criminal conviction therefore or not shall, upon a bill in equity, filed by the attorney for the Commonwealth of such county or by any person whose property is damaged or whose property is threatened with damage from any such violation, award an injunction enjoining any violation of this law by any person found by the court in such suit to have violated this law or causing the same to be violated, when made a party defendant to such suit.

§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.

NOTES

CHAPTER 11

GLOSSARY OF FORESTRY TERMS

The word cloud contains the following words:

- Permeability
- Erosion
- Geotextile
- Soil
- Oxidation
- Sediment
- Pollutant
- Turnout
- Soil Productivity
- Sloughs
- Susceptibility
- Watershed Area
- Residual Trees
- Regeneration
- SOIL CONSERVATION
- Waterbar
- Switchback
- Ditch
- Barriers
- Stream
- Wetlands

Glossary of Forestry Terms

Access road – A temporary or permanent access route for vehicles into forestland.

Barriers – Obstructions to pedestrian, horse and/or vehicular traffic. They are intended to restrict such traffic to a specific location.

Bearing capacity – Maximum load that a material (soil) can support before failing.

Bedding – A site preparation method in which special equipment is used to concentrate surface soil and forest litter into a ridge six to 10 inches high on which forest seedlings are to be planted.

Bottom lands – A term often used to define lowlands adjacent to streams.

Broad-based dip – A surface drainage structure specifically designed to drain water from an access road while vehicles maintain normal travel speeds.

Brood trees – Trees that harbor reproducing insect pest populations. They often serve as sources of infection for neighboring trees.

Channel – A natural stream that conveys water. A ditch or channel excavated for the flow of water.

Check dam – A small dam constructed in a gully or other small water-course to decrease streamflow velocity, minimize channel scour and promote deposition of sediment.

Contamination – A general term signifying the introduction into water of micro-organisms, chemical, organic, inorganic wastes or sewage, which renders the water unfit for its intended use.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation. A line drawn on a map connecting points of the same elevation.

Cultipacker – A cultipacker is a piece of agricultural equipment that crushes dirt clods, removes air pockets, and presses down small stones, forming a smooth, firm seedbed. Where seed has been broadcast, the roller gently firms the soil around the seeds, ensuring shallow seed placement and excellent seed-to-soil contact.

Culvert – A conduit through which surface water can flow under roads.

Cut – Portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

Cut-and-fill – Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Dispersion, soil – The breaking down of soil aggregate into individual particles, resulting in single grain structure. Ease of dispersion is an important factor influencing the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is.

Diversion – A channel with a supporting ridge on the lower side constructed across or at the bottom of a slope for the purpose of intercepting surface runoff.

Diversion ditch – A drainage depression or ditch built across the top of a slope to divert surface water from that slope.

Erosion – The process by which soil particles are detached and transported by water, wind and gravity to some downslope or downstream point. The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep; detachment and movement of soil or rock fragment by water, wind ice or gravity.

Erosion classes (soil survey) – A grouping of erosion conditions based on the degree of erosion or on characteristic patterns. Applied to accelerated erosion, not to normal, natural or geological erosion. Four erosion classes are recognized for water erosion and three for wind erosion.

Fill slope – The surface area formed where earth is deposited to build a road or trail.

Firebreaks – Naturally occurring or man-made barriers to the spread of fire.

Fireline – A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel nonflammable by use of water or fire retardants.

Ford – Submerged stream crossing where tread is reinforced to bear intended traffic. A place where a perennial stream may be crossed by vehicle.

Forest chemicals – Chemical substances or formulations that perform important functions in forest management. They include fertilizers, herbicide, repellents and other chemicals.

Forestland – Land bearing forest growth or land from which the forest has been removed but which shows evidence of past forest occupancy and which is not now in other use.

Forest landowner – An individual, combination of individuals, partnership, corporation, foundation, government agency, or association of whatever nature that holds an ownership interest in forestland.

Forest Practice – An activity relating to the growing, protecting, harvesting or processing of forest tree species on forestland and to other forest management aspects, such as wildlife, recreation, etc.

Grade – The slope of a road or trail expressed as a percent or change in elevation per unit of distance traveled.

Geotextile – A fabric underlayment for roads to increase bearing capacity.

Gully erosion – Erosion process whereby water accumulates in narrow channels and over short periods removes soil from this narrow area to considerable depths (one foot plus).

Harvesting – The felling, loading and transportation of forest products, roundwood or logs.

Herbicide – Any substance, or mixture of substances, intended to prevent the growth of or destroy any tree, bush, weed, algae and other aquatic weeds.

11 | Glossary

Herbicide mobility – The ease with which the active ingredients can move away from the area of application. This movement can be by drift, evaporation, rain, runoff or through the soil.

Insecticide – A liquid or chemical compound used to kill insects.

Intermittent streams – A stream or portion of a stream with defined stream banks and scoured stream channel that flows during part of the year. Defined as a dotted blue line on the 1:24,000 USGS topographic maps.

Karst – A unique geological terrain formed in limestone and dolomite by the dissolving of bedrock, eroding of underground spaces and collapsing of the ground surface. Karst terrain is characterized by sinkholes, caves and underground drainage patterns.

Landing – A place where logs are gathered in or near the forest for further transport, sometimes called a “deck.”

Logging debris – That unwanted, unutilized and, generally, unmarketable accumulation of woody material in the forest, such as large limbs, tops, cull logs and stumps, that remain as forest residue after timber harvesting.

Mineral soil – Organic-free soil that contains rock less than two inches in size.

Mulch – A natural or artificial layer of plant residue or other materials covering the land surface that conserves moisture, holds soil in place, aids in establishing plant cover and minimizes temperature fluctuations.

Mulching – Covering forest soil with any loose cover of organic residues, such as grass, straw, bark or wood fibers, to check erosion and stabilize exposed soil.

Nonpoint source pollution – Pollution that enters a water body from a diffuse origin on the watershed and does not result from discernible, confined or discrete pathways.

Nutrients – Mineral elements in the forest ecosystem, such as nitrogen, phosphorus or potassium, that are naturally present or may be added to the forest environment by forest practices, such as fertilizer or fire retardant applications. Substances necessary for the growth and reproduction of organisms. In water, those substances that promote growth of algae and bacteria; chiefly nitrates and phosphates.

Organics – Particles of vegetation or other biologic material that can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Oxidization – The process of breaking down organics into their basic chemical constituents.

Perennial stream – A stream that maintains water in its channel throughout the year. Defined as a solid blue line on the 1:24,000 USGS topographic maps.

Permeability, soil – The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable.

Persistence – The relative ability of a pesticide to remain active over a period of time.

Pesticides – Chemical compounds used for the control of undesirable plants, animals or insects. The term includes insecticides, herbicides and rodenticides, but as used in this handbook does not include non-toxic repellents or other chemicals.

Pocosin – A rare natural community characterized by peaty soils and heath-like vegetation, tucked between coastal freshwater marshes and deepwater swamp forests of the Atlantic Coastal Plain. A high water table, an abundance of sphagnum moss and the slow decay of dead vegetation contribute to the deep peat and acidic soils of these areas. Pocosins are one of Virginia's rarest wetlands.

Pollutant – Dredged soil, solid wastes, incinerator residue, sewage, garbage, sewage sludge, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock sand, cellar dirt and industrial, municipal and agricultural waste discharged into water. (P.L. 92-500, Section 502(6)).

Pollution – The presence in a body of water (or soil or air) of substances of such character and in such quantities that the natural quality of the environment is impaired or rendered harmful to health and life or offensive to the senses.

Puncheon – A structure used to cross wet locations on a trail, constructed of logs and/or lumber.

Regeneration – The young tree crop replacing older trees removed by timber harvest or disaster; the process of replacing old trees with young ones.

Residual trees – Live trees left standing after the completion of timber harvesting.

Rill erosion – An erosion process in which numerous small channels only several inches deep are formed. Occurs mainly on disturbed and exposed soils.

Rip-rap – Aggregate placed on erodible sites to reduce the impact of rain or surface runoff on these areas.

Rolling dip – A shallow depression built diagonally across a light duty road or trail for the purpose of diverting surface water runoff from the road or trail.

Runoff – In forest areas, that portion of precipitation that flows from a drainage area on the land surface or in open channels.

Ruts – Gullies or channels created by logging.

Salvage harvest – Removal of trees that are dead or imminently threatened with death to utilize wood before it is rendered valueless by natural decay agents.

Sanitation harvest – Removal of trees that are under attack by or highly susceptible to insect and disease agents to stop or prevent the spread of such agents.

Sediment – Solid material that is in suspension, is being transported or has been moved from its site of origin.

Seedbed – The soil prepared by natural or artificial means to germination of seed and the growth of seedlings.

Sheet erosion – The removal of a fairly uniform layer of soil from the land surface by water runoff.

11 | Glossary

Silvicultural activities – All forest management activities, including logging, log transport and forest roads.

Site preparation – A forest activity to remove unwanted vegetation and other material and to cultivate or prepare the soil for reforestation.

Skid trails – A temporary pathway over forest soil to drag felled trees or logs to a landing.

Slope – Degree of deviation of a surface from the horizontal, measured as a numerical ratio, percent or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise) as 2:1. A 2:1 slope is a 50 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90 degree slope being vertical (maximum) and 45 degrees being a 1:1 slope.

Sloughs – Normally sections of old stream channel that have been abandoned by the normal reach and flow of the stream, but that still may carry or flow water to the main channel, especially during periods of moderate to high water.

Soil – The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

Soil conservation – Using the soil within the limits of its physical characteristics and protecting it from unalterable limitations of climate and topography.

Soil productivity – The output or productive capability of a forest soil to grow timber crops.

Stream – A permanently or intermittently flowing body of water that follows a defined stream course with scoured channel bottom.

Streamside Management Zone (SMZ) – An area of reduced management activity on both sides of the banks of perennial and intermittent streams and bodies of open water where extra precaution is used in carrying out forest practices to protect bank edges and water quality.

Streambanks – The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.

Susceptibility – The likelihood of attack or infection by a destructive insect or disease organism.

Susceptible species – A type of tree or plant that has a high probability to be attacked by a given insect or disease agent.

Switchback – A 180-degree direction change in a trail or road used to climb steep slopes.

Thermal pollution – A temperature rise in a body of water sufficient to be harmful to aquatic life in the water.

Toxicity – The characteristic of being poisonous or harmful to plant or animal life; the relative degree or severity of this characteristic.

Tread – Load bearing surface of a trail or road.

Turnout – a) A widened space in a road to allow vehicles to pass one another. b) A drainage ditch that drains water away from roads.

Vernal Pools – Vernal pools are seasonally flooded depressions found on ancient soils with an impermeable layer, such as hardpan, claypan or volcanic basalt. The impermeable layer allows the pools to retain water much longer than the surrounding uplands; nonetheless, the pools are shallow enough to dry up each season. Vernal pools normally hold water for a minimum of two continuous months during spring and/or summer and are free of adult fish populations. These pools are required habitat for numerous amphibian and invertebrate species that have evolved to take advantage of the relative safety of waters without predatory fish.

Waste – Materials and substances usually discarded as worthless to the user.

Water bar – A diversion ditch and/or hump across a trail or road tied into the uphill side for the purpose of carrying water runoff into the vegetation, duff, ditch or dispersion area so that it does not gain the volume and velocity that causes soil movement and erosion.

Water body – An area where water stands with relatively little or slow movement (ponds, lakes, bays).

Water course – A definite channel with bed and banks within which concentrated water flows continuously or intermittently.

Water pollution – Any introduction of foreign material into water or other impingement upon water that produces undesirable changes in the physical, biological or chemical characteristics of that water.

Water quality – A term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water quality standards – Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonate, pH total dissolved salts, etc. In Virginia, the Department of Environmental Quality sets water quality standards.

Watershed area – All land and water within the confines of a drainage divide or a water problem area consisting in whole, or in part, of land needing drainage or irrigation.

Weir – A dam in a stream or river to raise the water level or divert its flow.

Wetlands – Geographic areas characteristically supporting hydrophytic vegetation, hydric soils and some saturation or flooding during the growing season.

Wildfire Control – Actions taken to contain and suppress uncontrolled fires.

Wildfires – Uncontrolled fires occurring in forestland, brushland and grassland.

NOTES

APPENDIX A

BMP SPECIFICATIONS



1 – Forest Roads

The following is a simple list of recommended specifications for forest roads.

- ◆ Roads should follow contour as much as possible with road grades between two percent and 10 percent. Steeper gradients for up to 15 percent are permissible for up to 200 feet. By breaking or changing grade frequently, fewer erosion problems will result.
- ◆ On highly erodible soils, grades should not exceed eight percent. Graveling the road surface can help maintain stability.
- ◆ Forest roads should be out-sloped whenever road gradient and soil type will permit. Out-sloping allows surface water to drain off the road quickly, reducing erosion potential.
- ◆ Use in-sloping when constructing a road where road gradients are greater than 10 percent, toward sharp curves or when constructed on clay and/or slippery soils. In such cases, the use of an under-road culvert positioned at a 30° angle to ensure proper inside road drainage is recommended. The use of broad-based and rolling dips is encouraged to provide adequate drainage of the road surface.
- ◆ Intermittent or perennial streams, as well as certain ephemeral drains, should be crossed using bridges, culverts or fords. Cross as close to a right angle as possible. Structures should be sized so as not to impede fish passage or stream flow. (See “Permanent Culvert Specifications” on page 43.)
- ◆ Install water turnouts prior to a stream crossing to direct road water runoff into undisturbed areas of the streamside management zone. Road gradients approaching water crossings should be changed to disperse surface runoff water at least 50 feet from the stream. With the exception of stream crossings, roads should be located a minimum of 50 feet from any flowing or identifiable stream. Distance is measured from the bank to the edge of soil disturbance or, in case of fills, from the bottom of the fill slope.
- ◆ Where a road must be constructed or used within 50 feet of the stream, locate road as far away from the active channel as possible and surface the road section within 50 feet of the stream with material to create a non-erodible running surface. Cut banks and fill should be stabilized immediately using vegetation, rock, erosion blankets, or other suitable material. Install silt fence barriers at outlets of any drainage structures that are constructed.
- ◆ Where haul roads intersect highways, use gravel, mats or other means to keep mud off the highway. (See “21 – Logging Entrance” on page 138.)
- ◆ Install rip rap or other devices at the outlets of culverts and dips to absorb and spread water if needed.
- ◆ Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.
 - ◆ Control the flow of water on road surfaces by keeping drainage systems open and intact during logging operations.
 - ◆ Inspect roads at regular intervals to detect and correct potential maintenance problems.



2 – Skid Trails

Definition

An unsurfaced trail, usually single lane and occurring on a gradient steeper than a truck road. A skid trail is generally temporary in nature and is used to move the log or tree by either dragging or carrying, thus creating ground disturbance.



Purpose

A trail used to move logs and trees from the stump to the landing or concentration area.

Recommended Specifications

- ◆ Bladed or dozed skid trail grades should not exceed 25 percent. However, steeper segments may be required to avoid boundary lines, sensitive areas or other areas not accessible using skid trails of lesser grades. Allowances for skid trail grades of up to 35 percent for short segments can be acceptable. If steeper grades are necessary, practices must be used to prevent concentrated water flow that causes gullying. Skid trails should not be constructed on sidesteps exceeding 60 percent. If it is impossible to limit exposure of mineral soil, alternate systems, such as extra cable length, cable yarding or others, should be considered.
- ◆ Overland and dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
- ◆ Avoid skidding in a streambed.
- ◆ Skid trails should be located outside the SMZ.
- ◆ Any skid trail that must cross a perennial or intermittent stream or drainage ditch should use a bridge or culvert of acceptable design. Logs shall not be dragged through a stream of any type.
- ◆ Skid trail crossings of any stream channel should be as close to a right angle as possible.
- ◆ Turn water out of skid trail at least 25 feet prior to stream crossing.
- ◆ Break grade frequently to avoid long, continuous stretches of the same grade.
- ◆ 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. Site preparation should be used to ameliorate excessively compacted or rutted sites.
- ◆ Upon completion of skidding, areas subject to erosion should have water bars installed immediately. (See “7 – Water Bars” on page 108.)
- ◆ A permanent vegetative cover should be established upon exposed soils that are greater than or equal to five percent slope, or less if soil type is highly erodible. (See “APPENDIX D” on page 151.)

- ◆ Temporary closeout of skid trails should occur if the skid trail will be inactive for periods longer than seven days or if a severe storm event is anticipated.

3 – Wing (Lead Off) Ditches

Definition

A water turnout, or diversion ditch, constructed to move and disperse water away from the road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduced on slopes.



Purpose

To collect and direct road surface runoff from one or both sides of the road away from the roadway and into undisturbed areas.

