TEXAS
FORESTRY
BEST MANAGEMENT PRACTICES

Texas Forestry Association

TEXAS FOREST SERVICE
The Texas A&M University System

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This reprint, funded by the Texas Forestry Association, combines the *Texas Best Management Practices for Silviculture* and *Texas Best Management Practices for Forested Wetlands*.

ADDITIONAL SOURCES FOR HELP WITH BMPs

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Texas Forestry Association
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Lufkin, Texas 75902-1488
(936) 632-8733

Natural Resources Conservation Service
118 E. Hospital Suite 301
Nacogdoches, Texas 75961
(936) 564-1153

USDA Forest Service
National Forests in Texas
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Lufkin, Texas 75901
(936) 639-8501

TFS District Offices

Carthage	(903) 693-6865
Center	(936) 598-2192
Coldspring	(936) 653-5772
Conroe	(936) 273-2263
Crockett	(936) 544-7798
Gilmer	(903) 734-7007
Henderson	(903) 657-0511
Huntsville	(936) 295-5688
Jacksonville	(903) 586-7545
Jasper	(409) 384-9427
Kirbyville	(409) 423-2890
Kountze	(409) 246-2484
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Livingston	(936) 327-4832
Hudson	(936) 875-4400
Marshall	(903) 938-8712
Nacogdoches	(936) 564-9276
New Boston	(903) 628-2711
Palestine	(903) 729-7738
Pittsburg	(903) 856-7181
San Augustine	(936) 275-3438
Tyler	(903) 561-7020
Woodville	(409) 283-3785

Summary of BMP Revisions

The Texas Forest Service, Texas Forestry Association, and the Texas State Soil and Water Conservation Board have evaluated and made revisions to the current BMP guidelines. These revisions were made in an effort to continue to improve and enhance the ability of forest landowners, loggers, and other forestry professionals to effectively protect water quality before, during, and after silvicultural operations. You should review all of the revisions to familiarize yourself with the changes and to ensure that they are being implemented properly.If you have any questions about any of these revisions please call the Texas Forest Service BMP Project Office at (936) 639-8180.

The following is a reference list of the revised guidelines and recommendations:

Revisions Listed by Section:

Guideline Revisions

- 2.0 Planning – 2.24
- 3.0 Road Construction and Maintenance – 3.18, 3.60
- 5.0 Harvesting – 5.22
- 6.0 Site Preparation/Planting – 6.26
- 7.0 Fire – 7.13
- 8.0 Silvicultural Chemicals – 8.11
- 9.0 Streamside Management Zones – 9.13, 9.31

Recommended Specifications Revisions

- Waterbars – 2, 10
- Wing Ditch – 7
- Stream Crossings
  - General – 4, 5
  - Fords – 1
- Streamside Management Zones – 3, 4, Minimum SMZ Width Chart, Stream Classification

Appendix

The following terms were added to the Glossary of Forestry Terminology:

1) Basal Area
2) Below Grade Road
3) Crown Cover
4) Hydrophytic Vegetation
5) Municipal Water Supply
6) Sinuosity

The following term was added to the Glossary of Wetland Terminology

1) Hydrophytic Vegetation
2) Waters of the United States

A “How To” section was added to the Appendix to properly show how to calculate basal area.

How to Use this Book

This book is divided into four parts.

I

The first part, pages 6-28, the Best Management Practices Guidelines, includes Sections 2.0-9.3. These sections describe the various BMPs.

II

The second part, pages 29-69, the blue pages, contains Section 10, detailed Recommendation Specifications for the practices outlined in the Guidelines. Specific construction details are found in this section.

III

The third part, beginning on page 70,the green pages, contains Guidelines for forest wetlands or wetland-like areas.

IV

The Appendix, part four, includes the Glossary of Terminology, How To Calculate Basal Area, and the Index.

TABLE OF CONTENTS

Part II

Part III

Part IV

APPENDIX

1.0 Introduction

Texas has more than 23,000,000 acres of land that is forested. Half of this area, roughly 11.9 million acres, lies in East Texas and is considered to be commercial timberland (capable of growing timber crops). East Texas timberlands are located near the neighboring states of Oklahoma, Arkansas, and Louisiana and are often referred to collectively as the "Piney Woods."

Most streams that originate or flow through these timberlands are sources of water supply, prime recreation, and other high quality uses. Because of this, forest management programs should incorporate adequate measures to protect water quality. The only practicable approach for maintaining low levels of nonpoint source pollution from forestry activities is through the use of preventive Best Management Practices (BMPs).

Planning for protection of water quality from nonpoint source pollution is provided for in the 1972 Federal Water Pollution Control Act, and as amended in the Clean Water Act of 1987. The basic goal of this law is to protect and improve the quality of the nation's waters so they remain "fishable and swimmable." The purpose of this handbook is to recommend sound forest practices for Texas's climate, soils, and topography. Most BMPs involve the application of conservation principles, which not only minimize water pollution, but also maintain or enhance the productivity of the land and are consistent with economic objectives.

Those who carry out forestry practices should use these *non-regulatory* BMPs. The progress of this program, in protecting our water resources, will be reviewed annually. Therefore, to guarantee future flexibility in employing our forest practices, it is important that the forest manager, landowner and logging contractor recognize that these freedoms can be lost if these non-regulatory measures fail to achieve established water quality goals.

Since the economy of East Texas is based on its natural resources, we must continue good stewardship of our forests to maintain this resource for ourselves and our posterity.

East Texas Pineywoods

FORESTRY BEST MANAGEMENT PRACTICES

The Society of American Foresters (1967) defines forestry as the science, the art, and the practice of managing and using, for human benefit, the natural resources that occur on and in association with forest lands.

These guidelines are intended to cover all activities on the land, from planting to transporting the harvested crop from the forest area.

Best Management Practices (BMPs) are designed to help landowners, foresters, loggers and others protect water quality during forestry (silvicultural) operations. BMPs can prevent, or at least greatly reduce, nonpoint source pollution of water bodies from forestry activities. The use of the BMPs is non-regulatory in Texas; and, if everyone involved in forest management implements these practices, water quality can be protected without strict government regulation.

A thorough understanding of the BMPs and flexibility in their application are of vital importance in selecting BMPs, which offer site-specific control of potential nonpoint source pollution. Those responsible for forest management practices should remain aware of potential problems and be prepared to make changes as they become necessary. With each situation encountered at various sites, there may be more than one correct BMP for reducing or controlling potential nonpoint source pollution. Care must also be taken to select BMPs that are practical and economical while maintaining both water quality and the productivity of forest land.

The positive use of non-regulatory BMPs will not only minimize any potential for nonpoint source pollution, but will also protect vital soil resources and maintain productivity and related values in forested areas. The following BMP guidelines relate to planning, road construction and maintenance, harvesting operations, locations of landings, skid trails, drainage, treatment of wastes and chemicals and the protection of stream courses.

These Forestry Best Management Practices are a part of the Nonpoint Source Management Program administered by the Texas State Soil and Water Conservation Board. Under the requirements of the Agricultural Code of Texas, the Board is responsible for planning, implementing, and managing programs and practices for abating agricultural and silvicultural (forestry) nonpoint source pollution. The specific silvicultural practices section of the program was modeled with contributions from the Texas Forest Service and Texas Forestry Association.

Part I

Best Management Practices

Guidelines

2.0 Planning

Methods to control potential nonpoint sources of pollution resulting from forestry activities should include careful planning of the layout of all operations. The plan should maximize efficiency, minimize traffic, preserve soil integrity, and protect water quality. Practices to achieve these goals during the planning stage of harvest operations follow:

2.10 General

.11 Use available topographic maps, aerial photographs and soil surveys in combination with local knowledge or field reconnaissance to determine site conditions.

.12 Operations on wet soils should be scheduled to minimize adverse impacts to the soils and water. .

.13 The forest manager, landowner or contractor for any silvicultural activity should carefully evaluate the tradeoffs in different forest management strategies against their potential for increased erosion and other harmful water quality impacts. Selecting the best strategy to maintain environmental standards and sustain an economic forest system is the responsibility of the forest manager or landowner. This is best approached on a site-specific basis. Working with the landowner or forest manager, the logging contractor is responsible for following the BMPs.

2.20 Planning Design

.21 Locate landings away from natural drainage channels (see page 27) with skidding pulling away from the SMZ on these channels to the set to minimize stream crossings.

