COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Kentucky Forest Practice Guidelines for Water Quality Management

Jeffrey W. Stringer, Ph.D., Department of Forestry, University of Kentucky, Lexington, KY 40546-0073
Cary Perkins, Kentucky Division of Forestry, 627 Comanche Trail, Frankfort, KY 40601

Revised 2001

Acknowledgments
This document was printed with
specially designated funds from an
Act Relating to Agricultural Chemical Usage
passed by the 1990 Kentucky General Assembly.

Contents

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE

Kentucky Forest Practice Guidelines for Water Quality Management

Jeffrey W. Stringer, Ph.D., Department of Forestry, University of Kentucky, Lexington, KY 40546-0073
Cary Perkins, Kentucky Division of Forestry, 627 Comanche Trail, Frankfort, KY 40601

Introduction and Background

Purpose

The purpose of the *Kentucky Forest Practice Guidelines for Water Quality Management* is to provide, in capsule form, the most feasible ways to manage silvicultural activities, including timber harvesting, with respect to water quality. Section 319 of the Federal Clean Water Act Amendment of 1987 requires states to develop management programs for the control of nonpoint sources of pollution from various land use activities, including silviculture. The 1997 version is the third edition of the *Forest Practice Guidelines* and establishes Best Management Practices (BMPs) for silvicultural operations, including timber harvesting, in Kentucky. BMPs, as defined by Kentucky Revised Statute 224.71, are "the most effective, practical, and economical means of reducing and preventing water pollution. BMPs establish minimum acceptable quality levels for planning, siting, designing, installing, and maintaining agriculture and silviculture facilities and operations." The 1997 version was developed to support the planning and implementation of Silvicultural BMPs set forth by the *Kentucky Agriculture Satewide Water Quality Plan* (Kentucky Agriculture Water Quality Act [KRS 224.71]) and was revised in 2001 to reflect amendments to the Kentucky Statewide Plan.

This document is designed for technical assistance providers and planners as a technical reference in the identification, planning, and treatment of existing or potential nonpoint sources of pollution resulting from silvicultural activities. Neither the requirements of the *Agriculture Statewide Water Quality Plan* or the *Forest Practice Guidelines* is in any way intended to prevent the practice of state-of-the-art silviculture, but rather that silviculture may be practiced in such a way that it will result in the least possible negative impact upon water quality through nonpoint source pollution.

History of the *Kentucky Forest Practice Guidelines for Water Quality Management*

The *Kentucky Forest Practice Guidelines for Water Quality Management* has been revised three times since its development in 1980 by the Silviculture Nonpoint Source Task Force for Statewide Water Quality Management Planning directed by the Department for Natural Resources and Environmental Protection, Division of Water Quality in response to the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500, section 208). The Task Force was composed primarily of personnel from public forestry and natural resource agencies and private forest industries. The Kentucky Division of Forestry was responsible for chairing the Task Force and publishing the *Forest Practice Guidelines*. The second edition was prepared by the second session of the Silviculture Nonpoint Source Task Force convened in 1991-92. The 1991-92 Task Force was composed of a broader spectrum of both public agencies and private entities than the 1980 Task Force. The second edition was also compiled and printed by the Kentucky Division of Forestry. The technical specification of the third

edition of the *Forest Practice Guidelines* was completed in 1997 by the Silviculture Technical Advisory Committee of the Silviculture Subcommittee of the Kentucky Agriculture Water Quality Authority and voted on by the Silviculture Subcommittee. Table 1 provides the names and affiliations of the Silviculture Subcommittee and the Silviculture Technical Advisory Committee. The 1997 edition included a new BMP providing information for operations around sinkholes. In addition to the new BMP, revisions were also made to previous versions of the BMPs. Four of the BMPs were substantially revised, including "Access Roads, Skid Trails and Landings," "Vegetative Establishment on Silviculturally Disturbed Areas," "Streamside Management Zones," and "Silviculture in Wetland Areas."

The 1997 edition of the *Kentucky Forest Guidelines for Water Quality Management* was compiled and edited by Jeffrey W. Stringer, Assistant Professor, Department of Forestry, University of Kentucky, and Cary Perkins, Chief Forest Resource Management, Kentucky Division of Forestry, Natural Resources and Environmental Protection Cabinet. Assistance in editing was also provided by Vicki Hilpp, Continuing Education Specialist, Department of Forestry, University of Kentucky. The 1997 edition was published as a joint effort by the University of Kentucky, Department of Forestry, and the Kentucky Division of Forestry through the University of Kentucky Cooperative Extension Service.

The 2001 edition *Kentucky Forest Guidelines for Water Quality Management* was compiled and edited by Jeffrey W. Stringer, Associate Professor, Department of Forestry, University of Kentucky, and Cary Perkins, Forest Stewardship Section Supervisor, Kentucky Division of Forestry, Natural Resources and Environmental Protection Cabinet. Assistance in editing was also provided by Amy Thompson, BMP Program Coordinator, Department of Forestry, University of Kentucky. The 2001 edition was also published as a joint effort by the University of Kentucky, Department of Forestry, and the Kentucky Division of Forestry through the University of Kentucky Cooperative Extension Service. This edition of the Forest Practice Guidelines contains only limited changes and clarifications to the 1997 edition. These revisions reflect changes in the Agriculture Statewide Water Quality Plan.

Kentucky Agriculture Water Quality Act and the *Kentucky Forest Practice Guidelines for Water Quality Management*

1997 Edition

The 1997 edition of the *Kentucky Forest Practice Guidelines for Water Quality Management* was developed to support effective implementation of silvicultural BMPs as mandated by the Kentucky Agriculture Water Quality Act (AWQA). In 1994, the Kentucky General Assembly enacted the Kentucky Agriculture Water Quality Act (KRS 224.71-100). The act established a 15-member Agriculture Water Quality Authority representing the state's agricultural and environmental community. The Authority developed the Kentucky Agriculture Statewide Water Quality Plan (Statewide Plan), which was an effort to produce a practical, flexible, coordinated natural resources management system that protects the waters of the Commonwealth and complied with applicable government regulations. It should be noted that the Water Quality Act or the Statewide Plan does not alter existing water quality or waterway regulations. Rather, it provides a system for development and implementation of practices to eliminate or mitigate pollution from agricultural and silvicultural operations. The act also provides a system that governs the process of addressing deficiencies in the observance of water quality or waterway regulations.

Table 1. Silviculture Subcommittee

Mark Matuszewski	**Subcommittee Chair** Director, Kentucky Division of Forestry	State Agency
Bob Bauer	Kentucky Forest Industries Association	Industry
Don Girton	Kentucky Woodland Owners Association	Landowner
Judith McCandless	Kentucky Conservation Committee	Environmental Organization
Pete McNeill	Private Forest Owner	Landowner
Paschal Phillips	Private Forest Owner	Landowner
Walt Rybka	Private Forest Owner	Landowner
Rep. William Scott	Private Logger and State Representative	Industry
James “Tommy” White	Chairman, Forestry Committee Farm Bureau	Producer Organization

Technical Advisors

Cary Perkins[1,2]	**AWQA Staff, Kentucky Division of Forestry**	**State Agency**
David Brown[1]	**Department of Forestry, University of Kentucky**	**University**
Gary Mullaney[1]	**Westvaco Corporation**	**Forest Industry**
Jeffrey W. Stringer[1,2]	**Department of Forestry, University of Kentucky**	**University**
Bill Bailey	Natural Resources Conservation Service	Federal Agency
Danny Barrett[1]	Corps of Engineers	Federal Agency
Robert Blevins	Department of Agronomy, University of Kentucky	University
Faith Burns	Office of Legal Services, NREPC	State Agency
George Chalfant	Daniel Boone National Forest	Federal Agency
Gary Coleman[1]	Daniel Boone National Forest	Federal Agency
Mary Lynn Collins	Legislative Research Commission	State Agency
Henry Duncan	Division of Conservation	State Agency
Lynn Garrison	Kentucky Department of Fish and Wildlife Resources	State Agency
Craig Givens	Division of Conservation	State Agency
Donald Graves	Department of Forestry, University of Kentucky	University
J.K. Henshaw	Farm Bureau Federation	Producer Organization
Morgan Jones	Kentucky Division of Water	State Agency
Curtis Kirk	Division of Conservation	State Agency
Patti Kirk	Economic Development Cabinet	State Agency
Laura Knoth	Farm Bureau Federation	Producer Organization
Larry Lowe[1]	Kentucky Division of Forestry	State Agency
Tom Marcum	Natural Resources Conservation Service	Federal Agency
Bob Marsh	University of Kentucky Cooperative Extension Service	University
Mike Mills	Kentucky Division of Water	State Agency
Bill Morris	Economic Development Cabinet	State Agency
Robert Muller	Department of Forestry, University of Kentucky	University
Ken Negray[1]	Westvaco Corporation	Forest Industry
John Perry[1]	Berea College	University
David Rome	Kentucky Division of Water	State Agency
Ann Ross	Economic Development Cabinet	State Agency
Larry R. Smith	Farm Bureau Federation	Producer Organization
Jeff Sole[1]	Kentucky Department of Fish and Wildlife Resources	State Agency
David Stipes[1]	Natural Resources Conservation Service	Federal Agency
Jon Walker[1]	Daniel Boone National Forest	Federal Agency
Benjamin Worthington	Daniel Boone National Forest	Federal Agency

Boldface type: Indicates Technical Advisor Ad hoc Committee Chairs
[1] Technical Advisor Ad hoc Committee Members
[2] Development, Silviculture Section Agriculture Water Quality Authority Producer Workbook

The Statewide Plan mandates that any person, who owns 10 or more contiguous acres of land in Kentucky and who uses that land for agriculture and/or silviculture, must have an individual water quality plan by October 23, 2001. The individual plan must stipulate the BMPs, as set forth by the Kentucky Agricultural Statewide Water Quality Plan, which will be used during agricultural and silvicultural operations on the property. The Statewide Plan is based on pollution prevention through the use of BMPs. These BMPs are divided into the following categories: silviculture, pesticide and fertilizer, farmstead, crops, livestock, and streams and other waters. The silvicultural portion of the plan includes ten BMPs that are to be used in silvicultural operations (including timber harvesting). To facilitate the development of the individual water quality plan, the Kentucky Agriculture Water Quality Authority developed a Producer Workbook. This workbook allows the landowner to determine which BMPs should be used by answering a set of questions for each operation. The landowner must also ensure that the plan is implemented as part of operations on the property. In effect, this mandates the use of the BMPs as defined in the Statewide Plan.

The *Kentucky Forest Practice Guidelines for Water Quality Management* contains detailed BMP information and is cited as the reference document in the silvicultural section of the Statewide Plan. In many instances, the *Forest Practice Guidelines* include tables, graphics, and detailed explanations providing specific implementation information not included in the Statewide Plan. For example, the Statewide Plan stipulates in silvicultural BMP No. 2 that silviculturally disturbed areas are to be revegetated and references BMP No. 2 in the *Forest Practice Guidelines*. BMP No. 2 in the *Forest Practice Guidelines* provides detailed information on the recommended temporary and permanent species for different sites and conditions; recommendations for the timing of seeding, mulching, fertilizing, and liming; and other information needed to facilitate the revegetation of silviculturally disturbed areas.

2001 Edition

In 1998 the Kentucky Forest Conservation Act (KRS 149.330 to 149.355) was established. A part of this legislation required that forestry best management practices be implemented on timber harvesting operations. The act also formed the Forestry Best Management Practices Board whose duties (among others) are to review and rewrite, as necessary, forestry best management practices used in timber harvesting operations. This governor-appointed board was established in 1999. The board is provided monthly status reports on the implementation of forestry best management practices as determined by the Kentucky Division of Forestry. It uses this information as well as site visits; operator, landowner, and forestry industry testimonials; and results of ongoing research to periodically review Kentucky's forestry best management practices as outlined in the *Kentucky Forest Practice Guidelines for Water Quality Management*.

Table 2. Kentucky Forestry Best Management Practices Board and Silviculture Subcommittee of the Agriculture Water Quality Authority.

Name	Representing
Jeff Stringer	UK Department of Forestry
Greg Dale	Kentucky Wood Industry
Robert Dunning	Logger In Good Standing
Jane Harrod	At-Large Woodland Owner
Oliver H. Lloyd	At-Large Woodland Owner
Walter Rybka	Farmers-At-Large
Roger Smith	Department of Agriculture
Bob Woford	Kentucky Wood Industry
Mike Lyon	At-Large Woodland Owner
Leah MacSwords	Kentucky Division of Forestry
Bob Bauer	Kentucky Wood Industry
John Bullock	Kentucky Farm Bureau Federation
Pam Wilson	Farmers-At-Large

In 2000, members of this board were also named to the Silviculture Committee of the Agriculture Water Quality Authority, and as such the board currently has responsibilities to the Kentucky Forest Conservation Act and the Kentucky Agriculture Water Quality Act. This dual appointment allows the forestry community to function efficiently within the current statutory framework, providing all those engaged in forestry operations with a consistent set of forestry best management practices. In 2001 the board submitted changes, additions, and clarifications to the Agriculture Water Quality Authority for approval and inclusion in the *Agriculture Statewide Water Quality Plan*. These changes were approved by the authority, and the 2001 version of the *Kentucky Forest Practices for Water Quality Management* reflects the forestry best management practices that are required as part of the Kentucky Forest Conservation Act to be implemented by timber harvesting operators and for landowners to include in their individual water quality plans as specified by the Kentucky Agriculture Water Quality Act.

Summary of AWQA Minimum Requirements and Recommendations

The *Kentucky Forest Practice Guidelines for Water Quality Management* contains detailed BMP information and is cited as a reference document in the silvicultural section of the Statewide Plan. In many instances, the *Forest Practice Guidelines* includes tables, graphics, and detailed explanations providing specific implementation information not included in the Statewide Plan. For example, the Statewide Plan stipulates in silvicultural BMP No. 2 that silviculturally disturbed areas are to be revegetated and references BMP No. 2 in the *Forest Practice Guidelines.* BMP No. 2 in the *Forest Practice Guidelines* provides detailed information on the recommended temporary and permanent species for different site and conditions; recommendations for the timing of seeding, mulching, fertilizing, and liming; and other information needed to facilitate the revegetation of silviculturally disturbed areas. The recommendations along with the minimum requirements were developed by the forestry BMP board and ultimately approved by the Agriculture Water Quality Authority.

Implementation of the BMPs as specified by the *Kentucky Forest Practice Guidelines for Water Quality Management* is recommended for all silvicultural operations, regardless of size, to help control nonpoint source pollution from all silvicultural operations, including timber harvesting.

Nonpoint Source Pollutants from Silvicultural Operations

Silvicultural Operations as a Contributor to Water Pollution in Kentucky

Silvicultural activities have the potential to create a number of nonpoint source pollutants**.** Nonpoint source pollution is defined as pollution that comes from many diffuse or scattered sources rather than from a concentrated point. When silvicultural and/or timber-harvesting operations produce nonpoint pollution, they often do so by allowing sediments or other pollutants to enter a water body at a number of different points and not at a single source.

Pollution from silvicultural operations is a concern nationwide. In Kentucky, the most prevalent forest operation is timber harvesting and is included as a silvicultural activity in Kentucky. Pollution from timber harvesting operations is most noticeable on small-order streams. These types of streams often contain shallow, riffle areas where abundant oxygen and habitats for pollutant-intolerant organisms can be found. When streams containing riffle areas maintain good water quality, they will contain a wide variety of organisms. Timber harvesting operations can negatively impact these systems by creating a number of

nonpoint source pollutants. In a study determining the source of suspended sediments in two to three small watersheds in each major physiographic region in the state, it was found that silvicultural operations accounted for approximately 2 to 25 percent of the suspended sediments found in the stream.[1] The highest values were found in the eastern coalfield physiographic region.

However, impacts of nonpoint source pollutants from silvicultural activities is minor when compared to other contributors on a statewide basis. Figure 1[2] shows that silvicultural activities are a relatively minor source of pollution, accounting for only 2.7 percent of the problems associated with loss of aquatic habitat or recreation use of our large watersheds.

Figure 1. Sources of Non-Support for Recreational Use and Aquatic Habitat in Kentucky.

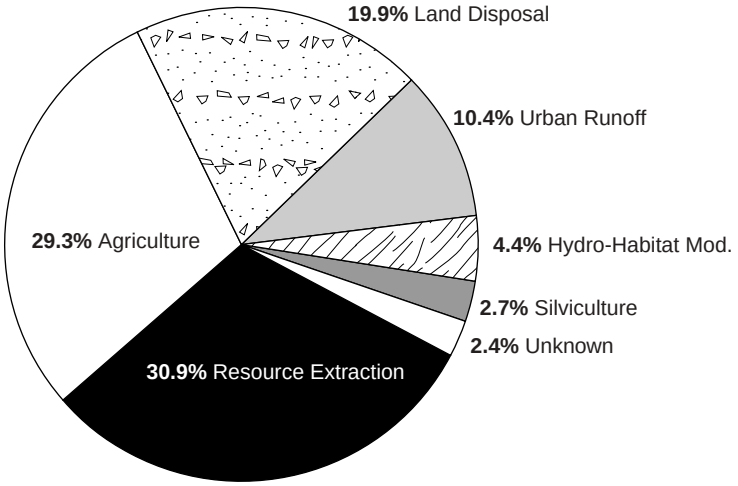
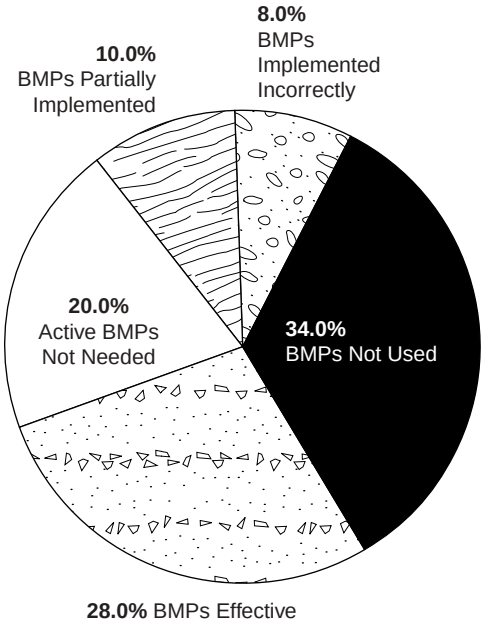


Figure 2. Timber Harvesting BMPs in Kentucky.



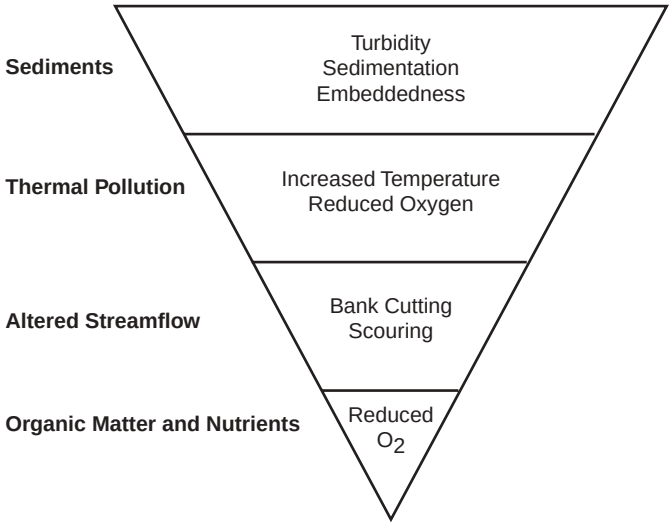
A survey of timber harvesting operations in Kentucky[3] found that 20 percent of the sites sampled either had no surface waters/drainage features (including swallets) present (6 percent) or the intensity or design of the harvesting operation was sufficient to avoid surface runoff into bodies of water or drainage features (14 percent). Active BMPs were necessary on the remaining 80 percent (Figure 2). BMPs were needed but not implemented on 34 percent of these sites. Eight percent of the sites had BMPs, that because of improper implementation did not mitigate any nonpoint source runoff. Ten percent of the sites had both properly and improperly implemented BMPs that partially mitigated nonpoint source runoff. Twenty-eight percent of the sites had BMPs that were implemented correctly and were functioning to effectively reduce nonpoint source runoff.

[1] USDA and KNREPC. 1985. Source Distribution of Sediment by First Approximation of Sediment Source (FASS) Procedure. 55 pp.
[2] Division of Water. 1996. Kentucky Report to Congress on Water Quality, Commonwealth of Kentucky, Natural Resources and Environmental Protection Cabinet. Frankfort, KY.
[3] Stringer, J. W., and T. R. Queary. 1997. Kentucky's Timber Harvesting BMP Implementation Study. Preliminary Results. University of Kentucky, Department of Forestry. FORFS 97-4. 2 pp.

Types of Nonpoint Source Pollutants from Silvicultural Operations

Silvicultural activities can cause an increase in a number of factors that have harmful effects on aquatic habitats and decrease the ability of our streams to support aquatic communities. The following is a brief description of each of the nonpoint pollutants that can be produced by silvicultural operations. Figure 3 shows the relative importance of each of these pollutants to silvicultural operations in Kentucky.

Figure 3. Relative Importance of Silvicultural Nonpoint Source Pollutants.



- **Sediment:** Sediments are the most common pollutant resulting from silvicultural activities. Sediments principally result from erosion of soil, but they can also include organic matter. Excessive sediments upset balanced ecology within streams by smothering bottom-dwelling organisms in the water, interfering with photosynthesis by reducing light penetration, serving as carriers of nutrients and pesticides, inhibiting fish reproduction, eliminating benthic habitats, and altering stream flow.
- **Nutrients:** Nutrients, above natural levels, generally originate from the application of fertilizers. Soluble nutrients can reach surface or ground water through runoff, seepage, and percolation. Insoluble forms can be absorbed on soil particles and reach surface waters through erosion. Nutrients can also reach water by direct washoff from debris and recently applied fertilizer. Excessive nutrients lead to an imbalance in natural life cycles of water bodies. In Kentucky, silvicultural use of fertilizers is limited and generally excessive nutrients are not a primary pollutant from silvicultural activities.
- **Organic debris:** Tree limbs, tree tops, and other waste materials are the principal organic pollutants from silviculture. They may reach streams through direct pushing or felling into water drainages, or washout during storms. Organic debris can place oxygen demand on the receiving body of water during the decomposition process. Associated decomposition problems include odor, color, taste, and nutrients. In addition, large, pieces of woody debris (e.g., logs, tree tops) have the potential to cause downstream damage during flood conditions.
- **Thermal pollution:** Thermal pollution is an increase in water temperature such that some aquatic organisms can no longer survive. Removal of canopy cover along stream drainages causes water temperature to rise. Temperature increases influence dissolved oxygen concentrations, algal growth, fish populations, invertebrates, and bacteria populations in streams. The saturated dissolved oxygen concentration in streams is inversely related to temperature.
- **Streamflow:** Removal of vegetation can result in a temporary increase in streamflow by reducing evapotranspiration. The amount of streamflow increases as more vegetation is removed. Increased streamflow can result in erosion of the stream bank and scouring of the streambed.
- **Forest chemicals:** Pesticides, including herbicides, insecticides, and fungicides, are used to control forest pests and undesirable vegetation. Pesticides in surface or ground water can result in toxicity problems, affecting water quality and food sources for aquatic life. Pesticides used in connection with forestry in Kentucky are limited and not considered a problem on a statewide basis.

Outline of Kentucky's Silvicultural Best Management Practices

The Silvicultural Best Management Practices found in the *Kentucky Forest Practice Guidelines for Water Quality Management* were developed to guide silvicultural and timber harvesting operations in a manner that protects water quality. However, implementation of the *Guidelines* will also help maintain soil productivity and ecological components of riparian habitats. Each BMP section contains specific practice recommendations, as well as information on the regulatory requirements that might be mandated during the operation and the minimum requirements of the *Kentucky Agricultural Statewide Water Quality Plan*. The following is a brief description of each Silvicultural Best Management Practice.

BMP No. 1 Access Roads, Skid Trails, and Landings

General recommendations for the placement, grade, drainage, maintenance, and retirement of access roads, skid trails, and landings as part of silvicultural and timber harvesting operations are given. These recommendations were devised to minimize soil erosion and to protect nearby bodies of water from sediments. Specific information on placement relative to bodies of water and sinkholes is presented in BMP No. 3 and No. 4, respectively. Details of the revegetation component of retirement are presented in BMP No. 2.

BMP No. 2 Vegetative Establishment on Silviculturally Disturbed Areas

This BMP contains species and species mix recommendations for various soil and site conditions for the revegetation of sediment-producing, erodible, or severely eroded areas, such as access roads, skid trails, and landings. These areas have the potential to produce sediment in runoff, which can affect downstream areas. Recommended seeding dates, seeding rates, cultural practices and general fertilizer and mulching rates are also provided. These guidelines normally apply to roads, trails, and landings. Disturbed areas resulting from site preparation activities, such as shearing, raking, chopping, and prescribed burning, will be allowed to revegetate naturally or be converted directly to a forest crop. Revegetation of these areas, based on this BMP, is often not appropriate or consistent with state-of-the-art silviculture. Guidelines for site preparation, prescribed burning, and tree planting are provided in other BMPs.

BMP No. 3 Streamside Management Zones

Streamside Management Zones (SMZs) are areas adjacent to intermittent and perennial streams and other waters where only limited disturbance is desirable. To help minimize or eliminate sediment delivery to bodies of water, this BMP specifies the minimum distance, based on slope percent and water body type, between roads, trails, and landings and bodies of water. This BMP also provides information on the width of residual trees that should be maintained near bodies of water and the percent of trees that can be removed within these zones during timber harvesting operations. These latter specifications are used to maintain natural stream temperature in perennial streams through shading, to maintain the integrity of the stream bank, and to reduce the amount of sediment entering the water by minimizing soil disturbance and filtering overland flow. As a general rule these guidelines do not apply to watercourses that flow only in direct response to precipitation (ephemeral channels). BMP No. 5 "Logging Debris," also contains information concerning streams and ephemeral channels.

BMP No. 4 Sinkholes

The purpose of this BMP is to minimize the flow of nonpoint source pollutants into sinkholes. For purposes of this BMP, sinkholes include: depressional areas with or without swallets, sinking streams, caves, karst windows, and pits or vertical shafts. Silvicultural pollutants can cause degradation to groundwater, underground drainage systems, and downstream surface waters into which the underground streams flow. Sinkholes containing open swallets are of particular concern. This BMP specifies the distance between sediment-generating structures, such as roads, skid trails, and landings, and the bottom or open swallet of a sinkhole. Information concerning felled tree density and other logging debris is also given.

BMP No. 5 Logging Debris

Logging debris consists of the noncommercial portions of trees and brush, including tops and cutoffs, or other logging operation waste products, that can clog or in some other way degrade water courses and water quality. This BMP specifies removal of debris, fill, and trash from intermittent and perennial streams and provides information for operations around ephemeral channels. It also provides guidance for equipment concerning fluid leakage.

BMP No. 6 Proper Planting of Tree Seedlings by Machine

This BMP provides recommendations for the proper planting of tree seedling stock with mechanical tree planters in order to minimize potential degradation of water quality resulting from planting slits.

BMP No. 7 Fertilization

This BMP concerns minimizing water quality degradation while artificially applying specific chemicals to the soil to favor increased growth of vegetation. General guidelines concerning application in Streamside Management Zones and in and around sinkholes are also given.

BMP No. 8 Application of Pesticides

Pesticides include insecticides, herbicides, fungicides, rodenticides, and nematocides. These chemicals are used to destroy, prevent, or control woody or herbaceous vegetation and forest pests on forested lands or areas being reforested. All forest chemicals are labeled with detailed use information, which must be strictly followed. This BMP has general information on cleanup, storage, and use of pesticides around Streamside Management Zones and in and around sinkholes.

BMP No. 9 Site Preparation for Reforestation

The purpose of this BMP is to minimize potential water quality degradation while eliminating or suppressing undesirable vegetation that would otherwise prevent the successful establishment and growth of tree seedlings through competition for sunlight, moisture, and nutrients, and to facilitate hand- or machine-planting operations. Specifications for windrowing and other site-preparation methods using heavy equipment are given.