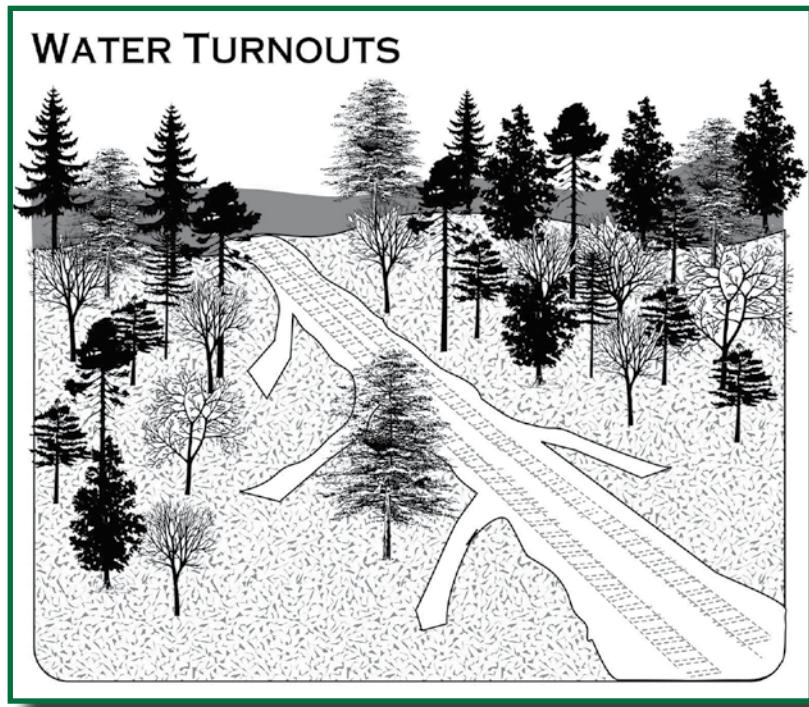
Conditions Where Practice Applies

- ◆ Any road or trail section where water could accumulate or accelerate. The water should be diverted onto undisturbed areas so the volume and velocity is reduced.

Recommended Specifications

Wing 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 maintenance with logging equipment, such as skidders.



On sloping roads, leave the road ditch line at a 30- to 45-degree angle to the roadbed and be downsloped less than two percent of the natural contour.

Wing ditches may be needed to provide outlets for other water control devices, such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect. Topography and relief of the area will determine the spacing of wing ditches. Soil texture should also be considered for wing ditch spacing. On highly erodible or sandy soils, wing ditches (turnouts) should be spaced closer together than on clay soils.

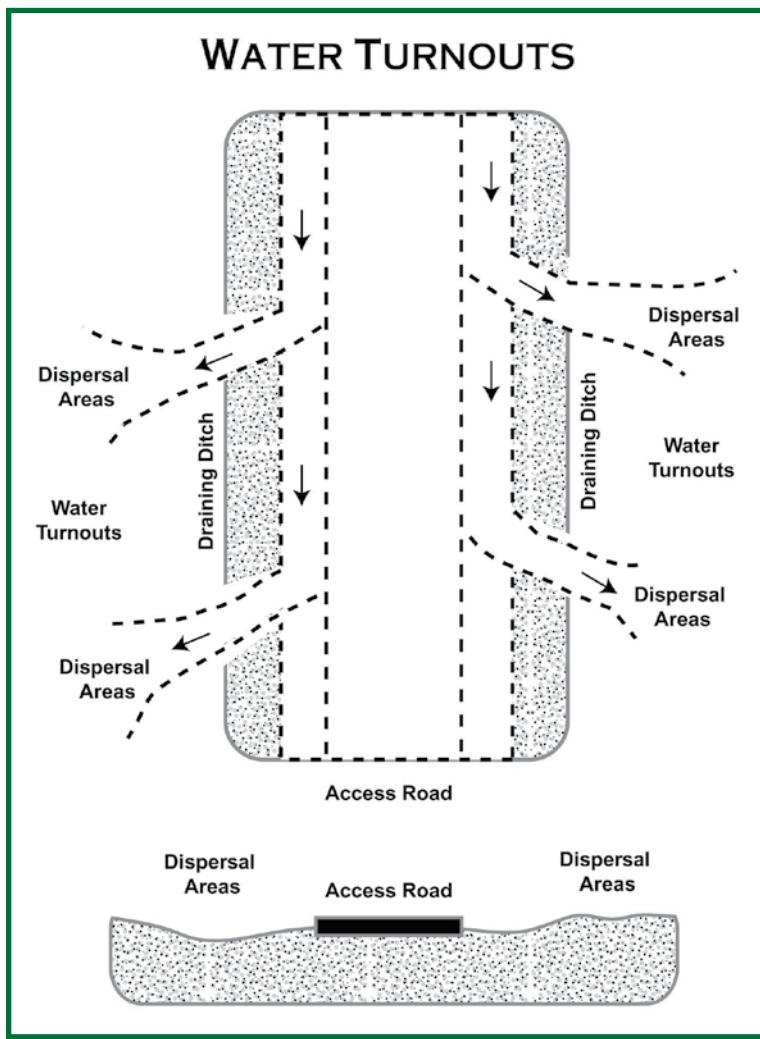


Table 13
Maximum Distance Between Wing Ditches/Turnouts

Topography	Slope (%)	Spacing 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

4 – Culvert Sizes for Cross-Drainage of Roads

Definition

Pipe made of metal, plastic or other suitable material installed under haul roads to transmit water from the roadside ditch, storm runoff, seeps and drains.



Purpose

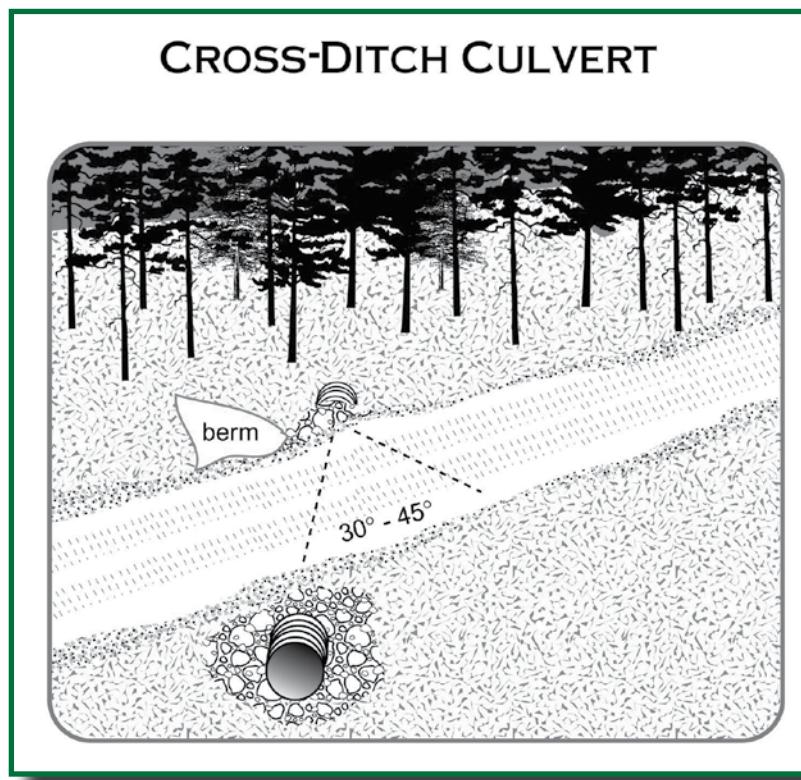
To collect and transmit water safely from side ditches, seeps or natural drains under haul roads and skid trails without eroding the drainage system or road surface.

Conditions Where Practice Applies

- ◆ Culverts can be used for any operation where cross-drainage of water is needed. In some cases, a culvert is necessary for temporary drainage crossings. Permanent installation should be periodically inspected for obstructions.

Recommended Specifications

- ◆ Pipe length should be long enough so both ends extend at least one foot beyond the side slope of fill material.
- ◆ The culvert should be placed one percent to two percent downgrade to prevent clogging and be laid so the bottom of the culvert is as close as possible to the natural grade of the ground or drain.
- ◆ The culvert should be angled 30 degrees to 45 degrees across the direction of the road.



Erosion protection should be provided for outflows of culverts to minimize erosion downslope or downstream of the outfall; it may also be needed on the upstream end of culverts on flowing streams. This protection can be in the form of headwalls, rip rap, geotextile filter cloth, large stone or prefabricated outflow and inflow devices.

Culverts should be firmly seated and earth compacted at least halfway up the side of the pipe. Cover equal to a minimum of half the culvert diameter (preferably 1 foot of fill per 1 foot of culvert diameter) should be placed above the culvert. Never use less than one foot of cover. The distance between pipes in a multiple culvert application should be a minimum of half the pipe diameter.

Spacing should be determined by the following formula:

$$\text{Spacing} = 400 \text{ feet/slope} + 100 \text{ feet}$$

Also refer to Table 15 Suggested Spacing for Broad-Based Dips. (See "Table 15" on page 106.)

Table 14 Suggested Spacing for Cross-Drainage Culverts	
Cross-Drainage Road Grade (%)	Culvert Spacing Distance (ft.)
0 - 2	500 - 250
3 - 5	250 - 167
6 - 10	167 - 140
11 - 15	140 - 126
16 - 20	126 - 100
21 +	100

5 – Broad-Based Dip

Definition

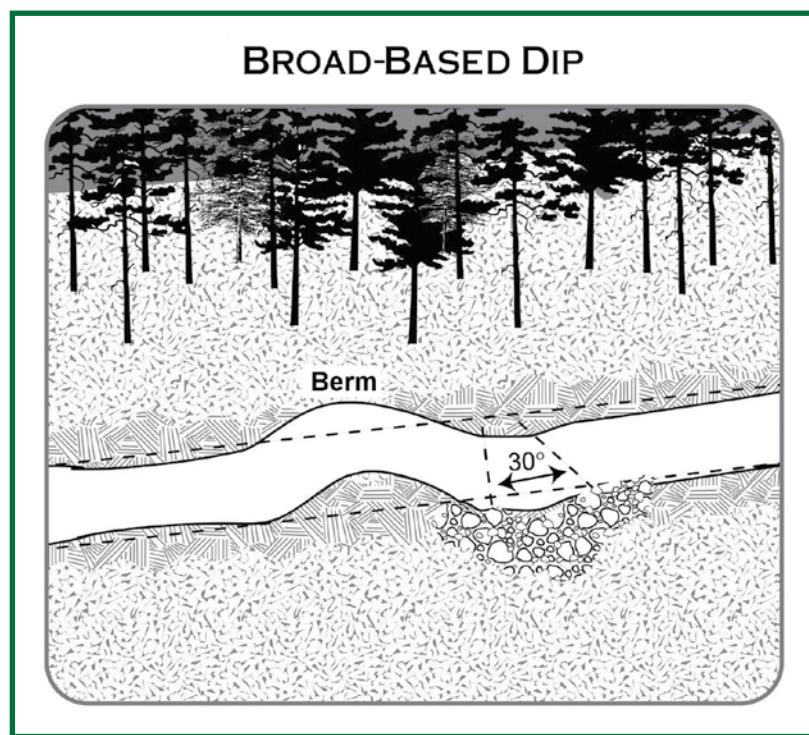
A surface drainage structure specifically designed to drain water from an access road while allowing vehicles to maintain normal travel speeds.

Purpose

To gather surface water and direct it off the road to prevent buildup of surface runoff and subsequent erosion while allowing the passage of traffic.

Conditions Where Practice Applies

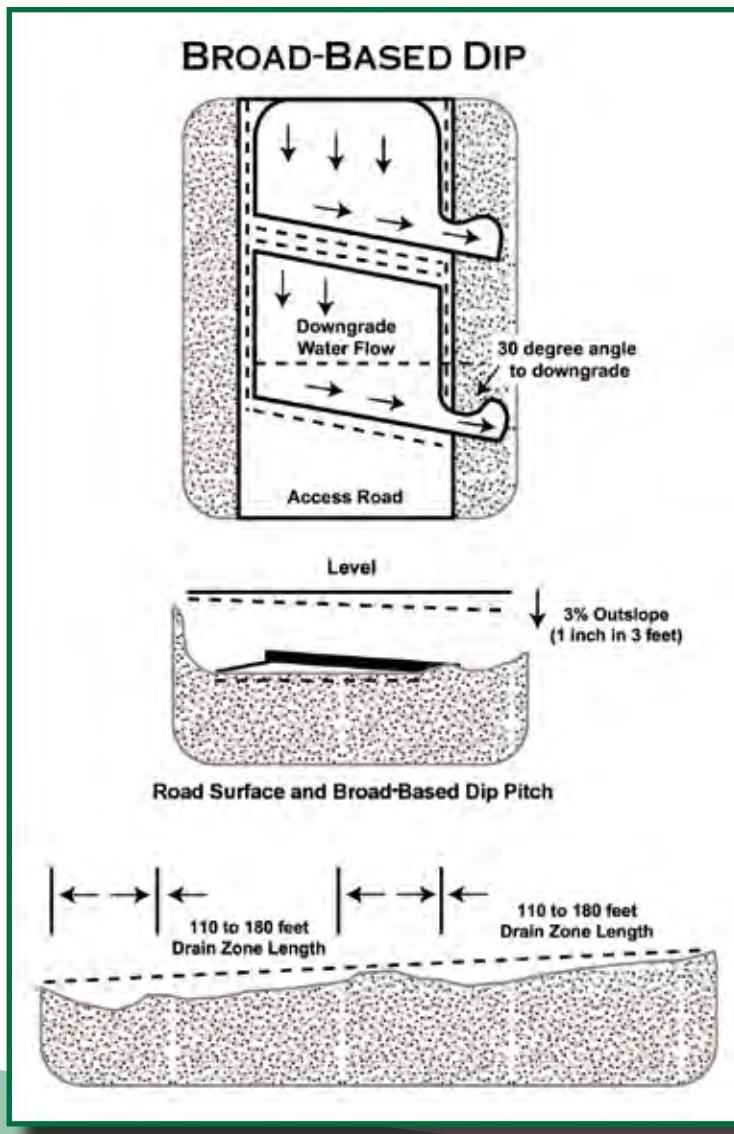
- ◆ Used on truck haul roads and heavily-used skid trails generally having a gradient of eight percent or less. Should not be used for stream crossings.



Recommended Specifications

- ◆ Installation should take place following basic clearing and grading for roadbed construction.
- ◆ A 20-foot, three percent reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location.
- ◆ The cross-drain outslope will be two percent to three percent maximum.
- ◆ An energy absorber, such as rip rap, and, in some cases, a level area where the water can spread, should be installed at the outfall of the dip to reduce water velocity, thus minimizing erosion.
- ◆ On some soils, the dip and reverse grade section may require bedding with three inches of crushed stone to avoid rutting the road surface.
- ◆ Broad-based dips are very effective in gathering surface water and directing it safely off the road. Dips should be placed across the road in the direction of water flow.

Table 15 Suggested Spacing for Broad-Based Dips	
Road Grade (%)	Spacing Distance (ft.)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135



6 – Rolling Dips

Definition

Rolling dips are a cross between a water bar and a broad-based dip. Like broad-based dips, they have a reverse grade (although shorter) and direct water off the road. Like water bars, they may rely on a mound of soil at the downhill side. Rolling dips should be used on roads with a grade steeper than where a broad-based dip is used.



Purpose

To gather water and direct it safely off the road to prevent buildup of surface runoff and subsequent erosion, while allowing the passage of traffic.

Conditions Where Practice Applies

- Used on truck haul roads and heavily-used skid trails having a gradient of 15 percent or less. Should not be used for crossing streams, springs and seeps.

Recommended Specifications

- Installation follows basic clearing and grading for roadbed construction or on skid trails after logging is completed.
- A 10- to 15-foot-long, three percent to eight percent reverse grade is constructed into the roadbed by cutting upgrade to the dip location and then using cut material to build the mound for the reverse grade.
- In hills, rolling dips are located to fit the terrain as much as possible. They should be spaced according to the slope of the planned roadbed.

Table 16 Suggested Spacing for Rolling Dips	
Road Grade (%)	Spacing Distance (ft.)
2 - 5	180
6 - 10	150
11 - 15	135
16 +	120

7 – Water Bars

Definition

A diversion dam constructed across a road or trail to remove and disperse surface runoff in a manner that adequately protects the soil resource and limits sediment transportation.