.22 Skidding area boundaries should use terrain, roads and a forest area size compatible with available logging equipment, planting schedules, or other management objectives. Its size should minimize soil movement and protect water quality.

.23 Set design should balance skidding distances against road densities for the most efficient operations.

.24 Special care should be taken to avoid increasing erosion on below grade roads.

3.0 Road Construction and Maintenance

Well-located, well-constructed, and properly maintained forest roads are essential to forest management activities and critical to reducing pollution impacts on forest streams. Practices to provide maximum practical stream protection for road construction and maintenance follow:

Applicable Recommended Specifications: Haul Roads, Waterbars, Wing Ditches, Culverts, Broad-based Dips, Rolling Dips and Stream Crossings.

3.10 Road Location

.11 Always use available soil surveys, topographic maps, and aerial photographs to achieve the most practical road location with the best possible grade.

.12 As a general practice, confined terrain or natural drainage areas requiring an SMZ should not be used for road locations or traffic areas.

.13 All attempts should be made to stabilize or reconstruct existing roads where significant erosion problems exist. Stabilize, and retire roads where repair is impractical.

.14 Minimize the number of stream crossings.

.15 Cross streams at straight sections and at right angles.

.16 Locate roads on the best available sites, avoiding excessive slope.

.17 Upgrade an existing woods road only if it has been determined that the existing right-of-way (ROW) is properly located.

.18 Locate roads far enough outside the SMZ to prevent encroachment and to protect its integrity.

3.20 Construction

.21 Right-of-way timber salvage should closely follow the right-of-way clearing.

.22 Use the minimum road design sufficient to carry anticipated traffic loads with reasonable safety and with minimum environmental impact.

.23 Balance cuts and fills so that the excavated material will be deposited in the roadway fill sections and thereby minimize the need for borrow pits.

.24 To minimize erosion, cut and fill slopes should be designed at the normal angle of repose or less.

.25 Seeding, mulching, or other stabilizing means should be used wherever necessary to mitigate the potential for erosion.

.26 Plan and construct erosion control structures to minimize the adverse effects of rain during any construction phase.

.27 Once construction begins, all phases of that construction should be completed in a timely manner.

3.30 Drainage

.31 Ditches, culverts, cross drains, and wing ditches should be installed at the same time as the construction of the roadway.

.32 Roads should be designed to drain at all times by crowning, using ditches, culverts and/or by outsloping. When needed, similar drainage structures should be provided on secondary (woods) roads.

.33 Cross drains, relief culverts and wing ditches should not discharge onto erodible soils or over erodible fill slopes unless outfall protection is provided.

.34 Make effective use of diversion or wing ditches to carry road drainage away from the road and onto the undisturbed forest floor. Wing ditches should not discharge within 50 feet of a stream bed or channel.

.35 All culverts, permanent or temporary, should be of adequate size to carry the normal water flow anticipated during heavy rains. (See Culvert Sizing Chart, page 51)

.36 If needed, waterbars and other appropriate water control structures should be constructed to minimize erosion of the road bed.

3.40 Water Crossings

.41 If a ford or crossing cannot be found that minimizes rutting or siltation, then bridges, culverts, concrete slabs or other constructed fords should be used.

.42 Stream crossings should be constructed to minimize the disturbance to stream banks and existing stream channels. Temporary crossings should be removed and the site promptly restored.

.43 Use of equipment in the stream bed should be kept to an absolute minimum.

.44 Crossing streams at fords should take place when stream flow is down and the threat of sedimentation is low.

.45 Low water bridges, fills, and earth embankments used as bridge approaches should be stabilized to minimize potential erosion by using headwalls, wing walls, rip-rap, surfacing, etc.

.46 Excess material and woody debris from road construction should be cleared from streams and drainage ways and deposited above the ordinary high water mark.

.47 Bridges should not constrict clearly defined stream channels nor unduly impede flood waters.

3.50 Road Maintenance

Proper maintenance of permanent access roads is of vital importance to logging and land management activities. All road systems must be kept in serviceable condition at all times to minimize erosion by controlling rainfall runoff.

.51 The road surface should be crowned, or outsloped to dissipate surface runoff and minimize erosion of the roadbed.

.52 Ditches should be kept free from siltation, logging debris, brush etc.

.53 Culverts should be kept open and clean to allow unrestricted passage of water.

.54 Exposed soil subject to excessive erosion should be revegetated or otherwise stabilized if natural revegetation will not suffice.

.55 Roads not currently in use should be retired and periodically inspected to ensure their integrity.

.56 Re-establish vegetation on roadbeds, drainage systems, sideslopes, and backslopes following significant soil disturbances as quickly as site sensitivity requires.

.57 When extended periods between activities are expected (logging, logging/site prep, site prep/planting, etc.), temporary preventive measures should be taken when the potential for significant erosion exists.

.58 Re-sizing culverts and/or installing additional drainage structures may be necessary on highly erodible sites due to the increased runoff which usually follows logging and site preparation.

.59 Grassed-over roadbeds, sideslopes, and backslopes should be mowed or hand cleared, etc., to minimize soil disturbance.

.60 Special care should be taken when maintaining roads so that below grade roads are not created.

4.0 Road Material Sites

Deposits of surfacing, fill, and site stabilization materials are an extremely important resource for forest management activities. Excavation of these deposits represents a potential for nonpoint source pollution. Use proper planning, layout, maintenance, and reclamation of these sites to maximize utilization of the deposit and minimize soil movement. Guidelines, which should aid in reducing sediment and protecting water quality for road material site operations follow:

4.10 Planning and Layout

.11 To adequately reduce sediment movement both during and after pit operations, assess natural drainage patterns, adjacent SMZs, soils, slopes, and the location and shape of the deposit during planning.

.12 Deposits covering large areas should be divided and worked in stages, maintaining a minimum size working area and accomplishing partial or complete reclamation of the disturbed area before moving on. Avoid leaving large areas disturbed for extended periods, active or not.

.13 Size the site to minimize soil movement and protect water quality.

.14 Do not locate road material sites within an SMZ. Maintain a minimum of 50 feet from the edge of the SMZ. If you must locate near an SMZ, use control measures to ensure protection of water quality.

4.20 Active Sites

.21 Minimize changes to the area's natural drainage patterns to avoid directing large volumes of high velocity water onto disturbed soil.

.22 On steep slopes, fragile soils, or highly erodible sites, use settling basins, waterbars and/or terraces to slow runoff and disperse surface flow.

.23 When extended periods of inactivity are expected, use temporary erosion control measures to control surface runoff.

.24 Do site work during dry weather, whenever possible, to eliminate excessive runoff and accelerated erosion of freshly disturbed areas.

4.30 Reclamation

.31 Upon completion of pit operations and depletion of the deposit, redeposit and shape the overburden in a uniform layer over the pit area.

.32 Leave the area so that the pit will drain, have no areas of standing water, and prevent substantial soil movement and stream sedimentation.

.33 Cut and slope steep banks to at least a 2:1 slope and revegetate if needed as recommended in the Revegetation Specifications, page 65.

.34 Reclaim these sites to aid the future use of the area (i.e. ponds, non-timber areas, reforested, etc.) and implement control measures to minimize surface runoff for each case.

.35 Consider the area's slope, soil erosiveness, and capability to naturally revegetate and then fertilize and reseed all disturbed areas as needed. (Refer to the Revegetation Specifications, page 65.)

5.0 HARVESTING

Harvesting trees is an integral part of most forest management. Harvesting operations necessarily cause a temporary disturbance in the forest, but can be conducted to minimize the impact to water quality. Guidelines to help reduce the potential for nonpoint source pollution from harvesting trees follow:

Applicable Recommended Specifications: Waterbars, Culverts, Rolling Dips, Skid Trails, Stream Crossings, Logging Sets, SMZs and Revegetation.

5.10 HARVEST DESIGN

.11 Sets should be located to reduce the impact of skidding on the natural water drainage pattern. Skidding should avoid road ditches, culverts, sensitive sites, excessive slopes, etc.

.12 Sets should be located on firm ground well outside of the SMZ so runoff is well dispersed before reaching the SMZ.

.13 When operations are complete make provisions to disperse water runoff from landings and secondary roads by constructing waterbars or other structures where the potential for increased erosion exists.

.14 Activities located adjacent to navigable waters must comply with applicable U.S. Army Corps of Engineers regulations (see page 81).