BMP No. 10 Silviculture in Wetland Areas

Wetlands are defined as areas characterized as having hydric soils and supporting a dominance of hydrophytes (plants adapted to primarily wet conditions). Such areas are transition zones between predominately dry upland sites and permanent water in streams and lakes. The U.S. Army Corps of Engineers officially determines whether a forested area is a wetland, unless there is adjacent cropland, in which case the Natural Resources Conservation Service may make the determination. The requirements in this BMP are supplemental to other silvicultural BMPs and contain information and specifications for trafficking and timber harvesting around streams, sloughs, and other waters in a wetland.

BMP No. 11 Livestock Management

Livestock management in forested areas is often necessary to maintain enough cover to protect the soil and prevent sedimentation of nearby bodies of water; to protect, maintain, or improve the quantity and quality of the plant resources; and to maintain soil productivity and to prevent soil compaction. This BMP can be applied where desired forest reproduction, soil hydrologic values, and/or existing vegetation can be seriously damaged by livestock.

BMP No. 12 Fire Lines for Wildfire Control

A fire line is a path of varying width constructed through the litter on the forest floor down to mineral soil to restrict and control wildfire. Both hand tools and mechanized equipment can be used to construct fire lines, and this BMP contains information to minimize the sedimentation of water bodies resulting from erosion of the line after fire suppression.

BMP No. 13 Prescribed Burning

Prescribed burning involves the use of fire under conditions that will assure confinement yet produce the intensity of heat and behavior required to accomplish one or more management objectives. The purpose of this BMP is to conduct those burning practices used to modify a forest stand or to reduce forest residue to some desired level that minimizes soil erosion and protects nearby bodies of water from sedimentation. Guidelines concerning fire lane placement, drainage, and retirement are also included in this BMP.

Relationship between Silvicultural Activities, Nonpoint Pollutant, and Best Management Practices

Different silvicultural operations and suboperations have the potential to generate nonpoint source pollutants to varying degrees. Table 2 summarizes, in broad terms, the relationship between nonpoint source pollutants, their sources, and BMP measures used to mitigate pollution in streams.

Table 3. Relationship between NPS Pollutants, Their Sources, and Corrective BMP Measures

Nonpoint Source Pollutant	Primary Source	Corrective BMP Measures
Sediments:		
Turbidity Sedimentation Embeddedness	Disturbed bare ground: Roads, trails, landings Intensive site preparation Mechanical tree planting Stream Crossings	1. Proper location relative to water bodies, sinkholes, and surface channels 2. Properly drain roads, trails, and landings 3. Revegetate and retire
Thermal	Removal of streamside vegetation	1. Maintain streamside management zones
Chemicals:		
Herbicides Pesticides	Runoff from site preparation activities Plantation stand management activities	1. Apply pesticides according to label 2. Maintain streamside management zones and sinkhole protection
Organic Matter and Nutrient Overloading:		
Fertilizer Logging slash	Runoff from retired, revegetated, fertilized roads Leaching and the breakdown of vegetation	1. Maintain streamside management zones and sinkhole protection 2. Keep tops out of water bodies
Altered Streamflow:		
Diverted flow Increased flow	Large logging debris in streams	1. Keep tops and logging slash out of streams

Determining Best Management Practices for Silvicultural Operations in Kentucky

The thirteen silvicultural BMPs in Kentucky have been developed to address nonpoint source pollution concerns in operations commonly found in the state. Table 3 identifies the appropriate silvicultural BMP for mitigating a particular pollutant associated with a specific type of silviculture operation. For any particular activity, a single BMP or a combination of BMPs may be needed.

Table 4. Nonpoint Source Pollutant and Applicable Kentucky BMP

Activity	Pollutant	Applicable BMPs
Timber Harvesting	sediment	1,2,3,4
	debris	3,4,5
Road, Skid Trail, & Log Landing Construction & Management	sediment	1,2,3,4
Activity in Streamside Corridors and Around Ponds and Lakes	sediment	3,11
	water temperature	3
	debris	3,5
	pesticides*	3,8
	fertilizers	4,7
	animal waste	11
Activity near Sinkholes	sediment	4
	debris	4,5
	pesticides*	4,8
	fertilizers	4,7
	animal waste	11
Revegetation of Disturbed Areas	sediment	2
	fertilizers	7
Site Preparation and Forest Regeneration	sediment	6,9
	pesticides*	8
	fertilizers	7
Forest Wetland Activity	sediment	1,2,3,10
	pesticides*	8,10
	fertilizers	7,10
Application of Fertilizers and/or Pesticides*	fertilizers	3,7
	pesticides*	3,8
Woodland Grazing	sediment	11
	animal waste	11
Fire Lines	sediment	2, 12
Prescribed Burning	sediment	12, 13

*Pesticides include insecticides, herbicides, fungicides, rodenticides, nematocides, etc.

Evaluating Sites and Operations

The following guide[1] can be used to determine which BMPs from the *Kentucky Forest Practice Guidelines for Water Quality Management* should be implemented on silvicultural operations in Kentucky. Use one or more of the following Silvicultural BMPs if your answer is "yes":

- As part of any timber harvesting and/or silvicultural operation, will roads, skid trails, and/or log landings be constructed, used, and/or maintained?
  ☐ Yes ☐ No If yes, use BMPs No. 1 and No. 5.

- Does the area where the silvicultural operation is to occur contain, or is it directly adjacent to, perennial or intermittent streams or other bodies of water?
  ☐ Yes ☐ No If yes, use BMPs No. 3 and No. 5.

- Does the boundary or tract where the silvicultural operation is to occur contain sinkholes?
  ☐ Yes ☐ No If yes, use BMPs No. 4 and No. 5.

- In conjunction with the silvicultural operation, are there disturbed or otherwise bare areas, such as roads, skid trails, or landings, that need to be revegetated to prevent and/or control soil erosion?
  ☐ Yes ☐ No If yes, use BMP No. 2.

- Will silvicultural activities occur in areas classified as wetlands by the Natural Resources Conservation Service (NRCS) or the U.S. Army Corps of Engineers?
  ☐ Yes ☐ No If yes, use BMP No. 10.

- Will site preparation activities occur as part of reforestation practices?
  ☐ Yes ☐ No If yes, use BMPs No. 6 and No. 9.

- Will pesticides, including herbicides, fungicides, rodenticides, insecticides, and nematocides, or fertilizers be used in connection with your silvicultural activities?
  ☐ Yes ☐ No If yes, use BMP No. 7 and/or No. 8.

- Do livestock have access to forested areas or to forested areas in streamside corridors or around lakes or ponds?
  ☐ Yes ☐ No If yes, use BMP No. 11.[1]

- Have fire lines been constructed on the property for wildfire control?
  ☐ Yes ☐ No If yes, use BMP No. 12.

- Will prescribed burning activities be used to minimize wildfire potential, improve wildlife habitat, restrict undesirable plant growth, and/or prepare a seedbed favorable to natural seeding reforestation?
  ☐ Yes ☐ No If yes, use BMP No.13.

[1] This guide is similar to the silvicultural section of the *Kentucky Water Quality Authority Producer Workbook*. Note: The *Producer Workbook* refers those grazing livestock in woodlands to the "Livestock" section of the *Producer Workbook*. This guide also contains BMPs No. 11, 12, and 13, which are not included in the *Kentucky Water Quality Authority Producer Workbook.*

Planning: The Key to Proper BMP Effectiveness

Selection of the BMPs that must be used is only the first step in proper water quality management. Proper implementation is also critical to BMP effectiveness. BMP implementation begins before any silvicultural activity, by planning the layout and location of sale boundaries, streamside management zones, and access roads. Equipment type and operating systems, along with site characteristics, will influence which recommendations within each BMP will be needed. Familiarity with the operating systems and equipment limitations is critical for developing the operation so that the BMPs used will be effective. For example, the size and type of log truck and the equipment used to skid logs or trees may determine whether a stream will be crossed or the type of water control structures that will be used on access roads. The time of year also plays an important role in the selection and timing of construction of water control structures and revegetation mixes that should be used for retirement.

BMP 1

Access Roads, Skid Trails, and Landings

Purpose

The purpose of this BMP is to construct and maintain roads, skid trails, and landings in a way that minimizes soil erosion and protects nearby bodies of water from sedimentation.

Definitions

Access roads connect silvicultural operations, including timber-harvesting operations, with the farm or public road system. In the case of timber harvesting, access roads are commonly referred to as **haul roads** and carry log trucks from the landing to the farm or public road system. **Skid trails** are secondary vehicle travel routes through the forest used to remove harvested timber from a point near where trees were felled to an access road or concentration area. They are generally temporary, minimum or nonstructural pathways over forest soils, where felled trees or logs are dragged, resulting in duff and ground disturbance. **Cable corridors**, narrow corridors used in cable yarding operations, and **forwarding paths** are also used for moving felled trees or logs from their point of origin to a concentration area. **Landings, log decks,** or **yards** are concentration areas where harvested forest products are temporarily concentrated and stored before being permanently removed from the woods.

These trafficked areas are used where needed to provide access from the public or private transportation system to the forest activity area and trees within the area. The intended purpose of these areas will dictate the construction standards (high standards for permanent use or lower standards for temporary use), and the type, placement, and timing of construction of water control structures used to control erosion.

Specifications

Access Roads

General Layout

Topography, property lines, economic constraints, and sensitive areas in the landscape often dictate approximate location and extent of the road system. Common sense in applying guidelines to a specific situation is vital. The end result of these combined efforts is to keep the forest soil in place for future production of forest products and maintenance of water quality and aquatic habitat, while providing for safe and efficient silvicultural operations.

Control points: Control points, such as rock outcrops, ledges, swampy places, and other features likely to present difficulties in construction, should be avoided, if possible. While soil survey information and topographic maps are helpful in defining these areas and other similar features that may be present, a thorough walk-through prior to construction is often required to adequately identify these control points.

General Construction Considerations

- If possible, roads should be properly constructed, seeded and armored (if appropriate) several months in advance of their use to allow for settling. This normally reduces maintenance and increases surface stability.

- A right-of-way of sufficient width to handle the equipment using the road should be cleared.
- Merchantable timber should be removed before construction.
- The radius on curves should be sufficient for trucks to negotiate easily.
- All cuts and fills should have side slopes that are stable for the soil or fill material involved.
- Equipment should not be operated off hard-surfaced roads under conditions that can cause the development of excessive rutting.

Grade

It is desirable and economical to keep vertical grades as low as possible and compatible with topography and property lines. Slippage of equipment can cause rutting, which can accelerate erosion and result in increased concentrated flows of sediment-laden water. Grade is positively related to slippage and should be controlled to reduce slippage.

> **Where possible, access roads should not exceed a grade of 15 percent except for short stretches of 200 feet or less where grades should not exceed 18 percent.**

Drainage

Proper drainage is the single most important factor in controlling soil erosion and keeping a road in serviceable condition. Use of drainage techniques, such as outsloping and/or the use of drainage control structures, should be completed to reduce or eliminate rill and gully erosion of the road surfaces. Techniques should also be implemented so as not to cause similar erosion to the relatively undisturbed forest floor adjacent to the road. Appendix 1 in this BMP contains specifications for drainage structures.

Outsloping

Outsloping is a drainage technique where the entire width of the road is gently sloped toward the downhill or fill bank side of the road. This technique reduces the number of drainage control structures necessary and is an effective way to drain the road surface. However, out-sloped roads can be dangerous on some soils when wet or frozen.

> **A recommended slope for this type of road is ¼ inch per foot or a 3-inch drop per 12 feet of road.**

Crowning and Turnouts

Access roads on relatively flat areas can be drained by crowning or raising the center of the roads and allowing runoff to be shed to either side onto the forest floor or into a roadside ditch. Runoff can be drained from the ditch using turnouts. Turnouts are a continuation of the ditch angled away from the road for a sufficient distance to allow runoff to dissipate onto the undisturbed forest floor. Generally, turnouts should be angled 30 degrees from the road. Keep turnout lengths to a minimum. Turnout spacing should be consistent with Table 1-1.

Drainage Control Structures

Drainage control structures are carefully constructed outsloping sections of the road that act as a water catchment and drainage channel. Use of drainage control structures, such as open or closed culverts and reverse grade structures, such as dips or water breaks, are the most common and practical methods of draining roads. Exhibits, recommended specifications, and information on culverts and reverse grade structures are included in Appendix 1 of this section. This information will help determine which structure should be used in a specific situation. General recommendations for drainage control structures include:

- **During the operation:** Heavy short-term trafficking of roads normally occurs. Proper construction and maintenance of drainage structures is critical during this time period.
- **Running water:** Culverts, either open or closed, should be used to handle running water instead of reverse grade structures.
- **Ephemeral channels:** These channels carry water during or directly after precipitation events. Blockage of ephemeral channels should be avoided where possible.
- **Permanent road use:** If permanent use of the road is anticipated by the landowner, it is desirable to install culverts of corrugated plastic or metal and/or concrete pipe or to armor and reconstruct reverse grade structures to facilitate permanent trafficking.

Drainage Control Structure Intervals

Drainage control structures should be installed at intervals appropriate to remove water from the road's surface to prevent damage and eliminate or reduce rill or gully erosion to the road or the forest floor from channelized flow. The grade of the road, soil type and moisture, and intensity and type of trafficking influence how much erosion can potentially occur on a road. Table 1-1 provides general recommended intervals for drainage control structures based on percent road grade. However, these intervals should be altered when necessary to accommodate erosive soils, microtopography features, and hydrologically active control points, such as seeps or springs.

Table 1-1—Recommended Distances between Drainage Control Structures for Access Roads

Road Grade (%)	Spacing (slope distance in feet)
2-5	300-500
6-10	200-300
11-15	100-200
16-18	100

Note: Deviations from these recommendations may be appropriate depending upon the nature of the road surface material and its tendency to erode.

Stream Crossings

Points where streams and roads intersect or where roads come in close proximity to streams have the potential to deliver sediment-laden runoff into the streams. Several general recommendations can help reduce water quality problems.

Stream Avoidance

Roads should be located as far from a stream as is practical. See BMP No. 3 "Streamside Management Zones" for recommended distance between roads and streams. Stream crossings should be avoided if possible. If a stream must be crossed, it should be crossed at right angles where possible.

Crossings

When crossings are unavoidable temporary bridges or culverts are preferable. A bridge should not be constructed if a crossing can be avoided by an alternate road location or can be constructed by less expensive means, such as a culvert.

Bridges and culverts: Where feasible, install and use bridges or culverts to cross streams (perennial and intermittent) and ephemeral channels. Where bridges or culverts are not used, roads should cross streams and ephemeral channels at right angles. Bridges should be located to cross streams at right angles to the stream and should not interfere with natural stream flow. Piers and abutments should be parallel to the direction of stream flow and should be embedded in good foundation material. The grade of the bridge should coincide with that of the road. The bridge material and design should be adequate for safety and the intended use of the bridge. Native tree species are suitable materials in most bridges that need to be constructed for timber-harvesting operations. Exhibits, recommended specifications, and information on bridges and culverts are included in Appendix 1 of this BMP. This information will help determine which structure should be used in a specific situation.

Fords: Fords should be graveled on each side where significant soil disturbance can occur. The road should be drained to prevent water from running down the road into the stream during high flows. Fill areas and disturbed banks in the vicinity of stream crossings should be stabilized promptly.

Low-water crossings: Where road construction requires low-water stream crossings, the Division of Water has developed a standard design that is typically acceptable for issuance of a floodplain permit. This design is available upon request. See the "Streams and Other Waters" section of the *Agriculture Water Quality Authority Producer Workbook* for further details.

Maintenance

Access roads, skid trails, and landings should be maintained to adequately control or significantly abate soil erosion. Maintenance of access roads to control erosion is basically a problem of water control. This requires a properly functioning drainage system and maintenance to keep the road reasonably free of ruts, berms, and debris that prevent water from flowing freely off road surfaces.

If an access road is to remain open after the removal of timber, it is advisable to keep travel to a minimum unless the surface material permits all-weather use. Periodic inspections should be performed and maintenance work done as needed.

> **It is impossible to control erosion if unsurfaced roads are used during excessively wet weather. Problem areas having steep road grades and wet areas should be logged during the most favorable weather. Inspection of road surfaces and drainage control structures is necessary during the operation.**

Road surface: Maintenance of road surface is accomplished by grading where necessary to minimize rutting. Berms developed during trafficking should be removed to allow proper drainage and decrease erosion.

Reverse grade drainage control structures: Inspection of reverse grade structures, such as water breaks, must be done often. Reconstruction and armoring of drainage control structures may be necessary to insure proper structure function.

Culverts: Inspection of both open and closed culverts is necessary. Removal of materials from the inlet of closed culverts is often necessary. Check midsections for blockage and outlets for the development of rill or

gully erosion. Rocks or other materials can be used to dissipate water flowing from culverts. Open culverts should be cleaned when necessary.

Retirement

If an access road is not to be kept open, it should be retired after completion of forest activity by smoothing and shaping road surfaces and road banks and revegetating and removing any stream crossing structures. The following guidelines should be implemented to insure proper retirement:

- **Roads should be revegetated as soon as is practicable.** See BMP No. 2 "Vegetative Establishment on Silviculturally Disturbed Areas" for recommended seeding mixes and cultural treatments.
- **Control vehicle access** on revegetated access roads until cover is established and control structures have settled.
- **Open culverts** should be removed and replaced with closed culverts or reverse grade structures. These structures should be of sufficient size to carry maximum runoff to prevent them from being washed out. See "Pipe Culvert" specification. Outsloping can also be used for the retirement of access roads.
- **Ephemeral channels** should be cleared of disturbed soil.

Skid Trails

Provisions must be made in a timber harvesting operation for the moving of products from stumps to landings or concentration yards. Skid trails, primarily those that carry enough traffic to remove the duff layer and disturb the soil surface, have the potential to erode. Low-use secondary skid trails and skid paths that support only one or a few turns do not normally have a large amount of disturbed soil or duff and are less prone to erosion. Considerable soil erosion can be prevented and lower skidding costs will result from a well-designed primary skid trail system. Cable corridors, where the lack of proper deflection allows felled trees or logs to drag, and forwarding paths should also be planned to avoid water quality problems.

Layout and Construction

Skid trail layout is affected by many of the same factors that influence the layout of roads. Topography, property lines, economic constraints, equipment limitations, and sensitive areas in the landscape often dictate approximate location and extent of the skid trail system. Common sense in applying guidelines to a specific situation is vital. The following guidelines will help facilitate skid trail construction:

- **Grades:** Keep skid road grades as low as topography will permit. Do not go straight up the slope but proceed on a slant or zig-zag path. Break the grade occasionally and avoid long, steep slopes.
- **Ephemeral channels:** Keep the number of such crossings to a minimum. Where possible use culverts,temporary bridges, or other structures at ephemeral channels.

Drainage and Maintenance

While permanent drainage control structures normally cannot be constructed while skidding is underway, drainage of active skid trails is still important.

- **Berms** allowing excessive ponding on skid trails should be periodically removed to allow adequate drainage.
- **Skidding over wet soils** can cause excessive rutting and should be avoided if possible. Excessive rutting can be practically defined as a depth exceeding the ability of the available equipment to resurface the trail.
- **Bank seeps** need drainage control structures (which can be skidded across) immediately below them.
- **Extra steep skid trails** need drainage control structures (which can be skidded across) immediately above them.
- **Temporarily unused trails** need to have drainage control structures constructed if inactive for an extended period of time to prevent rill and gully erosion.

- **Maintenance of skid trails** during harvesting operations consists chiefly of maintaining an effective drainage system to control or significantly abate soil erosion.

Stream Protection

Skidding in streams: In no case should stream beds be used as roads or for the skidding of logs except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access, or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary, stream channels may be used as roads or for skidding only for the minimum distance required.

Stream crossings: Minimize the number of stream crossings. Where crossings are needed, install and use bridges or culverts to cross streams (perennial and intermittent) and ephemeral channels. Where bridges or culverts are not used, skid trails should cross streams and ephemeral channels at right angles.

Table 1-2—Recommended Distances[1] between Water Bars for Retirement of Skid Trails

Skid Trail Percent	Spacing (slope distance in feet)
1	400
2	245
5	125
10	78
15	58
20	47
25	40
30	35
35	32
40	29

1 Actual distance between water bars will depend upon the nature of the road surface material, its tendency to erode, and hydrologically active areas, such as seeps.

Retirement

On completion of the skidding operation or a seasonal shutdown, the following steps should be taken to prevent erosion:

- **Water bars and outsloping:** Install drainage control structures, normally water bars (a reverse grade structure developed specifically for skid trail retirement). Exhibits, recommended specifications, and information on water bars are included in Appendix 1 of this BMP. Outsloping of the skid trail can also be used to minimize or permanently eliminate rill or gully erosion. See Table 1-2 for recommended intervals between drainage control structures to provide for drainage and skid trail erosion control.
- **Stream crossings:** At stream crossings, the stream beds should be cleaned of debris and restored to natural shape and grade.
- **Revegetation:** Skid trail sections having bare soil (primary skid trails) should be revegetated in a manner similar to access road retirement. See BMP No. 2 "Vegetative Establishment on Silviculturally Disturbed Areas" for details.
- **Ephemeral channels:** Remove disturbed soil or concentrated logging slash from ephemeral channels.
- **Access:** Access must be controlled or restricted on retired trails to allow settling and revegetation.

Landings And Concentration Yards

One of the most important decisions that will influence the ability of the operation to adequately control sediment-laden runoff from the road and skid trail system is the location of the landing. All roads and trails intersect at the landing. Poor landing location can lead to difficulties in the placement and construction of roads and skid trails with regards to controlling pollution from sediment-laden flows. Identification of streams and other waters should be made before establishing the landing. Placement should be made as far from streams and other waters as practical.

Construction, Maintenance, and Drainage

- **Landings should be sloped** to allow sufficient water drainage. A recommended slope for this is at least 1/4 inch per foot or a 3-inch drop per 12 feet of landing.
- **Approach roads** should have adequate drainage so that road drainage does not enter the landing area.
- **Seepage and lateral flow** that move onto landings should be diverted with appropriate ditching on the upslope side of landings to prevent erosion, rutting, and runoff problems.
- **Maintain landings** to adequately control or significantly abate soil erosion.

Stream Protection

Yards and landings should be located outside of Streamside Management Zones (SMZs) where possible. See BMP No. 3 "Streamside Management Zones" for detailed recommendations.

Retirement

After silvicultural activities are completed, log landings should be promptly reshaped, revegetated, and retired.

Revegetate landings and yards immediately following completion of activity. See specification for "Vegetative Establishment on Silviculturally Disturbed Areas."

Regulatory Requirements for BMP No. 1

(See Appendix A for descriptions)

- Construction in floodplains: (KRS 151.250)
- Filling or draining of wetlands: (U.S. Clean Water Act, Section 404)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high quality waters and outstanding national resource waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 et seq. and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 1

The producer should:

- not operate skidders or other logging equipment off hard-surfaced roads under conditions that may cause the development of excessive rutting. Excess rutting is defined as a point where ruts cannot be resurfaced with available equipment.
- construct roads and skid trails so that grades are kept to a minimum. When possible, access roads should not exceed a grade of 15 percent except for short stretches of 200 feet or less where grades should not exceed 18 percent.
- install water bars, culverts, or other drainage structures at intervals appropriate to remove water from the road or skid trail to prevent damage and erosion to the surface of the road, trail, or the forest floor from channelized flow.
- use or install bridges or culverts to cross streams (perennial or intermittent) or ephemeral channels where feasible.
- cross streams or ephemeral channels at right angles where bridges or culverts are not used.
- not leave disturbed soil or concentrated logging slash in ephemeral channels.
- locate yards and landings outside of streamside management zones (SMZs) and ensure they have adequate drainage (see minimum requirements of Silvicultural BMP No. 3).

Appendix 1
Specifications for Drainage Structures and Bridges

Drainage structures include:

- Reverse grade structures (broad-based dips, water breaks)
- Culverts (open and closed)
- Crowning and turnouts
- Outsloping

Reverse Grade Structures

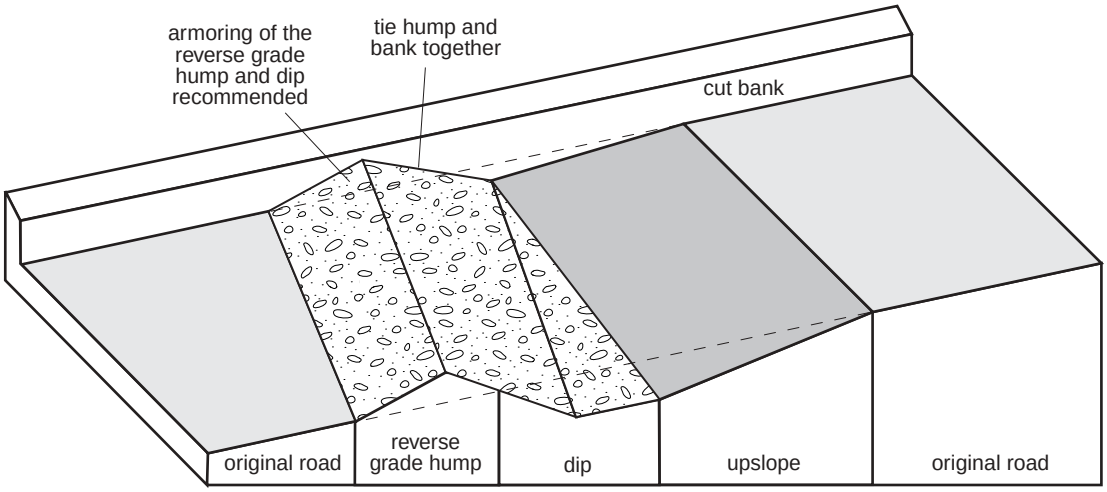
General Applications

These structures are constructed directly into the road or skid trail base using the soil from the road or trail surface. They are designed to stop the downgrade movement of water along a road surface and release the concentrated flow onto the undisturbed forest floor. They generally should not be used when running water from uphill sources, such as that associated with ephemeral channels, crosses the road. In these cases culverts or bridges should be used. Several common names exist for reverse grade structures, including water bars, waterbreaks (both shallow and deep), and broad-based dips, to name a few. Water bar and deep water break are the names commonly used for reverse grade structures used to permanently retire skid trails. Shallow water breaks and broad-based dips are designed to be trafficked during a harvesting operation or as part of forest management activities. Reverse grade structures are used for three different applications:

- **Access Roads:** Used to support log truck traffic.
- **Permanent Access Roads:** For use after the harvesting operation where medium-weight vehicles will need to be supported.
- **Skid Trail and Road Retirement:** For the closing of trails and roads that will not be trafficked.

The exact dimensions for these structures will depend on the application for which they are being used as well as the soil conditions, installation equipment, trafficking requirements, and microtopography. While the dimension of these structures can vary, they all contain three components as shown in Figure 1-1.

Figure 1-1. Typical Reverse Grade Structure



The **dip** is constructed below the level of the original grade of the road. The bottom of the dip is normally slanted downgrade to ensure that the outlet side is lower than the side tied to the cut bank or upslope side of the road or trail. Slanting of the dip across the road ensures that the outlet side is lower than the inlet or uphill side. The slant or angle of the dip depends on the application for the control structure.

The **hump** is constructed tall enough to maintain itself during hauling. For reverse grade structures used on retired skid trails, the hump must be tall enough to withstand off-road vehicle traffic. It should also be long enough to allow the safe movement of loaded log trucks. Note that the base of the hump is actually below the original grade of the road or trail. This normally provides a relatively compact soil at the bottom of the hump, helping it to withstand the erosive force of the water moving through the dip.

The **upgrade section** can be constructed over a distance long enough to facilitate movement of loaded log trucks, or it can be almost nonexistent in the case of such structures as water bars for the retirement of skid trails.