Purpose

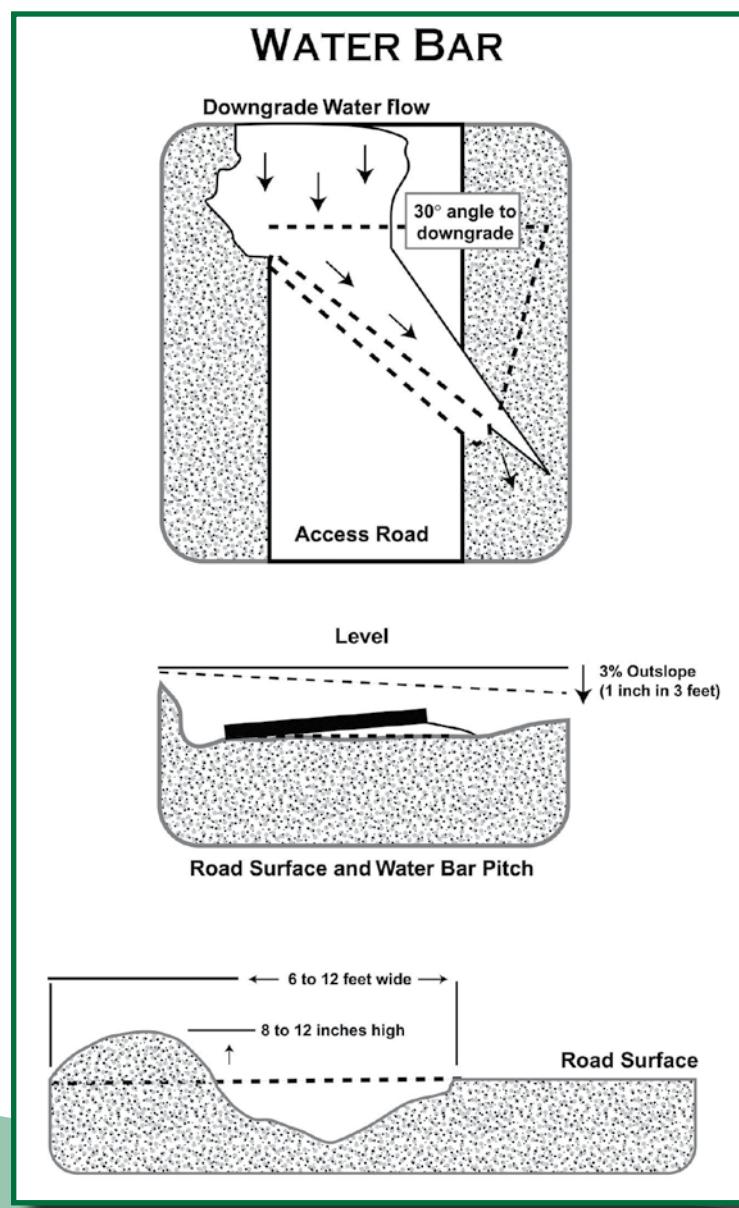
To gather and shed surface water off a road, firebreak, trail, etc.; prevent excessive erosion until natural or artificial revegetation can become established, and to divert water from an inside (uphill) ditch.

Conditions Where Practice Applies

- ◆ This is a practice that can be used on limited-use roads, trails and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface water runoff may cause erosion of exposed mineral soil.

Recommended Specifications

- ◆ Water bars should be placed at an angle of 30 degrees to 45 degrees to the road, firebreak or trail. Water bars are not dams. Water bars intercept and/or divert surface water runoff.
- ◆ The outflow end of the water bar should be fully open and extend far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor. The outlet should fall no more than two percent.



- ◆ The uphill end of the water bar should be tied into the cutbank of the road or trail, or into the upper bank of the road or trail.
- ◆ Specifications for water bar construction on forest roads, trails and firebreaks must be site specific and should be adapted to existing soil and slope conditions.

Table 17
Suggested Spacing for Water Bars

Road Grade (%)	Spacing Distance (ft.)
2	250
5	135
10	80
15	60
20	45
30	35

8 – Temporary Fill Diversion

Definition

A channel with a supporting ridge of soil on the lower side, constructed along the top of an active earth fill.

Purpose

To divert storm runoff away from the unprotected slope of the fill to a stabilized outlet or sediment-trapping condition, whether the sediment trapping is natural or man-made.

Conditions Where Practice Applies

- ◆ Where the drainage area at the top of an active “earth fill” slopes toward the exposed slope and where other drainage structures cause the fill to erode during and after construction of haul roads, log decks, skid trails, etc. The temporary fill diversion is used where other diversions are not feasible during construction of haul roads, log decks, etc. This temporary structure should remain in place for the period of active harvesting.



Photo courtesy of Missouri Department of Transportation

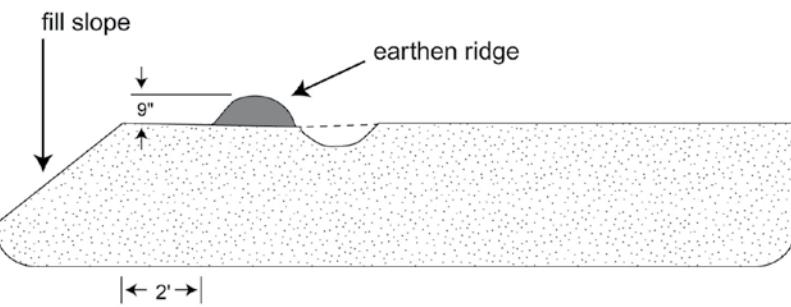
Planning Considerations

On rare occasions, a road, skid trail or log deck is installed on steep slopes where the construction of such roads and decks may take several days. This is not a good BMP and should be avoided when other alternatives are available. One important principle of the BMPs is to keep stormwater runoff away from exposed slopes. This can be accomplished by installing a dike, diversion, temporary slope drain or, if the road is to be permanently maintained after harvest, a vegetated or lined ditch may be appropriate to carry the runoff away from the slope to a stabilized outlet. In general, these measures may be installed after the final grade has been reached. On cuts, the measures may be installed at the beginning since the work proceeds from the top to the bottom of the slope, and the measures have little chance of being covered or damaged. On cuts, the work proceeds from the bottom to the top and the elevation changes daily until the final grade is reached (it is rare that a silvicultural operation will require such extreme excavation). It is, therefore, not feasible to construct a compacted dike or permanent diversion that may be covered by the next day's grading.

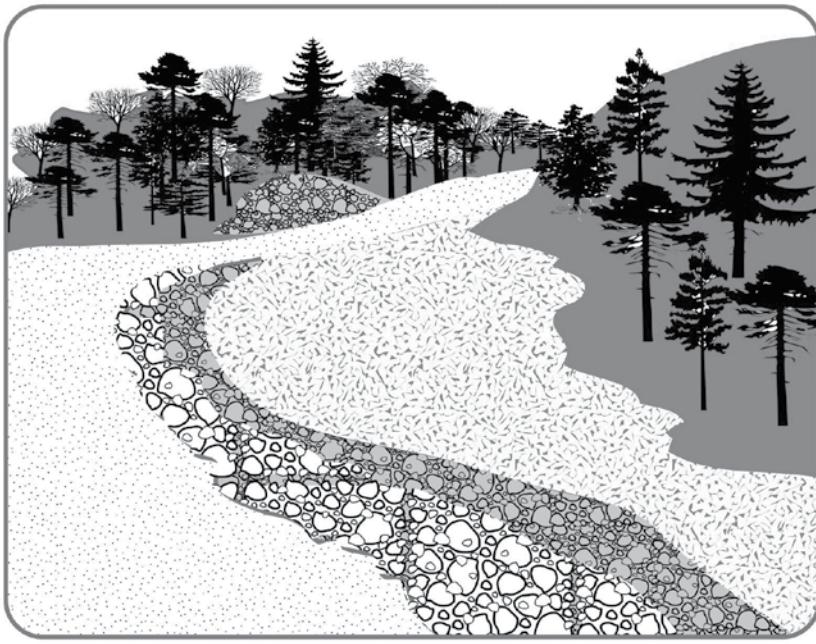
A | Appendix A – BMP Specifications

The temporary fill diversion is intended to provide some slope protection on a daily basis until final elevations are reached and a more permanent measure can be constructed. This practice can be constructed by the use of a motor grader or a small dozer. To shape the diversion, the piece of machinery used may run near the top edge of the fill with its blade tilted to form the channel. This work would be done at the end of the workday and provide a channel with a berm to protect the slope. Wherever possible, the temporary diversion should be sloped to direct water to a stabilized outlet. If the runoff is diverted over the fill itself, the practice may cause erosion by concentrating water at a single point.

TEMPORARY FILL DIVERSION



TEMPORARY FILL DIVERSION



9 – Temporary Slope Drain

Definition

A flexible tubing or conduit extending from the top to the bottom of a cut or fill slope.



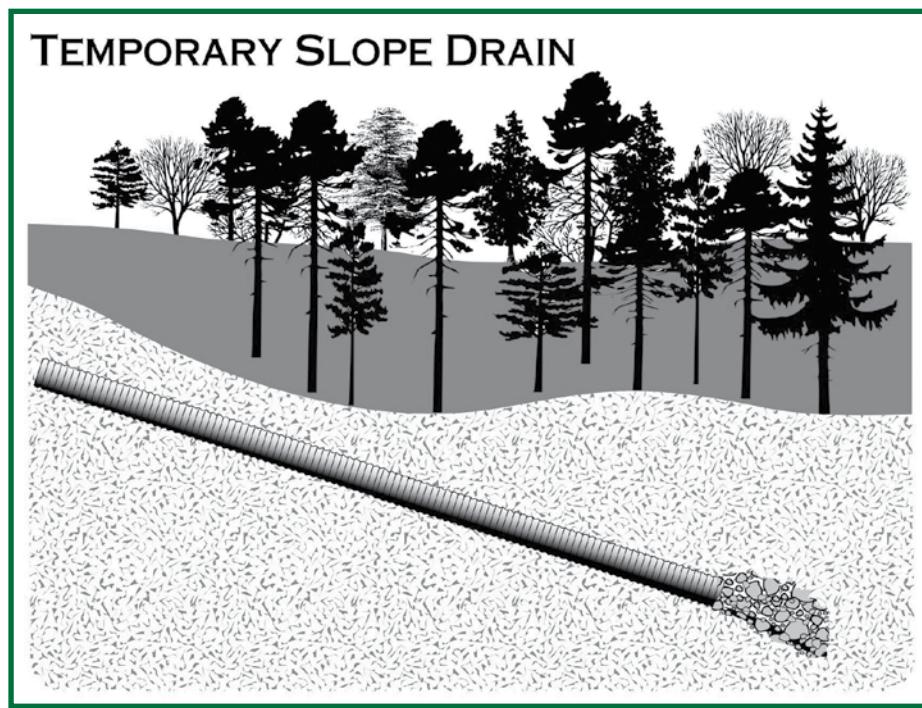
Purpose

To temporarily conduct concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion on or below the slope.

Conditions Where Practice Applies

- ◆ On cut or fill slopes where there is a potential for flows to move over the face of the slope causing erosion and preventing adequate stabilization.
- ◆ There is often a significant lag between the time a cut or fill slope is completed (on truck haul roads, log decks, skid trails, etc.) and the time a temporary or permanent drainage system can be installed or permanent vegetation established. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction that is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until temporary or permanent drainage structures can be installed or vegetation can be established.

Temporary slope drains can be used in conjunction with diversion dikes to convey runoff from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly as their failure will often result in severe gully erosion on the site and sedimentation below the slope. The entrance section must be securely entrenched, all connections should be watertight, and the conduit must be staked securely.



Drainage Area

The maximum recommended drainage area per slope drain is five acres.

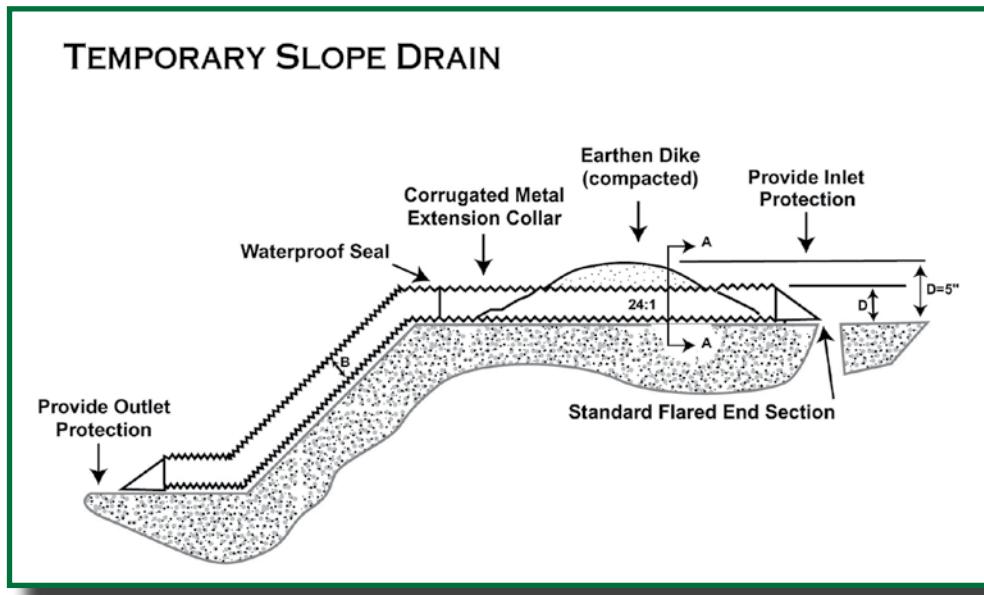
Flexible Conduit

The slope drain should consist of heavy-duty, flexible material designed for this purpose. The diameter of the slope drain should be equal over its entire length. Reinforced hold-down grommets should be spaced at 10-foot (or less) intervals.

Recommended Construction Specifications

- ◆ The measure should be placed on undisturbed soil or well-compacted fill.
- ◆ The entrance section should slope toward the slope drain at the minimum rate of $\frac{1}{2}$ inch per foot.
- ◆ The soil around and under the entrance section should be hand-tamped in eight-inch lifts to the top of the dike to prevent piping failure around the inlet.
- ◆ The slope drain should be securely staked to the slope at the grommets provided.
- ◆ The slope drain sections should be securely fastened together and have watertight fittings.
- ◆ Properly install culvert inlet protection and outlet protection.

The slope drain structure should be inspected weekly and after every storm, and repairs made if necessary. The logger should avoid the placement of any material on the slope drain, and prevent logging traffic (including skidding) across the slope drain.



10 – Level Spreader

Definition

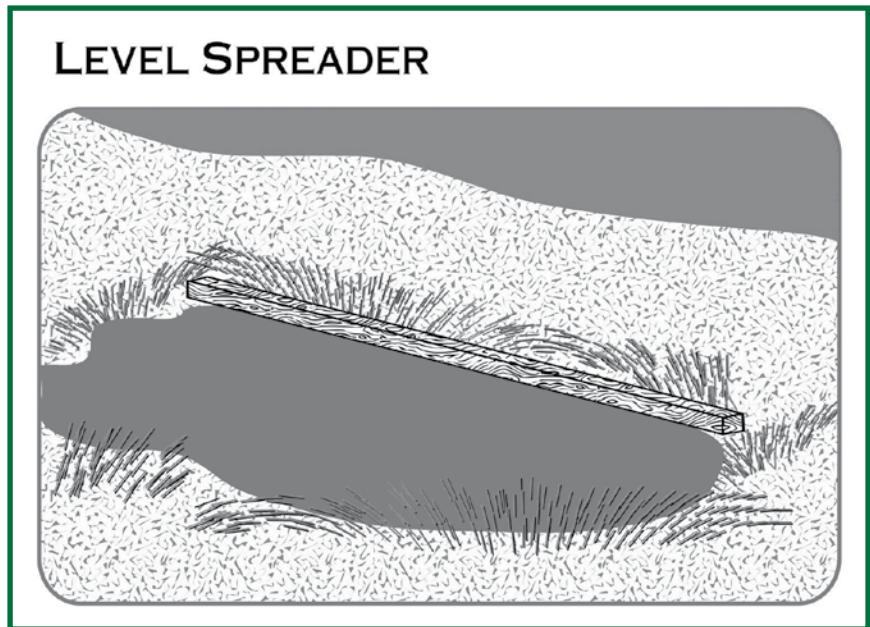
An outlet for drainage structures and diversions consisting of an excavated depression constructed at zero grade across a slope.

Purpose

To convert concentrated runoff to sheet flow and release it uniformly onto areas stabilized by existing vegetation.

Conditions Where Practice Applies

- ◆ Where there is a need to divert stormwater away from disturbed areas, such as log truck haul roads, log decks, skid trails, etc., to avoid overstressing erosion control measures, and where sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion.



This practice applies only in those situations where the spreader can be constructed on undisturbed soil and the area below the level lip is uniform with a slope of 10 percent or less and is stabilized by natural vegetation. The runoff water should not be allowed to re-concentrate after release.

Planning Considerations

Diversions installed in haul roads and skid trails should have stable outlets for concentrated stormwater flows. The level spreader is a relatively low-cost structure designed to release small volumes of concentrated flow where site conditions are suitable and there is a need to spread the runoff to prevent channeling.