.15 Shading, soil stabilization, and the water filtering effects of vegetation should be provided along streams by using one or more of the following methods:

- Leave trees, shrubs, grasses, rocks, and naturally-felled timber wherever they provide shade over a stream or stabilize the soil near such a stream;

- Harvest timber from the SMZ in such a way that shading and filtering effects are not destroyed, and;

- Where it is difficult to leave adequate vegetation within the SMZ to provide stream protection, cover should be re-established as soon as possible after harvesting is completed.

5.20 Felling and Bucking

.21 Directional felling should be used near streams to minimize debris entering the stream. Any tree that cannot be felled without falling into or across the streambed should be left standing.

.22 Minimize the number of trees harvested on the stream bank within an SMZ where they may help to protect the integrity of the stream, provide shade, and stabilize the bank.

.23 Trees should be removed from the SMZ before being limbed and topped if the adjacent areas are to be burned after logging operations.

.24 Every effort should be made to protect the residual timber stand within the SMZ

5.30 Skidding

.31 Skid trails should be placed to minimize disruption of natural drainage patterns.

.32 Stream channels, road ditches, or roads (primary or secondary) should not be used as skid trails.

.33 Where stream crossings cannot be avoided, use natural fords with firm bottoms, stable banks, and gentle slopes along approaches.

.34 Temporary crossings using culverts, poles, or portable bridges should be removed and the site restored as soon as their use is complete.

.35 Skid trails on slopes should have occasional breaks in grade to vent water. Upon completion of use, and if necessary, trails should be waterbarred and seeded to prevent excessive soil erosion.

.36 Service equipment away from streams so accidental spillage won't result in stream contamination.

.37 Erosion prone areas should be mulched or seeded to help re-establish permanent vegetative cover when necessary.

5.40 Disposal of Debris and Litter

.41 Logging debris in streams should be removed immediately.

.42 Logging debris should not be pushed into drains, streams, or SMZs.

.43 All trash associated with the logging operation should be promptly hauled (not buried) to a legal disposal site.

.44 All equipment fluids should be captured and disposed of properly.

6.0 Site Preparation/Planting

The major problems associated with site preparation involve soil erosion and potential sedimentation from runoff. The primary factors contributing to accelerated erosion from runoff are percent of the area with exposed soil, degree of slope, and type of soil.

The following guidelines recognize that erosion and sedimentation may result from any site preparation activity and are designed to protect soil. They should also be used to protect soil resources in situations where the SMZ may be damaged by fire and where organic residue may enter streams as a result of site preparation activities.

Applicable Recommended Specifications: Waterbars, SMZs, Revegetation.

See also: Section 7.0 Fire and Section 8.0 Silvicultural Chemicals.

6.10 General

.11 The boundaries of all SMZs should be clearly defined before beginning site preparation activities.

.12 The SMZ along streams should be protected by planning the use of equipment so as to minimize disturbance of these areas. Stream crossing construction should minimize disturbance of the area in which the crossing is being constructed. Such crossings will be restored promptly.

.13 Equipment operators should be trained and appropriate planning done so that soil disturbance, compaction, and displacement is minimized.

.14 Avoid intensive site preparation on steep slopes or highly erosive soils. Hand plant excessively steep slopes and wet sites.

.15 Prepare and plant sites in relation to the contour.

.16 Trash associated with site preparation and planting operations should be disposed of properly. All equipment fluids should be caught in containers and disposed of properly.

.17 Firebreaks should have well-installed and maintained water control structures to minimize erosion.

.18 All reasonable attempts should be made to stabilize and repair erosion resulting from site preparation and planting operations.

.19 All reasonable attempts should be made to avoid damage to existing water control devices (i.e. culverts, wing ditches). Site prep/planting equipment should avoid crossing or turning around in roads, road ditches, and wing ditches. Damages should be repaired immediately.

6.20 Equipment Operations

.21 Ripping, shearing, windrowing, and mechanical planting should follow the contour.

.22 On slopes exceeding 7%, parallel windrows should be located no more than 150 feet apart.

.23 Soil disturbance should be kept to a minimum. Avoid intensive site preparation on steep slopes and on slopes with thin or highly erodible soils.

.24 Site preparation activities should skirt SMZs and stream channels. Any debris should be placed above the ordinary high water mark of any stream, or body of open water.

.25 Provide water outlets on bedded or furrowed areas at locations that will minimize movement of soil. Discharge water onto a vegetated surface.

.26 Minimize the amount of soil pushed into a windrow.

7.0 Fire

A major concern of the forest manager is how fires affect surface runoff and soil erosion. For most flat, sandy soils of Southeast Texas, there is little danger of erosion. In the steeper topography of Northeast Texas, there is greater chance for soil movement. However, if the burn is under a timber stand and much of the duff remains, soil movement will be minor on slopes up to 25%. Site preparation burns are often the hottest type burn and can remove a substantial amount of the surface organic material. This type of burn would have the greatest potential for increased surface runoff or soil erosion, particularly on steeper slopes.

7.10 Prescribed Fire

.11 Site prep burns on steep slopes or highly erodible soils should only be conducted when they are absolutely necessary and should be as "cold" as possible.

.12 A significant amount of soil movement can be caused by the preparation for the burns, i.e., firebreaks. Firebreaks should have water control structures in order to minimize erosion.

.13 Site prep burning creates the potential for soil movement. Burning in the SMZ reduces the filtering capacity of the litter. All efforts should be made to minimize the impact from site-prep burning within an SMZ.

7.20 Wildfire Control

.21 The first and foremost concern in wildfire control is to prevent damage to people and property. During wildfire suppression, fireline BMPs which slow containment efforts must take a lower priority than fire suppression. Potential problems should, however, be corrected as soon as possible and when practical.

7.30 Wildfire Reclamation

.31 Actively eroding gullies should be stabilized when possible.

.32 Stabilize and revegetate, firelines, if needed on grades in excess of 5% or areas subject to accelerated erosion or known sensitive areas.

.33 Ensure that all road surfaces are left stabilized and protected.

7.40 Fireline and Firelane Construction and Maintenance

Fireline construction and maintenance is an essential part of forest management. It deals with site preparation burning, prescribed burning, and wildfire defense and control. A number of control practices can be implemented during fireline construction to prevent unnecessary erosion. Periodic inspection and proper maintenance can prevent potential erosion on established firelanes.

Fireline and Firelane Construction

.41 Firelines should be constructed on the perimeter of the burn area and along the boundary of the SMZ. The purpose of protecting the SMZ from fire is to safeguard the filtering effects of the litter and organic matter.

.42 Firelines should follow the guidelines established for logging trails and skid trails with respect to waterbars and wing ditches, and should be only as wide and as deep as needed to permit safe site preparation burns.

.43 Firelines which would cross a drainage should be turned parallel to the stream **or** have a wing ditch or other structure allowing runoff in the line to be dispersed rather than channeled directly into the stream.

Firelane Maintenance

.44 Firelanes on highly erodible sites or other problem areas should be inspected periodically to correct erosion problems by installing dips, wing ditches, waterbars, etc. and/or by seeding.

.45 Mowing, rather than blading, should be used to maintain firelanes in order to avoid exposing mineral soil to potential erosion. When blading is necessary, every effort should be made to minimize exposure of the mineral soil.

8.0 Silvicultural Chemicals

The following guidelines cover the handling and application of silvicultural chemicals to prevent the direct or indirect application of forest chemicals to open water sources.

These guidelines are to complement state or local regulations relating to the sale, transportation and use of chemicals.

Applicable Recommended Specifications: SMZs.

See also: Section 6.0 Site Preparation/Planting.

8.10 Planning

.11 Read and follow all guidelines on the manufacturer's label before applying silvicultural chemicals.

.12 Know the chemical characteristics, topography, soils, drainage, condition of bridges, weather, and any other factors that might be important for preventing water pollution during application.

8.20 Maintenance of Equipment

.21 No visible leakage of chemicals should be permitted from equipment used for transporting, storing, mixing or applying chemicals.

8.30 Mixing

.31 Water for mixing with chemicals should be carried to the site in tanks used only for the transport of water. The danger of getting a chemical into a ground or surface water supply must be avoided. An air gap is essential in the water intake to prevent back flow. Adding chemicals and mixing should only be done at the application site.

.32 Mix chemicals and clean tanks only where possible spills will not enter streams, lakes, or ponds. Do not mix chemicals or clean/flush tanks near well-heads.

8.40 Aerial Application

.41 Carefully plan application to avoid direct and indirect entry of chemicals into streams and impoundments. Realize that significant portions of the SMZ will probably be left untreated. Leave well-marked buffer zones between target area and surface water.