Providing Adequate Out-flow Protection

Care should be taken to ensure that there is adequate drainage at the outflow of the dip and that there is an adequate buffer zone to allow filtering of the discharge. The discharge area should be protected with stone, grass sod, heavy litter cover, brush, logs, or anything that will reduce the velocity of the water. Natural litter may be adequate in many cases if the terrain is not too steep. In cases were an adequate buffer zone is not available, sediment traps should be used. These can take several forms, such as small narrow sediment impoundments, consisting of 1- to 3-foot wide and deep trenches, or silt fences or barriers. These must be checked and maintained.

Specific Applications

Access Roads

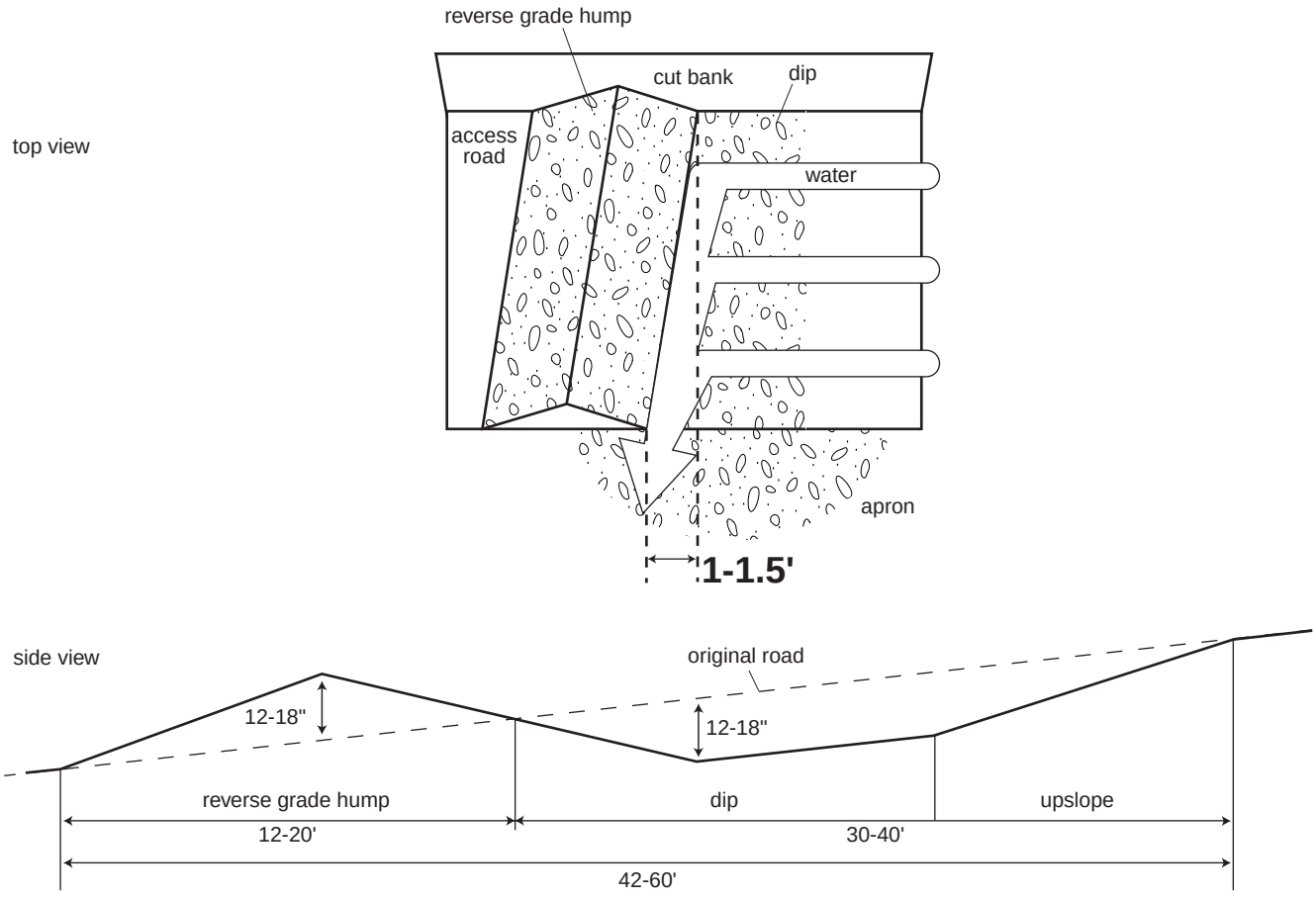
In this application the structures are used for controlling runoff during the harvesting operation. The exact design must be capable of supporting truck traffic during the harvesting operation, as well as consider the available installation equipment, soils, and microtopography. In all cases structures used for this application must be checked at frequent intervals and repaired when necessary. Failures usually occur because of rutting of the dip and hump.

Armoring reverse grade structures with crushed rock or gravel is helpful in increasing the life and effectiveness of the structure.

Gentle grade: Some specific design criteria have been developed for reverse grade structures for access roads, such as the broad-based dip. These design criteria were developed to support safe and efficient movement of large tandem axle and tractor-trailer trucks and to insure mitigation of erosion from the road surface. They do not increase wear on vehicles or significantly reduce hauling speed when properly installed. Recommended specifications are shown in Figure 1-2.

This particular structure is long and as such is limited to relatively low-grade roads (less than 10 percent). Constructing a reverse grade structure to these criteria on grades greater than 10 percent causes an increase in the grade of the road directly below the structure, which can result in trafficking problems.

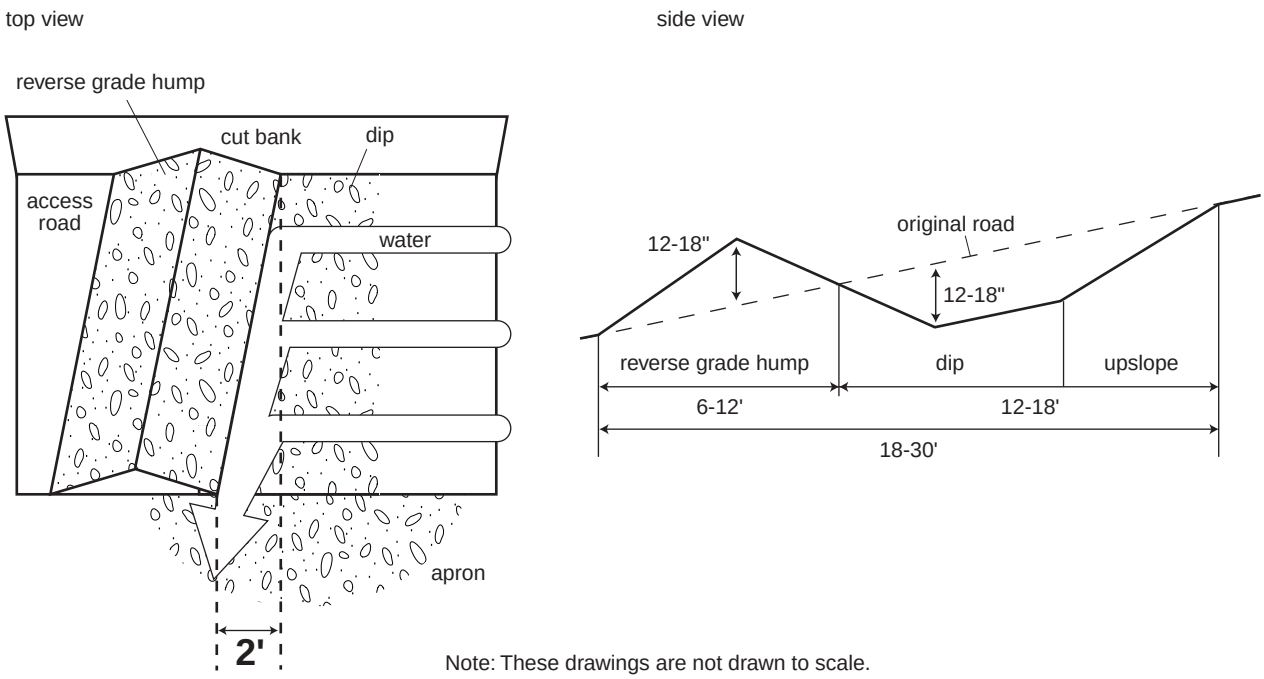
Figure 1-2. Reverse Grade Structure for Large Trucks.



Note: These drawings are not drawn to scale.

Steep grade: As road grades increase more than 10 percent, generally a shortening of the structure is needed. Both the upgrade section and the hump need to be shortened without sacrificing the integrity of the dip and hump. Figure 1-3 provides general dimension recommendations for reverse grade structures for roads with grades more than 10 percent:

Figure 1-3. Reverse Grade Structure Used on Steeper Grades

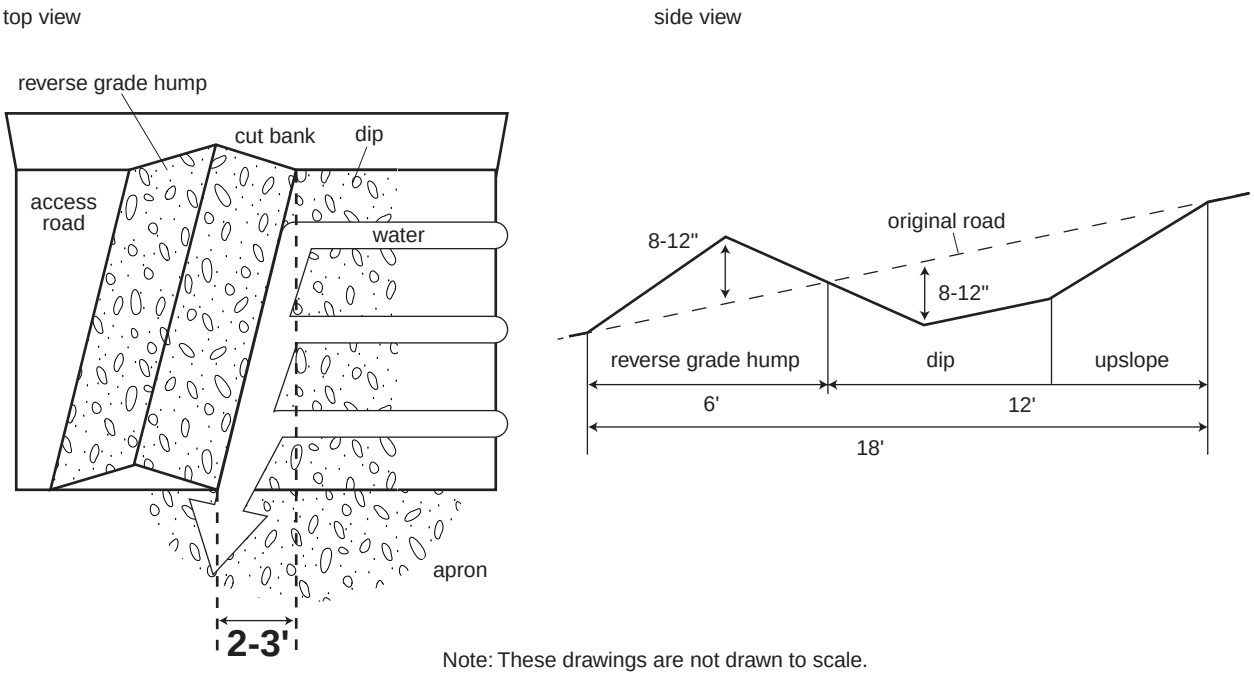


Note: These drawings are not drawn to scale.

Permanent Access Roads for Use after the Harvesting Operation

For this type of use, reverse grade structures must control runoff from woods roads that will be permanently used for light traffic, such as pickup trucks, ¾ ton vehicles, or farm tractors and wagons. Figure 1-4 shows recommended specifications for this application.

Figure 1-4. Reverse Grade Structure for Light Traffic (Water Break Structure)

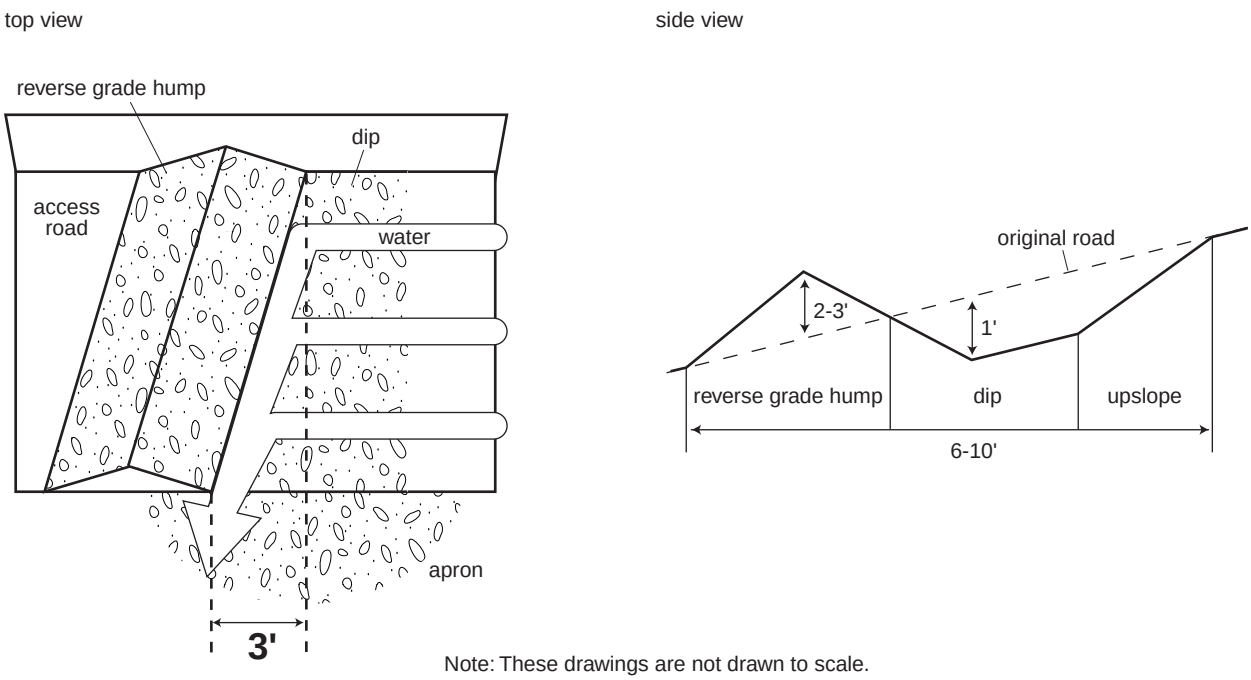


Note: These drawings are not drawn to scale.

Skid Trail and Road Retirement—Water Bars

For permanently controlling runoff on trails and roads that will not be trafficked, the deep water break or water bar is normally recommended. The dimension of these structures, having a pronounced hump, usually precludes the trafficking by most vehicles. Appropriate design criteria are shown in Figure 1-5. It is difficult to construct to these specifications with a wheeled skidder; bulldozers are most commonly used. It is best to start at the end of the road or trail and work out so that the breaks are not damaged by frequent crossing of machinery.

Figure 1-5. Reverse Grade Structure for Skid Trail Retirement (Deep Water Break or Water Bar)



Note: These drawings are not drawn to scale.

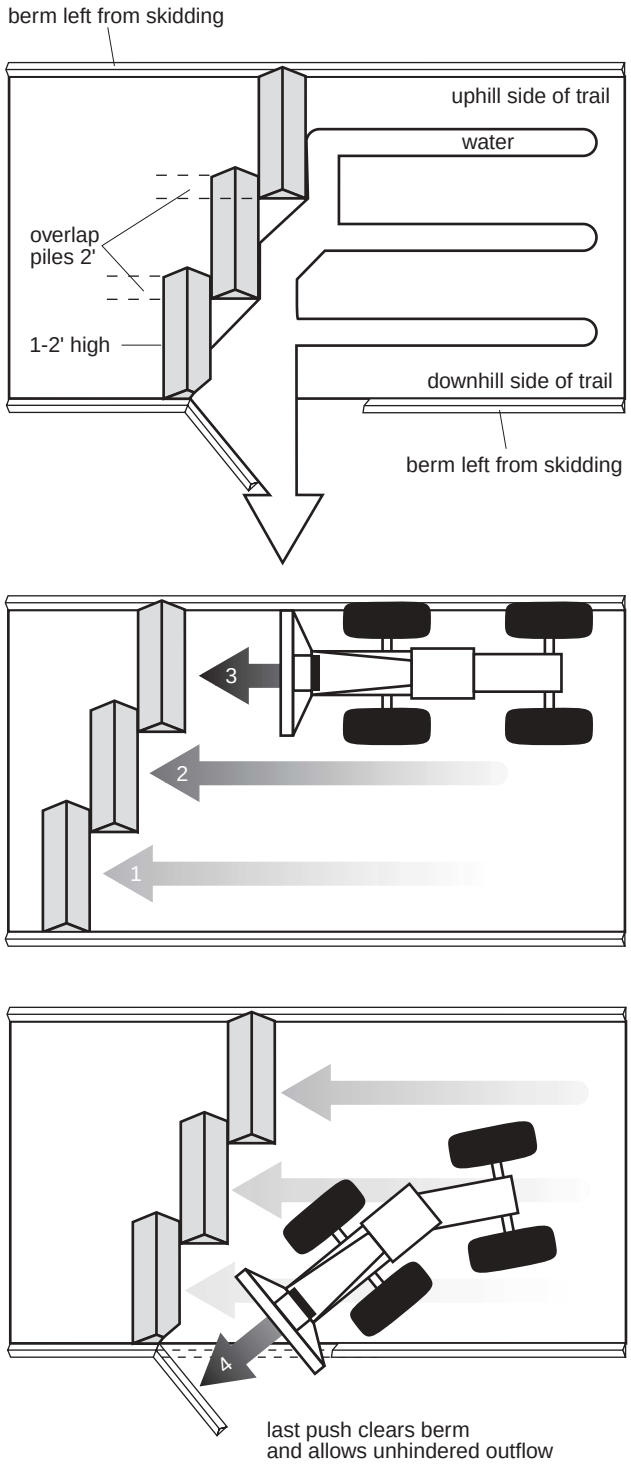
As a **supplement** to water breaks, logging slash can be lopped, scattered, and must be embedded and/or grass planted on roads and trails that will be closed. Water breaks should be installed at about a 30-degree angle down slope. The outflow end of the water break must be open to keep water from accumulating and be protected by a buffer or filter zone to clean the sediment out of the water and prevent erosion.

Skid Trail and Road Retirement—Skidder Bars

Deep water bars are designed to be installed with a dozer. Often when wheeled skidders attempt water bar construction, critical design criteria can not be met. The **skidder bar** has been designed as an an alternative structure. Figure 1-6 shows the sequence of pushes used to create the skidder bar as well as the design specifications.

This structure is developed from a series of 1- to 2-foot tall piles. These piles are developed by the skidder scraping surface soil. Do not attempt to dig the dip below the hard packed surface of the trail. Overlapping the piles is critical to prevent leakage. The final push clears the berm to allow drainage.

Figure 1-6 Skidder Bar Construction.



Culverts

Culverts are both open-faced and closed. Closed culverts include the use of pipes and hollow logs. Open-faced culverts are open to the air and are constructed from wood or cement.

Closed or Pipe Culverts

Closed culverts include the use of the following materials:

- Metal pipes (normally corrugated pipe)
- Plastic pipe (both single-walled [corrugated] and double-walled [smooth on the inside])
- Cement
- Hollow logs

Pipe culverts are used for the following two applications:

- To channel water under roadways from uphill drainages, such as ephemeral channels, seeps, and small streams (metal, plastic, and hollow logs can be used for this application)
- As a drainage control structure on a road to handle runoff associated with the road surface and the cut bank (metal and plastic pipes are recommended for this use).

Drainage of Active Uphill Water

A culvert inlet should be placed on the drainage level and as near as possible to natural drains including ephemeral, channels and intermittent, or perennial streams (Figure 1-7). In some instances, where the culvert level has to be lower than the drainage gradient, a drop box can be constructed. This box is a place for sediment to settle out and needs close maintenance.

Figure 1-7. Closed Culvert in a Ephemeral Channel

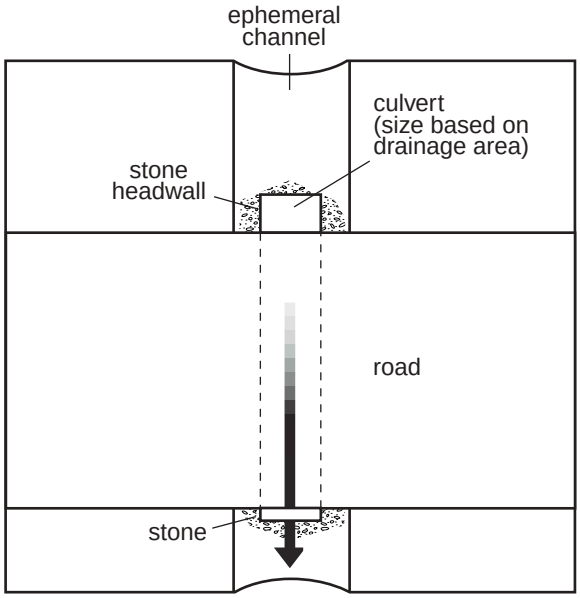


Table 1-3—Recommended Pipe Diameters for Streams and Ephemeral Channels

Area above Pipe (acres)	Recommended Pipe Diameter (inches)
2	12
4	15
7	18
12	21
16	24
27	30
47	36
64	42
90	48
120	54
160	60
205	66
250	72
350	78

During construction, place the culvert on firm ground and compact the earth at least halfway up the side of the pipe to prevent water from leaking around it. Adequate cover is needed; the rule is a minimum of one foot or one-half the culvert diameter, whichever is greater. If adequate cover cannot be achieved, then an arch pipe (squashed pipe) or two smaller culverts should be installed. The cover must also be compacted to prevent settling in the road. If erosion of the inlet end is a problem, a head wall must be provided. Sandbags, with some cement mixed with the sand, durable logs, concrete, or hand-placed riprap are suitable. The length of the culvert on the outlet end should be sufficient to avoid washing fill.

It is suggested that 12-inch pipe be the smallest used. Table 1-3 shows the culvert diameter recommended for particular drainage areas. These recommendations apply for shallow soils with frequent rock outcrops.

A Special Note on Hollow Logs

Hollow logs can be used for this application. However, they will have a shorter life span than metal or plastic and should not be used in a permanent situation. The following guidelines will help extend the life and effectiveness of hollow logs:

- **The butt or bottom end** of the log should be placed downstream, which will avoid premature obstruction within the log.
- **Use several logs** if possible to increase the capacity and allow flow if one becomes obstructed.
- **Provide adequate soil coverage** to avoid collapse under normal traffic conditions.
- Use **oversized** logs relative to the size recommended for metal or plastic culverts.

Culverts for Road Drainage

Closed culverts can be used as drainage control structures on roads (Figures 1-8 and 1-9). Particular attention should be given to culvert depth. A box made from natural stone can be used to help keep the inlet end of the culvert open. Do not allow the outlet end of the culvert to extend more than one foot beyond the edge of the road. Extension of culverts may cause outlets to be excessively high. This may accelerate erosion of the forest floor. Natural stone can be used to mitigate this erosion.

Figure 1-8. Closed Culverts for Road Drainage.

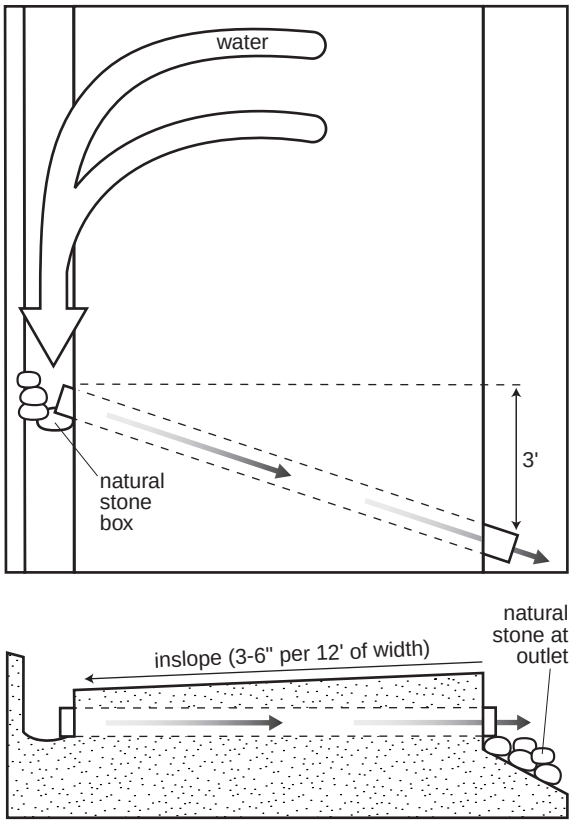
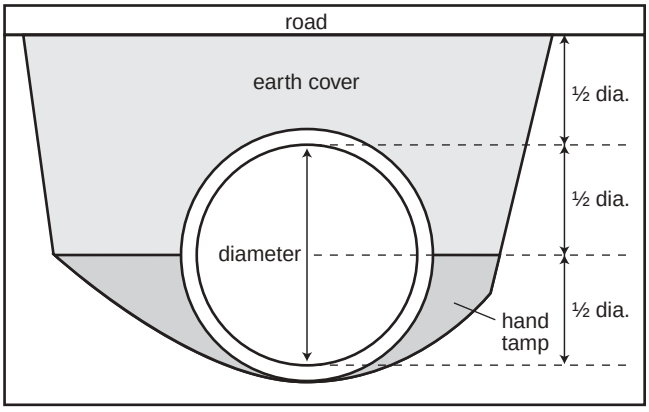


Figure 1-9. Cross-Sectional View of a Closed Culvert.



Open Top Culverts

This type of culvert is used on low-cost logging roads and is usually constructed from lumber logs (pole culverts, Figure 1-10) or lumber (box culvert, Figure 1-11). They can fill quickly when used on a newly disturbed access road where trafficking is high. They are less prone to fill when placed in roads that have settled. They are advantageous for forest owners because they can be constructed and installed by hand. When properly installed and maintained, these culverts will adequately drain small sources of water, such as seeps and springs. Log skidding tends to damage and plug them up, making them ineffective for water control on skid trails. Box culverts can also be damaged by bulldozer cleats. They must be cleaned frequently, even on haul roads, to be effective. Open top culverts should be installed at a 30-degree angle downgrade.

As with other water diversion methods, the discharge area should be protected to prevent erosion and enable sediment to settle out. See Table 1-1 for recommended distances between open top culverts on access roads.