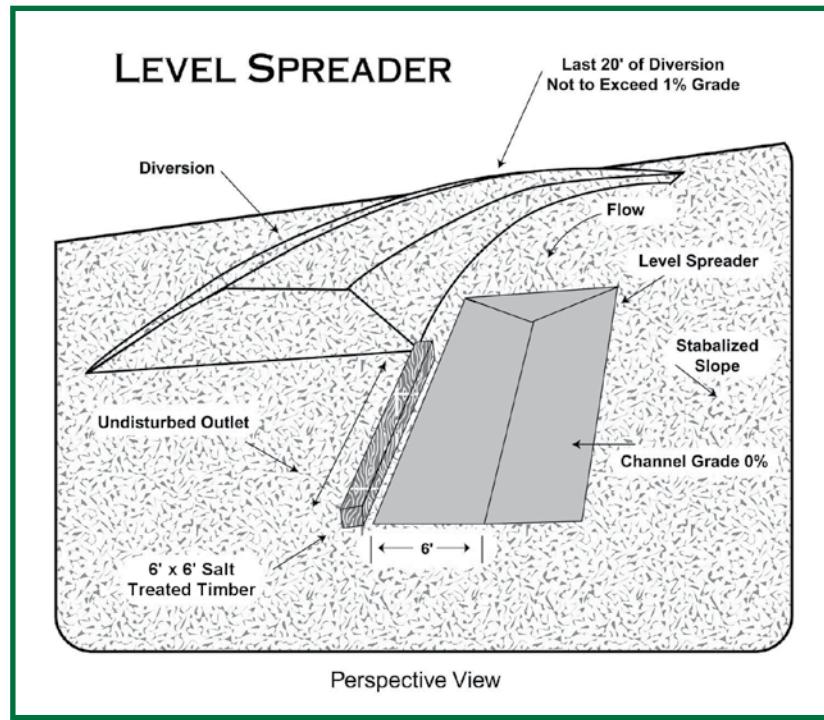
The outlet area must be uniform and well vegetated with slopes of 10 percent or less. Particular care must be taken to construct the outlet lip completely level in a stable, undisturbed soil. Any depressions in the lip will concentrate the flow, resulting in erosion.

Recommended Construction Specifications

- ◆ Level spreader should be constructed on undisturbed soil (not fill material).
- ◆ The entrance to the spreader should be shaped in such a manner as to ensure that runoff enters directly onto the zero percent channel.

A | Appendix A – BMP Specifications

- ◆ Construct a 20-foot transition section from the diversion channel to blend smoothly to the width and depth of the level spreader.
- ◆ The level lip should be constructed at zero percent grade to ensure uniform spreading of storm water runoff.
- ◆ Protective covering for vegetated lip should be a minimum of four feet wide and extending six inches deep in a vertical trench on the lower edge. The upper edge should butt against smoothly cut sod and be held securely in place with closely spaced heavy-duty wire staples.
- ◆ Rigid level lip should be entrenched at least two inches below existing ground and be securely anchored to prevent displacement. An apron of VDOT #1, #2 or #3 Coarse Aggregate should be placed on top of level lip and be extended down slope at least three feet. Place filter fabric under stone and use galvanized wire mesh to hold stone securely in place.
- ◆ The released runoff must outlet onto undisturbed stabilized areas with slope not exceeding 10 percent. Slope must be sufficiently smooth to preserve sheet flow and prevent flow from concentrating.
- ◆ Immediately after its construction, appropriately seed and mulch the entire disturbed area of the spreader.



Maintenance

The measure should be inspected after every rainfall and repairs made, if required. Level spreader lip must remain at zero percent slope to allow proper function of measure. The operator should avoid the placement of any material on the structure and prevent logging traffic across the structure. If the measure is damaged by logging traffic, it should be repaired immediately.

11 – Temporary Sediment Trap

Definition

A temporary ponding area formed by constructing an earthen embankment with a stone outlet.

Purpose

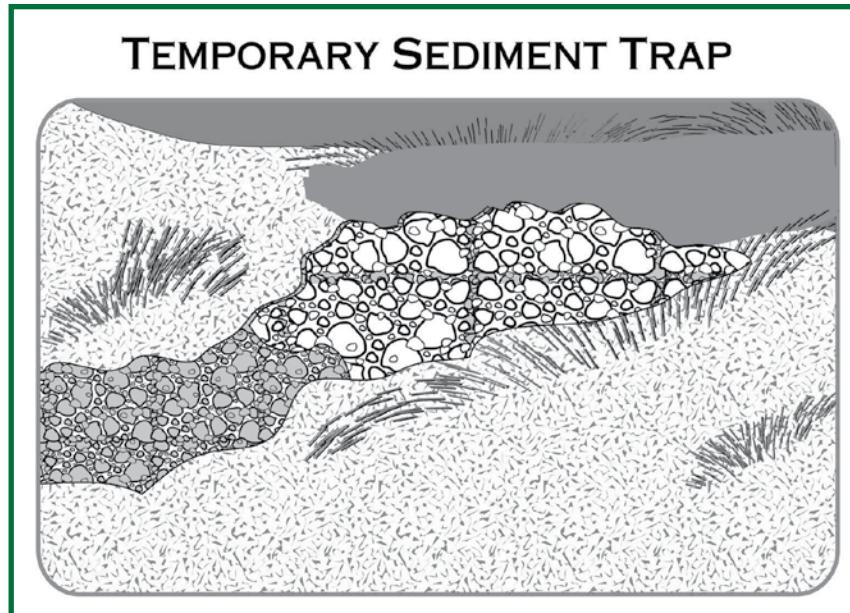
To detain sediment-laden runoff from small disturbed areas long enough to allow the majority of the sediment to settle out.

Conditions Where Practice Applies

- ◆ Below disturbed areas where the total contributing drainage area is less than three acres.
- ◆ Where the sediment trap will be used not longer than 18 months (the maximum useful life is 18 months).
- ◆ The sediment trap may be constructed either independently or in conjunction with a temporary diversion dike.

Rarely is the Temporary Sediment Trap used or needed in silvicultural operations. Proper pre-harvest planning will, in most cases, eliminate the need for such structures. Changing land use from silvicultural to development, for example, may require installation of such control structures if grading or stumping is performed during harvest. A soil disturbance permit may be required and can be obtained from the county or city when certain soil-disturbing activities take place. It is most cost efficient and environmentally correct to plan temporary and permanent stabilization to suit the intended land use.

Sediment traps should be constructed as a first step in any land clearing activity expected to be 10,000 square feet contiguous or more (e.g., log decks, haul roads or skid trails that cannot be properly drained and filtered otherwise). Sediment traps should be made functional before upslope land disturbance takes place.



A | Appendix A – BMP Specifications

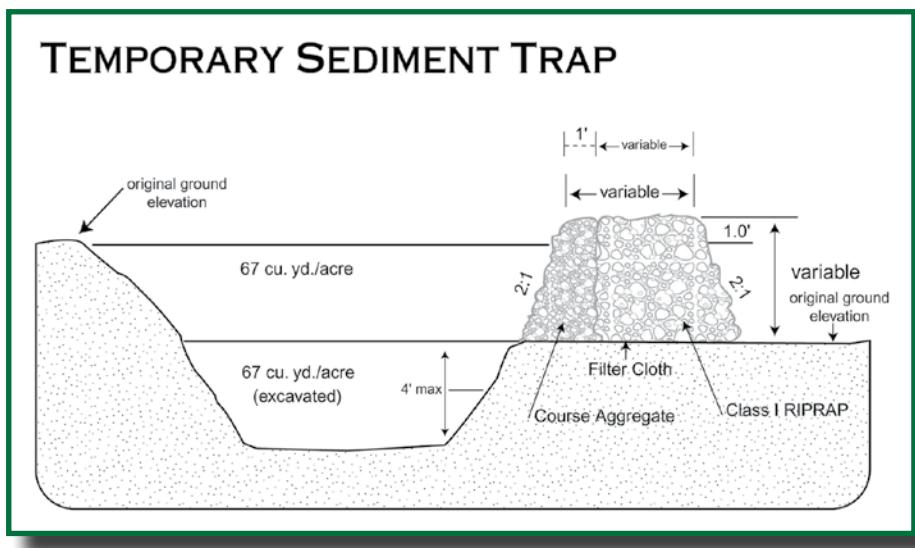
A properly constructed sediment trap will remove 60 percent or more of the sediment during large storm events. To achieve this rate, the sediment trap must have adequate storage volume. There are both a “wet” storage volume and a draw down or “dry” storage volume that help to enhance sediment fall-out and prevent excessive sediment losses during large storm events that occur during advanced stages of land disturbance.

In most cases, excavation will be required to attain the necessary storage volume. Sediment must be periodically removed from the trap to maintain the required volume. Plan to properly dispose of and stabilize excavated sediment.

There are a number of acceptable ways to design many of the BMP structures, and this is true in the case of the sediment trap. However, variations in design should be considered by an engineer to ensure that the minimum storage requirements and structural integrity noted in this specification are maintained.

Trap Capacity

The sediment trap must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which should be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half should be in the form of a draw down or dry storage that will provide extended settling time during less frequent, larger storm events. The volume of the wet storage should be measured from the low point of the excavated area to the base of the stone outlet structure. The volume of the dry storage should be measured from the base of the stone outlet to the crest of the stone outlet (overflow mechanism). Sediment should be removed from the basin when the volume of the wet storage is reduced by one-half. Calculation of the sediment trap should be done by a forest engineer or civil engineer.



12 – Rock Check Dams

Definition

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

Purpose

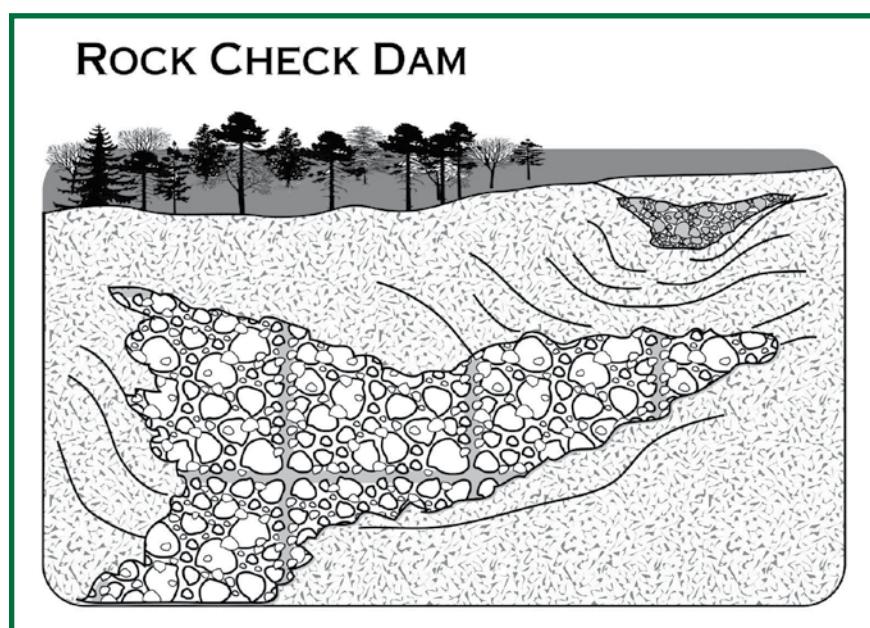
To reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. This practice also traps sediment generated from adjacent areas or from the ditch itself, primarily by ponding of the stormwater runoff. Field experience has shown it to perform more effectively than silt fences or straw bales in the effort to stabilize “wet-weather” ditches.

Conditions Where Practice Applies

- ◆ Alongside haul roads and other areas where ditches are the method of drainage, and in the bottom of hollows or swales where skidding has occurred (skidding is not recommended in these areas) and a temporary solution is needed until permanent vegetation can be established. This practice, using a combination of stone sizes, is limited to use in small open channels that drain 10 acres or less. It should not be used in a live stream as the objective should be to protect the live watercourse.
- ◆ Temporary ditches or swales that, because of their short length of service, cannot receive a non-erodible lining but still need protection to reduce erosion.
- ◆ Permanent ditches or swales that, for some reason, cannot receive a permanent non-erodible lining for an extended period of time.
- ◆ Either temporary or permanent ditches or swales that need protection during the establishment of vegetation.
- ◆ An aid in sediment trapping strategy for silvicultural operations.



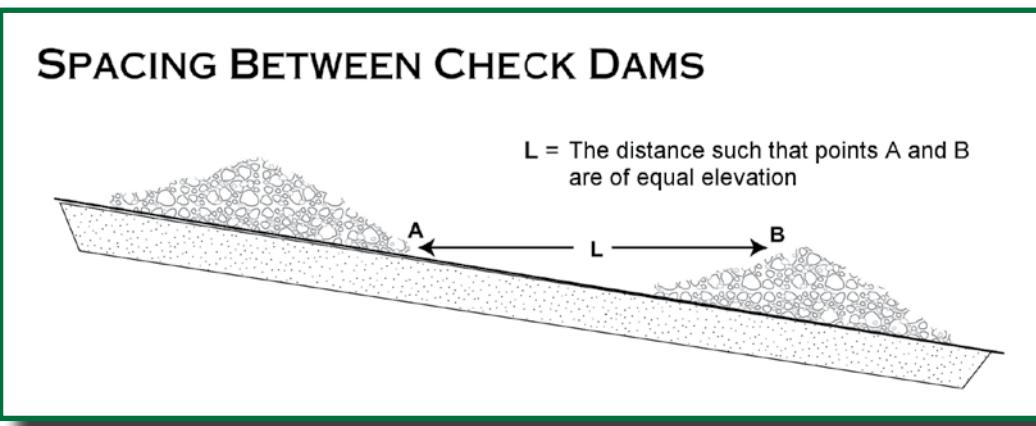
Photo courtesy of Missouri Department of Transportation



Planning Considerations

Check dams are effective in reducing flow velocity and, thereby, the potential for channel erosion. It is preferable to establish a protective vegetative cover lining or to install a structural channel lining than to install check dams in log haul road ditches, swales, etc. However, under circumstances where this is not feasible, check dams are useful.

As previously mentioned, rock dams have been found to be an effective aid in trapping sediment particles by virtue of the ability to pond runoff. Other measures may be required in addition to rock dams to more completely filter sediment in ditches and swales.



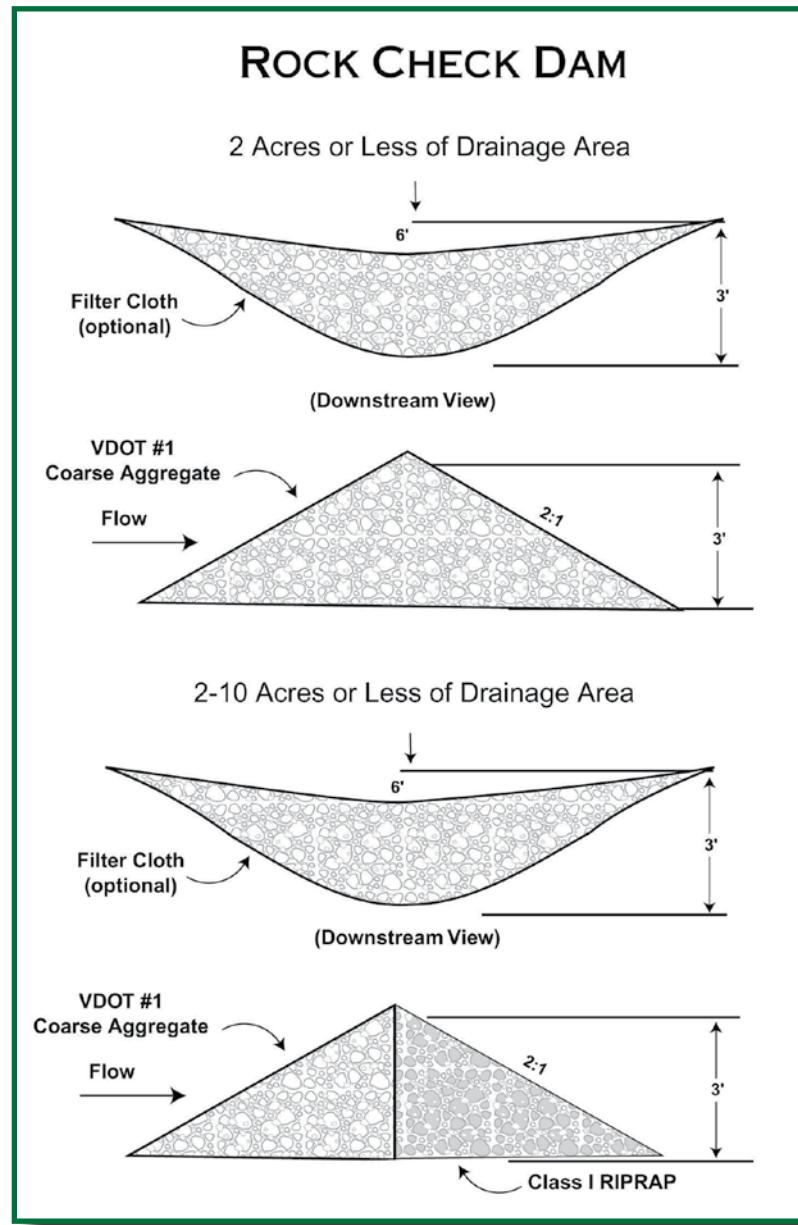
Recommended Specifications

- ◆ The drainage area of the ditch or swale being protected should not exceed two acres when VDOT #1 Coarse Aggregate is used alone and should not exceed 10 acres when a combination of Class I Rip-rap (added for stability) and VDOT #1 Coarse Aggregate is used. An effort should be made to extend the stone to the top of channels banks.
- ◆ The maximum height of the dam should not exceed three feet.
- ◆ The center of the dam should be at least six inches lower than the outer edges to promote a “weir” effect. If not constructed in such a manner, stormwater flows are then forced to the stone-soil interface, thereby promoting scour at that point and subsequent failure of the structure to perform its intended function.
- ◆ For added stability, the base of the check dam should be keyed into the soil approximately six inches.
- ◆ The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

- Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Filter cloth may be placed under the stone to provide a stable foundation and to facilitate the removal of the stone.