.42 Chemicals should not be applied when stream pollution is likely to occur through aerial drift.

.43 Use a spray device capable of immediate shutoff.

.44 Shut off chemical application during turns and over open water.

8.50 Ground Application

.51 Carefully plan application to avoid direct and indirect entry of chemicals into streams and impoundments.

.52 Exercise care not to exceed intended or allowable dosages.

.53 Where feasible, utilize injection or stump treatment herbicide methods in areas immediately adjacent to open water.

.54 Special care should be taken when chemicals are used in the SMZ.

.55 Avoid applying chemicals to vegetation protecting eroded slopes, gullies, drainages, and other fragile areas subject to erosion.

8.60 Managing Spills

.61 Should a spill occur, shovel a dike around the spill. Use absorbent material (kitty litter, slaked lime, sawdust, soil, etc.) to soak up fluid. Keep spill from flowing into streams or bodies of water.

Some spills will require notifying appropriate authorities.

8.70 Container Handling and Disposal

.71 Before disposal, containers should be rinsed as described in equipment clean up. Containers should be disposed of in accordance with manufacturers' recommendations.

8.80 Equipment Clean Up

.81 Clean up equipment in a location where chemicals will not enter any stream, lake, pond, or where stream pollution might occur.

.82 Rinse empty herbicide containers and mixing apparatus three times. This rinsate should be applied in spray form to the treatment area, NOT onto the ground.

9.0 Streamside Management Zones (SMZs)

Forest management within the area immediately adjacent to stream channels should direct specific attention to measures to protect both instream and downstream water quality. Under proper management, timber production, wildlife enhancement and water quality may all be achieved.

Applicable Recommended Specifications: Haul Roads, Culverts, Skid Trails, Stream Crossings, SMZs, and Revegetation.

9.10 General

.11 The purpose of an SMZ is to reduce the potential quantity of sediment and logging debris reaching the streams and to prevent increased water temperatures.

.12 Management activities that could cause pollution or erosion should be restricted in the SMZ.

.13 Roads, skid trails and firelines should be located outside the SMZ. Log landings should be located at least 50 feet from the edge of the SMZ.

.14 Timber may be logged carefully and selectively in such a way as not to destroy the filtering effects of the SMZ.

.15 If the vegetative cover is removed from a stream bank or filter strips, cover should be reestablished as soon as possible. See Revegetation Specifications on page 65.

9.20 Planning Design

.21 Intermittent streams should have a minimum width

of 50 feet on each side and above the head maintained as an SMZ. Width measurement begins at the stream bank. Some sites (i.e. erodible slopes, spring heads, oxbows, or upland flats) may require establishing an SMZ wider than 50 feet.

.22 Perennial streams should have a minimum of 50 feet on each side maintained as an SMZ. Specific sites may require an even greater width for the SMZ to safeguard filtering effectiveness and to protect the integrity of other values of the waterway. These values may include, but are not limited to, areas with heavy recreation, wildlife, biologically unique ecosystems, and natural hardwood sites.

.23 The width of an SMZ should be a site-specific determination made by foresters or other qualified professionals. Soil type, slope gradient, vegetative cover, volume of flow, and stream classification should be taken into consideration when designing each SMZ.

.24 The SMZ should be clearly defined and distinctly delineated on the ground prior to beginning any forestry activities, which might affect water quality.

9.30 Canopy and Vegetation Criteria

.31 Within the SMZ, a minimum of 50 square feet of basal area per acre should be left to provide adequate shade for the stream, lessen impact from raindrops, and to intercept sediment and debris washing toward the stream. Refer to page 105 of the Appendix to properly calculate basal area.

Part II

10.0
Recommended Specifications

HAUL ROADS

Refer to Section 3.0 Road Construction and Maintenance.

Definition: A road system, temporary or permanent, installed primarily for transporting wood products from the harvest site by truck and with a secondary use for other forest activities.

Purpose: To provide an effective and efficient transportation system to protect forest land and water quality when removing forest products from the harvest site, developing the forest for recreation, accessing the area for forest fire suppression, or other needed forest management activities. Properly located and constructed roads will provide safety, higher vehicle speeds, and longer operating periods while reducing operating and maintenance cost.

Condition Where Practice Applies: Where the area to be cut and volume per acre makes it necessary and economically feasible to install a road system.

Recommended Specifications

1. Roads should follow ridges as much as possible with road grades between 2% to 10%. Grades steeper than 10% should not exceed 500 feet in length and slopes greater than 15% should not exceed 200 feet in length.

2. On highly erodible soils, grades should be 8% or less, but grades exceeding 12% for 150 feet may be acceptable as long as measures are taken to prevent erosion. Graveling the road surface can help maintain stability.

3. Intermittent or perennial streams should be crossed using bridges, culverts, or rock fords. Cross as close to a right angle to the stream as possible. Structures should be sized so as not to impede fish passage or stream flow.

See Pipe Culvert Recommended Specifications on page 40 and Size Chart on page 51.

4. Install water turnouts prior to a stream crossing to direct road runoff water into undisturbed areas of the SMZ. Road gradients approaching water crossings should be changed to disperse surface water at least 50 feet from the stream. With the exception of stream crossings, roads should be located a minimum distance of 50 feet from any flowing stream. Distance is measured from the bank to the edge of soil disturbance, or in case of fills, from the bottom of the fill slope. See Recommended Specifications for SMZs on page 57. Fords may be used when stream banks are stable and stream bottoms hard. Where banks are unstable, stabilize the stream bank approach with rock or other material. Fords should only be used when vehicles crossing the stream do not cause increased sedimentation.

5. Outslope the entire width of the road where road gradient and soil type will permit. Usually inslope the road toward the bank as a safety precaution on sharp turns, road gradients of 15%+, or on clay and/or slippery soils. Use cross drainage on insloped or crowned roads to limit travel distance of runoff water.

6. Where roads are insloped or crowned, and gradients begin to exceed 2% for more than 200 feet, broad-based dips or rolling dips should be placed within the first 25 feet of the upgrade.

7. When possible, meander roads along ridge tops or place on the side of ridges, avoiding the level ridge tops and side slopes; also avoid wet flood plain soils where drainage is difficult to establish.

8. Haul roads that intersect highways should use gravel, mats or other means to keep mud off the highway.

9. Road bank cuts normally should not exceed five feet in height.

Road bank cuts more than five feet high should normally be sloped to at least a 2:1 ratio and seeded to prevent erosion. Roads requiring high cut banks should be used only when no other alternative is feasible. Some cuts may need to be mulched, fertilized or limed to establish cover.

10. Ensure good road drainage with properly constructed and spaced wing ditches, broad-based dips, rolling dips, culverts, and bridges. Wing ditches should be constructed so water will be dispersed and will not cut channels across the SMZ. See spacing chart within each specific practice.

11. At cross drains (culverts or dips), install rip rap or other devices at the outlets to absorb and spread water, if needed.

12. Cut trees along the side(s) of the road where sunlight is necessary to ensure drying of the road.

13. Use brush barriers or check dams as needed along road fill areas or other sensitive areas.

Road Maintenance

14. If possible, restrict traffic on roads during wet conditions. Wooden mats and gravel allow operations during wet soil conditions when damage may otherwise occur. Haul only during dry weather on normally wet soils, erodible soils or road gradients exceeding 10%, which do not have erosion protection.

15. Close or restrict traffic following maintenance activities on sensitive primary and secondary roads to allow them to stabilize, revegetate (naturally or after seeding) and heal over.

16. Keep roads free of obstructions, ruts, and logging debris to allow free flow of water from the road surface.

17. Control the flow of water on the road surface by keeping drainage systems open and intact at all times during logging operations.

18. Re-work roads to remove ruts when the average rut depth exceeds 6 inches over a distance of more than 50 feet or when erosion damage may occur from hauling operations.

19. Inspect the road at regular intervals to detect and correct maintenance problems.

20. When all forestry activities are completed, reshape the roadbed if necessary. Ensure that all drainage systems are open, and seed all areas of bare soil along the access roads, main skid trails, and log landings which are subject to excessive erosion. See Revegetation of Disturbed Areas on page 65.

WATERBARS

Refer to Section 3.0 Road Construction and Maintenance.

Definition: A cross drain and/or diversion dam constructed across a road or trail which may be pole-reinforced on sandy soil.