Figure 1-10. Overhead View of Pole Culvert Showing Spacers

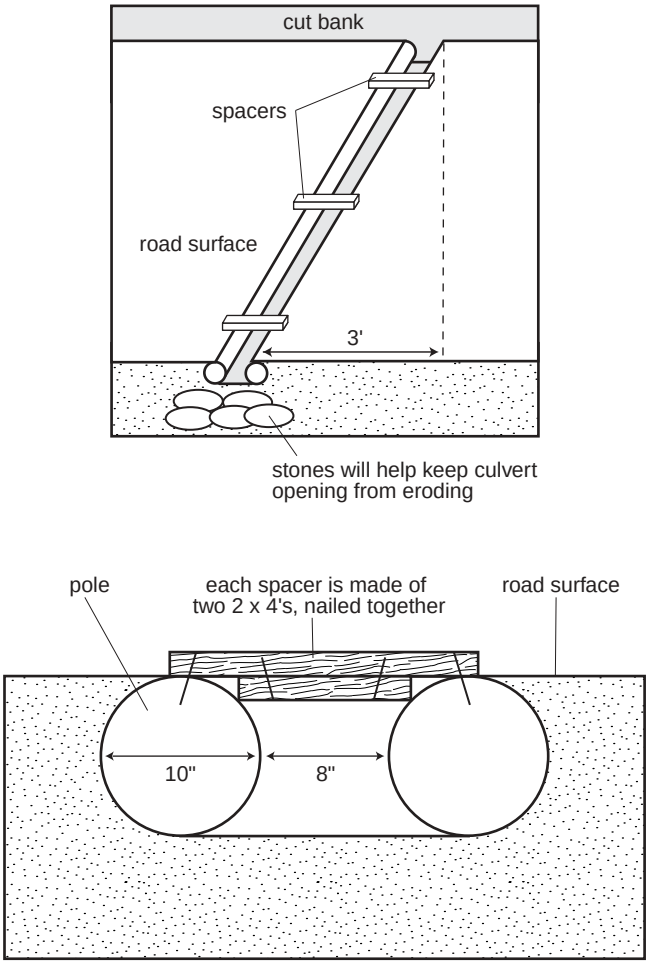
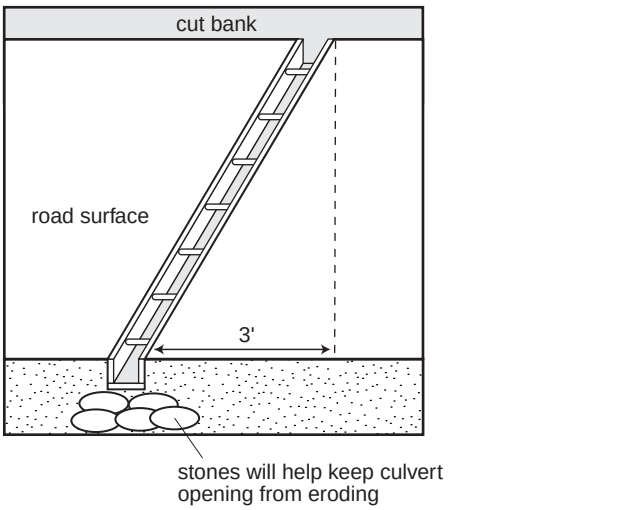
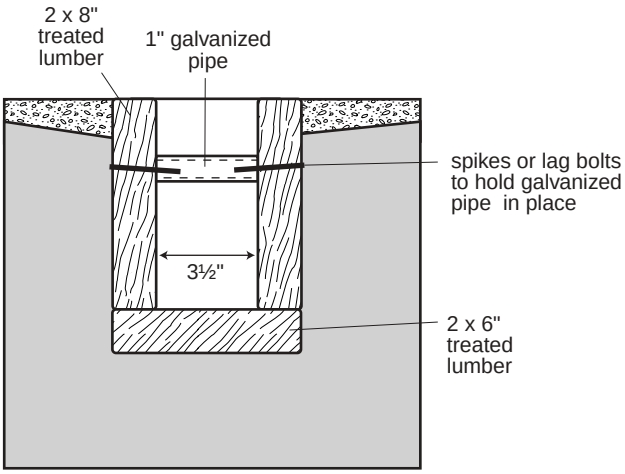


Figure 1-11. Box Culvert

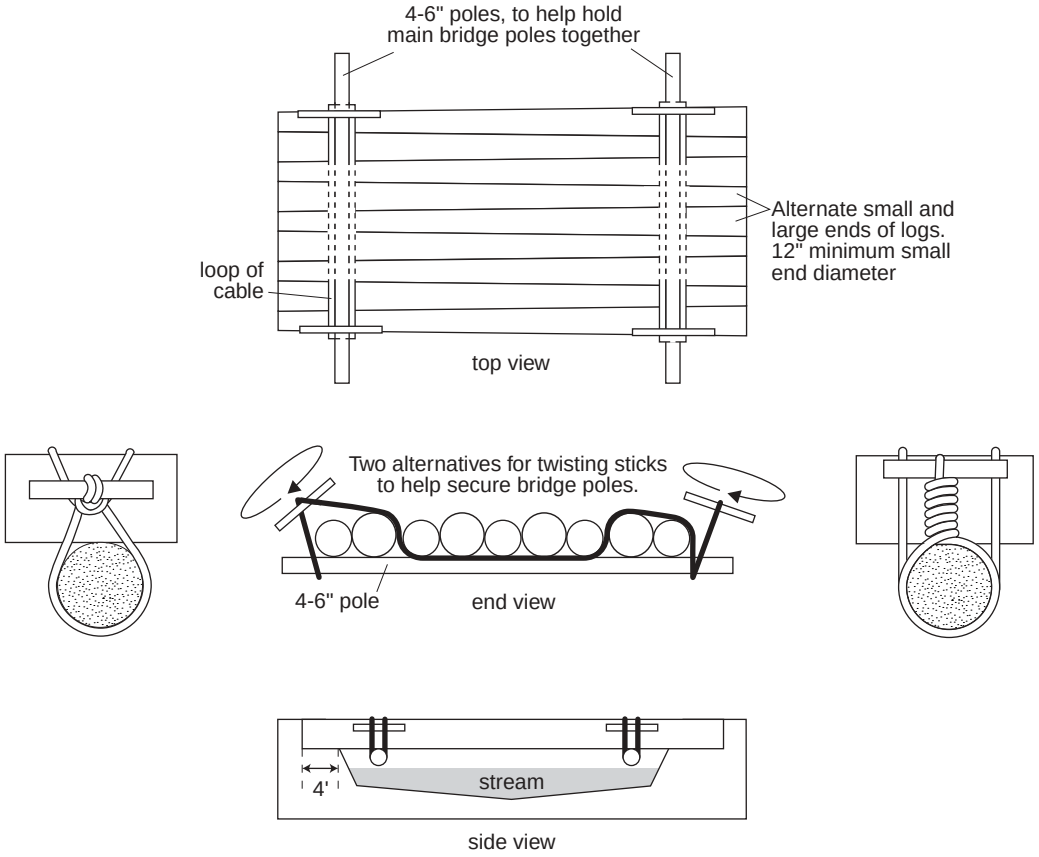




Bridges

Bridges are excellent choices for minimizing nonpoint source pollution associated with crossing both perennial and intermittent streams, as well as ephemeral channels. Bridges have been made out of a variety of materials, and some commercially available portable bridges can be used effectively for skidding. Figure 1-12 shows the design criteria that can be used for a bridge made from small-diameter logs. As with all bridges, the integrity and the safety associated with the approach is critical, as well as the ability to maintain traction when the surface is wet or frozen.

Figure 1-12. Temporary Log Stringer Bridge



BMP 2

Vegetative Establishment on Silviculturally Disturbed Areas

Purpose

Vegetative establishment of herbaceous cover is used to stabilize the soil and reduce damage to downstream areas from sediment and runoff from silvicultural disturbed areas. Vegetative establishment can also be used to improve wildlife habitat and enhance natural beauty. Vegetative establishment is needed on sediment-producing, erodible, or severely eroded areas, such as logging roads, skid trails, and log landings.

Definitions

Herbaceous cover includes a mixture of annual and perennial herbaceous species, primarily grasses and legumes. This BMP uses both temporary species and permanent mixes to revegetate disturbed areas. **Temporary cover species** are those that come up quickly and vigorously and act to provide a rooting mass until the permanent mixtures take hold. **Permanent mixes** are a combination of grass and legume species that are compatible and will establish themselves and grow for a number of years on a site until natural seeding can occur. Many of these mixes can also be maintained indefinitely through mowing or other practices. **Silviculturally disturbed areas** include all areas where the duff layer has been removed leaving the bare mineral soil, such as access roads, primary and some secondary skid trails, and landings. Areas that have been harvested and will be naturally regenerated or where artificial regeneration efforts will be undertaken are generally not considered in this BMP.

Specifications

These specifications contain guidelines useful for the planned treatment of an area, based on an evaluation of conditions and needs of the area. Some areas may not be stable due to soil slippage, water movement, or excessive sediment production. Therefore, additional practices may be required in combination with this vegetative practice to effectively stabilize soil. Also, the selection of plant species and methods of establishment are important considerations for adequate establishment of desired vegetation.

Revegetation should be sufficient to adequately control or to significantly abate potential soil erosion from the site and should be established according to generally accepted agricultural principles.

Preparation of the Site

- Grade the area to be vegetated as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulching, and maintenance.
- Seedbed preparation is generally needed. This can be accomplished using such standard agricultural practices as disking. In cases where this is not practical and the soil surface is glazed or crusted, the surface should be scarified or otherwise roughened before lime, fertilizer, and seed are applied.

Soil Amendments

Fertilizer and Lime

Applications of fertilizer and lime are recommended. A soil test can be used to determine fertilizer and lime requirements or, in lieu of a soil test, apply fertilizer and lime at rates sufficient to provide adequate vegetative cover, considering site conditions and species of plants.

> **General Fertilizer and Lime Recommendation:**
> Usually a minimum rate of 70 to 80 pounds of nitrogen (N), 120 pounds of phosphorus (P_2O_5), and 120 pounds of potassium (K_2O) per acre is adequate. For native grasses, a maximum of 40 to 50 pounds of nitrogen should be applied at planting to avoid excessive competition. Where the need is indicated, 2 or 3 tons of agricultural ground limestone per acre are generally adequate.

Application of an additional 100 pounds per acre of ammonium nitrate later in the season on areas low in organic matter and fertility will enhance vegetative growth. Additional nitrogen, where needed, should also be applied to native grasses the first year after stands are recognizable and moisture is available. Apply nitrogen thereafter when warm season growth begins in the spring.

Work the fertilizer and lime into the soil to a depth of 4 to 6 inches, if possible, with a harrow, disk, or rake, operated across the slope. See Appendix 1 in this BMP to determine the amount of land area where application is needed.

Mulch

Mulch materials should be applied primarily to disturbed areas that are steep, eroding, or are difficult to vegetate to conserve moisture, prevent surface compaction, and reduce runoff and soil erosion (Table 2-1). Mulch materials can be applied by any method that will give even distribution of materials, such as by hand, mulch-blowing machine, or hydraulic-seeding machine.

Table 2-1—Mulching Materials, Rates, and Uses

Mulch Material and Quality	Rate Per 1000 Sq. Ft.	Acre	Remarks
a. small grain straw, tall fescue straw or hay	75-100 lbs. (1½-2 bales)	1½ tons (60-80 bales)	Spread uniformly. Leave 10-20% of the area exposed. Subject to wind blowing unless left moist or tied down.
b. wood fiber cellulose air-dried, non-toxic, and no growth inhibiting substances	37-41 lbs.	1600-1800 lbs.	Apply with a hydro-mulcher. No tie-down is required. Packaged in 100 lb. bags.
c. tree bark air-dried, non-toxic and no growth inhibiting substances		6-12 tons	Resistant to wind blowing. Decomposes slowly.

See Appendix 1 in this BMP for determination of land area were mulching is needed.

Plant Selection

Revegetation should be accomplished using both:

- **Temporary cover crop species**
- **Permanent species mix**

The tables in this BMP provide the recommended seeding rates and seeding dates, as well as specific considerations, such as light requirements for temporary species and permanent mixes. Each table contains recommendations for different environmental or operational situations. Select a table that is most suitable for the particular situation encountered.

- **Table 2-2. Temporary Species.** Select one of these species to be used in conjunction with a permanent mix.
- **Table 2-3. Permanent Mixes for Slopes Less than 10 Percent**. These are grass and legume mixes that can be successfully established on relatively gentle slopes where erosion potential is not extreme. Generally these mixes are suitable for wildlife use. Mix "e" contains native species.
- **Table 2-4. Permanent Mixes for Slopes Greater than 10 Percent**. These mixes are designed to be effective in establishing themselves on sites where the erosion potential is high. Mixes that contain KY 31 tall fescue are not compatible with a number of wildlife species; however, these mixes do have the ability to aggressively establish themselves under conditions where other grass-based mixtures might fail.
- **Table 2-5. Permanent Mixes for Wet or Poorly Drained Areas**. These species have the ability to establish themselves in wet soils. Note that switchgrass is native but must receive full sunlight to thrive.
- **Table 2-6. Permanent Mix for Establishing Native Species**. This mix provides an option for the establishment of native warm season grasses. Please note that the full development of the species in this mix takes several years, and generally good seedbed preparation and full sunlight are needed. Caution should be exercised to ensure that these conditions can be met. Due to the relatively long establishment time, it is not recommended that this mix be used on areas that have a significant erosion potential.

How to Use the Tables

- **Species:** The species or mixes in **boldface type** have been shown to be the most effective in each table as defined by establishment success and growth in agronomic and wildlife planting situations.
- **Seeding Dates**: In the case of the permanent mixtures the seeding dates are for the mixture and not for each species. For example: the seeding dates in Table 2-2 recommend that mixture "a" be seeded between February 1 and May 1 or between August 1 and October 15.
- **Seeding Rates:** Lbs/acre/pls refers to "pounds per treated acre of pure live seed." Information on the germination percentage or some other measure of the amount of live seed will be provided with some species. The seeding rates in these tables are based on 100 percent of the seed being viable. Make the appropriate adjustment in seeding rates if germination percentage is significantly below this (see Appendix 1 in this BMP).
- **Special Considerations:** Some mixes have special light requirements or restricted seeding dates. Consider these special needs when selecting a mix.

Seeding Outside the Recommended Seeding Dates

When seeding must be accomplished outside of the recommended seeding windows, it is recommended that seeding rates be increased by 50 percent and mulch be used.

Temporary Cover Crop Species

The primary temporary cover crop species are winter wheat, rye (grain rye), and spring oats. Other species listed in Table 2-2 can also be used at the recommended rates and times. Footnotes provide important explanatory comments. All legume seed should be inoculated using the proper inoculant.

Permanent Mixes

Tables 2-3 through 2-6 below list permanent species options for revegetation plant selection based on specific site conditions. Each mixture in these tables should be mixed with a temporary species. The mixes in **boldface type** have been shown to be the most effective in each table as defined by establishment success and growth.

Table 2-2—Temporary Cover Crop Species

Species	Seeding Rates (lbs/ac/pls[1])	Recommended Seeding Dates
winter wheat[2]	35	Oct. 15 - March 1
grain rye	35	Oct. 15 - March 1
spring oats	35	Oct. 15 - March 1
foxtail millet	12	May 1 - July 15
Japanese millet	15	May 1 - July 1
pearl millet	10	May 1 - July 1
annual ryegrass	5	Aug. 1 - Oct. 15
browntop millet	15	May 1 - July 1
cereal rye (Aroostook)	25	Sept. 15 - Oct. 15

1 pls: pure live seed (see Appendix 1 in this BMP).

2 Species in **boldface type** are primary recommendations.

Table 2-3—Mixtures for Slopes Less than 10 Percent

Species Mixture		Seeding Rates (lbs/ac/pls[1])	Seeding Dates for Mixture[2]	Special Considerations
a.	**orchard grass[3]**	8	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	red clover	6		
b.	**orchard grass**	8	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	ladino clover	2		
c.	timothy	4	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	ladino clover	2		
d.	**orchard grass**	10	Feb. 1 - May 1	No fall planting due to lespedesa
	Kobe or Korean lespedesa	10		
e.	switch grass	1	May 1 - June 30	For open canopy conditions only. A good seed bed is required. No fall planting due to lespedesa.
	big bluestem	2		
	indiangrass	2		
	red clover	4		
	Korean lespedesa	5		
f.	little bluestem	3	May 1 - June 30	No fall planting due to lespedesa
	side-oats gramma	3		
	Korean lespedesa	5		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 1 and May 1 or between August 1 and October 15.

3 Mixes in **boldface type** are primary recommendations.

Table 2-4—Mixtures for Highly Erodible Areas (Areas Exceeding 10 Percent Slope)

Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2] for Mixture	Special Considerations
a. Kentucky 31 fescue	30	Feb. 1 - May 15 Aug. 1 - Oct. 15	High seedling and plant vigor on droughty, exposed sites. The endophyte-free fescue is more valuable for wildlife and is acceptable on lesser slopes.
flatpea[3]	30		
b. Kentucky 31 fescue	30	Feb. 1 - May 15 Aug. 1 - Oct. 15	High seedling and plant vigor on droughty, exposed sites. The endophyte-free fescue is more valuable for wildlife and is acceptable on lesser slopes.
birdsfoot trefoil	10		
c. creeping red fescue	20	Feb. 1 - May 15 Aug. 1 - Oct. 15	**For use in shaded areas.**
white clover	2		
d. switch grass	8	May 1 - June 30	For open canopy conditions only. Switch grass is a native.
partridge pea	5		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 1 and May 1, or between August 1 and October 15.

3 Mixes in **boldface type** are primary recommendations.

Table 2-5—Mixtures for Wet or Poorly Drained Areas

Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2]	Special Considerations
a. **redtop**	7	Feb. 15 - June 30 Aug. 1 - Oct. 1	
alsike clover or **birdsfoot trefoil**[3]	6		
b. switch grass	8	May 1 - June 30 Aug. 1 - Oct. 1	For open canopy conditions only.
alsike clover or birdsfoot trefoil	6		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 15 and June 30, or between August 1 and October 1.

3 Mixes in **bold face type** are primary recommendations.

Table 2-6—Mixtures for Establishing Native Species

Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2]	Special Considerations
a. switch grass	2.0	May 1 - June 30	For open canopy conditions only.
indiangrass	2.0		
big bluestem	1.5		
little bluestem	1.5		
partridge pea	5.0		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 1 and May 1, or between August 1 and October 15.

Regulatory Requirements for BMP No. 2

(See Appendix A for explanations)

- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resource waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 2

The producer should:

- revegetate sediment-producing, erodible, or severely eroded areas, such as logging roads, skid trails, and log landings, as soon as possible. Revegetation should be sufficient to adequately control and to significantly abate erosion from the site. For the purpose of this minimum requirement, erodible areas include those with slope equal to or greater than 10 percent.

Appendix 1
Determining the Amount of Seed Needed on Roads and Trails

Multiply the appropriate acre figure times the pounds/acre that is recommended in seed mixtures. For example:

1500-foot-road length of 12-foot-wide access road was produced. According to the table this area = 0.41 acres. The recommended seeding rate for winter wheat is 35 lbs/ac. The total amount of seed that is needed is 35 lbs/ac times 0.41 acres = 14.35 lbs.

Determining the Amount of Acreage in Other Areas

To determine acreage and pounds of seed for other areas, such as log landings or denuded areas, use the following procedure:

1. Measure the width across the area in several locations and determine the average width.
2. Measure the length of the area in several locations and determine the average length.
3. Multiply the average width by the average length to get the square feet of disturbed area.
4. Divide the square feet of disturbed area by 43, 560 feet/acre to get the acreage of the area.
5. Multiply the acreage of the area by the recommended amount of seed per acre to determine the amount of seed required.

Table 2-7—Road and Trail Surface Area Determination for Fertilizer, Seed, Lime, and Mulch

Road Length (feet)	Road Width (feet)				
	8	10	12	14	18
	acres				
50	.01	.01	.01	.02	.02
100	.02	.02	.03	.03	.04
250	.05	.06	.07	.08	.10
500	.09	.12	.14	.16	.21
750	.14	.17	.21	.24	.31
1000	.18	.24	.28	.32	.41
1500	.28	.34	.41	.48	.62
2000	.36	.48	.56	.64	.83
5000	.92	1.15	1.38	1.16	2.07
5280	.97	1.21	1.45	1.70	2.18

Pure Live Seed is determined by multiplying percent germination by percent purity. Divide result into recommended pounds of seed per acre, which gives the bulk seed needed. For example: fescue can have 98 percent purity, 80 percent germination. To seed 40 lbs/ac of pure live seed, the procedure would be:

Multiply 0.98 purity by 0.80 germination = 0.784

Divide 40 lbs/ac by 0.784 = 51 lbs needed

BMP 3

Streamside Management Zones

Purpose

Streamside Management Zones (SMZs) are used to maintain natural environments in streams by maintaining the integrity of the streambank, reducing the amount of sediment entering the water by minimizing soil disturbance and filtering overland flow, and in the case of perennial streams by maintaining shade on the stream.

Definitions

Streamside Management Zones (SMZs) are strips of woodland located adjacent to perennial or intermittent streams where silvicultural activities will occur. SMZs are also commonly used where lakes and ponds exist near logging areas. **Perennial streams** are streams that flow throughout the year. **Intermittent streams** flow continuously only during the wet portions of the year and in response to rain events. Both perennial SMZs and intermittent SMZs require protection of the stream bank and channel and of the adjacent strip of forest land. **Stream canopy cover** is defined as that portion of the canopy providing shade to the stream and is maintained along perennial streams. As a general rule these guidelines do not apply to watercourses that flow only in direct response to precipitation (e.g., ephemeral channels). However, protection of ephemeral channels, as determined necessary, can also benefit water quality in a comprehensive watershed management scheme. **Coldwater Aquatic Habitats** (CAHs) are identified by the Kentucky Division of Water as those bodies of water having the potential to carry trout. These waters receive greater protection than **Warmwater Aquatic Habitats** (WAHs), which include the majority of our streams.

Specifications

SMZs are maintained to help provide a stable ecosystem adjacent to the stream and to provide shade to perennial streams to moderate and stabilize water temperature. They are also extremely valuable in providing a filtering area where runoff can be dispersed and sediment and other nonpoint source pollutants can be removed before entering the main body of water. Management for timber, wildlife habitat, recreation, and aesthetics is normally compatible with SMZ objectives as long as stream canopy cover and adequate ground cover are maintained. Silvicultural activities, including periodic harvesting, thinnings, timber stand improvement, and other practices that alter canopy cover are acceptable to maintain the vigorous growth of vegetation and to provide the necessary replacement of ground litter on the forest floor essential to adequate filtering.

General Recommendations for Timber Harvesting and Silviculture Operations

- **Concentrated flows**, such as flows from road culverts, when directed into an SMZ should be dispersed as much as possible to assure adequate infiltration.
- **Roads and the skidding of logs** should avoid the stream bed except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access, or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary,

stream channels can be used as roads or for skidding only for the minimum distance required.

- **Roads and log landings** should not be located in SMZs and should be placed as far away from streams as practical.
- **Tops or other logging debris** that can block perennial and intermittent streams should be removed or placed so they will not cause a blockage.
- **Logging equipment and vehicles** should not be operated in SMZs except at designated crossings to minimize disturbing the forest floor and to protect the banks of streams.
- **Winching** is the preferred method of removing logs from an SMZ.
- **Equipment fluids** should not be drained near streams, and logging equipment should not be parked near stream banks where direct runoff of pollutants from equipment into the stream is likely to occur.
- **Livestock** should be excluded from SMZs except for designated crossings and at watering sites. See BMP No. 11 for other livestock considerations.
- Use of **fertilizers, herbicides and other pesticides** in SMZs is generally undesirable, and they should only be applied in strict compliance with label directions for application near bodies of water. Fertilizers and pesticides should be applied in SMZs only in compliance with silviculture BMPs 7 and 8, respectively.

Streamside Management Zone Specifications

Specifications for SMZs include:

- The width and amount of stream canopy cover, and
- The distance of roads, trails, and landings from the stream or body of water.

Recommended specifications for the widths and density of stream canopy cover and the distance of roads, trails, and landings are based upon the slope percent of the ground and the type of water body. Table 3-1 provides a summary of these specifications by type of water body.

Table 3-1—Summary of Streamside Management Zone Minimum Criteria

Water Body Type	% Remaining Canopy Trees	Width of Trees (ft)	Distance to Disturbed Ground (ft)
Perennial			
WAH[1] < 15% slope	50	25	variable based on slope %[3]
WAH > 15% slope	50	55	variable based on slope %[3]
CAH[2]	75	60	variable based on slope %[3]
Streams and sloughs in wetlands	50	50	50
Intermittent	0	0	25/5/5[4]

1 WAH: Warm-water aquatic habitat

2 CAH: Cold-water aquatic habitat

3 Refer to Table 3-2.

4 25/5/5: 25 feet distance on flat ground, which increases 5 feet for every 5 percent increase in slope (refer to Table 3-3).

Perennial Streams

Stream Canopy Cover

Width and Amount of Trees for WAHs (excluding wetlands)
In areas adjacent to perennial streams, lakes, and ponds, stream canopy cover should be maintained for a minimum surface distance of 25 feet on ground with less than 15 percent slope and a minimum surface distance of 55 feet on ground with slope of 15 percent or greater. At least 50 percent of the original tree overstory (canopy cover) should be retained to shade the water and maintain water temperature (Figure 3-1).

Disturbed Ground

Distance of Disturbed Ground from WAHs (excluding wetland)
Equipment operation should be avoided in a zone of at least 25 feet on each side of a perennial stream on flat ground except for designated crossings. Erosion potential from steep slopes and unstable soils can require a width greater than this, as determined by slope percent (Figure 3-1).

Management activities are acceptable in SMZs; however, equipment operation should be avoided except at designated crossings. Table 3-2 provides the minimum recommended distances for roads, trails, and landings to perennial warm and cold water aquatic habitat streams. Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances but should be constructed to protect water quality. Tops or other logging debris that can block perennial streams should be removed and/or placed so they will not cause a blockage.

Figure 3-1. Streamside Management Zone Criteria for Perennial Warmwater Aquatic Habitats

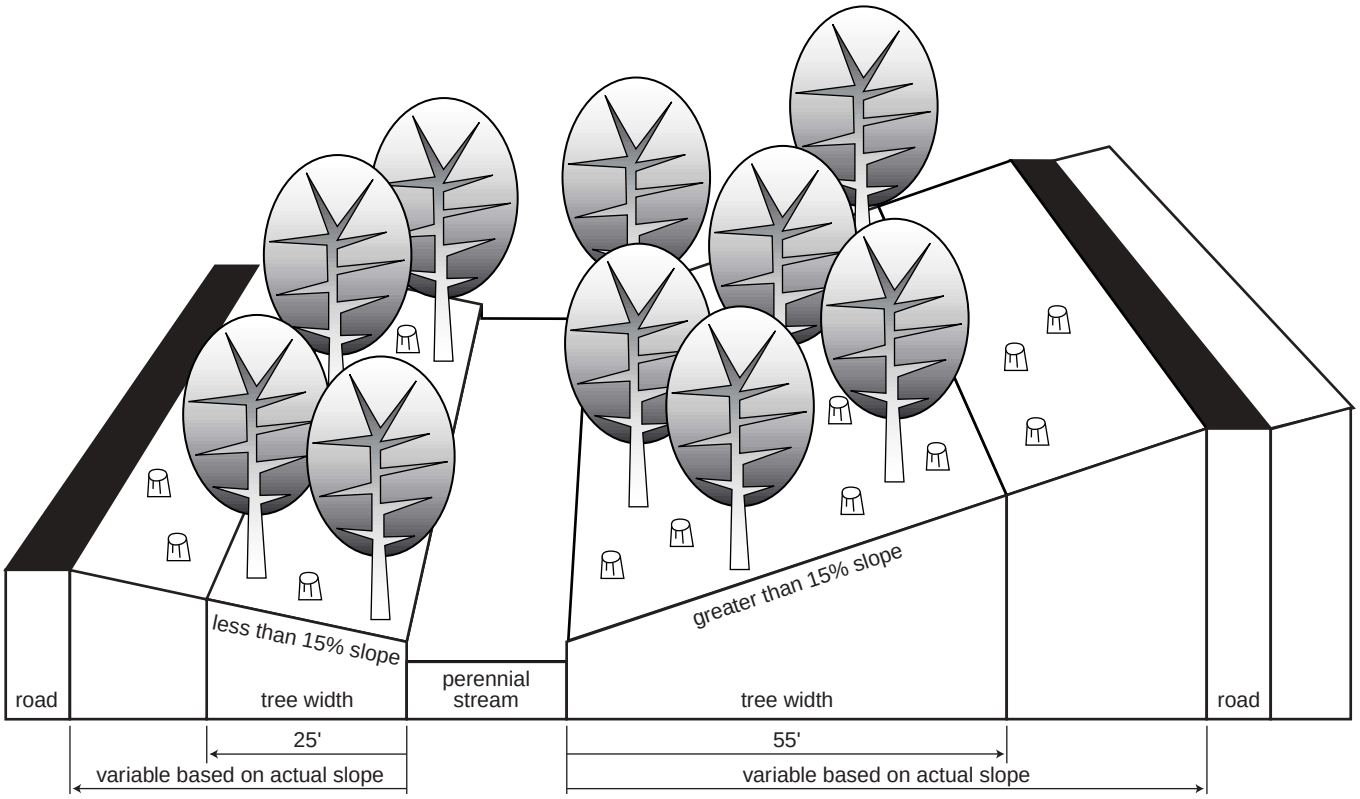


Table 3-2—Minimum Distances from Perennial Water Bodies to Roads, Trails, or Landings[1]

Slope of Land (%) away from stream bank	Width of Zone (feet) away from stream bank
0	25
5	35
10	45
15	55
20	65
25	75
30	85
35	95
40	105
50	125
60	145
70	165

1 Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality. In no case should stream beds be used as roads or for the skidding of logs except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary, stream channels can be used as roads or for skidding only for the minimum distance required.