Maintenance

Check dams should be inspected for sediment accumulation after each runoff-producing storm event. Sediment should be removed from behind the check dams when it has accumulated to one-half of the original height of the dam.



13 – Mulching

Definition

Application of plant residues or other suitable materials to the soil surface.



Purpose

To prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow.

To foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

Conditions Where Practice Applies

- ◆ Areas that have been permanently seeded may require mulching to enhance seedling germination.
- ◆ Areas that cannot be seeded because of the season may be mulched to provide some protection to the soil surface. An organic mulch should be used and the areas then seeded as soon as weather or seasonal conditions permit. In most cases, the area should be seeded immediately so that if desirable seasonal conditions occur, vegetation is established at the earliest date.
- ◆ Mulching may be used in conjunction with temporary seeding operations.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land.

Mulches can increase the infiltration rate of the soil; reduce soil moisture loss by evaporation; prevent crusting and sealing of the soil surface; modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark and fiber mulch, have been found to be the most effective.

Chemical soil stabilizers or soil binders should not be used alone for mulch. These materials are useful to bind organic mulches together to prevent displacement.

A variety of manufactured soil stabilization blankets and matting have been developed for erosion control. Some of these products can be used as mulches, particularly in critical areas, such as waterways. They may also be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, the season and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures.

Organic Mulches

Straw – The mulch most commonly used in conjunction with seeding. The straw may come from wheat, oats, barley, etc., and may be spread by hand or machine. Straw can be windblown and should be anchored down by lightly scattering brush over the straw, or by other acceptable methods.

Hay – May be used in lieu of straw and may be spread by hand or machine. Hay can be windblown and may need anchoring or tacking down.

Corn Stalks – These should be shredded into four- to six-inch lengths. Stalks decompose slowly and are resistant to displacement.

Wood Chips, Bark Chips, Shredded Bark chipping trash – Decompose slowly and do not require anchoring. Chips must be treated with 12 pounds of nitrogen per ton to prevent nutrient deficiency in plants and should not be used on stream banks where there is a chance woody debris and logging slash can enter the stream channel during storm events. Logging slash is better used as filters at outlets of drainage structures, brush barriers, etc. Green wood chips, bark, logging slash, etc., can be used in combination with straw or hay mulches, but used alone it is not the best mulch to promote perennial vegetation.

Fiber Mulch – Used in hydroseeding operations and applied as part of the slurry. It creates the best seed-soil contact when applied over (as a separate operation) newly seeded areas. This form of mulch does not provide sufficient protection to highly erodible soils. Fiber mulch is not considered adequate mulch when used during the dry summer months or when used for late fall mulch cover. Use straw or old hay mulch during these periods. Fiber mulch may be used to tack (anchor) straw or hay mulch. This treatment is well suited for steep slopes, critical areas and areas susceptible to displacement.

Chemical Mulches and Soil Binders

A wide range of synthetic, spray-on materials are marketed to stabilize and protect the soil surface. These are emulsions or dispersions of vinyl compounds, rubber or other substances that are mixed with water and applied to the soil. They may be used alone in some cases as a temporary stabilizer, or in conjunction with fiber mulches or straw.

When used alone, chemical mulches do not have the ability of organic mulches to insulate the soil or retain soil moisture. This soil protection is also easily damaged by traffic. Application of these mulches is usually more expensive than organic mulching and the mulches decompose in 60 to 90 days. A composted or air-dried organic mulch is preferred when available.

Blankets and Matting

Field experience has shown that plastic netting, when used alone, does not retain soil moisture or modify soil temperature. In some cases, it may stabilize the soil surface while grasses are being established, but is primarily used in waterways and on slopes to hold straw, hay or similar mulch in place.

Jute mesh and other soil stabilization blankets are good choices for mulching on difficult slopes and in minor drainage swales. Many of the soil stabilization matting (used to create a permanent matrix for root growth within the soil) must receive mulching to properly stabilize an area. Notably, permanent matting is available that includes self-contained, temporary mulching materials; however, these measures should meet the recommendations noted in Appendix A: Specification 14 Soil Stabilization Blankets and Matting, before being used on steep slopes and in channel flow situations. (See “14 – Soil Stabilization Blankets and Matting” on page 124.)

The most critical aspect of installing blankets and mats is to obtain firm, continuous contact between the material and the soil. Without such contact, the material may fail and thereby allow erosion to occur. It is important to use an adequate number of staples and make sure the material is installed properly to maximize soil protection. These are discussed in more detail in Appendix A: Specification 14 Soil Stabilization Blankets and Mats. (See “14 – Soil Stabilization Blankets and Matting” on page 124.)

Recommended Specifications

Organic mulches may be used in any area where mulch is required.

Materials – Select mulch material based on site requirements, availability of materials and availability of labor and equipment. Other materials, such as peanut hulls and cotton burs, may be used as a mulch. Many of the organic mulches may require the addition of Nitrogen (N) to replace Nitrogen removed from soils in the process of decomposition of the mulch, which is in addition to soil requirements before mulch is added. Mulches, such as bark mulch, may deter germination and growth of vegetation, which in extreme cases may require the removal of bark mulch to be replaced by a more compatible mulch.

Prior to Mulching – Complete required grading and install temporary erosion control structures and other BMPs as needed.

Lime and fertilizer should be incorporated and surface roughening accomplished as needed. Seed should be applied prior to mulching, except in the following cases:

- ◆ Where seed is to be applied as part of a hydroseeder slurry containing fiber mulch, or
- ◆ Where seed is to be applied following a straw mulch spread during winter months.

Application – Mulch materials should be spread uniformly, by hand or machine.

When spreading straw or hay mulch by hand, divide the area to be mulched into approximately 1,000 sq. ft. sections and place 100 to 200 lbs. (two to four bales) of straw or hay in each section to facilitate uniform distribution.

Mulch Anchoring – Straw and hay mulch may need anchoring immediately after spreading to prevent displacement. Hay is less likely to be displaced than straw. The following methods of anchoring straw or hay may be used:

1. **Brush** – Cut brush and, in some cases, hay mulch, may be scattered thinly over straw to prevent displacement. The brush should be single branched (butt of branch no larger than 1.5 inches) and only enough applied to hold mulch in place.
2. **Mulch Anchoring Tool** (often referred to as a Krimper or Krimper tool) – This is a tractor-drawn implement designed to punch mulch into the soil surface. This method provides good erosion control with straw. It is limited to use on slopes no steeper than 3:1, where equipment can operate safely. Machinery should be operated on the contour.
3. **Fiber Mulch** – A very common practice with widespread use. Apply fiber mulch by means of a hydroseeder at a rate of 500 lbs. to 750 lbs./acre on top of straw mulch or hay. It has an added benefit of providing additional mulch to the newly seeded area.
4. **Liquid Mulch Binders** – Application of liquid mulch binders and tackifiers should be heaviest at edges of areas and at crests of ridges and banks to prevent displacement. The remainder of the area should have binder applied uniformly. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil. There are several suitable binders available. Seek recommendations from a forest engineer.
5. **Mulch Netting** – Lightweight plastic, cotton or paper nets may be stapled over the mulch according to manufacturer's recommendations.
6. **Peg and Twine** – Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8- to 10-inch wooden pegs to within three inches of the soil surface, every four feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross within a square pattern. Turn twine two or more times around each peg.

Maintenance

All mulches and soil coverings should be inspected periodically (particularly after rainstorms) to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied. Nets and mats should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, re-install netting or matting as necessary after repairing damage to the slope or ditch. Inspections should take place up until vegetation is firmly established.

14 – Soil Stabilization Blankets and Matting

Definition

The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of a steep slope or channel.



Purpose

To aid in controlling erosion on critical areas by providing a microclimate that protects young vegetation and promotes its establishment. Some types of soil stabilization mats are also used to raise the maximum permissible velocity of vegetated channels by reinforcing the vegetated channel to resist the forces of erosion during storm events.

Conditions Where Practice Applies

- ◆ On short, steep slopes, such as cut and fill slopes, and in side ditches on haul roads and skid trails, where erosion hazard is high and planting is likely to be slow in providing adequate protective cover.
- ◆ In vegetated channels where the velocity of flow exceeds recommended velocity for other applications.
- ◆ On streambanks or other areas where moving water is likely to wash out or destroy germinating and juvenile vegetation.
- ◆ In areas where wind may prevent standard mulching practices from remaining in place until vegetation becomes established.

Planning Considerations

Soil stabilization blankets and mats can be applied to problem areas to supplement nature's erosion control system (vegetation) in its initial establishment and in providing a safe and "natural" conveyance for high-velocity stormwater runoff.

Installation Recommendations

Site Preparation – After site has been shaped and graded, prepare a friable seedbed relatively free of clods and rocks more than one inch in diameter and any foreign material that will prevent uniform contact of the protective covering with the soil surface. If necessary, redirect any runoff away from the ditch or slope during installation.

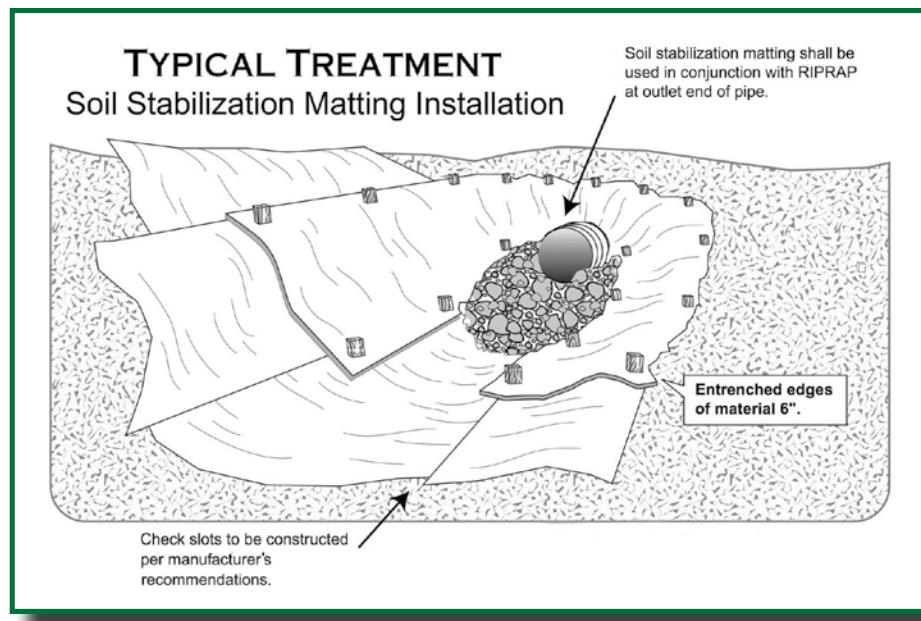
Seeding – Lime, fertilize and seed as appropriate for site conditions. When using jute mesh on a seeded area, apply approximately one-half the seed after laying the mat.

When open weave nets are used, lime, fertilizer, seed and mulch should be applied before laying the net. When using a combination blanket, such as an excelsior blanket, seed and soil amendments should be applied before the blanket is laid. In some treatments, mulching is applied after installation of treatment, depending on volume and velocity of flow expected in channel treated.

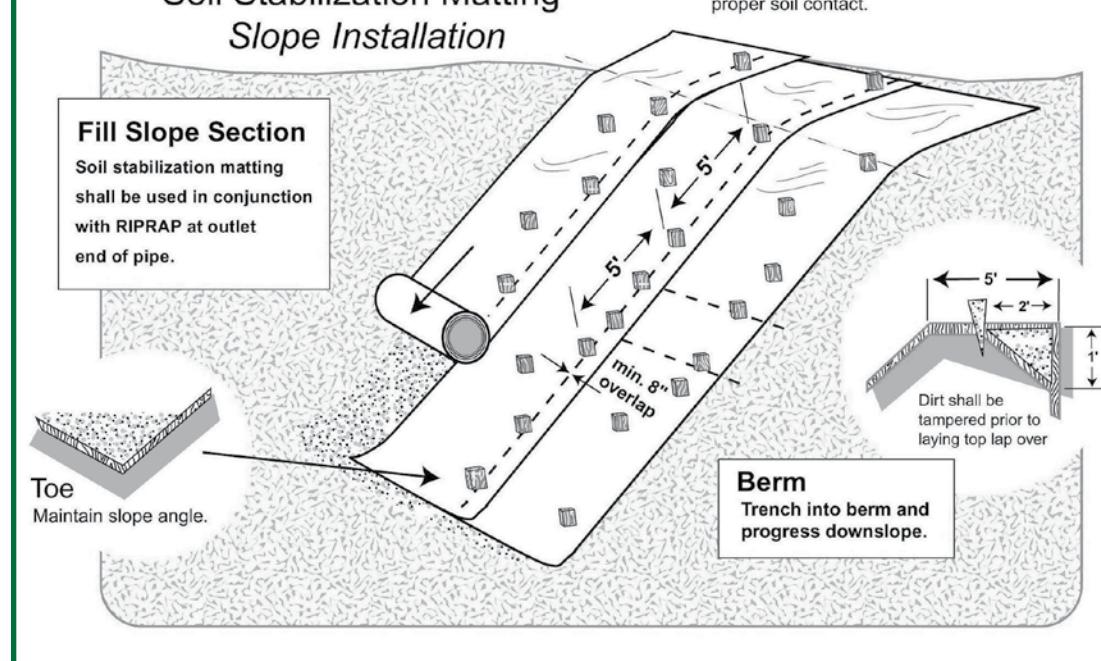
When installing blankets and mats, it is important to follow the manufacturer's recommendations for laying and anchoring, orientation on slope, overlap, etc. A forest engineer can assist with recommendations for the proper treatment, application and installation.

Maintenance

All soil stabilization blankets and matting should be inspected periodically following installation, particularly after rainstorms, to check for erosion and undermining. Any dislocation or failure should be repaired immediately. If washouts or breakage occurs, re-install the material after repairing damage to the slope or ditch. Continue to monitor these areas until they become permanently stabilized.



TYPICAL TREATMENT Soil Stabilization Matting Slope Installation



15 – Straw Bale Barrier

Definition

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



Purposes

To intercept and detain small amounts of sediment from disturbed areas of limited extent to prevent sediment from leaving the logging site and/or entering stream channels.

To decrease the velocity of sheet flows.

Conditions Where Practice Applies

- ◆ Below disturbed areas subject to sheet and rill erosion, such as haul roads, log decks and skid trails.
- ◆ Where the size of the drainage area is no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet, and the maximum slope gradient behind the barrier is 50 percent (2:1).
- ◆ Where effectiveness is required for less than three months.
- ◆ Straw bale barriers should not be constructed in live streams.
- ◆ This measure should not be used where water may concentrate in defined ditches.

Straw bale barriers should *not* be used on areas where rock or another hard surface prevents the full and uniform anchoring of the barrier.

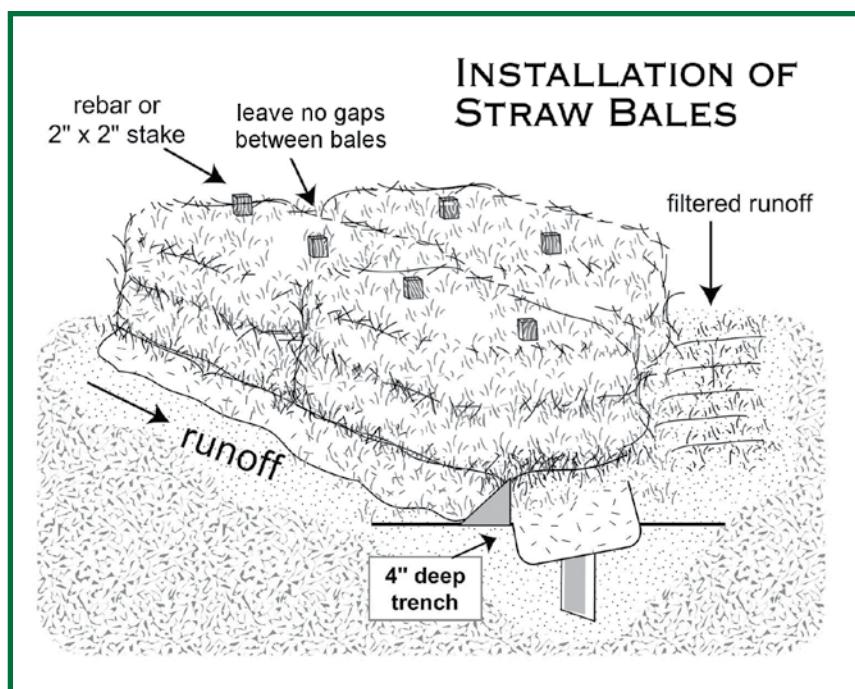
Straw bale barriers are poor filters of sediment if not properly installed and maintained. In cases where the barrier is not properly installed and maintained, the measure can create additional problems.