Purpose: To intercept and/or divert side ditch and surface runoff from roads, firebreaks, and trails, (which may or may not have vehicular traffic) to minimize erosion and provide conditions suitable for natural or artificial revegetation. On moderate slopes, waterbars will remove water from the road, or firebreak, allowing for adequate natural revegetation within one year.

Conditions Where Practice Applies: This is a practice that can be utilized on limited use road, trail and firebreak grades where surface water runoff may cause erosion of the exposed soil.

Recommended Specifications

1. Waterbars should be placed at an angle of 30 to 45 degrees to the road, firebreak or trail. The waterbar turns runoff, not dams it.

2. Avoid constructing waterbars within an SMZ when possible.

3. When cross drains are used, trench depth should equal that of the uphill ditch line and be one to three feet below the surface of the road. Spoil materials should be used to develop the height of the waterbar.

4. To prevent additional erosion, waterbars used in conjunction with cross drains should be designed for the soil and the site.

5. Proper spacing between waterbars can be determined from the following Table:

Grade of Road (Percent)	Distance between Waterbars (Feet)
2	250
5	135
10	80
15	60
20	45
30	35

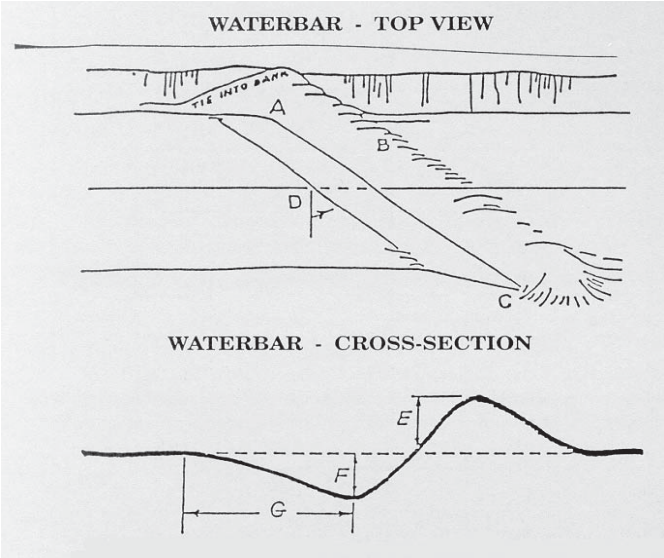
6. To fully intercept any ditch flows, the uphill end of the bar should extend beyond the side ditch line of the road and tie into the bank.

7. The outflow end of the waterbar should be fully open and extend far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor. The outlet length should not be excessive.

8. Waterbars alone (without cross drains) should be used on sandy, erodible soils and other sensitive sites.

9. Waterbars should be located to take advantage of existing wing ditches and cross drainage. They should be constructed at an angle of 30 to 45 degrees from the center of the roadbed and tied into the wing ditch dam (i.e. the diversion plug in the borrow ditch). Waterbars should be inspected after major rainstorms and damage or breeches should be promptly corrected.

10. In below grade situations waterbars should be constructed from material taken from road shoulders. This will help provide an outlet.



1. Specifications for waterbar construction on forest roads, trails and firebreaks must be site specific and should be adjusted to existing soil and slope conditions.

2. A - Bank tie-in point, cut 1 to 2 feet into the roadbed.

3. B - Cross drain berm height 1 to 2 feet above the roadbed.

4. C - Drain outlet cut 1 to 3 feet into roadbed.

5. D - Angle drain 30 to 45 degrees downgrade with road centerline.

6. E - Approximately 2 feet in height.

7. F - Depth 1 to 2 feet.

8. G - 3 to 4 feet.

9. Ensure that the outlet is open and extends far enough beyond the edge of the road or trail to disperse runoff water onto the undisturbed forest floor. Consider the need for energy absorbers or water spreaders at or below the drain outlet on sensitive areas.

WING DITCHES

Refer to Section 3.0 Road Construction and Maintenance.

Definition: A water turnout, or diversion ditch to move water away from the road and/or side ditch.

Purpose: To collect and direct road surface runoff from one or both sides of the road away from the roadway and into undisturbed areas. To slow and channel water away from these roadside ditches and disperse it onto areas adjacent to the road.

Conditions Where Practice Applies: Any road or trail section where water could accumulate or accelerate. The water should be diverted onto undisturbed areas so the volume and velocity is reduced on slopes. Where a buildup of drainage water in roadside ditches can gnaw at roadbeds, scour the road ditch itself, and otherwise move soil particles downslope.

Recommended Specifications

1. The wing ditch should intersect the ditch line at the same depth and be outsloped to a maximum grade of 1% on erodible soils and to a maximum grade of 2% on stable soils.

2. On sloping roads, the wing ditch should leave the road ditch line at a 30 to 45 degree angle to the roadbed and be designed to follow the natural contour.

3. The spacing of wing ditches will be determined by the topography and relief of the area. Generally wing ditches should be located no more than:
    1) 200 feet apart on 2% - 5% grades,
    2) 100 feet apart on 5% - 10% grades, and
    3) 75 feet apart on 10% grades.

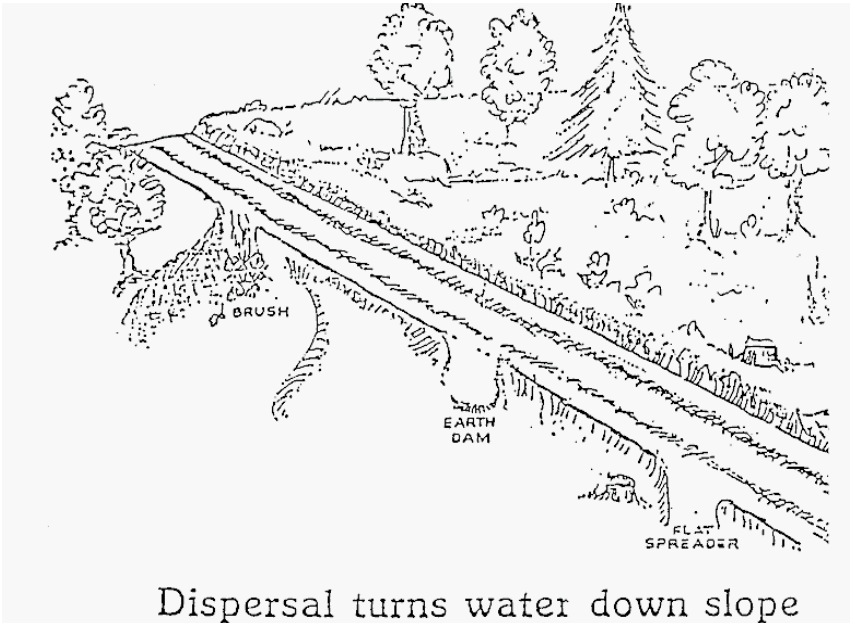
4. Wing ditches should be spaced to permit the roadbed to dry and reduce the volume and velocity of side ditch waters.

5. Runoff water should be spread, retained, or filtered at the outlet of the wing ditch.

6. Wing ditches should not feed directly into adjacent drainages, gullies or channels.

7. Avoid cutting a narrow channel to serve as a wing ditch. Outlets should be constructed to disperse water over a broad area.

8. Three types of wing ditch outlets can be used:
   1) wing ditches into brush;
   2) wing ditches into a well-designed earthen dam; and
   3) a wing ditch into a flat spreader that distributes water on the undisturbed forest floor.



WING DITCH

CROSS-ROAD DRAINAGE: CULVERTS

Refer to Section 3.0 Road Construction and Maintenance.

Definition: Corrugated metal pipe, wooden open top culverts, or other suitable material installed under haul roads to transmit water from the road side ditch, storm runoff, seeps and drains.

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

Conditions Where Practice Applies: Culverts can be used for any size operation where cross drainage of water is needed. In some cases, a culvert is necessary for temporary drainage crossings. Permanent installations should be periodically inspected for obstructions.

Recommended Specifications:
Pipe Culverts

1. Pipe length should be long enough so both ends extend at least one foot beyond the side slope of fill material.

2. The culvert should be placed 1% to 2% downgrade to prevent clogging and laid so the bottom of the culvert is as close as possible to the natural grade of the ground or drain.

3. The culvert should be skewed 30 to 45 degrees downslope.

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

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

Open-Top Box Culvert

1. Box culverts should be installed flush or just below road surface and skewed at an angle of 30 to 45 degrees downgrade.

2. The upper end should be at grade with the side ditch and the lower side should extend into the toe of the upslope bank.