Coldwater Aquatic Habitats

Coldwater Aquatic Habitats (CAHs) (high-quality trout waters), as designated by the Kentucky Division of Water, need additional protection.

> **CAHs should have only individual trees or small groups of trees removed within a 60-foot wide strip on eitherside of the stream. A minimum of 75 percent of the original tree overstory (canopy cover) should also be left intact.**

Understory vegetation immediately adjacent to CAH streams should be left intact. Refer to Appendix A for a list of designated surface CAHs.

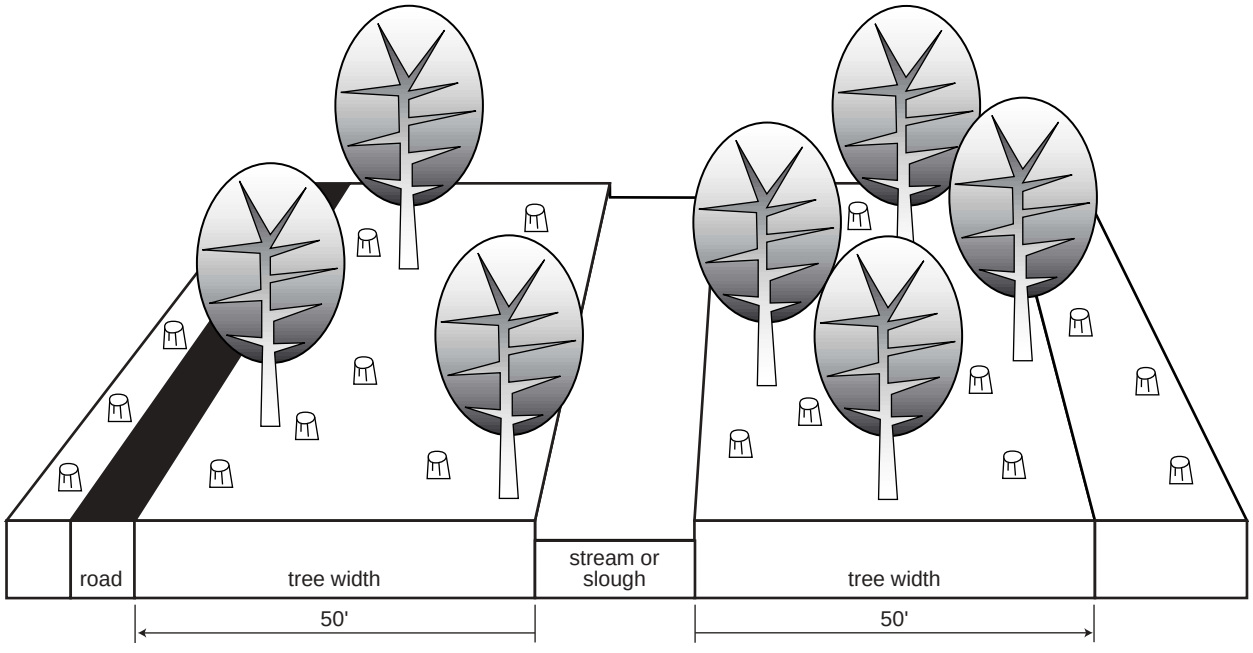
Wild Rivers

Wild Rivers are designated sections of a number of streams in Kentucky (Appendix E). Before undertaking any silvicultural activity in a corridor of a designated Wild River, the landowner or owner should contact the Wild Rivers Program of the Kentucky Division of Water.

Perennial Streams and Sloughs in Wetlands

> **Streams and sloughs in wetlands are provided special protection. Figure 3-2 indicates that 50 percent of the canopy trees should be maintained to a minimum distance of 50 feet regardless of slope. Roads, trails, and landings should be maintained at a minimum distance of 50 feet from streams, ponds, and sloughs in wetlands.**

Figure 3-2. Streamside Management Zone Criteria for Streams and Sloughs in Wetlands



Intermittent Streams

Stream Canopy Cover

In areas adjacent to intermittent streams, complete removal of overstory trees is acceptable (Figure 3-3).

Disturbed Ground

> **Equipment operation should be avoided in a zone of at least 25 feet on each side of an intermittent stream except for designated crossings. Erosion potential from steep slopes and unstable soils can require a width greater than this.**

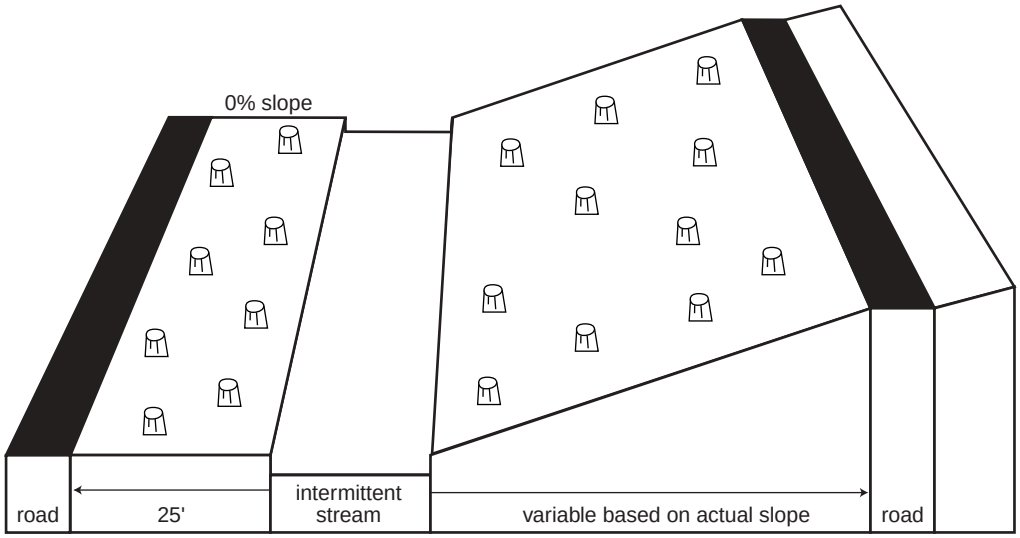
Table 3-3 provides the minimum recommended distances of roads, trails, and landings to intermittent stream channels. Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality. Mechanical site preparation should be excluded from areas adjacent to intermittent streams to maintain the duff layer and filtering capacity. Tops or other logging debris that can block the intermittent stream channel should be removed and/or placed such that they will not cause a blockage.

Table 3-3—Minimum Distances from Intermittent Streams to Roads, Trails, or Landings[1]

Slope of Land (%) away from stream bank	Width of Zone (feet) away from stream bank
0	25
5	30
10	35
15	40
20	45
25	50
30	55
40 or higher	65

1 Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality. In no case should stream beds be used as roads or for the skidding of logs except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary, stream channels can be used as roads or for skidding only for the minimum distance required.

Figure 3-3. Streamside Management Zone Criteria for Intermittent Streams



Regulatory Requirements for BMP No. 3

(See Appendix A for explanations)

- Debris in floodplains: (KRS 151.250)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resource waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 3

The producer should:

- in no case use stream beds as roads or for the skidding of logs except where site conditions (rock walls, notches, or other limiting factors) leave no other alternatives for access or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation.
- if an exception due to physical site conditions is necessary, stream channels may be used only as roads or for skidding for the minimum distance required.
- in areas adjacent to perennial streams, lakes, and ponds, forest buffers should be maintained for a minimum surface distance of 25 to 55 feet on the ground with less than 15% slopes and a minimum surface distance of 55 to 90 feet on the ground with slope of 15% or greater. Management activities are acceptable in these areas; however, equipment operation should be avoided except at designated crossings, and at least 50% of the original tree overstory (canopy cover) should be retained to shade the water and to maintain water temperature. Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distance but should be constructed to protect water quality. Take precaution to prevent tree debris, such as tops from harvested trees, from remaining in or being washed into perennial streams.
- in areas adjacent to intermittent streams, complete removal of overstory trees is acceptable. Equipment operation should be avoided in a zone of at least 25 feet on each side of an intermittent stream except for designated crossings. Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances but should be constructed to protect water quality. Mechanical site preparation should be excluded from areas adjacent to intermittent streams to maintain the duff layer and filtering capacity. Take precautions to prevent tree debris, such as tops from harvested trees, from remaining in or being washed into intermittent streams.
- Coldwater Aquatic Habitats (CAHs) (high-quality trout streams), as designated by the Kentucky Division of Water, need additional protection.
- CAHs should have a minimum of 75 percent of the original tree overstory (canopy cover) retained within the 60-foot-wide strip on either side of the stream.
- Understory vegetation immediately adjacent to CAH streams should be left undisturbed.
- Fertilizers and pesticides should only be applied in SMZs in compliance with silviculture BMPs 7 and 8, respectively.

BMP 4

Sinkholes

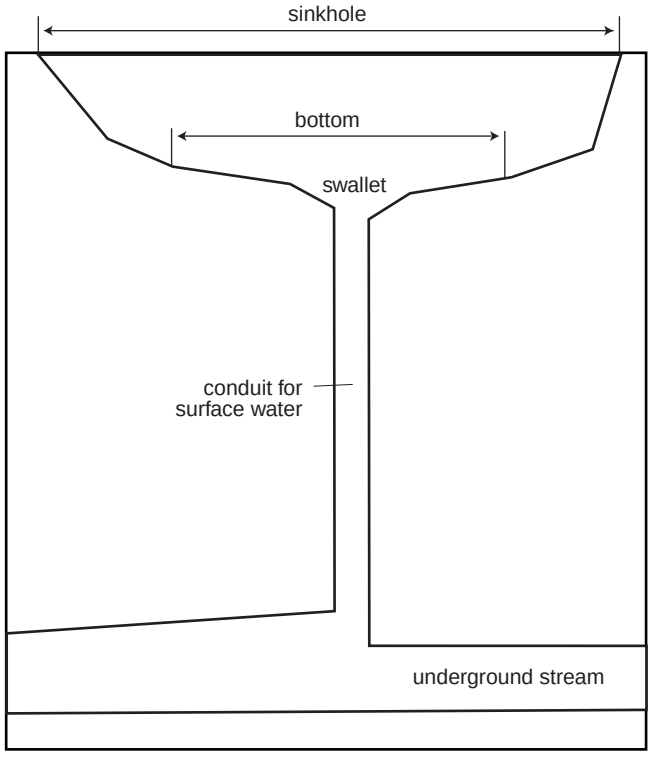
Purpose

Best Management Practices should be implemented to reduce nonpoint source pollutants from flowing into the bottom of sinkholes and to minimize degradation to groundwater, the underground drainage system, and the downstream surface water into which the underground streams flow.

Definitions

Sinkholes (or karst windows) are open or closed circular depressions in karst (limestone) areas where surface waters flow to join an underground drainage system (Figure 4-1). Sinkholes are caused by dissolution of the underlying limestone bedrock. A "**swallet**" is a point where surface water leaves the surface and flows underground. For purposes of this BMP, sinkholes include depressional areas with or without swallet, sinking streams, caves, karst windows, and pits or vertical shafts.

Figure 4-1. Flow of Waters through a Sinkhole



Specifications

Sinkholes with open swallets, where surface water can drain unfiltered into underground drainage systems, require special concern. While sinkholes with no open swallet should pose no significant concern, it is often difficult to determine if an open swallet exists in forested sinkholes. Therefore, caution must be exercised during silvicultural and timber harvesting operations around sinkholes.

Disturbed Ground

- Runoff from access roads, skid trails, and log landings should be diverted so as not to drain directly into sinkholes, sinking streams, or caves. (Note: If runoff does enter a sinkhole, a UIC permit may be required. See Appendix A.)
- Disturbing soil in sinkholes with open swallets should be avoided. However, each case can be evaluated individually, and minimum distances in Table 4-1 are recommended (Figure 4-2).

> **Distance from Disturbed Area to Sinkhole Bottom**
> The distance between any disturbed area (disturbed areas include access/haul roads, skid trails, log landings, or those disturbances produced from mechanical site preparation treatments) and the bottom of a sinkhole will be at least 30 feet for areas of 5 percent slope. An additional 10 feet in width will be added to this zone for each 10 percent increase in slope, up to a maximum width of 65 feet (Table 4-1).

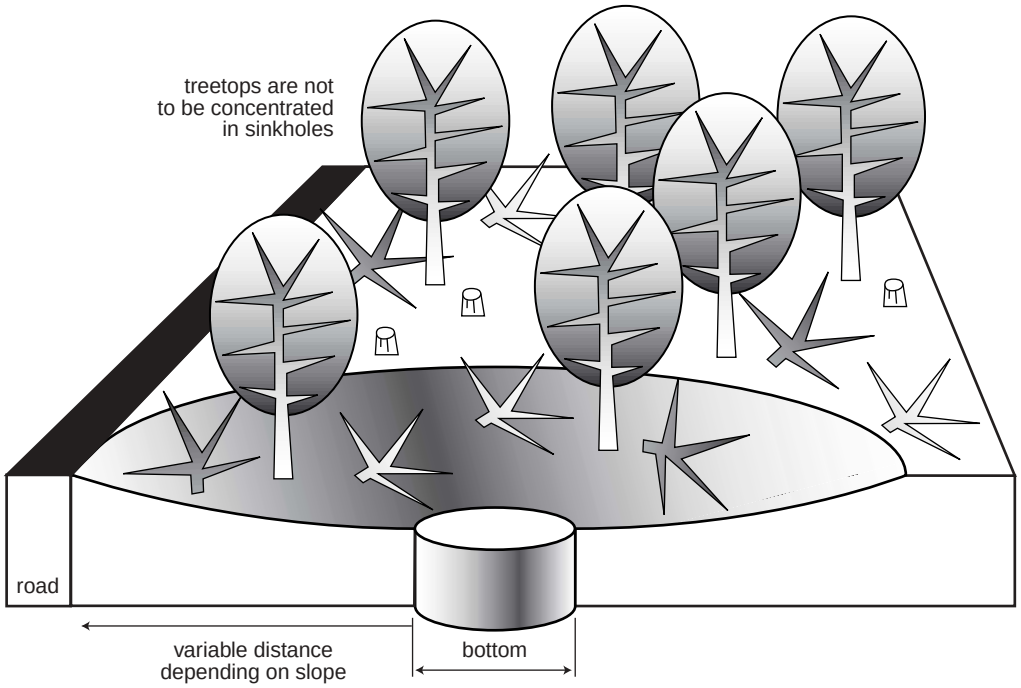
- Divert runoff away from openings in sinkholes.
- Reestablish vegetation on disturbed areas as quickly as possible (see BMP No. 2 for recommendations).

Table 4-1—Minimum Distances from Silviculturally Disturbed Areas and the Point of Lowest Elevation or Open Swallet of a Sinkhole

Slope of Land (%)	Distance (feet)
5	30
10	35
20	45
30	55
40 or higher	65

Note: this table corresponds to the recommended minimum distances for roads, trails, and landings from intermittent streams.)

Figure 4-2. Specifications for Sinkhole BMP



Debris and Fluids

- **Soil, logging debris, and other waste materials** should not be pushed into the bottom of any sinkhole or into any noticeable sinkhole opening.
- **The density of tree tops** in sinkholes should not exceed the density present in the area surrounding the sinkhole (Figure 4-2).
- **Equipment fluids** should not be drained onto the ground, and logging equipment should not be parked in the bottom of sinkholes where direct runoff of pollutants from equipment into the bottom of the sinkhole is likely to occur.

Pesticides and Fertilizers

Use of fertilizers and pesticides within 30 feet of the bottom of a sinkhole and/or swallet is undesirable and should only be applied in strict compliance with label directions for application near bodies of water. Fertilizer and pesticide use in the vicinity of a sinkhole with no swallet should pose no problem. However, a buffer zone should be employed in the vicinity of a sinking stream or sinkhole with an open swallet.

Regulatory Requirements for BMP No. 4

(See Appendix A for explanations)

- Activities around sinkholes, cave entrances, etc.: (KRS 433.870-433.875)
- Endangered species in caves: (Federal Register 55:6184 and 56:58804-58836)
- Modified sinkholes: (May need to be registered and/or permitted)
- Cave streams and other underground surface waters: (may deal with KY Surface Water Statutes and/or Outstanding Resource Waters)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resource Waters: (401 KAR 5:029, 5:030, and 5:031w
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)
- Karst Groundwater Basin Protection

Summary: AWQA Minimum Requirements for BMP No. 4

The producer should:

- leave a buffer zone should be left between any disturbed area and the open swallet of a sinkhole of 30 feet for areas of 5 percent slope. An additional 10 feet in width will be added to this zone for each 10 percent increase in slope.
- divert runoff from haul/access roads, skid trails, and log landings so as not to drain directly into sinkholes, sinking streams, or caves. (Note: if runoff does enter a sinkhole, a UIC permit may be required.)
- not push soil, logging debris, and/or other waste material into the bottom of a sinkhole or into any noticeable sinkhole opening.
- not drain fluids from equipment onto the ground. They should be collected in a container, transported off site, and recycled or properly disposed.
- maintain a buffer zone along sinking streams or in sinkholes with an open swallet if there is fertilizer and/or pesticide usage in the vicinity.

BMP 5

Logging Debris

Purpose

It is important to protect bodies of water from pollution by organic and inorganic debris that can result from silvicultural practices, such as timber harvesting, site preparation, or woodland improvement, and to protect stream channels and reduce erosion of stream banks and adjacent areas.

Definitions

Logging debris such as noncommercial portions of trees and brush, including tops and cutoffs that often cause water quality problems when improperly placed in waterways. **Disturbed soil,** such as fill dirt, and other by-products associated with silvicultural operations, such as brush, can clog or, in some other way, degrade water courses and water quality. **Waste products**, such as hydraulic fluid, oil, grease, and **trash**, such as oil cans, filters, lunch bags, and bottles, can also degrade water quality.

Specifications

Trees and brush cut during silvicultural operations often result in an abundance of organic debris that can be a potential water pollutant. This logging debris places an oxygen demand on the body of water during decomposition. In addition, it can create problems with odor, color, and excessive nutrients. Streams can cut new channels around dense logging debris blockages, increasing erosion and stream sediments.

Logging debris (tree tops, limbs, and other waste materials) should be removed from perennial and intermittent streams, lakes, or ponds to a sufficient distance or located to insure it does not move back into the body of water (see BMP No. 3 “Streamside Management Zones”).

Disturbed soil or concentrated logging slash (i.e., debris and tops) should not be left in ephemeral channels.

Equipment should not be left on stream banks, nor oil or equipment fluids changed in a manner by that pollutants can drain onto the ground or wash into a stream.

Trash, such as cans, bottles, lunch bags, filters from logging and silvicultural operations, and waste products, such as used oil and hydraulic and other fluids, should be disposed of properly (see BMP No. 8).

Regulatory Requirements for BMP No. 5

(See Appendix A for explanations)

- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Debris in floodplains: (KRS 151.250)
- Activities near high-quality waters and outstanding national resource waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 5

The producer should:

- not allow tree debris, such as tops from harvested trees, to be left in or washed into perennial streams.
- not leave equipment on stream banks or change equipment fluids in such a manner where pollutants may wash into streams.
- dispose of cans, bottles, lunch bags, oil filters or air filters, and other trash properly.

BMP 6

Proper Planting of Tree Seedlings by Machine

Purpose

Degradation of water quality from the movement of soil from the erosion of planting slits produced by mechanical tree planters during the planting of tree planting stock should be minimized.

Definition

Mechanical tree planters, or tree setters, have a chisel plow and/or coulter-type disk and create a planting slit. Generally they are most suitable for use on relatively even or gently rolling topography where slopes do not exceed 20 percent. Regardless, the planting slit is a continuous linear strip of furrowed disturbed ground that has the potential to erode.

Specifications

Mechanical tree planters should be operated along the contour to the maximum extent possible to prevent erosion and soil movement originating from the continuous planting slit.

Regulatory Requirements for BMP No. 6

(See Appendix A for explanations)

- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resources waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq*. and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 6

The producer should:

- operate mechanical tree planters only on the contour during tree planting operations

BMP 7

Fertilization

Purpose

This BMP is used to minimize water quality degradation while artificially applying specific chemicals to the soil to favor increased growth of vegetation. The purpose of proper fertilization is to induce desirable, target vegetation to achieve maximum growth practical for site conditions, while managing the fertilizer in such a way as to protect the quality of nearby bodies of water.

Definition

Fertilization enriches the soil to improve the growth of tree plantations or potential high-value natural tree stands or to aid in the establishment of herbaceous vegetation used to stabilize the soil and/or while a tree plantation is becoming established. Fertilizer includes both organic waste and industrially produced liquid and granular or powdered formulations of plant nutrients.

Specifications

The practice of applying fertilizers to areas of commercial forest land as a means of stimulating tree growth has been very limited in Kentucky. Fertilization can be done by either manual, aerial, or machine application of soluble inorganic compounds or through the application of organic waste. Improper use of this practice can result in excessive nutrients in nearby bodies of water and an imbalance in natural aquatic life cycles. Before any application of fertilizer, it is recommended that a soil test be performed to determine what specific soil elements, if any, are lacking.

- **Avoid direct fertilizer application to bodies of water** and to those areas immediately adjacent to them. Nutrient pollution can also be controlled by eliminating excessive fertilizer applications, selection of proper fertilizer formulation, and the proper timing and method of application.
- **The use of fertilizers in SMZs is generally undesirable**, and fertilizer should be applied only in strict compliance with label directions.
- **Use of fertilizer within 30 feet of the bottom** of any sinkhole or noticeable ground opening is undesirable.

The application of some organic materials, such as sludge, can require a permit and compliance with federal and/or state regulations. For more information about permits required for the application of sludge, contact the Kentucky Division of Waste Management.

Regulatory Requirements for BMP No. 7

(See Appendix A for explanations)

- Application of sludge: (may require a permit)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resource waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq*. and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 7

The producer should:

- use only the amount of fertilizer necessary, and no fertilizer should be used on bodies of water or those areas immediately adjacent to them.
- avoid using fertilizers in SMZs or within 30 feet of any noticeable sinkhole opening.

BMP 8

Application of Pesticides

Purpose

Use of pesticides should be managed in a way that prevents toxicity problems and protects human health and the quality of nearby bodies of water.

Definitions

Pesticides, including **insecticides, herbicides, fungicides, rodenticides**, and **nematocides,** are used to destroy, prevent, or control woody or herbaceous vegetation and forest pests on forested lands or areas being reforested. They can be used on forest lands to control insect infestations, undesirable woody and herbaceous growth, and plant diseases. This is primarily associated with reforestation and timber stand improvement.

Specifications

The Federal Environmental Pesticide Control Act of 1972 set general and specific standards concerning use of pesticides. As of October 21, 1977, all pesticides are classified for "general" or "restricted" use. Restricted pesticides can be used only by or under supervision of certified applicators. Pesticide users need to be familiar with this law and its regulations pertaining to certification and proper use of pesticides. For further information contact the local county Extension agent or personnel with the Division of Pesticides in the Kentucky Department of Agriculture, Frankfort, Kentucky. Pesticides used improperly can be injurious to humans, animals, plants, fish, and aquatic life.

- **Precisely follow all label directions** and heed all precautions on the labels. Pay close attention to label toxicity information for water-related concerns. Use only those pesticides labeled for forestry use, and be sure that intended use is in compliance with all federal and state laws and regulations.
- **Use of pesticides in SMZs or within 30 feet of the bottom of a sinkhole** or any noticeable ground opening is generally undesirable.
- **Do not dump excess spray material anywhere.** Excess spray material should be used according to label directions, or disposal should be according to disposal regulations. Minimize the amount of pesticide needing disposal by correctly mixing the proper amount.
- **Do not clean spray equipment or dump excess spray materials near ponds, streams, or wells.** Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that is used for herbicides. Triple rinse empty pesticide containers. Pour rinse liquid into the sprayer and spray on target. Puncture the rinsed container so that it can not be reused. Dispose of empty, rinsed, pesticide containers at an approved sanitary landfill.
- **Do not dispose of containers** or unused pesticide where there is any chance that the material can eventually cause surface or ground water contamination.
- **Do not clean equipment** or dump excess materials near bodies of water.
- **Remove empty containers** from the woods and dispose of them properly (see BMP No. 5).

When storing pesticides, make sure there is adequate ventilation. Adequate lighting will also ensure that labels can be read. Absorbent material should be on hand to absorb spills that can accidentally occur.

Develop an emergency plan. Know what you will do in the event of an accident and be prepared to do it!

Regulatory Requirements for BMP No. 8

(See Appendix A for explanations)

- Application of pesticides: (may require certification and/or licensing)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resources waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 8

The producer should:

- follow label directions.
- not clean equipment or dump excess materials near bodies of water.
- remove empty containers from the woods and dispose of them properly.
- avoid using pesticides in SMZs or within 30 feet of any noticeable sinkhole opening.

BMP 9

Site Preparation for Reforestation

Purpose

Site preparation for reforestation minimizes potential water quality degradation while eliminating or suppressing undesirable vegetation that would otherwise prevent the successful establishment and growth of tree seedlings through competition for sunlight, moisture, and nutrients and facilitates hand or machine planting operations.

Definitions

Site preparation includes treatment of lands and vegetation before artificial or natural regeneration to eliminate or suppress undesirable vegetation and/or to facilitate hand or machine planting operations. This is done to aid in the successful establishment and growth of tree regeneration. Site preparation can be used in fields, in harvested woodlands, in understocked woodlands, or on any other area where establishing a stand of trees or shrubs may be desirable. Mechanical site preparation includes **shearing,** the breaking off of unmerchantable residual trees in order to flatten or reduce the material; **raking,** the dragging of residual tree material; and **drum chopping,** involving the process of crushing debris or breaking it apart in order to flatten residual trees and branches. Site preparation can also include the use of herbicides (see BMP No. 8).

Specifications

Site Preparation Methods

Careful consideration should be given to the type and intensity of site preparation chosen to treat areas scheduled for reforestation to minimize adverse water quality impacts.

Table 9-1 lists site preparation methods, some of which have the potential to impact water quality. The method selected should be based on the amount, size, and type of vegetation present and the slope gradient and erodibility of the soil. The following are recommendations for minimizing potential nonpoint source pollution problems that can be associated with the more common types of site preparation activities:

Table 9-1—Site Preparation Methods Impacting Water Quality

Site Preparation Method	Hazard Level
Herbicide injection	Little or no hazard
Clear felling with chain saw	Little or no hazard
Herbicide spraying	Has potential if BMP No. 8 “Application of Pesticides” not followed
Drum chopping	Medium potential
Drum chopping with burning	Medium potential
Shearing and windrowing	High potential
Disking	High potential

- **Remove as much timber volume** during harvesting as possible to minimize the need for extreme treatments.
- **When possible, confine mechanical methods to slopes less than 30 percent.**
- **Minimizing the creation** of bare soil while achieving the desired results should be a consideration in determining site preparation methods. Favor chemical treatments over mechanical methods on steep

slopes and highly erodible soil. See BMP No. 8 "Application of Pesticides" for cautions when using chemicals.

- **Use low-impact methods to facilitate tree planting when possible** to minimize potential for nonpoint source pollution. Low-impact methods are defined as those practices that cause a minimum of site disturbance. The more extreme site preparation methods are more expensive and increase the potential for erosion, sedimentation of streams, and reduction of site productivity.
- **Use Streamside Management Zones (SMZs)** between streams and site-prepared areas. This will prevent disturbance of channels and stream banks by equipment and prevent soil, logging debris, and organic materialfrom reaching streams. SMZs will also help in maintaining desirable stream water temperatures.
- **Avoid operating heavy equipment during wet weather** to minimize soil disturbance, primarily rutting and compaction. When possible, carry out heavy site preparation during the summer and early fall to avoid wetness caused by winter rains and to allow time for loose soil to settle before planting.