Locate the straw bale barrier at least five to seven feet from the base of disturbed slopes with grades greater than seven percent.

Recommended Installation

1. Bales should be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.
2. All bales should be wire-bound or string-tied. Straw bales should be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent deterioration of the bindings.

3. The barrier should be entrenched and backfilled. A trench should be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging), the excavated soil should be backfilled against the barrier. Backfill soil should conform to the ground level on the downhill side and should be built up to four inches against the uphill side of the barrier.



4. Each bale should be securely anchored by at least two stakes (minimum dimensions two inches x two inches x 36 inches) or standard "T" or "U" steel posts (minimum weight of 1.33 pounds per linear foot) driven through the bale. The first stake or steel post in each bale should be driven toward the previously laid bale to force the bales together. Stakes or steel pickets should be driven a minimum 18 inches into the ground to securely anchor the bales.
5. The gaps between bales should be chinked with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Inspection should be frequent, and repair or replacement should be made promptly as needed.

Straw bale barriers should be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized.

Straw bale barriers should be inspected immediately after each rainfall and at least daily during prolonged rainfall.

Close attention should be paid to the repair of damaged bales, end runs and undercutting beneath bales.

Sediment deposits must be removed when the level of deposition reaches approximately one-half the height of the barrier.

Any sediment deposits remaining in place after the straw bale barrier is no longer required should be dressed to conform to the existing grade, prepared and seeded.

16 – Silt Fence

Definition

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



Purposes

To intercept and detain small amounts of sediment from disturbed areas during logging operations to prevent sediment from leaving the site. To decrease the velocity of sheet flows and low-to-moderate level channel flows.

Conditions Where Practice Applies

- ◆ Below disturbed areas where erosion would occur in the form of sheet and rill erosion.
- ◆ Where the size of the drainage area is no more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet, and the maximum gradient behind the barrier is 50 percent (2:1).
- ◆ In minor swales or ditch lines where maximum contributing drainage area is no greater than one acre and flow is no greater than one cubic foot per second.
- ◆ Silt fence should not be used in areas where rock or other hard surfaces prevent the full and uniform depth anchoring of the barrier.

Silt fence will trap a much higher percentage of suspended sediments than straw bales because the silt fence passes the sediment-laden water more slowly. Silt fences are preferable to straw barriers in many cases because of their durability and potential cost savings. While the failure rate of silt fences is lower than that of straw barriers, improperly installed silt fences invite failure and sediment loss. The installation methods outlined here can improve performance and reduce failures.

As noted, flow rate through silt fence is significantly lower than the flow rate for straw bale barriers. This creates more ponding and, therefore, more time for sediment to fall out. Both woven and non-woven synthetic fabrics are available commercially. The woven fabrics generally display higher strength than the non-woven fabrics and, in most cases, do not require any additional reinforcement. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength, while the reactions of non-woven fabrics to these conditions are variable. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type. While all the fabrics demonstrate very high filtering efficiencies for sandy sediments, there is considerable variation among both woven and non-woven fabrics when filtering the finer silt and clay particles.

1. As with straw bale barriers, an effort should be made to locate silt fences at least five to seven feet beyond the base of disturbed slopes with grades greater than seven percent.

2. The use of silt fences, because they have such a low permeability, is limited to situations in which only sheet flow or overland flows are expected and where concentrated flows originate from drainage areas of one acre or less.
3. Field experience has demonstrated that silt fences are often installed too short (less than 16 inches above ground elevation). The short fences are subject to breaching during even small storm events and will require maintenance “clean outs” more often. Properly supported silt fences that stand 24 to 34 inches above the existing grade tend to promote more effective sediment control.

Materials

1. Synthetic filter fabric should be a pervious sheet of propylene, nylon, polyester or ethylene yarn and should be certified by the manufacturer or supplier.
2. Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of zero degrees to 120°F.
3. If wooden stakes are used for silt fence construction, they should have a diameter of two inches when oak is used and four inches when pine is used. Wooden stakes should have a minimum length of five feet. Some silt fences come with preinstalled stakes that meet the manufacturer’s standards; these are adequate for forestry uses.

If steel posts (standard “U” or “T” section) are used for silt fence construction, they must have a minimum weight of 1.33 pounds per linear foot and should have a minimum length of five feet.

Wire fence reinforcement for silt fences using standard-strength filter cloth should be a minimum of 14 gauge and should have a maximum mesh spacing of six inches.

The height of a silt fence should be a minimum of 16 inches above the original ground surface and should not exceed 34 inches above ground elevation. The filter fabric should be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter cloth should be spliced together only at a support post, with a minimum six-inch overlap, and be sealed securely.

A trench should be excavated approximately four inches wide and four inches deep on the upslope side of the proposed location of the silt fence.

When wire support is used, standard-strength filter cloth may be used. Posts for this type of installation should be placed a maximum of 10 feet apart. The wire mesh fence should be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tie wires or hog rings. The wire should extend into the trench a minimum of two inches and should not extend more than 34 inches above the original ground surface. The standard-strength fabric should be stapled or wired to the wire fence, and eight inches of the fabric should be extended into the trench. The fabric should not be stapled to existing trees.

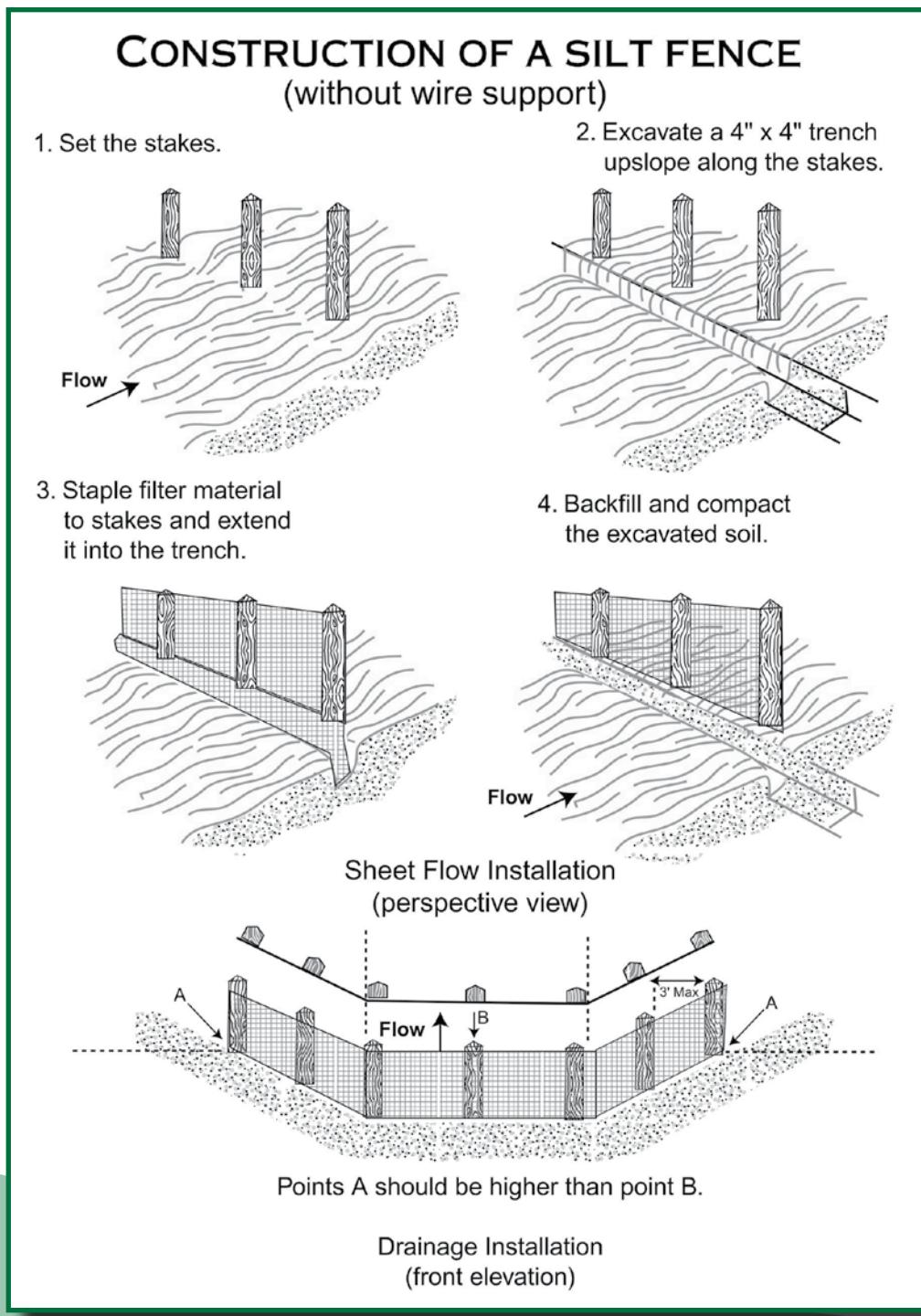
When wire support is not used, extra-strength filter cloth should be used. Posts for this type of fabric should be placed a maximum of six feet apart. The filter fabric should be fastened securely to the upslope side of the posts using one-inch-long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric should be extended into the trench. The fabric should not be stapled to trees.

If a silt fence is to be constructed across a ditch line or swale, the measure should be of sufficient length to eliminate endflow, and the plan configuration should resemble an arc or horseshoe with the

ends oriented upslope. Extra-strength filter fabric with a maximum three-foot spacing of posts should be used for this application.

The four-inch by four-inch trench should be backfilled and the soil compacted over the filter fabric.

Silt fences should be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.



Silt fence should be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs should be made immediately.

Close attention should be paid to the repair of silt fence damaged by end runs and undercutting.

Should the fabric on a silt fence decompose or become ineffective prior to the end or the expected usable life and the barrier still be necessary, the fabric should be replaced promptly.

Sediment deposits should be removed after each storm event. They should be removed when deposits reach approximately one-half the height of the barrier.

Any sediment deposits remaining in place after the silt fence is no longer required should be graded to conform with the existing road grade, prepared and seeded.



17 – Brush Barriers

Definition

A temporary sediment barrier constructed at the perimeter of a disturbed area, such as log decks within the SMZ or skid trails in the bottoms of swales.

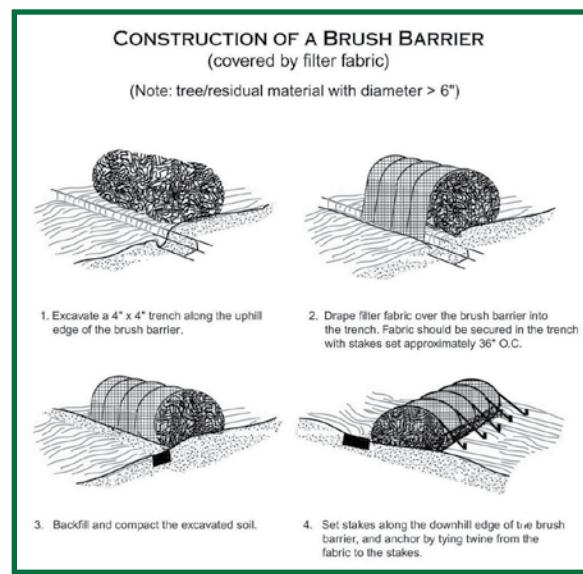


Purpose

To intercept and retain sediment from disturbed areas of limited extent, preventing sediment from leaving the site.

Conditions Where Practice Applies

- ◆ Below disturbed areas subject to sheet and rill erosion, where enough residue material is available for construction of such a barrier.
- ◆ Where the size of the drainage area is no greater than $\frac{1}{4}$ of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet, and the maximum slope gradient behind the barrier is 50 percent (2:1).



Planning Considerations

Slash from the logging operation and organic litter, spoil material and woody debris from clearing logging decks and haul roads are usually piled nearby. Much of this material can be used effectively on the site. During the logging operation, equipment can push and pile the mixture of limbs, small vegetation and root mat into windrows along the toe of a slope where erosion and accelerated runoff are expected. Because brush barriers are fairly stable and composed of natural materials, maintenance requirements are small. Field experience has shown, however, that many brush barrier installations are not effective when there are large voids created by the use of material that is too large to provide a compact, dense barrier. It is necessary to use residual material less than six inches in diameter that will create a more uniform barrier, or use a filter fabric overlay to promote enhanced filtration of sediment-laden runoff.

Recommended Construction Specifications

Without Filter Cloth

- ◆ The height of a brush barrier should be a minimum of three feet.
- ◆ The width of a brush barrier should be a minimum of five feet at its base. The sizes of brush barriers may vary considerably based upon the amount of material available and the judgment of the operator.
- ◆ The barrier should be constructed by piling brush, stone, root mat and other material from the logging process into a mounded row on the contour. Material larger than six inches in diameter should not be used to create the mound as the non-homogeneity of the mixture can lead to voids where sediment-laden flows can easily pass.

If a Filter is Used

- ◆ The filter fabric should be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. Where joints are necessary, the fabric should be spliced together with a minimum six-inch overlap and sealed securely.
- ◆ A trench six inches wide and four inches deep should be excavated along the length of the barrier and immediately uphill from the barrier.
- ◆ The lengths of filter fabric should be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other.
- ◆ The filter fabric should be secured in the trench with stakes set approximately 36 inches on center.
- ◆ The trench should be backfilled and the soil compacted over the filter fabric.
- ◆ Set stakes into the ground along the uphill edge of the brush barrier, and anchor the fabric by tying twine from the fabric to the stakes.
- ◆ Brush barriers should be inspected after each rainfall and necessary repairs should be made promptly. Sediment deposits should be removed when they reach approximately one-half the height of the barrier.

18 – Surface Roughening

Definition

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.



Purpose

- To aid in establishment of vegetative cover with seed.
- To reduce runoff velocity and increase infiltration.
- To reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies

- ◆ Haul roads, log decks, skid trails and other areas requiring cut and fill slopes.
- ◆ All slopes steeper than 3:1 should be surface roughened by stair-stepped grading, grooving, furrowing or tracking to stabilize with vegetation.
- ◆ Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loosened to a depth of two to six inches prior to seeding.
- ◆ Areas that have been graded and will not be stabilized immediately (within seven days) should be roughened to reduce runoff velocity until seeding takes place.
- ◆ Install on cut slopes and fill slopes of haul roads, log decks, skid trails, etc.
- ◆ Slopes with a stable rock face do not require roughening or stabilization.

Planning Considerations

It is difficult to establish vegetation on graded or fill areas with smooth, hard surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and small rocks left in place encourage water infiltration; speed the establishment of vegetation, and decrease runoff velocity.

Rough, loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates that generally provide a cooler and more favorable moisture level than hard, flat surfaces; this aids seed germination.

There are different methods of achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving and tracking. Factors to be considered in choosing a method are slope steepness; landowner desires regarding maintenance and future land use (mowing requirements, fire break, wildlife habitat, reforestation, etc.), and whether the slope is formed by cutting or filling.

A | Appendix A – BMP Specifications

1. Disturbed areas that will not require maintenance, such as mowing for wildlife habitat, may be stair-step graded, grooved or left rough after filling.
2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above and provides a level site where vegetation can become established.
3. Areas that will be mowed (these areas should have slopes less than 3:1) may have small furrows left by discing, harrowing, raking or seed planting machinery (such as seed drill or sod seeder) operated on the contour.
4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening because the soil surface is severely compacted and runoff is increased.

Recommended Specifications

Cut Slope Areas

Cut slopes with a gradient steeper than 3:1 should be stair-step graded or grooved.

1. Stair-step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

The ratio of the vertical cut distance to the horizontal distance should be less than 1:1 and the horizontal portion of the "step" should slope toward the vertical wall (in-sloped).

Individual vertical cuts should not be more than 30 inches on soft soil materials and not more than 40 inches in rocky materials.

2. Grooving is achieved by using machinery to create a series of ridges and depressions that run perpendicular to the slope (on the contour).