3. The outfall should extend beyond the road surface with adequate rip rap or other material to slow the water to prevent erosion of fill material.

4. Periodic clean-out maintenance is necessary to keep this type culvert working properly.

Culvert spacing can be determined by the following formula:

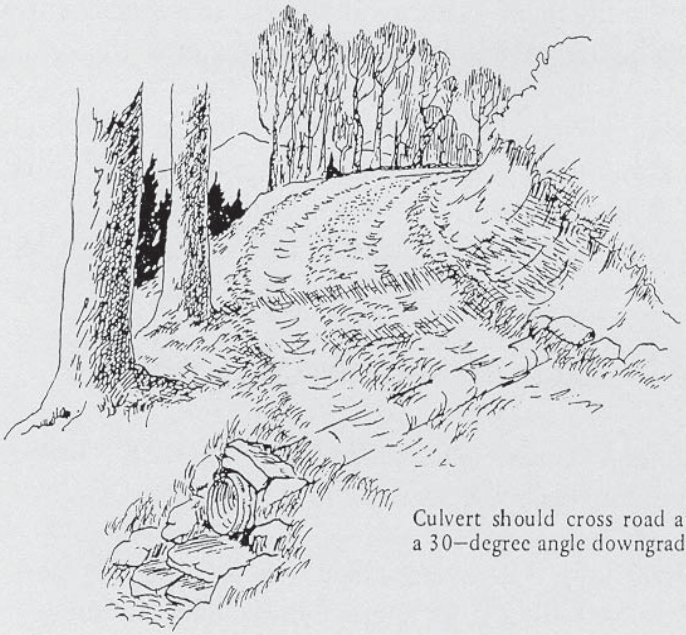
$$Spacing = \frac{400'}{Slope\,\%} + 100'$$

*Slope in percent expressed as a whole number
(i.e. 15% = 15)

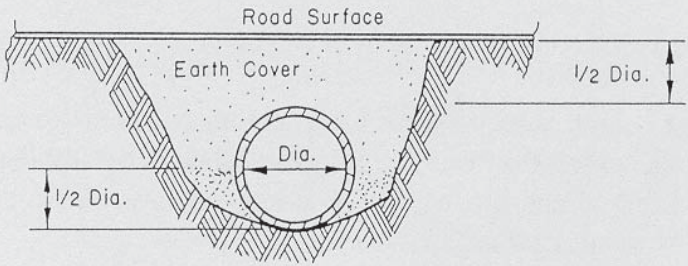
EXAMPLE:

$$Spacing = \frac{400'}{15} + 100'$$

$$Spacing = 127'$$



Culvert should cross road at about a 30–degree angle downgrade.



BROAD-BASED DIPS

Refer to Section 3.0 Road Construction and Maintenance

Definition: A dip and reverse slope in a road surface with an outslope in the dip for natural cross drainage.

Purpose: To provide cross drainage on insloped truck roads to prevent buildup of surface runoff and subsequent erosion. Allows higher vehicle speeds than rolling dips.

Conditions Where Practice Applies: Used on truck haul roads and heavily used skid trails having a gradient of 12% or less. Should not be used for cross draining springs and seeps or intermittent or perennial streams. May be substituted for other surface water cross drain practices such as culverts.

Recommended Specifications

1. Installation should take place following basic clearing and grading for roadbed construction.

2. A 20-foot long, 3% reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location.

3. The cross drain outslope will be 2% to 3% maximum.

4. An energy absorber such as rip-rap and, in some cases, a level area where the water can spread, should be installed at the outfall of the dip to reduce water velocity thus assuring no erosion of cast materials

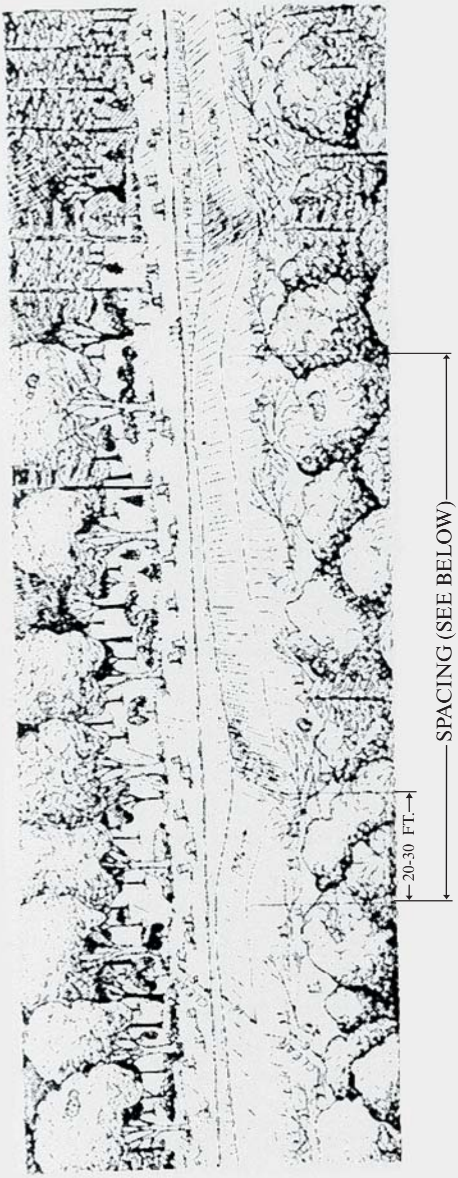
5. On some soils the dip and reverse grade section may require bedding with 3 inch crushed stone to avoid rutting the road surface.

6. Broad-based dips are very effective in gathering surface water and directing it safely off the road. Dips should be placed across the road in the direction of water flow.

7. Recommended Spacing Table for Broad-Based Dips.

Road Grade (percent)	Spacing between Dips (feet)
2	300
4	200
6	165
8	150
10	140
12	130

8. An inherent problem in construction of a broad-based dip is not recognizing that the roadbed consists of two planes rather than one unbroken plane. One plane is the 15 to 20 foot reverse grade toward the uphill road portion and outlet. Another plane is the grade from the top of a hump or start of a down grade to the outlet of the dip. Neither the dip nor the hump should have a sharp, angular break, but should be rounded to allow a smooth flow of traffic. Properly constructed broad-based dips do not damage loaded trucks, or slow vehicle speed. Dips require minimal annual maintenance and continue to function years after abandonment. Only the dip should be outsloped to provide sufficient break in grade to turn the water.



Road Grade (percent)	Approximate Spacing Distance Needed Between Dips (feet)
1	500
2	300
5	180
10	140

BROAD-BASED DIP

ROLLING DIPS

Refer to Section 3.0 Road Construction and Maintenance

Definition: A dip and reverse slope in a road surface with an outslope in the dip for natural cross drainage. Use on steeper grade roads than broad-based dips.

Purpose: Provides cross drainage on in-sloped haul roads to channel excessive runoff and reduce erosion.

Conditions Where Practice Applies: Used on haul roads and heavily used skid trails having a gradient of 15% or less. Should not be used for cross draining springs and seeps, or intermittent or perennial streams. May substitute for other surface water cross drain practices such as culverts.

Recommended Specifications

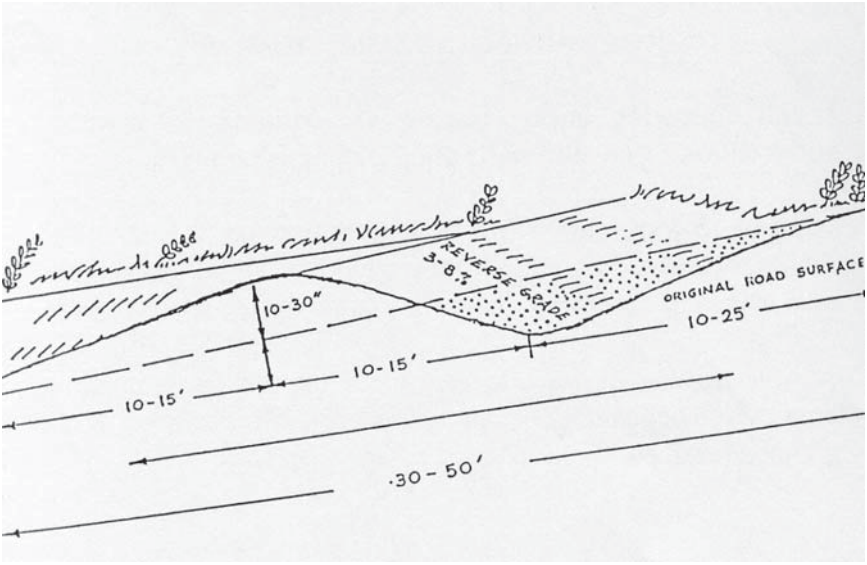
1. Install following basic clearing and grading for roadbed construction or on skid trails after logging is completed.