Windrowing

When windrowing is necessary on the site:

- Locate windrows well away from drains to prevent material from being washed into streams.
- Minimize soil incorporated into windrows.
- Space windrows 100 to 300 feet apart on the slope, and construct along the contour.
- Provide occasional breaks in windrows to permit access by fire suppression and other vehicles. This will also prevent damming of water and possible gullying that can occur if water breaks through the windrow.

Regulatory Requirements

(See Appendix A for explanations)

- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resources waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 9

The producer should:

- when possible, use only low-impact methods of site preparation during tree planting activities. Low-impact methods are defined as those practices that cause a minimum of site disturbance.

BMP 10

Silviculture in Wetland Areas

Purpose

It is important to reduce the potential impacts of nonpoint source pollution to wetland areas from silvicultural activities. Forested wetlands, because of their uniqueness, require considerations that are greater than those listed in other BMPs dealing with silvicultural activities. The requirements listed here are supplemental to other silvicultural BMPs.

Definitions

Wetlands are defined as areas characterized by soils saturated with moisture during all or a significant proportion of the year and that support a dominance of hydrophytes (plants adapted to primarily wet conditions). Such areas are transition zones between predominately dry upland sites and permanent water in streams and lakes. Official determinations of whether a forested area is a wetland are the responsibility of the U.S. Army Corps of Engineers unless there is adjacent cropland, in which case the determination may be made by the Natural Resources Conservation Service of USDA.

This BMP is applicable in wetlands dealing with the following situations:

- **Sediment Production:** Sediments can be produced as a result of construction and use of access roads and by other activities, such as operation of equipment in streams and sloughs and disturbance of stream and slough banks with logging equipment and vehicles.
- **Drainage Alteration:** Road construction associated with logging is the activity most likely to cause drainagealteration in wetlands. In such instances, certain areas can receive prolonged flooding that can cause timber mortality or decline and can prevent regeneration of desirable species. Altering drainage could also cause wetlands to drain.
- **Stream Obstruction:** Trees and logging debris that are not removed from streams and dry natural drainages during logging can alter stream flow and cause scour erosion of channels and banks. In extreme cases, trees and logging debris can partially dam streams and cause flooding in forested areas.
- **Soil Compaction:** The potential for soil compaction in wetlands caused by the operation of logging vehicles and equipment is high, especially when the woods are partially flooded or before soils have had a chance to dry after seasonal flooding or periods of wet weather. Skid trails, haul roads, and log landings are areas where compaction is often severe. Compaction reduces infiltration of water into the soil, which affects absorption of moisture and nutrients by tree roots and restricts root growth. Thus, regeneration, growth, and development of trees can be severely affected where soils are compacted.
- **Herbicide Use:** Herbicides can be used in forested wetlands for control of cull and other unmerchantable trees, vines, and brush. With careful handling and use, herbicides pose little threat to wildlife and other wetland values. Herbicides are also prescribed for broadcast use on former croplands and other nonforested areas for control of grasses and vines to permit development of tree seedlings. Such herbicides are applied during the summer after seasonal flood waters have receded and when growth of weeds is active. Herbicides prescribed for such use are degraded by sunlight and soil microorganisms within one to two months following application and, barring accidental spills, pose little or no threat to wetland values.

Specifications

The following BMPs for wetland sites should be considered supplementary to BMPs developed for forestry operations on upland areas in the state:

Access Roads, Skid Trails, and Landings

- **Construction of permanent roads should be minimized**, and landings should be located on higher ground. When needed, locate roads on the higher ground or "ridges" that are parallel to the drainage system, and use a minimum amount of fill material.
- **Restrict vehicle traffic** to a minimum.
- **Crossing streams and sloughs should be avoided** if possible. However, when unavoidable, cross at right angles, and use culverts and bridges to carry water without altering natural drainage and disturbing stream banks and other sensitive areas.
- **Retire** temporary roads, trails, and landings. Reshape road beds, remove culverts and bridges, and revegetate, as needed, to stabilize bare and disturbed soil. Roads, then, should be closed to prevent erosion and roadbed damage (see BMP No. 1).
- **Locate log decks on elevated areas** away from streams as far as is practical. Keep log landings small and few in number.

Streamside Management Zones (SMZs)

SMZs protect stream, slough, and lake banks from disturbance that can be caused by operation of logging and other forestry equipment. In addition, SMZs filter out sediments that can enter streams and reduce movement of logging debris into main channels (see BMP No. 3).

> **A stream canopy cover width of at least 50 feet should be maintained with a minimum of 50 percent of the overstory trees retained to shade perennial streams and sloughs (see BMP No. 3).**

- **Operation of logging vehicles** and equipment should be minimized in SMZs to avoid disturbing the forest floor and to protect the banks of streams and sloughs.
- **Remove tops** of harvested trees from streams and sloughs to allow unrestricted waterflow.

Harvesting

- **Plan harvesting during dry weather.** Erosion and soil compaction caused by repeated operation of logging vehicles and equipment can occur on skid trails and log landings. Wetlands are particularly sensitive to rutting. To minimize the adverse effects of harvesting, logging should be planned during dry weather.
- **Use low ground pressure tires on skidders,** when available, and concentrate skidding as much as possible on a few primary skid trails to minimize site disturbance and compaction. Avoid or minimize use of skidders in SMZs and streams and sloughs.
- **Scarify severely compacted areas** on log landings and skid trails and revegetate to prevent erosion and improve wildlife habitat (see BMP No. 2).

Herbicide Use

- Always **use herbicides in accordance with label instructions** and adhere to all federal and state policies and regulations governing pesticide use.
- **Plan aerial application** of herbicides carefully to prevent contamination of streams, ponds, and forested wetlands and to reduce the possibility of damage to nontarget plant and animal life.

Regulatory Requirements for BMP No. 10

(See Appendix A for explanations)

- Filling or draining of wetland: (33 USC 1251 *et seq.*, Section 404)
- All silvicultural operations: (410 KAR 5:026, 5:029, 5:030, and 5:031)
- Activities near high-quality waters and outstanding national resources waters: (401 KAR 5:029, 5:030, and 5:031)
- Activities near wild rivers: (KRS 146.200 *et seq.* and 401 KAR 4:100-140)

Summary: AWQA Minimum Requirements for BMP No. 10

The producer should:

- minimize construction of permanent roads and locate landings on higher ground.
- restrict vehicle traffic to a minimum.
- avoid crossing of streams and sloughs if possible.
- leave 50 to 70 percent of the overstory to shade perennial streams and sloughs.

BMP 11

Livestock Management

Purpose

Livestock should be managed in a way that enough cover to protect the soil from erosion is maintained and sedimentation of nearby bodies of water is prevented. It is important to protect, maintain, or improve the quantity and quality of the plant resources, to maintain soil productivity, and to prevent soil compaction.

Definition

Exclusion of livestock in areas where desired forest reproduction, soil hydrologic values, and/or existing vegetation may be seriously damaged by grazing.

Recommendations

In forested areas where livestock exclusion is desirable, steps can be taken to minimize impacts from livestock. Fencing pastures separately from woodlands is a good step in keeping livestock out of a wooded area, which can enhance productivity of the forest vegetation and protect vegetation that provides wildlife food and cover. The cost of livestock exclusion can be reduced by taking advantage of such natural barriers as rock cliffs (streams are an exception).

Summary: AWQA Minimum Requirements for BMP No. 11

See the Livestock BMP in the *Agriculture Water Quality Plan* for more information about livestock exclusion.

BMP 12

Fire Lines and Lanes

Purpose

The purpose for constructing and maintaining fire lines and fire lanes is to restrict and control wildfire or to manage areas to be treated with prescribed burning in such a way as to minimize soil erosion and protect nearby bodies of water from sedimentation.

Definitions

A **fire line** is a line of varying width constructed through the litter on the forest floor down to mineral soil to control a fire. A **fire lane** is also constructed through the litter on the forest floor to mineral soil and is a precautionary effort to protect an area from wildfire. The construction method can be by hand tools or by use of mechanized equipment. In all cases, it should be noted that a fire line will cause less damage to water quality than the damage caused by a wildfire.

Specifications

Layout and Construction

Fire lanes constructed for fire protection and fire lines constructed to control an actual fire should be planned and installed to cause minimum soil disturbance and be no larger than actually needed to control a fire.

- **Avoid constructing fire lines and lanes at right angles to land contour**, except to control activity on a wildfire.
- **Minimize the grade** of fire control lines and lanes around slopes, except to control activity on a wildfire.
- **Do not construct the fire line deeper or wider than necessary** to control spread of a fire.

Drainage

Plan and install water bars as the fire line is being constructed or following control activity on a wildfire. Intervals between water bars are identical to those needed for skid trails. See Table 1-2 for recommended distances between water bars for retirement of skid trails.

On sloping or steep land, do not locate a fire line or lane so drainage is directed into a stream or sinkhole. Turn the line approximately 15 to 20 feet from the drainage so that the drainage is parallel to it. The final 15 to 20 feet should be lightly scraped of leaves and limbs leaving the mineral soil as undisturbed as possible. Use of foam retardant is also recommended in these areas. It is important that this section of line be sufficient to halt the spread of a fire.

Revegetation

Where there is a potential soil erosion problem on fire lines and lanes that are meant to be long lasting, permanent vegetation should be established and maintained (see BMP No. 2).

Summary: AWQA Minimum Requirements for BMP No. 12

The AWQA plan does not contain this BMP.

BMP 13

Prescribed Burning

Purpose

Prescribed burning is used to modify a forest stand or to reduce forest residue to some desired level in a manner that minimizes soil erosion and protects nearby bodies of water from sedimentation. Prescribed burning can be used on forested sites for reduction of hazardous accumulations of fuel to lessen wildfire potential, for improvement of wildlife habitat, for discouragement of undesirable plant growth that can inhibit natural or artificial regeneration of a stand of trees, and for creation of a seedbed favorable to natural or direct seeding reforestation.

Definition

Prescribed burning involves the use of fire under conditions that will assure confinement yet produce the intensity of heat and behavior required to accomplish one or more management objectives.

Specifications

The prescribed use of fire involves careful planning and determination of specific weather and fuel conditions to achieve the desired environmental and management objectives. The prescribed burn is specifically located, confined in an area, carefully timed, and regulated in intensity. State laws regarding burning and air pollution must be followed.

Considerations for prescribed burning are:

- Is it the safer, cheaper, more efficient, and practical means of achieving desired results?
- Burn only with trained crews under carefully prescribed conditions of humidity, temperature, and wind.
- Fire lines should be planned and constructed before burning to assure burning will be confined to the prescribed area (see BMP No. 12).

Potential water pollution hazards should be recognized and control measures installed to include:

- Construction of water bars on fire lines in hilly or steep terrain.
- Provision for an adequate strip of undisturbed surface between the prescribed burn and perennial and intermittent water courses (see BMP No. 3).

Note: runoff from a burned-over area has the potential to transfer nutrients into the water system.

Summary: AWQA Minimum Requirements for BMP No. 13

The AWQA plan does not contain this BMP.

Appendix A

Regulatory Requirements All Silvicultural Operations, 401 KAR 5:026, 5:029, 5:030, and 5:031

All operations must meet Kentucky water quality standards.

Activities Near High-quality Waters and Outstanding National Resources Waters, 401 KAR 5:029, 5:030, and 5:031

Kentucky water quality standards (401 KAR 5:029) require the use of BMPs to protect high-quality waters and outstanding national resources waters listed in 401 KAR 5:030. In addition, outstanding resource waters that support federally listed threatened and endangered species require protection (see 401 KAR 5:031).

Activities Near Wild Rivers, KRS 146.200 et seq. and 401 KAR 4:100-140

The Kentucky Wild Rivers Act and associated regulations give special protection to streams designated as "wild rivers," including regulation of silvicultural activity. Before undertaking any silvicultural activity in a corridor of a designated wild river, the landowner or logger should contact the Wild Rivers Program of the Kentucky Division of Water for applicable regulations and instructions.

Debris in Floodplains, KRS 151.250

The Kentucky Division of Water has authority over the placement of debris (including logging slash) in floodplains of perennial streams that have a drainage area larger than one-square mile. The Division of Water advises that as long as the BMPs for Streamside Management Zones and logging debris are followed, landowners and loggers will be considered in compliance with floodplain regulations that address debris. If these BMPs are not followed, the Kentucky Division of Water can institute enforcement proceedings.

Construction in Floodplains, KRS 151.250

All structures (bridges, berms, or other construction that could obstruct flood flows) that are to be constructed in the floodplain of a perennial stream that drains more than one-square mile require a floodplain permit from the Kentucky Division of Water.

Filling or Draining of Wetlands, U.S. Clean Water Act, Section 404

The U.S. Army Corps of Engineers regulates all filling or draining of wetlands, streams, lakes, or other bodies of water. Normal ongoing silvicultural activities, including building and maintaining forest roads, do not require individual permits, providing certain conditions are met, including adherence to the federal baseline BMPs for forest roads. For detailed information on the silvicultural exemption, contact the Kentucky Division of Forestry.

Activities around Sinkholes and Cave Entrances, KRS 433.870-433.875

The Kentucky Cave Protection Act offers protection to any sinkhole, pit, karst window, and/or sinking stream that has an opening large enough for a person to enter a black zone. The Federal Cave Protection Act is used to manage nonrenewable cave resources on federal lands. Management techniques include buffer zones around sinkhole and cave entrances to provide food sources for cave life, regulate thermal variations, and prevent sedimentation. Extremely sensitive karst systems can include the entire recharge area as a buffer zone.

Endangered Species in Caves, Federal Register 55:6184-6229 and 56:58804-58836

The Kentucky State Nature Preserves Commission maintains the list of Kentucky plants and animals that are considered endangered, threatened, and of special concern. The U.S. Fish and Wildlife Service administers the federal Endangered Species Act of 1973, as amended in 1990, and the 1991 Candidate Review. Many species protected by these acts live in caves and can be threatened by pollutants entering sinkholes.

Modified Sinkholes

Any sinkhole that has been modified to receive additional storm water runoff can be classified as a Class V Underground Injection Control (UIC) Well, which must be registered and/or permitted by the U.S. Environmental Protection Agency Underground Injection Control Program.

Cave Streams and Other Underground Surface Waters

Kentucky surface water statutes and regulations have defined subterranean streams that flow underground and have discrete banks and channels, such as cave streams, as surface waters. Several karst groundwater basins in the Mammoth Cave National Park that extend well outside of the Park's boundary have been designated as Outstanding Resource Waters and receive the same special protection of species as the blind shrimp in Mammoth Cave.

Karst Groundwater Basin Protection

The federal and state Wellhead Protection Programs are developing karst groundwater basin protection plans for public water supplies that use karst springs or groundwater as their water source.

Application of Sludge

The application of some organic materials, such as sludge, can require a permit for compliance with federal and/or state regulations. For more information regarding permits required for the application of sludge,contact the Kentucky Division of Waste Management.

Application of Pesticides

Use only pesticides approved by the Environmental Protection Agency for use in Kentucky. Follow all pesticide label directions. Application of some chemicals can require applicator certification and/or licensing.

Appendix B

Kentucky Bodies of Water Designated as Coldwater Aquatic Habitats

The additional protection given to SMZs bordering Coldwater Aquatic Habitats, as described in the BMP guidelines for SMZs, extends only to the main stem of listed streams.

Body of Water	Zone	County
Big Sandy River Basin		
Paintsville Lake	Entire Reservoir	Johnson
Little Sandy River Basin		
Big Caney Creek	Source to Grayson Lake	Elliott
Big Sinking Creek	River Mile 6.0 to Little Sandy River	Carter
Laurel Creek	Source to Little Sandy River	Elliott
Greenbo Lake	Entire Reservoir	Greenup
Licking River Basin		
Craney Creek	Source to North Fork Licking River	Rowan/Morgan
Licking River	River Mile 176.8 (Cave Run Lake Dam) to River Mile 169.6 (U.S. Highway 60 bridge.)	Bath/Rowan
Kentucky River Basin		
Chimney Top Creek	Basin	Wolfe
Dix River	Herrington Lake Dam to Kentucky River	Garrard/Mercer
East Fork Indian Creek	Source to Indian Creek	Menifee
Gladie Creek	Basin	Menifee
Middle Fork Red River	Source to River Mile 10.6	Powell
Parched Corn Creek	Source to Red River	Wolfe
Swift Camp Creek	Source to Red River	Wolfe
Bert Combs Lake	Entire Reservoir	Clay
Fishpond Lake	Entire Reservoir	Letcher
Mill Creek Lake	Entire Reservoir	Wolfe
Green River Basin		
Beaver Dam Creek	Source to Green River	Edmonson
Buffalo Creek	Source to Green River (in Mammoth Cave National Park)	Edmonson
Lick Creek	Source to West Fork of Drakes Creek	Simpson
Lynn Camp Creek	Source to Green River	Hart
Underground River System	Mammoth Cave National Park Barren	Edmonson/Hart
	Turnhole Spring Basin	Edmonson/Barren
	Echo River Basin	Edmonson
	Pike Spring Basin	Edmonson
	Mile 205.7 Spring Basin	Hart
	McCoy Spring Basin	Hart
	Suds Spring Basin	Hart/Barren
Nolin River	River Mile 7.6 (Nolin Lake Dam) to Green River	Edmonson
Rough River	River Mile 89.3 (Rough River Dam) to River Mile 72.4	Ohio/Grayson
Roundstone Creek	Source to Kentucky Highway 1140 (River Mile 3.5)	Hart
Trammel Fork	Source to Kentucky Highway 31E (River Mile 23.6)	Warren

Body of Water	Zone	County
Lower Cumberland River Basin		
Casey Creek	Source to Little River	Trigg
Skinframe Creek	Source to Livingston Creek	Lyon
Sulphur Spring Creek	Source to Red River	Simpson
Ohio River Basin		
Doe Run Creek	Source to Kentucky Highway 1628 (River Mile 5.15)	Meade
Sinking Creek	Source to Kentucky Highway 259 (River Mile 4.0)	Breckinridge
Upper Cumberland River Basin		
Bad Branch	Basin	Letcher
Bark Camp Creek	Basin	Whitley
Beaver Creek	Basin	McCreary
Breeden's Creek	Basin	Harlan
Bunches Creek	Basin	Whitley
Cane Creek	Basin	Laurel
Cogur Fork	Basin	McCreary
Cumberland River	Lake Cumberland Dam (River Mile 460.9) to Kentucky Highway 90 bridge (River Mile 426.5)	Cumberland
Difficulty Creek	Basin	McCreary
Dogslaughter Creek	Basin	Whitley
Fugitt Creek	Basin	Harlan
Indian Creek	Source to Barren Fork	McCreary
Kelly Branch	Basin	Harlan
Laurel Creek	River Mile 9.0 to River Mile 3.4	McCreary
Looney Creek	Basin above River Mile 5.3	Harlan
Martin's Fork	Basin above River Mile 27.4	Harlan
Poor Fork Cumberland River	Basin above River Mile 742.7	Letcher
Razor Fork	Basin	Harlan
Rock Creek	Tennessee/Kentucky State Line (River Mile 21.9) to White Oak Creek	McCreary
Shillalah Creek	Source to Cumberland Gap National Historical Park Boundary	Bell
Sugar Run	Source to Cumberland Gap National Historical Park Boundary	Bell
Troublesome Creek	Basin	McCreary
White Oak Creek	Basin above River Mile 1.2 (includes Little White Oak Creek)	Laurel
Wood Creek	Wood Creek Lake Dam (River Mile 4.0) to Hazel Patch Creek	Laurel
Beulah (Tyner) Reservoir	Entire Reservoir	Jackson
Cannon Creek Lake	Entire Reservoir	Bell
Laurel River Lake	Entire Reservoir	Laurel
Wood Creek Lake	Entire Reservoir	Laurel

Appendix C

Surface Waters Categorized as Outstanding National Resource Waters

Stream	Zone	County
Red River	River Mile 68.6 to 49.2	Menifee/Wolfe
Underground River System	Within Mammoth Cave National Park Boundary	Edmonson/ Hart/ Barren
Big South Fork of Cumberland River	River Mile 55.2 to 45.0	McCreary

Appendix D

Surface Waters Categorized as Bodies of Water Whose Quality Exceeds That Necessary to Support Propagation of Fish, Shellfish, and Wildlife and Recreation in and on the Water

Stream	Zone	County
Little Sandy River Basin		
Arabs Fork*	Source to confluence with Clay Fork	Carter
Big Caney Creek*	Source to Grayson Lake	Elliot
Big Stinking Creek*	Source to River Mile 10.7	Carter
Laurel Creek*	Source to River Mile 7.6	Elliot
Licking River Basin		
Bucket Branch*	Source to confluence with North Fork of the Licking River	Morgan
Devils Fork*	Source to confluence with North Fork of the Licking River	Morgan
North Fork of Licking River*	Source to River Mile 13.0	Morgan
Kentucky River Basin		
Clear Creek*	Source to River Mile 4.1	Woodford
Clemons Fork*	Source to Buckhorn Creek	Breathitt
Coles Fork*	Source to Buckhorn Creek	Breathitt
Right Fork of Buffalo Creek*	Source to Buffalo Creek	Owsley
South Fork of Station Camp Creek*	Source to River Mile 5.3	Jackson
Station Camp Creek*	River Mile 22.3 to 19.0	Estill
Sturgeon Creek*	Source to River Mile 4.0	Lee
Salt River Basin		
Salt Lick Creek*	Source to River Mile 5.3	Marion
Wilson Creek*	Source to River Mile 12.2	Bullitt
Green River Basin		
Beaverdam Creek*	Source to River Mile 7.6	Edmonson
Gasper River*	Source to River Mile 32.3	Logan
Goose Creek*	Source to River Mile 5.6	Casey
Green River	River Mile 207.8 to 181.7	Edmonson
Russell Creek*	Source to River Mile 60.5	Adair
Trammel Fork*	River Mile 30.15 (Kentucky/Tennessee State line) to River Mile 19.4	Allen
Lower Cumberland River Basin		
Whippoorwill Creek*	Source to Red River	Logan
Tennessee River Basin		
Blood River*	River Mile 15.65 (KY/TN state line) to 15.1	Calloway
Soldier Creek*	River Mile 5.3 to 2.6	Marshall

Stream	Zone	County
Tradewater River Basin		
Sandlick Creek*	Source to River Mile 3.5	Christian
Tradewater River*	Source to River Mile 126.0	Christian
Ohio River Basin		
Yellowbank Creek*	Source to River Mile 4.4	Breckinridge
Lakes and Reservoirs		
Metropolis	Entire Lake	McCracken
Swan	Entire Lake	Ballard
Mississippi River Basin (Main Stem and Minor Tributaries)		
Murphy's Pond	Entire Pond and Preserve Area	Hickman
Upper Cumberland River Basin		
Bad Branch*	Source to confluence with Poor Fork of Cumberland River	Letcher
Bark Camp Creek*	Source to River Mile 2.6	Whitley
Buck Creek*	River Mile 62.6 to 28.9	Pulaski
Cane Creek*	Source to River Mile 7.0	Laurel
Cumberland River	River Mile 574.6 to 558.5 (Headwaters of Lake Cumberland)	McCreary/Whitley
Eagle Creek*	Source to River Mile 3.0	McCreary
Horse Lick Creek*	Source to River Mile 12.3	Jackson
Little South Fork of Cumberland River	River Mile 35.6 to 4.1	Wayne
Marsh Creek*	Source to River Mile 12.6	McCreary
Martins Fork of Cumberland River	River Mile 31.3 to 27.4	Harlan
Rock Creek	TN/KY State Line (River Mile 21.9) to White Oak Creek	McCreary
Rockcastle River	River Mile 24.4 to 8.5	Laurel/Pulaski
South Fork of Dog Slaughter Creek*	Source to Dog Slaughter Creek	Whitley

* Bodies of water in the Kentucky Cabinet for Natural Resources and Environmental Protection reference reach network

Appendix E

Locations of Kentucky Wild Rivers

Body of Water	Zone	County
Cumberland River Basin		
Bad Branch	Headwaters to KY 932	Letcher
Big South Fork Cumberland River	TN State Line to Blue Heron (Mile 55.2 to Mile 45.0)	McCreary
Cumberland River	Summer Shoals to Lake Cumberland (Mile 574.6 to Mile 558.5)	McCreary, Whitley
Little South Fork Cumberland River	KY 92 to Lake Cumberland (Mile 14.5 to Mile 4.1)	McCreary, Wayne
Martins Fork	Boundary of Cumberland Gap National Historic Park to KY 987 (Mile 31.3 to Mile 27.4)	Harlan
Rock Creek	TN State Line to White Oak Creek (Mile 21.9 to Mile 3.9)	McCreary
Rockcastle River	KY 1956 at Billows to Lake Cumberland	Rockcastle, Laurel, Pulaski
Green River Basin		
Green River	East boundary of Mammoth Cave National Park to Lock and Dam No. 6 at Brownsville (Mile 207.7 to Mile 181.7)	Edmonson, Hart
Kentucky River Basin		
Red River	KY 746 to Swift Camp Creek (Mile 68.6 to Mile 59.5)	Wolfe, Menifee

Appendix F

Glossary of Terms

Access road
A temporary or permanent road over which timber is transported from a loading site to a public road. Also known as a haul road.

Best management practices
Effective, practical structural or nonstructural methods that prevent or reduce the movement of sediment, nutrients, pesticides, and other pollutants from the land to surface or groundwater, or that otherwise protect water quality from potential adverse effects of silvicultural activities.

Buffer strip
Area adjacent to a stream or other body of water where minimal management activity takes place in order to protect the stream or body of water from nonpoint source pollution.

Buffer zone
See buffer strip.

Cable corridors
Long, narrow paths used by yarders, primarily cable yarders, capable of vertical lift, to move felled trees or logs to a concentration point.

Coldwater aquatic habitat
Body of water that has characteristically cool water and is considered high-quality trout water by the Kentucky Division of Water.

Concentrated logging slash
The unwanted, unused, and generally unmerchantable accumulation of woody material, such as large limbs, tops, cull logs, and stumps, that remain as forest residue after timber harvesting.

Control points
Specific features in the topography that dictate or influence operations, commonly seeps, rock outcrops, or swamps.

Cull
Unusable portions of a tree due to damage, rot, sweep, or crook.

Cut-and-fill
Earth-moving process that entails excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Debris
See concentrated logging slash.

Deep water break (water bar)
Deep, reverse grade water control structure used in the retirement of skid trails.

Drainage structure
Structure that acts as a water catchment and drainage channel on access roads and skid trails, including pipe culverts, open-faced culverts, and reverse-grade drainage structures.

Drum chopping
Process of crushing debris or breaking it apart in order to flatten residual trees and branches.

Ephemeral channel
A channel formed by water during or immediately after precipitation events as indicated by an absence of forest litter and exposure of mineral soil, which conveys surface water directly or indirectly to surface or subsurface streams.

Felling
The process of cutting down standing trees.

Fill
Earthen material that is excavated from one spot and used to "fill" another.

Filter strip
See buffer strip.

Ford
Submerged stream crossing where tread is reinforced to bear intended traffic.

Forest buffer
See buffer strip.

Forwarder path
A path or trail used by forwarders where felled trees or logs are fully supported and moved to a concentration point.

Grade (gradient)
The slope of a road or trail expressed as percentage of change in elevation per unit of distance traveled.

Haul road
See access road.

Herbaceous
Nonwoody vegetation.

Infiltration
The process by which water enters the soil.

Inorganic debris
Logging operation waste products, including hydraulic fluids, excess oil, and trash that can degrade water quality.

Insloping
To shape the road surface to cause drainage to flow toward the inside shoulder.

Intermittent stream
Stream that holds water during wet seasons of the year; denoted by a line of blue dashes on topographic maps.