Grooves may be made with any appropriate implement that can be safely operated on the slope and that will not cause undue compaction. Suggested implements include discs, tillers, spring harrows and teeth on the front-end loader bucket. Such grooves should not be less than three inches deep nor farther apart than 15 inches.

Fill Slope Application

Fill slopes with a gradient steeper than 3:1 should be grooved or be allowed to remain rough as they are constructed. Method one or two below may be used.

1. Groove according to number two above.
2. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface.

Colluvial materials (soil deposits at the base of slopes or from old streambeds) should not be used in fills because they flow when saturated.

Slopes should not be bladed or scraped to produce a smooth, hard surface.

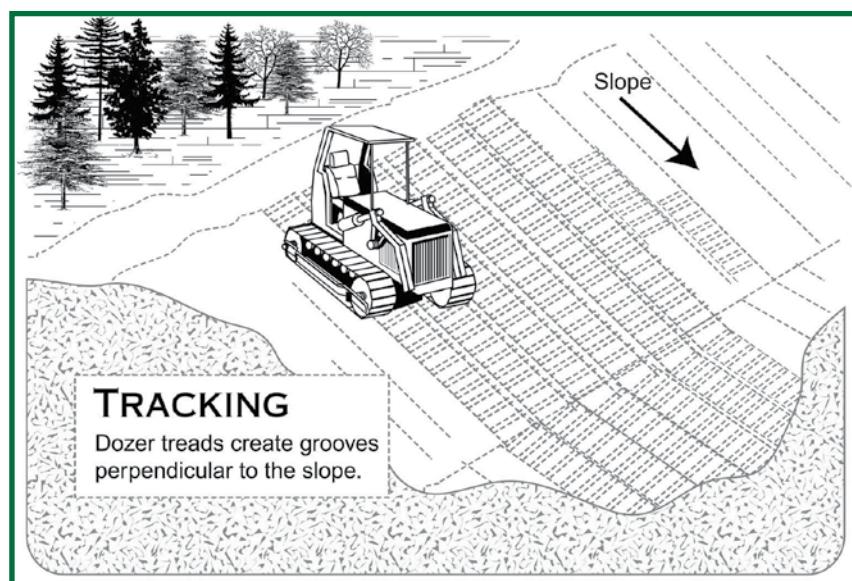
Mowed slopes (areas to be maintained as wildlife habitat, fire breaks, shoulders of access roads, etc.) should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned. These areas may be roughened with shallow grooves, such as remain after tilling, discing, harrowing, raking or after use of a cultipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than one inch deep and not farther than 12 inches apart. Fill slopes that are left rough as constructed may be smoothed with a dragline or pickchain to facilitate maintenance and/or mowing.

Roughening with Tracked Machinery – Roughening with tracked machinery on clay soils is not recommended. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely, and may be tracked. In no case is tracking as effective as the other roughening methods described.

When tracking is the chosen surface-roughening technique, it should be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes as possible of the machinery should be made to minimize compaction.

Seeding – Roughened areas should be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.



19 – Geotextile

Geotextile is a tough, nonwoven, porous 15-foot-wide roll of industrial polymer fabric. It is used to underlay gravel on soft sections of haul roads that are likely to rut excessively, and at logging road entrances where mud transfer to a public road may be a problem. The geotextile allows water on the road surface to flow through the gravel and fabric and into the ground but keeps the soil from working up through the fabric and into the gravel road surface as trafficking occurs. This dramatically reduces rutting and mud transfer and also decreases the amount of crushed rock necessary to keep the haul road serviceable.

Several types of geotextile are available in rolls ranging from 240 to 900 linear feet, depending on material composition and thickness. For maximum effectiveness, geotextile should be installed on critical haul road sections before trafficking begins or rutting occurs. Clear the road subgrade of any large stones or other sharp objects that could puncture the fabric, then carefully roll out the geotextile. Anchor it along the edges with rocks or soil, then dump a load of gravel along the leading edge and carefully spread it over the fabric with a bulldozer. Repeat this process until the geotextile is covered with the desired depth of gravel (typically four to six inches). Vehicles should not drive directly on the geotextile as the gravel is being spread.



Careful haul road planning, along with the proper use of geotextile to underlay crushed rock where appropriate; decreases haul road failure and equipment damage; eliminates problems with mud on public roads, and increases logging production and profitability.

20 – Geo Web® Improved Ford



Definition

A streambed modification to improve or “harden” a streambottom in a sandy-bottomed stream to provide support for logging trucks with minimal streambottom disturbance.

Purpose

To provide a permanent type of improved “ford” that will support the weight of a fully loaded logging truck without restriction of stream flow.

Conditions Where Practice Applies

- ◆ On stream crossings where the drainage area above the crossing is less than five square miles and where a design plan has been submitted to the Virginia Department of Forestry and has been approved by the Water Resources Team. This type of crossing is to provide a hardened stream bottom for a permanently improved ford in streams that are sandy or in silt bottomed streams.

Planning Considerations

Where a ford is to be considered as the least intrusive type of crossing to the stream with regard to the stream’s stability. It should be considered an option when a bridge or culvert installation has been ruled out due to culvert sizes or bridge spans being too great to allow for economical and safe transport. The approaches to the ford should be stabilized by the installation of geotextile road fabric cover with six inches of VDOT #3 gravel.

Geo Web® is a polymer fabric eight feet wide that is designed in a honeycomb pattern of depths of four, six and eight inches. For load support options, only the six-inch and eight-inch material should be considered. When the fabric is pulled out, the formation of “cells” becomes evident. The Geo Web® should have an underlayment of geotextile road cloth to support the crushed gravel that will be backfilled into each cell, thus providing the support for the truck traffic. The greater the depth of the cell, the more load capacity the installation can handle. The stream should be crossed at a right angle to the stream flow.

Construction Recommendations

The streambed should be excavated to the depth of the Geo Web® being used. It is recommended for tractor and trailer traffic that a six-inch or eight-inch Geo Web® be used. The streambed should be lined with geotextile road fabric to the width of the desired ford. The geotextile should be installed at least 50 feet on either side of the ford on the ford approaches.

The Geo Web® fabric should be stretched across the stream bottom and backfilled with VDOT #5 crushed gravel or limestone. The depth of the installation should not exceed the depth of the original streambottom, and no restriction of stream flow should occur.

Geo Web® of at least six inches in depth may be considered on stream approaches of 50 feet on either side of the ford if a soft soil condition exists. This will ensure stability of the approaches. All bare soil areas should be graded and vegetated according to specifications in Appendix D. (See “APPENDIX D” on page 151.)

Maintenance

The crossing should be checked periodically for maintenance and gravel added if necessary. The approaches to the crossing should be maintained with clean stone to prevent the tracking of sediment on truck tires into the stream channel. The crossing should not be used during periods of extremely high water (conditions where bankfull flow is reached). Safety considerations should be of paramount importance.

21 – Logging Entrance

Definition

The entrance from the state highway onto the haul road that accesses the harvesting operation.

Purpose

To allow for the ingress and egress of logging trucks in a safe and efficient manner.

Conditions Where Practice Applies

- ◆ On all haul road entrances where they intersect with a state highway.



Planning Considerations

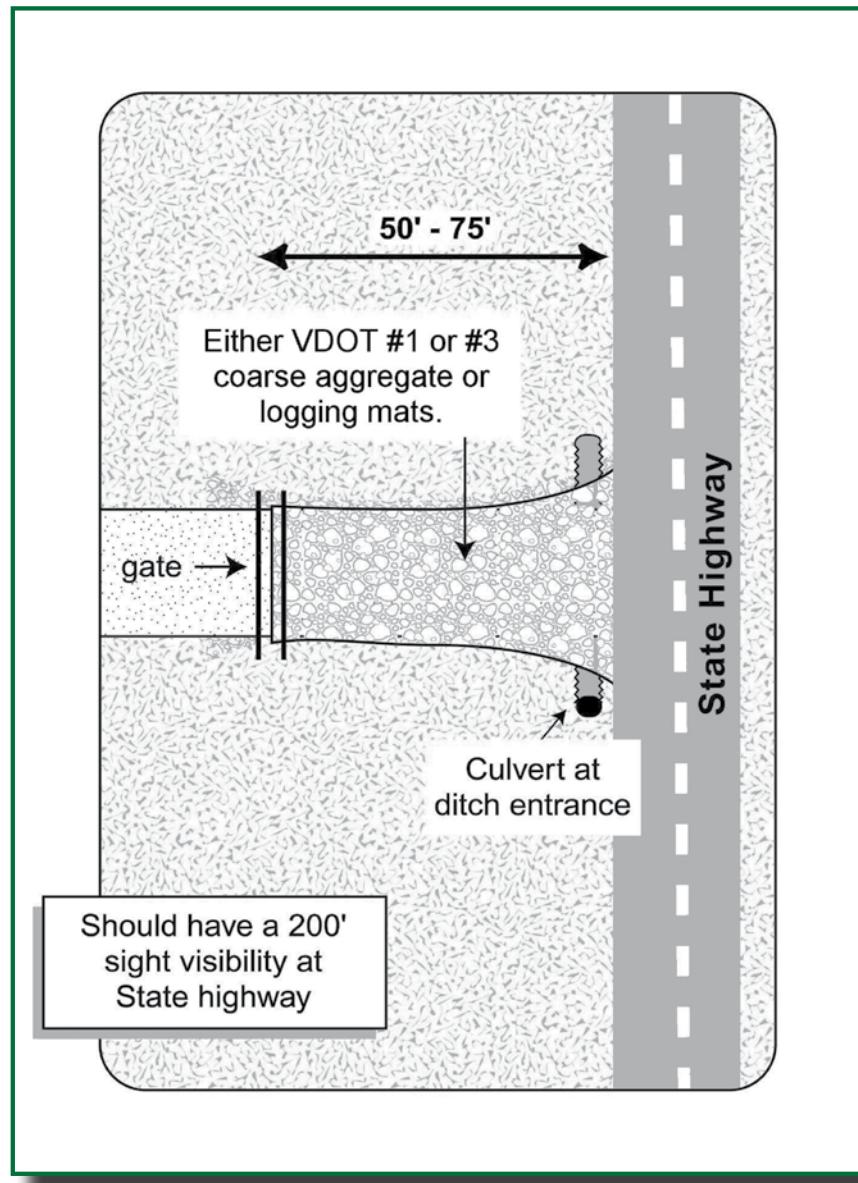
The entrance should be located in an area of good visibility to oncoming traffic. A minimum safe distance of 200 feet of visibility in both directions should be used as a guide for highway entrance. Consult with the Virginia Department of Transportation for areas of difficult access and/or limited visibility.

Entrance should be wide enough to accommodate the turning radius of the truck traffic anticipated.

A cross-drainage culvert for the highway ditchline should be installed according to Virginia Department of Transportation guidelines.

Clean, crushed gravel (VDOT #1 or #3) should be maintained at all logging road entrances to state highways. No mud should be tracked onto the state highway. The use of geotextile road fabric under the rock will save money for rock by providing a stable base for the rock. The use of wooden logging mats will also save money on rock expense.

Access to the logging site should be controlled by use of a clearly marked gate or cable.



NOTES

APPENDIX B

PLANNING TOOLS



Planning Tools

Evaluating Slope

Slope is the steepness of the land expressed as the amount (in percent) of vertical rise or fall per 100 feet of horizontal distance. For example, a five percent slope means a five-foot change in elevation per 100 feet of horizontal distance.

Slope, along with soil texture (sand, loam and clay) and ground cover, determines how fast water will drain from an area. Water drains quickly from steep slopes and erosion may be a problem. Flat surfaces may result in saturated soils. Slope can and should be managed during road design and layout. Slope can be divided into three broad categories: flat, moderate and steep. Standing downhill, and facing uphill, try to look level back into the hill. To help keep your line of site level, face uphill with your arm stretched out in front of you with a pencil pointing up out of your fist. Looking over the tip of the pencil will keep your site level. Estimate the horizontal distance between you and the point at which your site line hits the ground. Divide the height distance by horizontal distance to determine the percent of slope. Instruments that are readily available to measure slope with increased accuracy are an Abney Level; a clinometer, or a slope gauge.

Information on slope may also be obtained by using:

- ◆ USGS Topographic Maps
- ◆ Soil Surveys
- ◆ Soil Maps



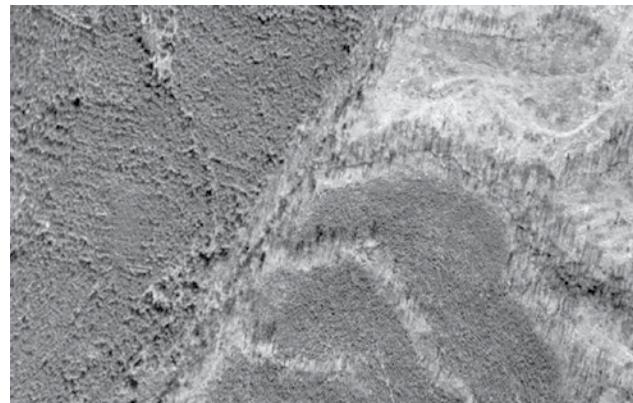
*Harvest planning maps are available (topographic maps, aerial imagery and culvert-sizing maps) when notifying via the Logger Notification website using latitude and longitude.
<http://www.ifris.dof.virginia.gov/harvestnotification/>*

Resource	Available From
USGS Topographic Maps	USGS Department of Mines, Minerals and Energy
Soil Surveys	Natural Resources Conservation Service
Aerial Photographs	Natural Resources Conservation Service Farm Services Agency Virginia Department of Forestry Field Offices Virginia Department of Transportation District Offices Private vendors

Evaluation of Aerial Photographs

Aerial photographs or “maps” are high altitude photos taken in a very concise and systematic manner. Although aerial photos can be made in color and even in infrared imagery, the most commonly used aerial photos are black and white. Generally, the top of the photograph is north. Information that can be delineated from aerial photographs is:

- ◆ Boundaries and timber types (for example, pines appear darker than hardwoods);
- ◆ Drainage patterns and streams;
- ◆ Roads, buildings and other areas of special interest; and
- ◆ Elevational changes if stereoscopic coverage is available.



Aerial photographs come in many scales such as 1 inch=660 feet, 1320 feet, 2000 feet, etc. It is very important that the individual using the photographs know the scale of the photograph so that the information will be accurate.

Evaluation of Soil Maps

Soil maps are aerial photographs on which the soil types are delineated. Soils are classified, mapped and ground truthed. They are published by the Natural Resources Conservation Service in a book called *A Soil Survey*, which can be obtained at your local NRCS office for most localities in Virginia.

Soil maps are excellent planning tools, especially in the coastal plain region of Virginia. They are very useful for:

1. Planning tract entry and operational routes;
2. Avoiding problem areas, such as wet areas;
3. Planning for stream crossing locations;
4. Estimating difficult slopes that may be encountered, and
5. Determining drainage patterns.



While soil surveys are an important tool for planning a silvicultural operation, it is still highly recommended that an on-site inspection occur to verify the exact soil type and slope on the site prior to beginning the operation.

Evaluation of Topographic Maps

Topographic maps, or “quad sheets,” are printed maps that portray the relief of the landscape and display physical features, such as roads, buildings and perennial and intermittent streams.

The most commonly used topographic map is the 7.5 minute map, which has a scale of 1:24,000 or one inch = 2,000 feet. The scale of the map is always displayed at the bottom of the map.

Changes in elevation are shown by a series of contour interval lines. These lines represent a point's elevation above sea level. Any point along a line is the same elevation as any other point on the same line. The closer the contour lines are to each other, the steeper the slope. The elevation distance between the lines is usually five or 10 feet, and can be 20 or 40 feet in the mountains. The information is given at the bottom center of the map. The elevation is frequently printed along several of the contour lines.



To determine the slope from a topographic map, first determine the elevation change between two points from the contour lines, being careful to use the proper contour interval. Divide the change in elevation by the distance between the two points. Multiply by 100 to get the percent slope.

Evaluation of Drainage Area

Drainage area, or watershed, is the total number of acres that drain to a common point in a stream channel, such as a culvert, creek crossing or bridge. Determining the acreage in the watershed is important in sizing culverts, locating stream crossings or locating bridges.

The use of topographic maps is critical in determining a watershed area. The topo maps show changes in elevation by a series of contour lines. These lines can be used to determine which slopes drain through an area. To determine the watershed, it is helpful to remember two things:

1. On hilltops, contour lines will form a small, rough circular shape.
2. On contour lines with fingerlike projections, which identify the stream flow, the fingers point uphill.

The watershed can be defined by drawing arrows in the direction of drainage to the common point. After the watershed is drawn, the number of acres in the area can be estimated. For a topographic map with a scale of 1:24,000 (a 7.5 minute map), Table 18 can be used as a quick guide.