2. A 10 to 15-foot long, 3% to 8% reverse grade is constructed into the roadbed by cutting from upgrade to the dip location and then using cut material to build the mound for the reverse grade.

3. In hills, rolling dips are located to fit the terrain as much as possible. They should be spaced according to the slope of the planned roadbed.

4. Spacing rolling dips can be determined from the following table:

Grade of road (percent)	Distance between Dips (feet)
2-5	180
5-10	150
10-15	135
15+	120



ROLLING DIP

STREAM CROSSINGS

Refer to Section 3.0 Road Construction and Maintenance

Definition: Culverts, bridges, or rock fords that enable equipment to cross intermittent or perennial streams, or drains and drainage ditches, and insure minimal negative impact to the stream.

Purpose: To cross intermittent or perennial streams without increasing stream sedimentation.

Conditions Where Practice Applies: Used for on-going operations where streams or drainages must be crossed by logging, site preparation, road maintenance, and fire suppression equipment.

Recommended Specifications

General

1. Aggregate or other suitable material should be laid on approaches to fords, bridges, and culvert crossings to ensure a stable roadbed approach and reduce sediment in the stream.

2. When necessary, stabilize road surfaces and cut and fill slopes using effective erosion control and water control methods (i.e., seeding, commercial erosion control materials, rip-rap, etc.)

3. Stream crossings will require frequent inspections during operations to determine their functional and safe condition. When needed, corrective measures should be taken immediately to restore to full functioning.

4. Remove all materials from temporary stream crossings upon completion of operations and return the crossing as closely as possible to its original condition. The materials removed from the stream should be deposited outside the SMZ or 50 feet from the stream.

5. Generally waterbars should not be constructed within 50 feet of a stream unless absolutely necessary (on steep slopes and/or highly erosive soils). This practice should be avoided to minimize disturbing soil near the stream.

Pipe Culvert

1. Pipe length should be long enough so that each end extends at least one foot beyond the edge of the fill material.

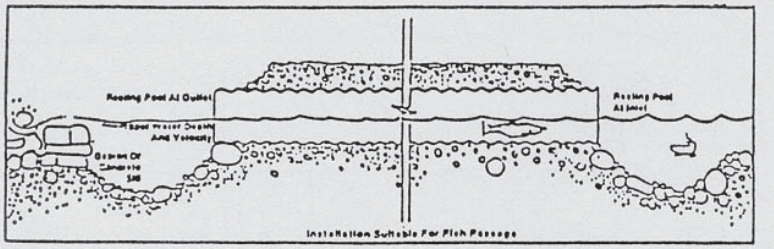
2. Pipe culverts should be of the proper type, size, and material to handle maximum stream flow. See Culvert Size Chart on page 51.

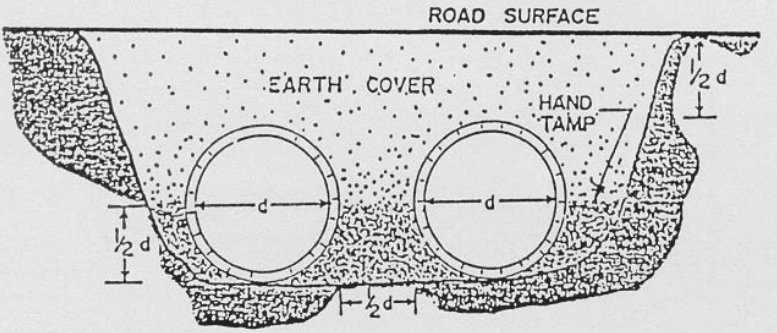
3. The culvert should be placed on a 1% to 2% downgrade to prevent clogging, but laid as closely as possible to the natural grade of the drain.

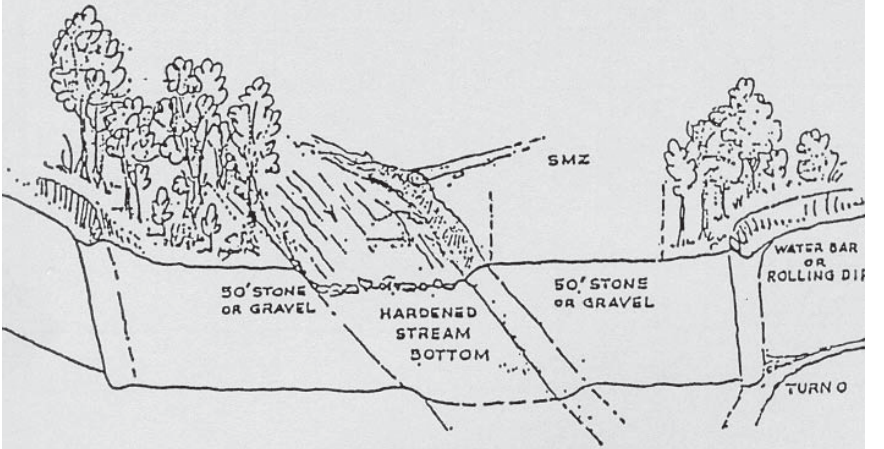
4. Erosion protection measures can be installed at the culvert outlet to minimize downstream erosion. This protection might include rip-rap, geo-textile filter cloth, large stone, prefabricated outflow devices, velocity reducers, etc. Rip-rap, etc. may be necessary on the downstream and upstream edge of fill or roadbed to prevent washouts during floods.

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

CULVERT







Low-water Crossing

Culvert Size Chart

ACRES DRAINED	Light Soils (Sands) Flat 0-5%	Light Soils (Sands) Mod. 5-15%	Light Soils (Sands) Steep 15%+	Medium Soils Flat 0-5%	Medium Soils Mod. 5-15%	Medium Soils Steep 15%+	Heavy Soils (Clays) Flat 0-5%	Heavy Soils (Clays) Mod. 5-15%	Heavy Soils (Clays) Steep 15%+
	Culvert Diameter in Inches								
5	18	18	18	18	18	21	21	21	24
10	18	18	18	21	24	27	27	27	36
20	18	18	18	24	27	36	36	36	42
30	18	18	18	27	30	36	36	42	48
40	18	18	18	27	36	42	42	48	
50	18	18	18	30	36	48	48	48	
75	18	21	21	36	42				
100	21	21	24	36	48				
150	21	24	24	42					
200	24	30	30	48					
250	27	30	30						
300	30	36	36						
350	30	36	42						
400	36	36	42						

Bridges

1. Bridges should be constructed with minimum disturbance to the stream bank, channel, and adjacent SMZ.

2. When necessary to protect approaches and roadbed fills near bridges, adequate erosion protection should be provided by head walls, wing walls, rip-rap, etc.

3. The use of temporary bridges may be necessary to minimize stream bank disturbances and provide a means of temporary access to critical areas when permanent structures are not warranted or needed.

Natural Fords

1. Rock fords may be used to cross streams when approaches, stream banks, and stream bottoms are hard enough or sufficiently stabilized to minimize stream bottom and bank disturbance.

SKID TRAILS

Definition: An unsurfaced, single-lane trail or road usually narrower and sometimes steeper than a truck haul road.

Purpose: To skid logs, tree lengths or other roundwood products from the stump to a common landing or concentration area.

Conditions Where Practice Applies: This practice is used to concentrate harvesting products for sawing or loading on trucks or trailers and where the topography and scale of operation make skidding the primary and most economical means of gathering trees, logs or other roundwood products.

RECOMMENDED SPECIFICATIONS

1. Skid trails should be planned to minimize damage to the residual stand, reduce erosion and sedimentation, and provide the most economical means for skidding.

2. Grades should not exceed 15%, but steeper segments may be required to avoid boundary lines, sensitive areas, or other areas not accessible using skid roads of lesser grade. When skidding is dispersed and mineral soil is not exposed, steeper grades are permissible. If steep grades are necessary, use practices, which will prevent concentrated water flow, that can cause gullying.