Karst
Areas with limestone bedrock that are prone to have sinkholes and/or underground stream systems.

Landing
A place in or near the forest where logs are gathered for further processing or transport. The act of depositing a turn of logs into a landing or log deck.

Log deck
See landing.

Logging debris (slash)
The unwanted, unused, and generally unmerchantable accumulation of woody material, such as large limbs, tops, cull logs, and stumps, or other logging operation waste products, that remain as forest residue after timber harvesting.

Logging road
See access road.

Merchantable
Forest products suitable for marketing under local economic conditions. With respect to a single tree, it means the parts of the bole or stem suitable for sale.

Nonpoint source pollution (pollutant)
Pollution coming form numerous small sources over a wide geographic area.

Organic debris
Accumulation of leaves or woody debris, such as large limbs, tops, cull logs, and stumps.

Outslope
To shape the road surface to cause drainage to flow toward the outside shoulder.

Overland flow
The movement of water over the earth's surface.

Overstory
Composition of the dominant trees in a forest, which shade the understory and forest floor.

Perennial stream
A stream that holds water throughout the year; denoted by a solid blue line on topographic maps.

Pesticides
Chemicals, including insecticides, herbicides, fungicides, rodenticides, and nematocides, used to destroy, prevent, or control woody or herbaceous vegetation and forest pests.

Planting slit
A closed furrow produced by a mechanical tree planter.

Primary skid trail
A temporary, nonstructural pathway over forest soil used repeatedly to drag felled trees or logs to the landing, resulting in ground disturbance.

Scarification
The process of removing the forest floor or mixing it with the mineral soil by mechanical action preparatory to natural or direct seeding or the planting of tree seedlings.

Scouring
The stripping of periphyton and other plant and animal life from the stream bottom.

Sediment
Soil, sand, and mineral particles that have been eroded from the land and deposited into a water body.

Sedimentation
The process of sediments entering and settling to the bottom of a stream or other body of water.

Shearing
To shear or break off unmerchantable residual trees in order to flatten or reduce the material.

Silvicultural activity
Any activity, following accepted silvicultural principles, whereby the tree species constituting forests are tended, harvested, and replaced.

Sinkhole
Open or closed circular depressions in karst (limestone) areas where surface waters flow to join anunderground drainage system.

Sinking stream
A stream that disappears from the surface and flows underground instead of draining into another aboveground body of water.

Site preparation
Practices used to prepare a site for planting or regenerating trees. These practices are used to reduce or eliminate unwanted and/or competing vegetation that would threaten the survival or proper development of planted tree seedlings.

Skid or Skidding
Short-distance moving of logs or felled trees from the stump to a point of loading.

Skid trail
A skid trail is a temporary pathway used to drag felled trees or logs to a landing or concentration point, resulting in duff (the partially decomposed organic material of the forest floor) and ground disturbance sufficient to cause erosion.

Slough
A slow-moving channel of water in or near a wetland.

Streamside management zone (SMZ)
A strip of land adjacent to either side of a stream or surrounding a lake or pond. These areas are carefully maintained and managed to protect water quality by filtering sediment, to provide shade to maintain water temperatures and to trap logging debris. They also provide wildlife travel lanes. Also referred to as a riparian area.

Swallet
A point where surface water leaves the surface and flows underground.

Yards
See landing.

Water bar
See deep water break.

Wetland
An area characterized by soils saturated with moisture during all or a significant portion of the year that supports a dominance of hydrophytes (plants adapted to primarily wet conditions).

Winching
The act of pulling felled trees or logs through the woods with a drum device located on the back of a skidder.

Windrow
Logging debris and unmerchantable woody vegetation that has been piled in rows to decompose or to be burned, or the act of constructing these piles.

Appendix G

Technical Assistance Providers: State Offices

The application of BMPs in the field requires a certain amount of planning before initiating the forest activity. Considerable information is currently available from state and federal agencies. The following agencies are available for technical assistance in Kentucky and have representatives that operate on a local county level. Industrial and consulting foresters are also available for information and assistance.

Kentucky Division of Forestry
627 Comanche Trail
Frankfort, KY 40601
(502) 564-4496

Natural Resources Conservation Service
771 Corporate Drive, Suite 110
Lexington, KY 40503
(606) 224-7350

Kentucky Department of Fish and Wildlife Resources
No. 1 Game Farm Road
Frankfort, KY 40601
(502) 564-3400

University of Kentucky
Cooperative Extension Service
College of Agriculture-Department of Forestry
T.P. Cooper Bldg.
Lexington, KY 40546-0073
(606) 257-7596

Kentucky Division of Water
14 Reilly Road
Frankfort, KY 40601
(502) 564-3410

Kentucky Division of Forestry District Offices

Northeastern District
Kentucky Division of Forestry
749 West First Street
Morehead, KY 40351
(606) 784-7504

Central District
Kentucky Division of Forestry
P.O. Box 663
Elizabethtown, KY 42702
(502) 766-5010

Southeastern District
Kentucky Division of Forestry
P.O. Box 130
Pineville, KY 40977
(606) 337-3011

South Central District
Kentucky Division of Forestry
120 Gaines Drive
Campbellsville, KY 42718
(502) 465-5071

Kentucky River District
Kentucky Division of Forestry
P.O. Box 702
Hazard, KY 41702
(606) 435-6073

Green River District
Kentucky Division of Forestry
P.O. Box 465
Madisonville, KY 42431
(502) 824-7527

Eastern District
Kentucky Division of Forestry
P.O. Box 189
Betsy Layne, KY 41605
(606) 478-4495

Western District
Kentucky Division of Forestry
P.O. Box 349
Mayfield, KY 42066
(502) 247-3913

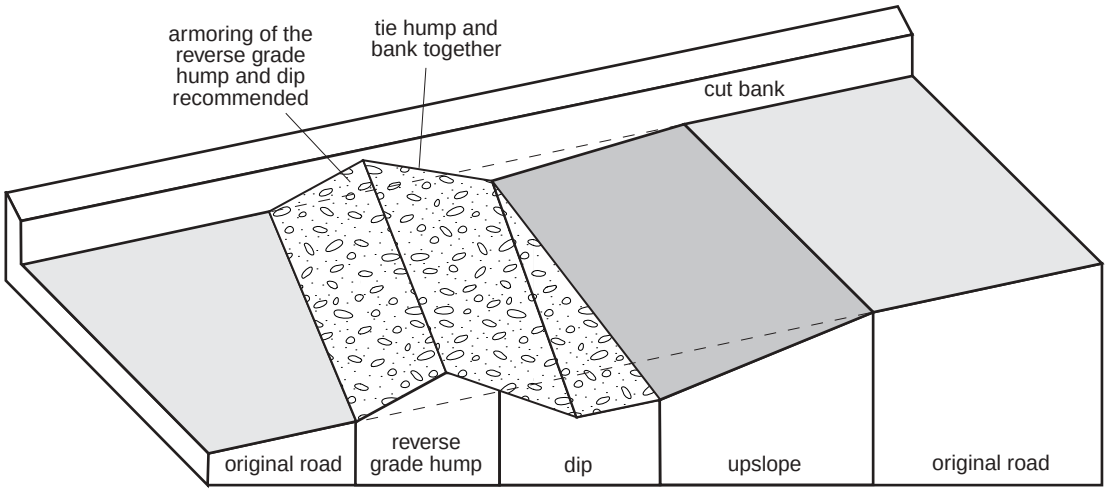
Bluegrass District
Kentucky Division of Forestry
P.O. Box 30
Stamping Ground, KY 40379
(502) 535-7741

Appendix H

Tables and Figures

BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-1. Typical Reverse Grade Structure



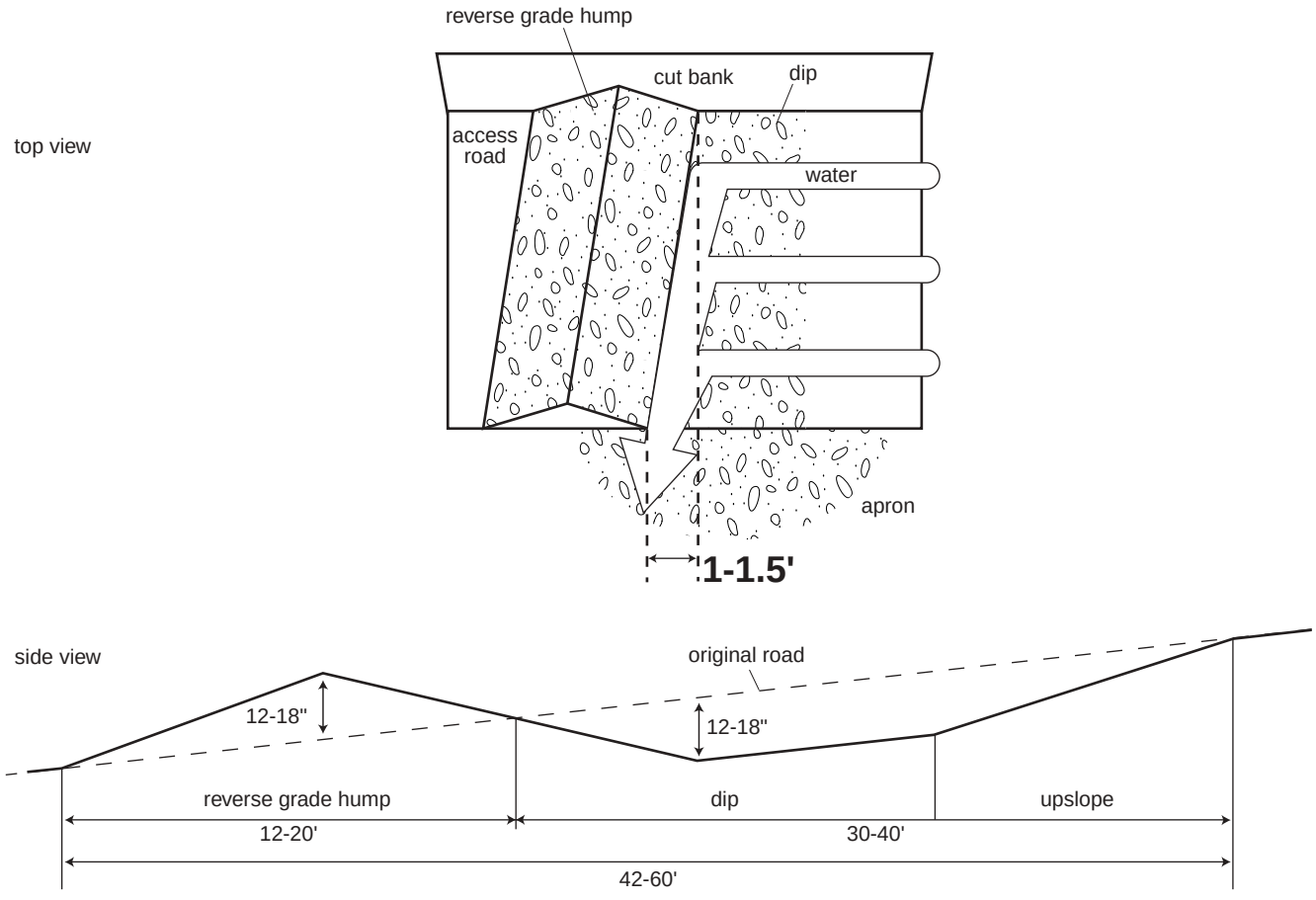
BMP No. 1–Access Roads, Skid Trails, and Landings

Table 1-1—Recommended Distances between Drainage Control Structures for Access Roads

Road Grade (%)	Spacing (slope distance in feet)
2-5	300-500
6-10	200-300
11-15	100-200
16-18	100

Note: Deviations from these recommendations may be appropriate depending upon the nature of the road surface material and its tendency to erode.

Figure 1-2. Reverse Grade Structure for Large Trucks.



Note: These drawings are not drawn to scale.

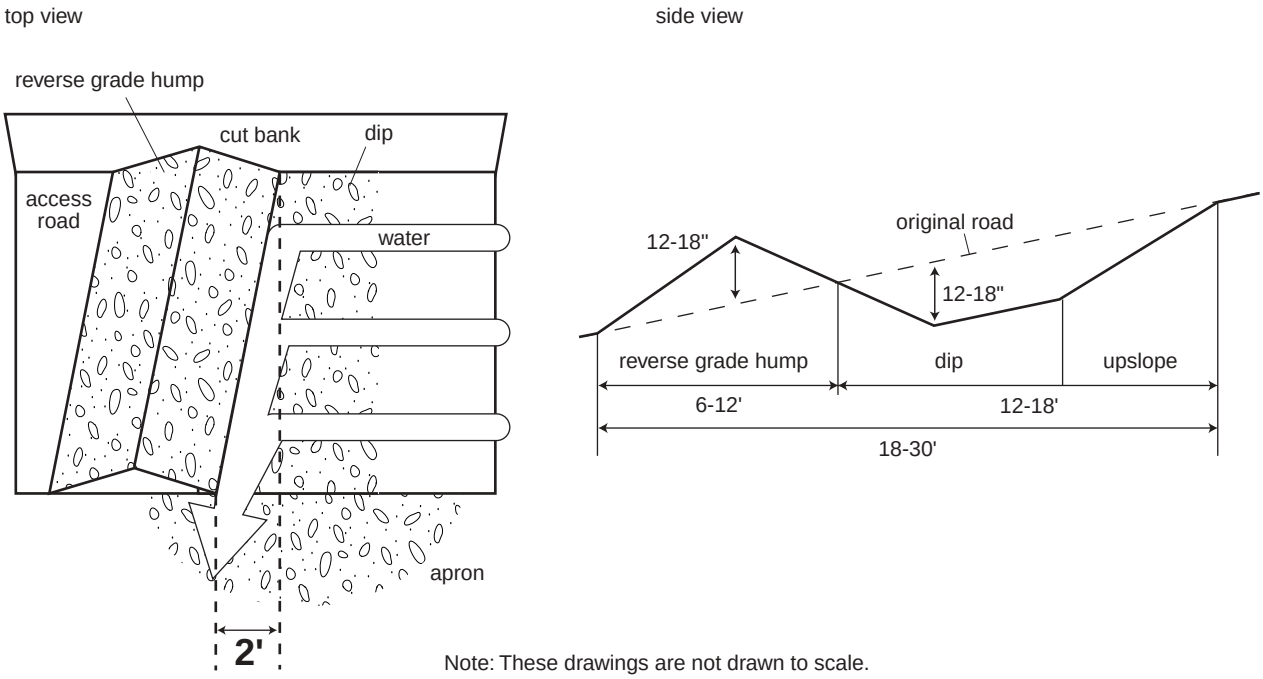
BMP No. 1–Access Roads, Skid Trails, and Landings

Table 1-1—Recommended Distances between Drainage Control Structures for Access Roads

Road Grade (%)	Spacing (slope distance in feet)
2-5	300-500
6-10	200-300
11-15	100-200
16-18	100

Note: Deviations from these recommendations may be appropriate depending upon the nature of the road surface material and its tendency to erode.

Figure 1-3. Reverse Grade Structure Used on Steeper Grades



Note: These drawings are not drawn to scale.

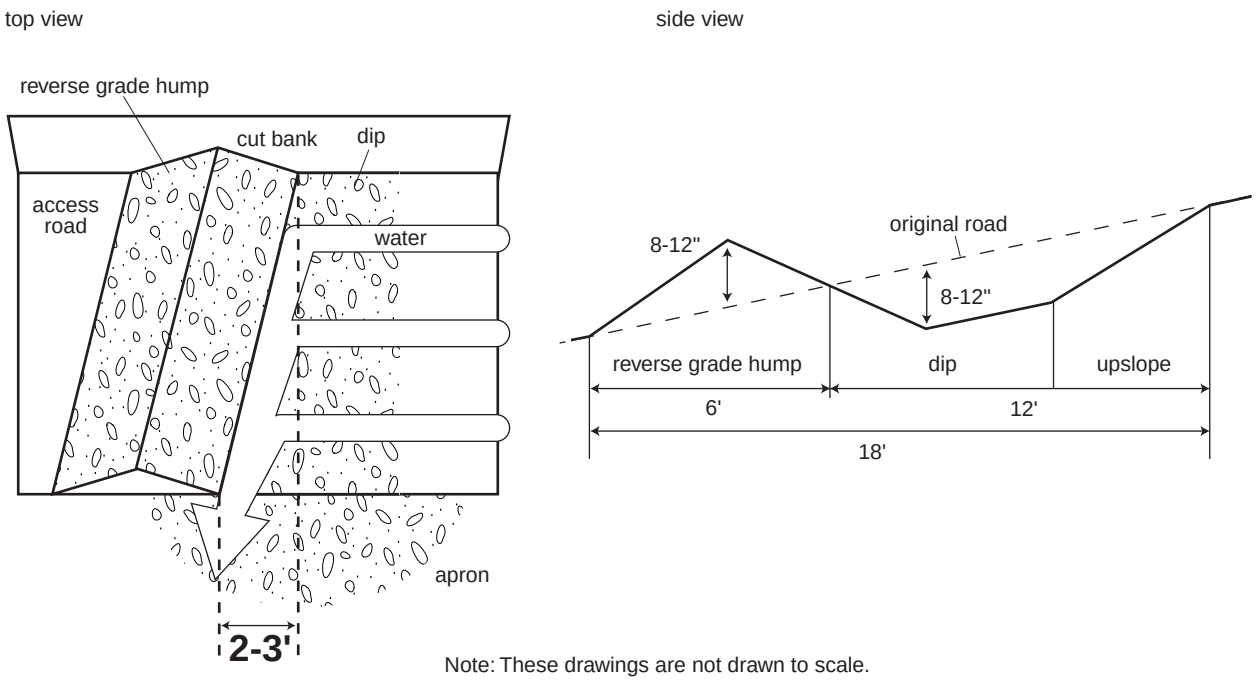
BMP No. 1–Access Roads, Skid Trails, and Landings

Table 1-1—Recommended Distances between Drainage Control Structures for Access Roads

Road Grade (%)	Spacing (slope distance in feet)
2-5	300-500
6-10	200-300
11-15	100-200
16-18	100

Note: Deviations from these recommendations may be appropriate depending upon the nature of the road surface material and its tendency to erode.

Figure 1-4. Reverse Grade Structure for Light Traffic (Water Break Structure)



Note: These drawings are not drawn to scale.

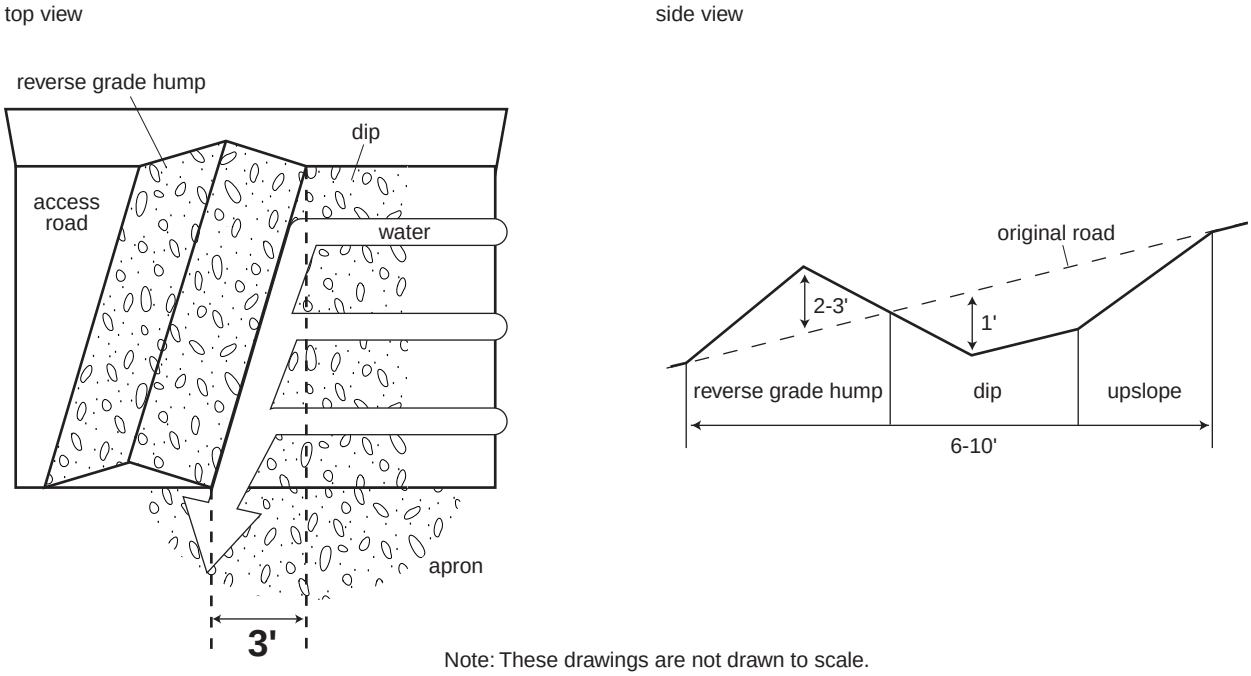
BMP No. 1–Access Roads, Skid Trails, and Landings

Table 1-2—Recommended Distances[1] between Water Bars for Retirement of Skid Trails

Skid Trail Percent	Spacing (slope distance in feet)
1	400
2	245
5	125
10	78
15	58
20	47
25	40
30	35
35	32
40	29

1 Actual distance between water bars will depend upon the nature of the road surface material, its tendency to erode, and hydrologically active areas, such as seeps.

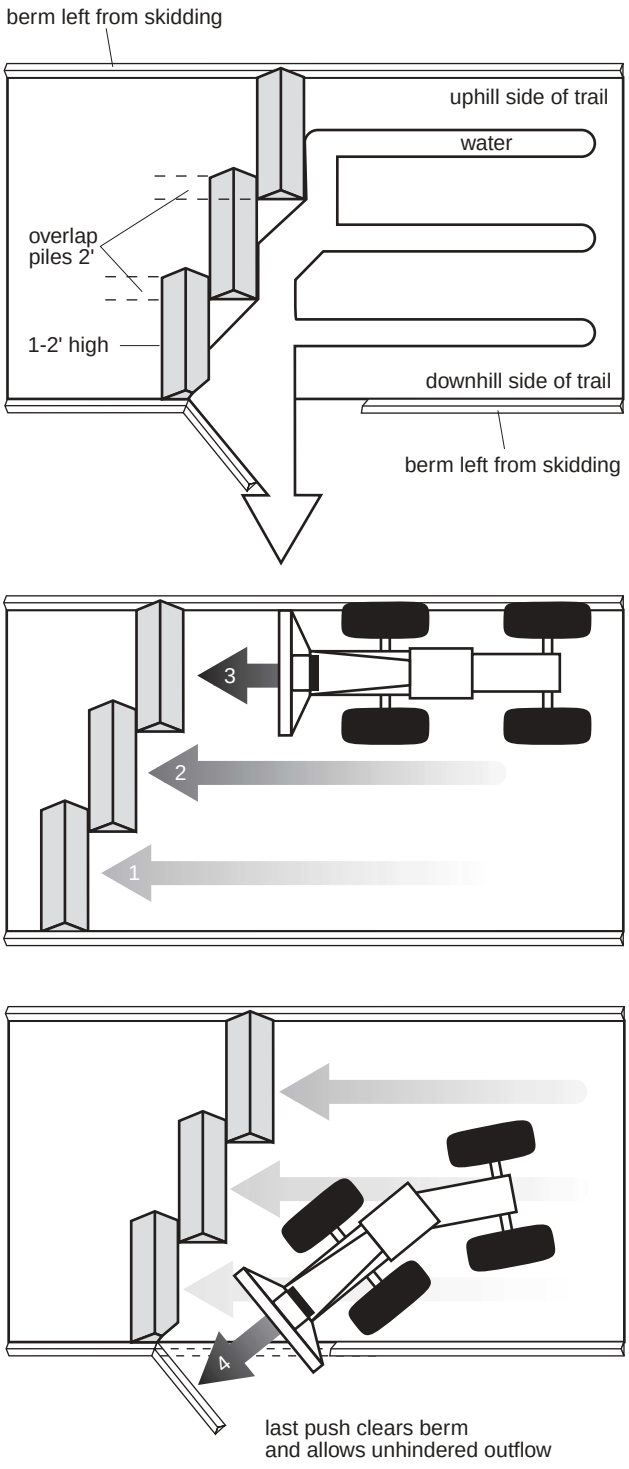
Figure 1-5. Reverse Grade Structure for Skid Trail Retirement (Deep Water Break or Water Bar)



Note: These drawings are not drawn to scale.

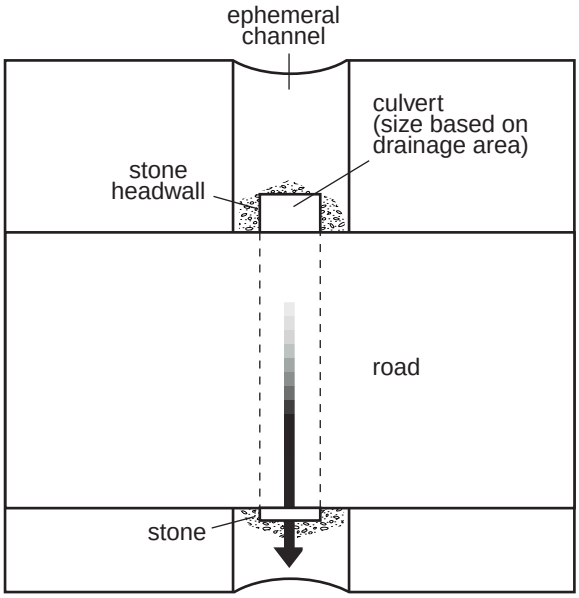
BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-6 Skidder Bar Construction.



BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-7. Closed Culvert in a Ephemeral Channel



BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-8. Closed Culverts for Road Drainage.

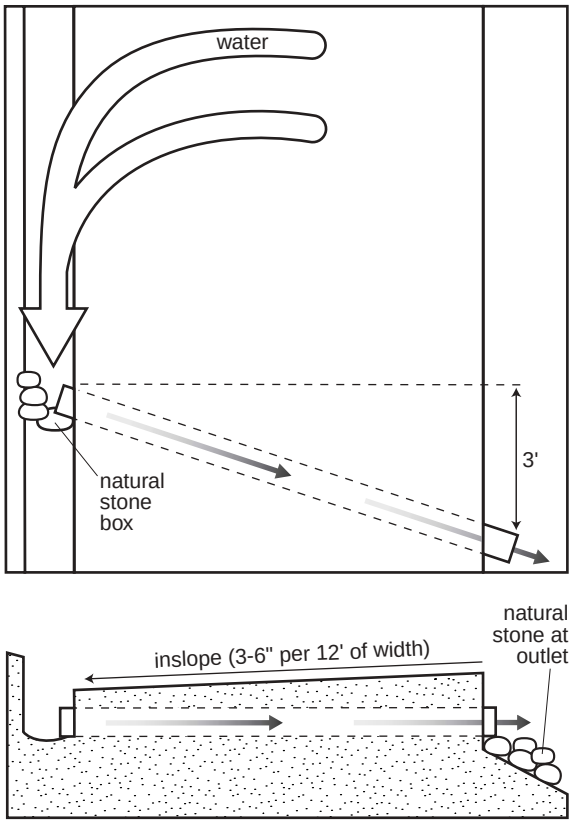
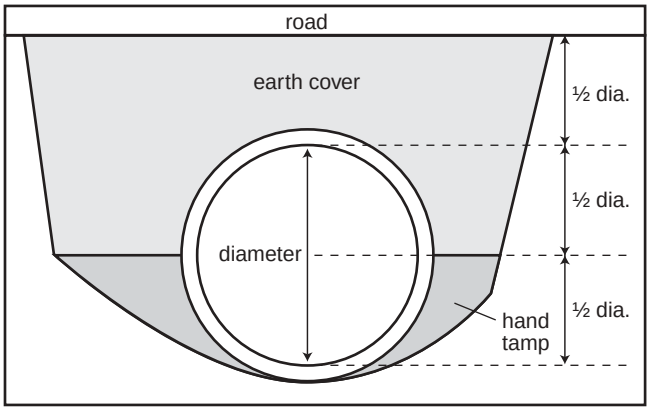
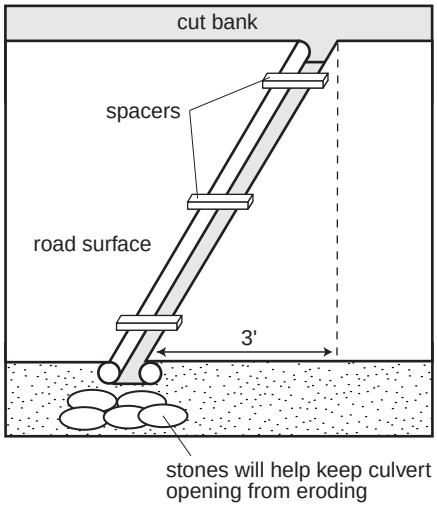


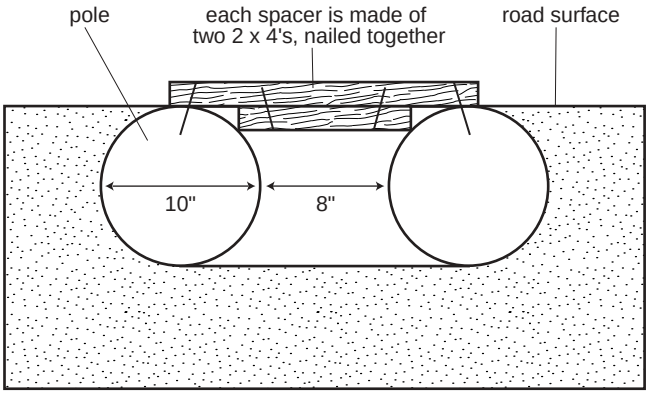
Figure 1-9. Cross-Sectional View of a Closed Culvert.