Table 18 Guide for Area Estimation on a 7.5 Minute Topographic Map	
Shape	Acres
Head of a Pencil Eraser	5
Dime	40
Nickel	50
Quarter	70
1 in. x 1 in. square	90

NOTES

APPENDIX C

ROAD SURFACE AREA



Road Surface Area

Determining Road Surface Area

The following is intended as an aid to determine the surface area of roads.

1. Determine the road acreage for each segment of the road system from the Road Surface Area table given below.
2. Combine the acreage of each road segment to determine the total acreage of the entire road system.

Multiply the total acreage of the road system by the recommended application/acre of the appropriate revegetating material (e.g., fertilizer, seed mix, mulch, etc.) to determine the total amount of materials needed.

Table 19
Guide for Determining Road Surface Area

Road Length (ft.)	Road Width						
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
	Road System Acreage						
50	0.01	0.01	0.01	0.02	0.02	0.02	0.02
100	0.02	0.02	0.03	0.03	0.04	0.04	0.05
250	0.05	0.06	0.07	0.08	0.09	0.10	0.11
500	0.09	0.12	0.14	0.16	0.18	0.21	0.23
750	0.14	0.17	0.21	0.24	0.27	0.31	0.34
1,000	0.18	0.24	0.28	0.32	0.37	0.41	0.46
1,500	0.28	0.34	0.41	0.48	0.55	0.62	0.69
2,000	0.36	0.48	0.56	0.64	0.73	0.83	0.92
5,000	0.92	1.15	1.38	1.61	1.80	2.07	2.30
5,280	0.97	1.21	1.45	1.70	1.94	2.18	2.43

Wider road widths can be calculated by using multiples from this table.

Determining Road Surface Material

The following is intended as an aid to determine the surface area of forest roads.

Road Width (ft.)	Surfacing Material Thickness (yd. ³)		
	2 in.	4 in.	6 in.
8	5	10	15
10	6	12	19
12	7	15	22
14	9	17	26
16	10	20	30
18	11	22	33
20	12	25	37
22	14	27	41
24	15	30	44
Cubic yards of surfacing material per 100 ft. of road length			

NOTES

APPENDIX D

REVEGETATION OF DISTURBED AREAS



Revegetation of Disturbed Areas

Revegetation of Bare Soil Areas

This Appendix focuses on stabilization of disturbed soil or bare soil areas following silvicultural operations. A typical construction site erodes at a rate of up to 100,000 tons per square mile per year. This rate is 200 times greater than erosion from cropland and 2,000 times greater than erosion from Woodland (Pennsylvania Alliance for the Chesapeake Bay, Citizen's Guide to Soil Erosion Control, Chesapeake Bay Education Office). Proper harvest planning for the ongoing harvest, close-out and stabilization of the tract is required to prevent excessive erosion and sedimentation of streams and channels. Without proper planning, stabilization and maintenance of disturbed soil areas, the harvested site can erode at rates approaching those of construction sites.

The successful mitigation of soil losses on harvested sites results in the reduction of on-site and off-site environmental damage and substantial savings to landowners, loggers and, in the long term, the Commonwealth of Virginia. When implemented properly, Best Management Practices can control soil movement to a point where there is only minimal loss of this very precious resource; no appreciable damage to the waters of the Commonwealth; less future productive soil loss; enhanced project aesthetics before, during and after harvesting, and fewer complaints from concerned government agencies and citizens. Notably, there is a state law that dictates the use of such measures.



Soil stabilization practices are necessary where soil is exposed and is likely to erode to adjacent streams. Stabilization through revegetation is recommended on all soil areas. Permanent soil stabilization should be applied to all disturbed soil areas immediately after harvest. Temporary soil stabilization should be applied within seven days to denuded areas where timber harvesting may not be final but will remain dormant for longer than 30 days. If the total harvest time of the operation is likely to exceed 30 days, the tract should be divided into parcels and each parcel permanently stabilized as soon as it is completed. A temporary or permanent vegetative cover should be established on all denuded areas that will not be affected by skidding or other soil-disturbing activity immediately after construction of cut and fill slopes, haul roads, skid trails, log decks, etc.

Permanent vegetation should not be considered established until a ground cover is achieved that is uniform; mature enough to survive, and will inhibit erosion. If permanent vegetation is not established within a reasonable time period, additional attempts should be made and/or alternative measures considered.

Stabilization measures should be applied to earthen structures, such as water bars, broad-based dips and rolling dips, dikes, traps, basins and other diversions.

Cut and fill slopes should be constructed in a manner that will minimize erosion. Concentrated runoff should not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

Whenever water seeps from a slope face, adequate drainage or other protection should be provided.

Specifications for Revegetation

- ◆ Prior to seeding, install all necessary water control structures, such as waterbars, broad-based dips and turnouts.
- ◆ Select a seed mix appropriate for the conditions and the landowner's objectives for future use of the site. Most of the species in the following tables are available in Virginia. Seed immediately following harvest using the seasonal seed variety mixes and application rates provided in the following tables. Choose a mixture of main crop, legumes and grains/grasses to equal a total of 100 to 150 pounds/acre seeding rate.
- ◆ Lime and fertilizer should not be applied to an area without first having the soil tested. Results from Virginia Tech take about two weeks and include lime and fertilizer application rates. There is a small charge for a soil test. Most Virginia soils are acidic and will require lime application. Proper pH helps ensure full use of applied fertilizer, so do not guess on lime and fertilizer application rates. In general, in areas with acidic soils, 1.5 tons of lime per acre and 600 pounds of fertilizer will assist germination and survival.
- ◆ To control erosion, seed must be able to germinate and grow. This requires adequate preparation of the seed bed. Disking, sub-soiling or dragging brush or a chain across the area to be seeded may be necessary to ensure good contact between the seed and soil.
- ◆ Seed shall be spread using a broadcast seeder, drill or hydro seeder. Most seed varieties will successfully germinate when planting 1/8 inch to 1/4 inch below the soil surface. Drag chains or brush over the area again after seed broadcast to ensure good seed-soil contact.
- ◆ Seed broadcast in dry summer months and fall can be helped with an application of mulch. Straw or hay mulch is effective and inexpensive. Often straw bales that the landowner cannot use for livestock are perfect sources of mulch for log roads and landings.

Critical Area Planting

Soil stabilization requirements may increase in severely disturbed or highly sensitive areas. The site should be prepared as indicated in the previous section. Higher seed rates that include fast-germinating grains and grasses are recommended in the table below. Critical areas include eroding skid trails leading directly to streams; areas where culverts were removed or disturbed, or areas impacted by severe storms or floods. Mulching should always occur for critical-area planting at rates of two tons 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.

D | Appendix D – Revegetation

Table 21 Seeding Mixtures and Guidelines for Revegetation of Critical Areas in Virginia				
Seeding Mixtures	Rates Per Acre	Northern Piedmont, Mountains, Valley	Southern Piedmont, Coastal Plain	Comments
MAIN CROP – Choose one of the following or a combination				
Perennial Ryegrass K-31 Fescue	Total 60-75 lbs.	Feb. 15 - May 15 Aug. 15 - Nov. 15	Feb. 1 - Apr. 15 Sept. 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				
Kobe orrean L. Koespedeza	15 lbs.	N/A	Mar. 1 - May 1	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.
Hairy or Woodford	15 lbs.	N/A	Feb. 1 - May 15	
Bigflower	15 lbs.	Feb. 15 - May 1	N/A	
Lathco Flatpea Alfalfa	25 lbs.	Sept. 1 - Nov. 1	N/A	
GRAINS AND GRASSES – Choose one of the following or a combination				
Weeping Lovegrass	20 lbs.	Mar. 15 - May 15	N/A	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.
Foxtail Millet	20 lbs.	May 15 - Aug. 15	May 1 - Sept. 1	
Hybrid Bermudagrass	15 lbs.	N/A	Mar. 1 - May 15	
Choose a mixture of main crop, legumes and grains/grasses to equal a total of 100 to 150 lbs./acre seeding rate.				

The Use of Native Plants for Restoration

Native grasses, shrubs, wildflowers and trees are natural to the ecosystems of Virginia. Many natural habitats for some of our native plants are rapidly being lost and, along with them, the environmental benefits that they provide. Using native plants for restoration helps preserve native species and their ecological relationships with other plants and animals. Erosion and flood control, animal habitat and nitrogen fixation are but a few of the values provided to Virginia. By including native plant species in our land management prescriptions, we can help conserve natural ecosystems and the organisms that are dependent on these well-adapted communities.

Table 22
Critical Planting Area

Late Winter/Spring	Rate Per 1,000 Sq. Ft.	Rate Per Acre
Oats	2 lbs.	95 lbs.
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats and Ryegrass	½ lb. - 1 lb.	45 - 60 lbs.
Oats and Korean Lespedeza	½ lb. - 1 lb.	45 - 60 lbs.
Summer	Rate Per 1,000 Sq. Ft.	Rate Per 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 Per 1,000 Sq. Ft.	Rate Per 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.

What are Native Plants?

Native species are classified as those that occur in the region in which they have evolved. Plants and animals evolve in specific habitats over extended periods of time. This selective development is a response to physical and biotic processes characteristic of that region, and is driven by a combination of interactive forces: vegetation and soil; soil and landform, and landform and vegetation. Drought, precipitation, solar radiation, slope position and orientation, geologic substrate and hydrologic factors all play a part in contributing to the ecological processes with which a plant evolves. Native plants, therefore, possess certain traits that make them uniquely adapted to local conditions.

Planting Methods for Native Warm Season Grasses

A specialized grass drill is necessary to plant big and little bluestem and Indiangrass. These drills may be locally available from the Virginia Department of Game and Inland Fisheries (804-598-3706) or from the local Soil and Water Conservation District. Conventional equipment can be used to plant switchgrass and coastal panicgrass (alfalfa seed box on grain drill) and eastern gamagrass (corn planter). Indiangrass and big and little bluestem seed are fluffy and will not pass through conventional equipment unless they are ordered as debearded or brushed, which is an extra expense.

Native warm season grasses can be planted using either the no-till method or with conventional tilling. With either technique, the seedbed should be cultipacked after drilling to ensure good seed contact with mineral soil. No-till planting is probably the preferred method since soil disturbance is lessened, thus reducing germination of competing weeds. Potential soil erosion is minimized, and buried rocks are not brought to the surface. May and June are the preferred planting months for native warm season grasses, although in Coastal Plain areas, late April may be suitable. Some have had good results planting into the first few days of July in the Piedmont and Blue Ridge regions.

Planting Rates

Warm season grass planting rates for grazing or wildlife (recommended by Virginia Department of Game and Inland Fisheries):

Grass Species	For Grazing		For Wildlife
	Drilled Rate Per Acre (lbs. per acre)	Broadcast Rate Per Acre	Broadcast Rate Per Acre
Switchgrass	7 lbs.	9 lbs.	5 lbs.
Big Bluestem	8 lbs.	10 lbs.	7 lbs.
Indiangrass	7 lbs.	10 lbs.	7 lbs.
Coastal Panicgrass	10 lbs.	10 lbs.	8 lbs.
Eastern Gamagrass	8 lbs.	*	7 lbs.

Pounds Pure Live Seed (PLS) per acre
 * Not recommended

For More Information

Virginia Native Plant Society
Virginia State Arboretum
Blandy Experimental Farm
400 Blandy Farm Road, Unit 2
Boyce, Virginia 22620
Phone: (540) 540-837-1600
vnpsofc@shentel.net
www.vnps.org

Department of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, Suite 312
Richmond, Virginia 23219
Phone: (804) 786-7951
Fax: (804) 371-2674
www.dcr.virginia.gov/dnh

Virginia Department of Game and Inland Fisheries
4010 West Broad Street
P.O. Box 11104
Richmond, Virginia 23230
Phone: (804) 367-1000
Fax: (804) 367-9147
www.dgif.virginia.gov

USDA Natural Resources Conservation Service
Richmond State Office
1606 Santa Rosa Road, Suite 209
Richmond, Virginia 23229-5014
Phone: (804) 287-1691
Fax: (804) 287-1737
www.va.nrcs.usda.gov

NOTES

APPENDIX E

AGENCY LISTING



Agency Listing

The following information is designed to assist the forest operator with information requirements. This information is broken out by federal and state agencies and topic area.

Virginia Department of Forestry (VDOF)

For information and assistance from VDOF in the areas of pre-harvest planning, water quality law questions and/or general assistance, contact:

Virginia Department of Forestry
900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903-0667
(434) 977-6555
Fax: (434) 296-2369

Western Region, Salem

210 Riverland Drive
Post Office Box 100
Salem, Virginia 24153-0100
(540) 387-5461
Fax: (540) 387-5445

Central Region, Charlottesville

900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903
(434) 977-5193
Fax: (434) 296-3290



Eastern Region, Providence Forge

11301 Pocahontas Trail
Providence Forge, VA 23140
(804) 966-2209
Fax: (804) 966-9801

Department of Game and Inland Fisheries (DGIF)

For information and assistance on wildlife and habitat protection, contact the Department of Game and Inland Fisheries at the address and number below:

4010 West Broad Street
Post Office Box 11104
Richmond, Virginia 23230-1104
(804) 367-1000
Fax: (804) 367-9147
www.dgif.virginia.gov

Department of Mines, Minerals and Energy (DMME)

For acquisition of topographic maps for pre-harvest planning, contact the map sales office of DMME, or call VDOF.

Department of Mines, Minerals and Energy
Division of Geology and Mineral Resources
900 Natural Resources Drive, Suite 500
Charlottesville, Virginia 22903-0667
(434) 951-6340
Fax: (434) 951-6366
www.dmme.virginia.gov

U.S. Army Corps of Engineers

For information and assistance on wetlands and to determine if a permit is required, contact the regional office of the U.S. Army Corps of Engineers.

www.usace.army.mil

Norfolk District

803 Front St.
Norfolk, VA 23510
(757) 201-7606
www.nao.usace.army.mil

Department of Conservation and Recreation (DCR) Division of Natural Heritage

For information regarding rare, threatened or endangered species, please contact:

Project Review Coordinator
DCR-Division of Natural Heritage
217 Governor Street
Richmond, Virginia 23219
(804) 786-7951
www.dcr.virginia.gov/dnh

DCR Division of Chesapeake Bay Local Assistance

For information and assistance on whether the harvested tract lies within the Chesapeake Bay Resource Protection Area, contact the DCR Division of Chesapeake Bay Local Assistance at the following address and phone number; the local county zoning official, or the VDOF.

DCR Division of Chesapeake Bay Local Assistance
James Monroe Building, 101 North 14th Street, 17th Floor
Richmond, Virginia 23219
1-800-ChesBay (1-800-243-7229) or (804) 225-3440
www.dcr.virginia.gov/cbla

Virginia Marine Resources Commission

For information and assistance on stream crossing permits if the drainage area above a stream crossing is larger than 3,000 acres, contact the Virginia Marine Resources Commission at the address and number below:

Virginia Marine Resources Commission
2600 Washington Avenue
Newport News, Virginia 23607-0756
(757) 247-2200
Fax: (757) 247-8026
www.mrc.virginia.gov

Virginia Department of Environmental Quality (DEQ)

Oil spills of more than 50 gallons must be reported. Please contact the appropriate Regional Office:

Richmond State Office

629 East Main St.
P.O. Box 1105
Richmond, VA 23218
(804) 698-4000
Fax: (804) 698-4500

Southwest Regional Office

355 Deadmore Street
PO Box 1688
Abingdon, Virginia 24212
Phone: (276) 676-4800

Valley Regional Office

4411 Early Road
PO Box 3000
Harrisonburg, Virginia 22801
Phone: (540) 574-7800

Piedmont Regional Office

PO Box 4949-A Cox Road
Glen Allen, Virginia 23060
Phone: (804) 527-5020

West Central Regional Office

3019 Peters Creek Road
Roanoke, Virginia 24019
Phone: (540) 562-6700

Lynchburg Satellite Office

7705 Timberlake Road
Lynchburg, Virginia 24502
Phone: (434) 582-5120

Tidewater Regional Office

5636 Southern Blvd.
Virginia Beach, Virginia 23462
Phone: (757) 518-2000

Northern Virginia Regional Office

13901 Crown Court
Woodbridge, Virginia 22193
Phone: (703) 583-3800

NOTES

NOTES

Logging Notification

www.dof.virginia.gov

1-800-939-LOGS

(1-800-939-5647)

**Because it's good business and
It's the LAW!**

Editing, Graphics and Design by Janet Muncy
Virginia Department of Forestry

Illustrations by Dianne Johnson
Dianne Johnson Illustration & Graphic Design
Atlanta, GA
www.diannejohnson.com

Printed on SFI certified paper.



This project was supported with funding from Environmental Protection Agency's Chesapeake Bay Program through the Virginia Department of Conservation and Recreation.



**Virginia
Department of Forestry**

Headquarters

900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903

www.dof.virginia.gov

Phone: (434) 977-6555

Fax: (434) 296-2369

VDOF P00104; 03/2011

This institution is an equal opportunity provider.