BMP No. 1–Access Roads, Skid Trails, and Landings

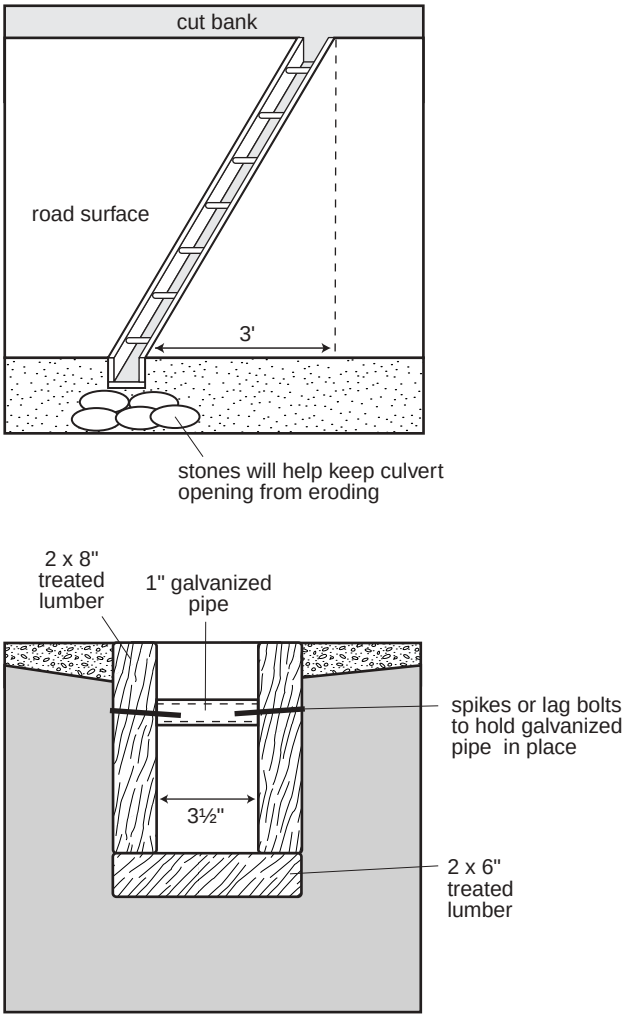
Figure 1-10. Overhead View of Pole Culvert Showing Spacers





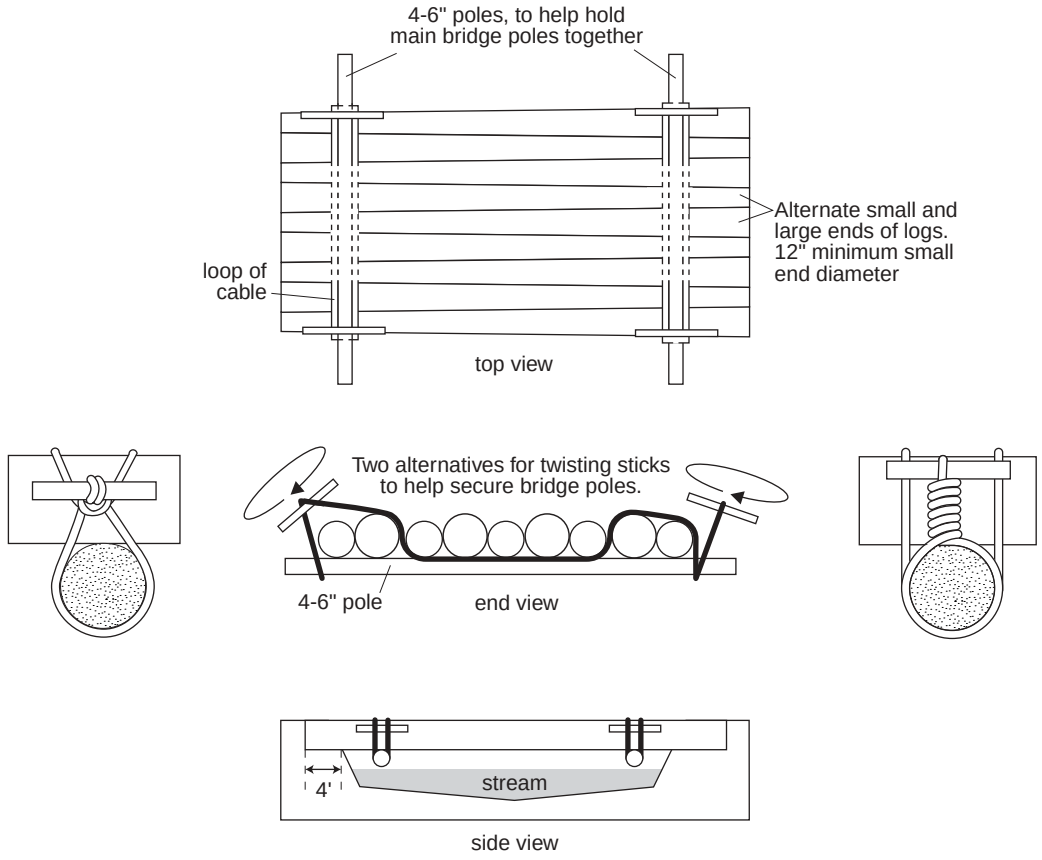
BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-11. Box Culvert



BMP No. 1–Access Roads, Skid Trails, and Landings

Figure 1-12. Temporary Log Stringer Bridge



BMP No. 2–Vegetative Establishment on Silviculturally Disturbed Areas

Table 2-1—Mulching Materials, Rates, and Uses

Mulch Material and Quality	Rate Per 1000 Sq. Ft.	Acre	Remarks
a. small grain straw, tall fescue straw or hay	75-100 lbs. (1½-2 bales)	1½ tons (60-80 bales)	Spread uniformly. Leave 10-20% of the area exposed. Subject to wind blowing unless left moist or tied down.
b. wood fiber cellulose air-dried, non-toxic, and no growth inhibiting substances	37-41 lbs.	1600-1800 lbs.	Apply with a hydro-mulcher. No tie-down is required. Packaged in 100 lb. bags.
c. tree bark air-dried, non-toxic and no growth inhibiting substances		6-12 tons	Resistant to wind blowing. Decomposes slowly.

See Appendix 1 in this BMP for determination of land area were mulching is needed.

Table 2-7—Road and Trail Surface Area Determination for Fertilizer, Seed, Lime, and Mulch

Road Length (feet)	Road Width (feet)				
	8	10	12	14	18
	acres				
50	.01	.01	.01	.02	.02
100	.02	.02	.03	.03	.04
250	.05	.06	.07	.08	.10
500	.09	.12	.14	.16	.21
750	.14	.17	.21	.24	.31
1000	.18	.24	.28	.32	.41
1500	.28	.34	.41	.48	.62
2000	.36	.48	.56	.64	.83
5000	.92	1.15	1.38	1.16	2.07
5280	.97	1.21	1.45	1.70	2.18

BMP No. 2–Vegetative Establishment on Silviculturally Disturbed Areas

Table 2-2—Temporary Cover Crop Species

Species	Seeding Rates (lbs/ac/pls[1])	Recommended Seeding Dates
winter wheat[2]	35	Oct. 15 - March 1
grain rye	35	Oct. 15 - March 1
spring oats	35	Oct. 15 - March 1
foxtail millet	12	May 1 - July 15
Japanese millet	15	May 1 - July 1
pearl millet	10	May 1 - July 1
annual ryegrass	5	Aug. 1 - Oct. 15
browntop millet	15	May 1 - July 1
cereal rye (Aroostook)	25	Sept. 15 - Oct. 15

1 pls: pure live seed (see Appendix 1 in this BMP).

2 Species in **boldface type** are primary recommendations.

Table 2-3—Mixtures for Slopes Less than 10 Percent

	Species Mixture	Seeding Rates (lbs/ac/pls[1])	Seeding Dates for Mixture[2]	Special Considerations
a.	**orchard grass[3]**	8	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	red clover	6		
b.	**orchard grass**	8	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	ladino clover	2		
c.	timothy	4	Feb. 1 - May 1 Aug. 1 - Oct. 15	
	ladino clover	2		
d.	**orchard grass**	10	Feb. 1 - May 1	No fall planting due to lespedesa
	Kobe or Korean lespedesa	10		
e.	switch grass	1	May 1 - June 30	For open canopy conditions only. A good seed bed is required. No fall planting due to lespedesa.
	big bluestem	2		
	indiangrass	2		
	red clover	4		
	Korean lespedesa	5		
f.	little bluestem	3	May 1 - June 30	No fall planting due to lespedesa
	side-oats gramma	3		
	Korean lespedesa	5		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 1 and May 1 or between August 1 and October 15.

3 Mixes in **boldface type** are primary recommendations.

BMP No. 2–Vegetative Establishment on Silviculturally Disturbed Areas

Table 2-4—Mixtures for Highly Erodible Areas (Areas Exceeding 10 Percent Slope)

	Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2] for Mixture	Special Considerations
a.	**Kentucky 31 fescue**	30	Feb. 1 - May 15 Aug. 1 - Oct. 15	High seedling and plant vigor on droughty, exposed sites. The endophyte-free fescue is more valuable for wildlife and is acceptable on lesser slopes.
	flatpea[3]	30		
b.	**Kentucky 31 fescue**	30	Feb. 1 - May 15 Aug. 1 - Oct. 15	High seedling and plant vigor on droughty, exposed sites. The endophyte-free fescue is more valuable for wildlife and is acceptable on lesser slopes.
	birdsfoot trefoil	10		
c.	**creeping red fescue**	20	Feb. 1 - May 15 Aug. 1 - Oct. 15	**For use in shaded areas.**
	white clover	2		
d.	switch grass	8	May 1 - June 30	For open canopy conditions only. Switch grass is a native.
	partridge pea	5		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture “a” be seeded between February 1 and May 1, or between August 1 and October 15.

3 Mixes in **boldface type** are primary recommendations.

BMP No. 2–Vegetative Establishment on Silviculturally Disturbed Areas

Table 2-5—Mixtures for Wet or Poorly Drained Areas

Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2]	Special Considerations
a. **redtop**	7	Feb. 15 - June 30 Aug. 1 - Oct. 1	
alsike clover or **birdsfoot trefoil**[3]	6		
b. switch grass	8	May 1 - June 30 Aug. 1 - Oct. 1	For open canopy conditions only.
alsike clover or birdsfoot trefoil	6		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 15 and June 30, or between August 1 and October 1.

3 Mixes in **bold face type** are primary recommendations.

Table 2-6—Mixtures for Establishing Native Species

Species Mixture	Seeding Rates (lbs/ac/pls)[1]	Seeding Dates[2]	Special Considerations
a. switch grass	2.0	May 1 - June 30	For open canopy conditions only.
indiangrass	2.0		
big bluestem	1.5		
little bluestem	1.5		
partridge pea	5.0		

1 pls: pure live seed (see Appendix 1).

2 the seeding dates were developed for the mixture and not the individual species. For example, it is recommended that mixture "a" be seeded between February 1 and May 1, or between August 1 and October 15.

BMP No. 3–Streamside Management Zones

Table 3-1—Summary of Streamside Management Zone Minimum Criteria

Water Body Type	% Remaining Canopy Trees	Width of Trees (ft)	Distance to Disturbed Ground (ft)
Perennial			
WAH[1] < 15% slope	50	25	variable based on slope %[3]
WAH > 15% slope	50	55	variable based on slope %[3]
CAH[2]	75	60	variable based on slope %[3]
Streams and sloughs in wetlands	50	50	50
Intermittent	0	0	25/5/5[4]

1 WAH: Warm-water aquatic habitat

2 CAH: Cold-water aquatic habitat

3 Refer to Table 3-2.

4 25/5/5: 25 feet distance on flat ground, which increases 5 feet for every 5 percent increase in slope (refer to Table 3-3).

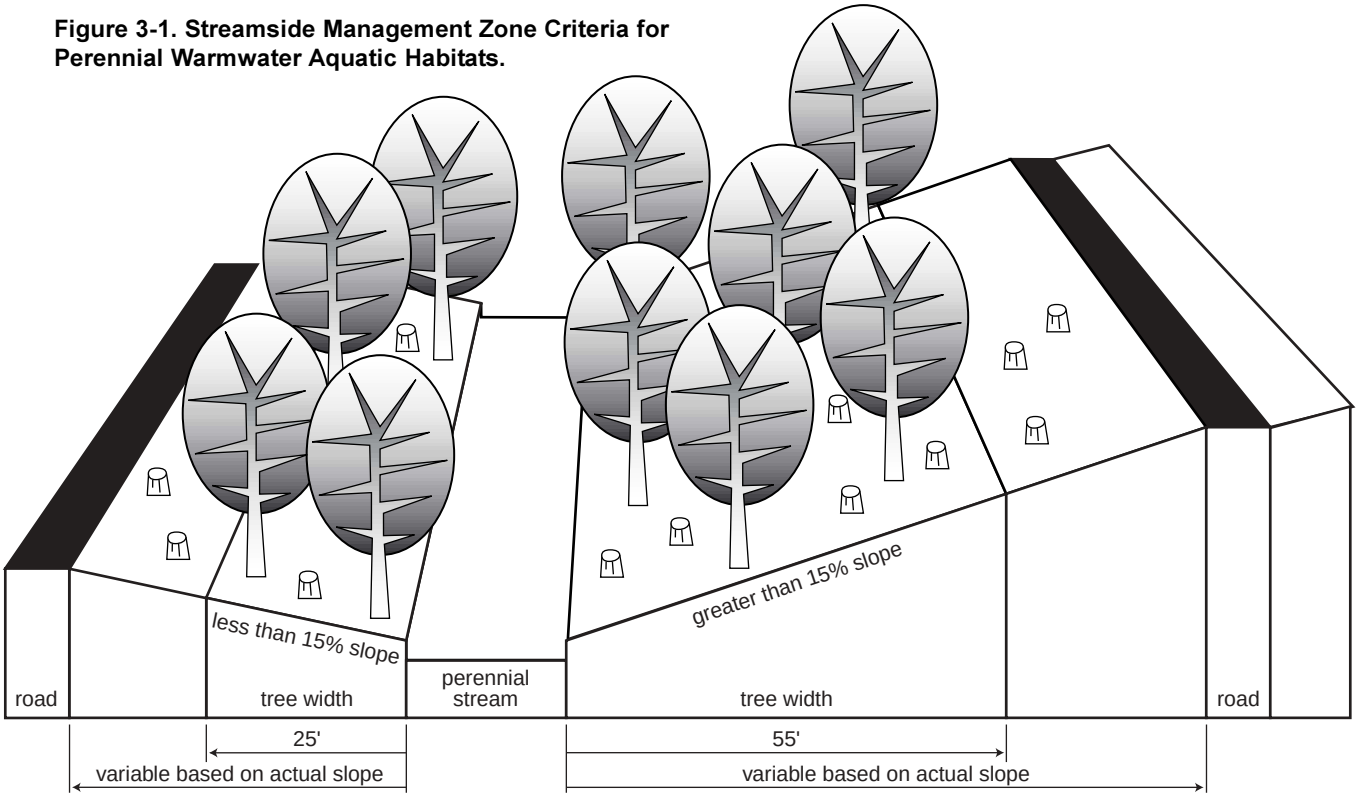
BMP No. 3–Streamside Management Zones

Table 3-2—Minimum Distances from Perennial Water Bodies to Roads, Trails, or Landings[1]

Slope of Land (%) away from stream bank	Width of Zone (feet) away from stream bank
0	25
5	35
10	45
15	55
20	65
25	75
30	85
35	95
40	105
50	125
60	145
70	165

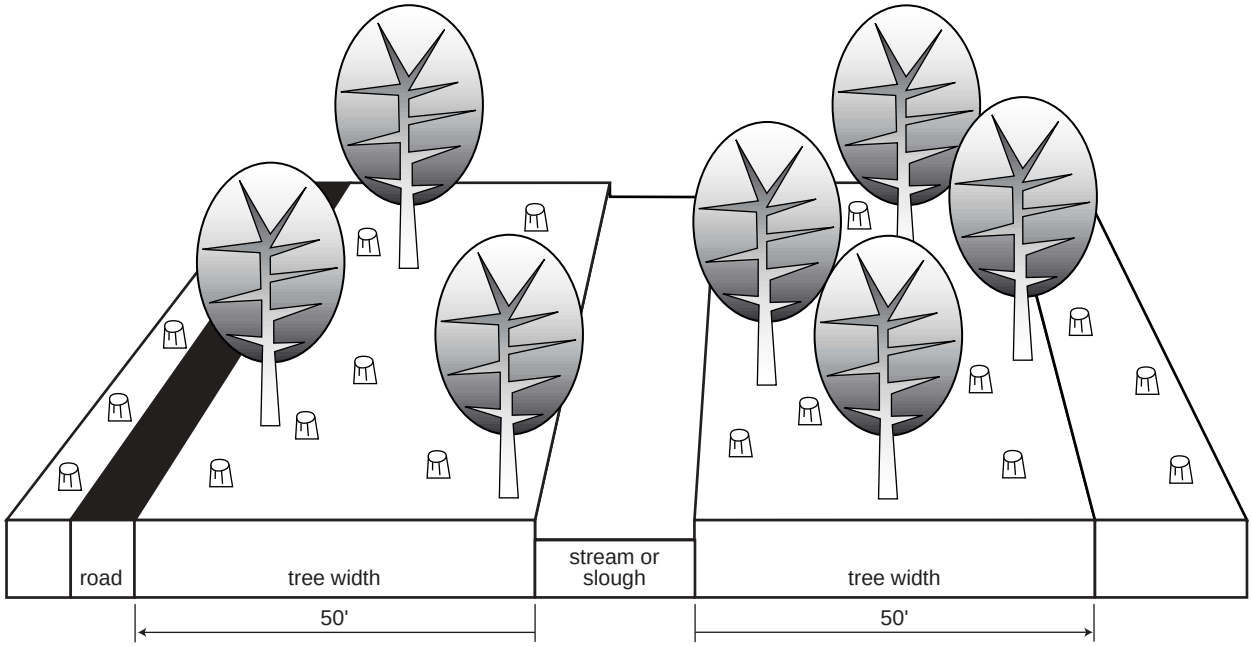
1 Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality. In no case should stream beds be used as roads or for the skidding of logs except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary, stream channels can be used as roads or for skidding only for the minimum distance required.

Figure 3-1. Streamside Management Zone Criteria for Perennial Warmwater Aquatic Habitats.



BMP No. 3–Streamside Management Zones

Figure 3-2. Streamside Management Zone Criteria for Streams and Sloughs in Wetlands.



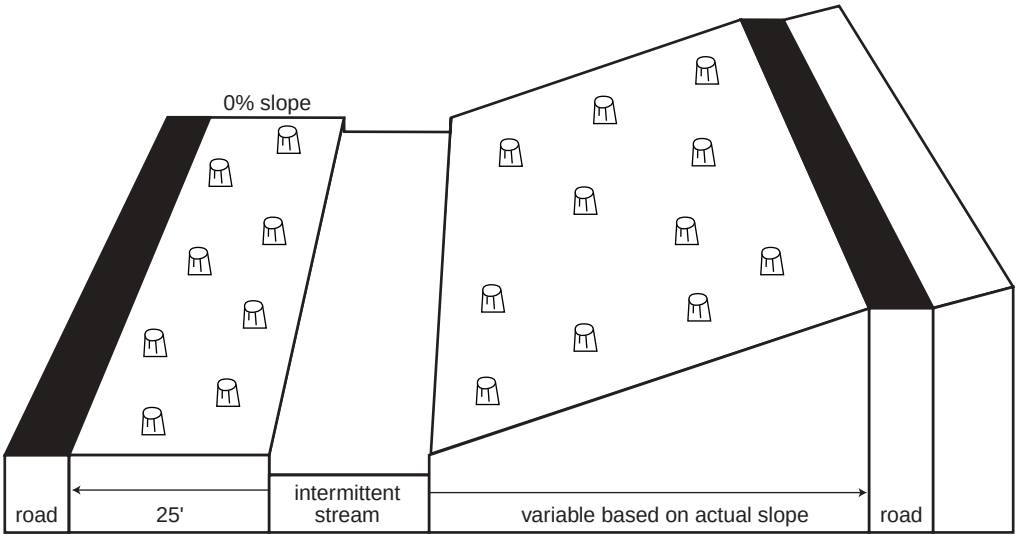
BMP No. 3–Streamside Management Zones

Table 3-3—Minimum Distances from Intermittent Streams to Roads, Trails, or Landings[1]

Slope of Land (%) away from stream bank	Width of Zone (feet) away from stream bank
0	25
5	30
10	35
15	40
20	45
25	50
30	55
40 or higher	65

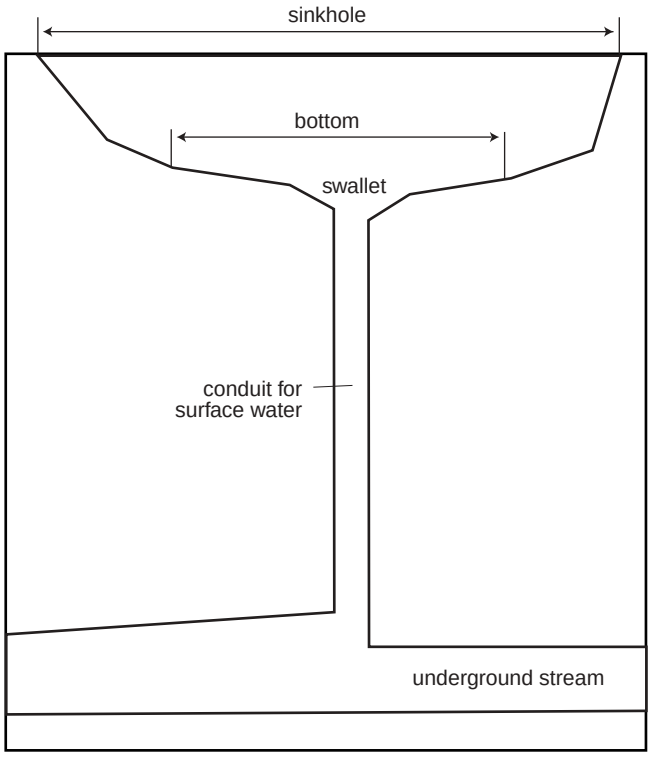
1 Where minimum distances are not possible, roads, trails, and landings can be located at less than the recommended distances, but they should be constructed to protect water quality. In no case should stream beds be used as roads or for the skidding of logs except where the geology or other physical conditions of the site (rock walls, notches, or other limiting factors) leave no other alternatives for access or where road or skid trail placement in normally recommended locations is either impossible or will cause a higher degree of water quality degradation. If an exception due to physical site conditions is necessary, stream channels can be used as roads or for skidding only for the minimum distance required.

Figure 3-3. Streamside Management Zone Criteria for Intermittent Streams.



BMP No. 4–Sinkholes

Figure 4-1. Flow of Waters Through a Sinkhole.



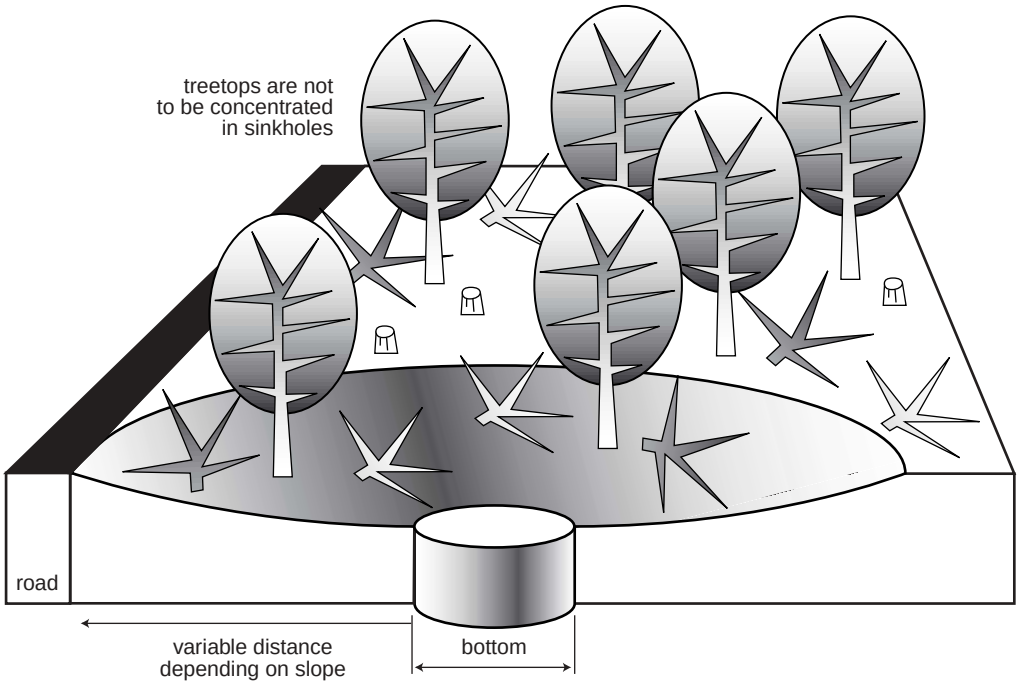
BMP No. 4–Sinkholes

Table 4-1—Minimum Distances from Silviculturally Disturbed Areas and the Point of Lowest Elevation or Open Swallet of a Sinkhole

Slope of Land (%)	Distance (feet)
5	30
10	35
20	45
30	55
40 or higher	65

Note: this table corresponds to the recommended minimum distances for roads, trails, and landings from intermittent streams.)

Figure 4-2. Specifications for Sinkhole BMP.



BMP No. 9–Site Preparation for Reforestation

Table 9-1—Site Preparation Methods Impacting Water Quality

Site Preparation Method	Hazard Level
Herbicide injection	Little or no hazard
Clear felling with chain saw	Little or no hazard
Herbicide spraying	Has potential if BMP No. 8 “Application of Pesticides” not followed
Drum chopping	Medium potential
Drum chopping with burning	Medium potential
Shearing and windrowing	High potential
Disking	High potential

 Issued 1-1997, Revised 8-2001, Last Printed 8-2001, 500 copies, 1000 copies to date.