3. On slopes, use a slant or zig-zag pattern, breaking the grade and avoiding long, steep grades.

4. Skid trails should be located outside the SMZ except when crossing a stream.

5. Skid trails crossing a perennial or intermittent stream should use a bridge or culvert of adequate size, unless natural conditions allow crossing without creating excessive sedimentation. Layers of poles (corduroy) along an approach can be used to provide temporary

bank protection. Temporary culverts or bridges should be removed and the site restored immediately after operations cease.

6. The approach to crossings should be as near to right angles to the stream channel as possible. Cross at straight sections of streams.

7. When soils are saturated, skidding should be restricted to prevent excessive soil compaction and channelized erosion. The effects of rutting caused from skidder and hauling traffic differ depending on soil conditions, relief of the site, depth of the rutting, and the angle to the contour. Minimize rutting where the potential for affecting water quality through increased sedimentation is present. For example: when skidding across the contour on sensitive, highly erodible sites and when crossing SMZs.

8. Upon completion of skidding, immediately protect areas subject to erosion. Usually the first need is drainage of skid roads and bare-earth skid trails by using waterbars at these recommended intervals:

Percent Slope	Distance apart	Percent Slope	Distance apart
2	250 ft.	15	60 ft.
5	135 ft.	20	45 ft.
10	80 ft.	30	35 ft.

9. Waterbars should be installed at a 30 to 45 degree angle downslope, with ends open to prevent water accumulation behind them. Permanent vegetative cover should be established upon roads, trails, and landings that show bare soil and are subject to erosion. Scattering slash or other mulch material to cover the trail may supplement waterbars and seeding.

LOG LANDINGS (DECKS, SETS)

Refer to Section 5.1 Harvest Design

Definitions: Area where logs are collected. This includes landings at the end of skid and haul roads as well as concentration yards near mills.

Purpose: To have a central location where harvested timber products are collected for sorting and/or loading on trucks.

Condition Where Practice Applies: An area that is large enough to require concentrating products for loading.

RECOMMENDED SPECIFICATIONS

1. This practice generally results in disturbing the soil surface. Care should be taken to properly locate landings and portable mill locations to minimize the chance of erosion or sedimentation.

2. The following points should be considered in the location and use of landings and concentration yards:

    a. Locate sites for landings and portable mill locations in advance of road construction.

    b. Locate landings and portable mills at least 50 feet from the edge of the SMZ.

    c. Landings and yards should have a slight (2 to 5%) slope to permit drainage and should be sited on well-drained soils which dry quickly.

    d. Provide adequate drainage on approach roads and trails so that runoff does not drain onto the landing area and cause pooling of water.

e. A diversion ditch around the uphill side of landings can intercept the flow of water and direct it away from the landing.

f. Equipment serviced on-site should have waste oil etc. drained into containers and properly disposed of in accordance with current waste disposal recommendations. Garbage and trash should be likewise removed and properly disposed of.

g. Locate residue piles (sawdust, slabs, field chipping residue, etc.) outside of wet weather drainages so that drainage water from residue will not drain into streams or other bodies of water.

h. Disturbed areas should be reshaped to provide adequate surface drainage. Revegetate landings and portable mill locations within the first 15 days of the next seeding season following completion of harvesting operations. Seeding is not necessary if the landowner plans construction, site preparation or other activity immediately following completion of harvest. See Revegetation Specifications on page 65.

STREAMSIDE MANAGMENT ZONES

Refer to Section 9.0 SMZs

Definition: Area on each side of the banks and above the head of intermittent streams, perennial streams, and other drains or bodies of water where extra precaution in carrying out forest practices is needed to protect bank edges and water quality.

Purpose: To provide a relatively undisturbed zone to trap and retain suspended sediments before these particulates can reach the stream.

Conditions Where Practice Applies: Should be maintained along all perennial and intermittent streams or areas where forest disturbances may cause substantial erosion to follow. Should be maintained around lakes, ponds, flowing natural springs, and all springs and reservoirs serving as domestic water supplies.

Recommended Specifications

1. The minimum SMZ width on each side and above the head of an intermittent stream should be 50 feet and the minimum SMZ width on each side of a perennial stream should be 50 feet. SMZs for man-made drainage ditches should be established if appropriate.

2. Limit the potential damage from heavy logging equipment by using dispersed skidding, cable and winch, etc.

3. Partial harvesting is acceptable. A minimum of 50 square feet of basal area per acre, evenly distributed, should be retained in the SMZ. A general rule of thumb that may be used to determine this is leaving 50% crown cover.

4. Timber should not be cut in the SMZ if the basal area is less than 50 square feet per acre, evenly distributed.

5. Leave the forest floor essentially undisturbed. An existing organic litter layer should not be disturbed enough to expose mineral soil.

6. Remove all logging debris from streams immediately. If adjacent areas are to be burned, all trees felled within an SMZ should be pulled out before delimbing and topping.

7 Access roads and skid trails should cross perennial or intermittent streams at or near a right angle. Crossings in the SMZ should be kept to a minimum.

8. Stabilize all roads, cuts and fills (greater than or equal to 5% slope or subject to erosion) in the SMZ by using a seeding mixture. Fertilizer use should be limited because of the pollution potential. See Revegetation Specifications on page 65.

9. Drainage structures such as ditches (less than two feet deep), cross drain culverts, waterbars, rolling dips and broad-based dips should be used on truck and skid roads before they enter into an SMZ to intercept and properly discharge runoff waters.

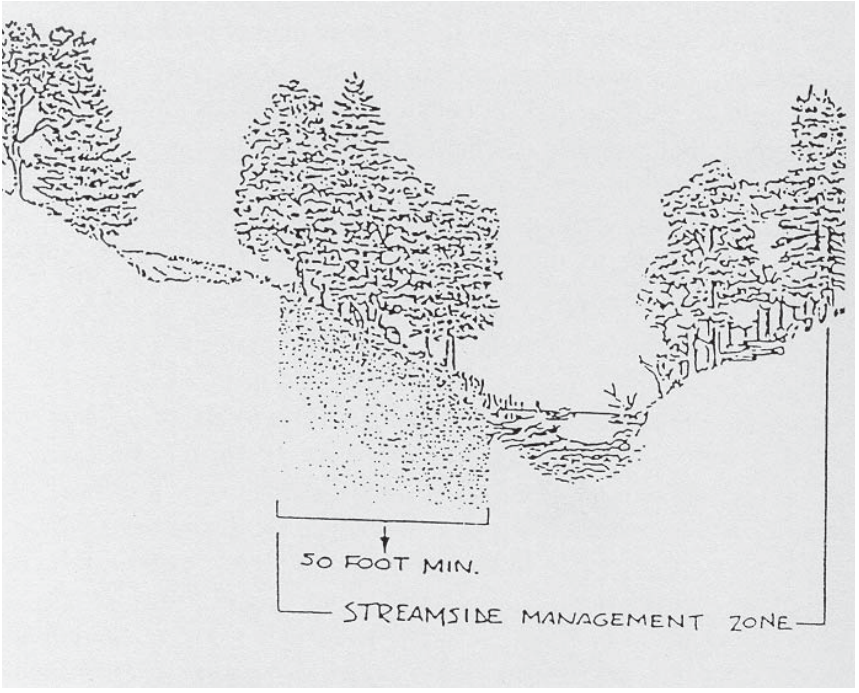
10. SMZ horizontal width is measured in linear feet from the pond, lake or stream bank to the toe of road, skid trail, or other surface disturbance. See Illustration on page 59.

11. The width of the SMZ should be adjusted for slope, soils, and cover type and especially when protecting municipal water supplies:

MINIMUM SMZ WIDTH

Percent slope:	0-10	11-20	21-45	45+
	Distance (feet)			
Perennial streams, intermittent streams, and lakes	50*	50*	*	*
Municipal Water Supplies	100	150	150	200

* Adjust for slope, soil type and cover type



STREAMSIDE MANAGEMENT ZONE

Stream Classification

Perennial

Perennial streams will flow 90%+ of the year under normal climatic conditions. If flow cannot be determined, the presence of five or more of the following characteristics should be helpful in recognizing a perennial stream.

1. Well-defined channel.
2. Water pools present, even during dry conditions.
3. A channel that is almost always sinuous (winding, snake-like, etc.). The degree of sinuosity is specific to physiographic regions. For example, in geographic regions that have mountainous terrain, the channels are less sinuous.
4. Evidence of fluctuating high water marks (flood prone width) and/or sediment transport. Indicators of a flood prone zone parallel to a stream course are sediment deposits, sediment stained leaves, bare ground, and/or drift lines.
5. Evidence of soil and debris movement (scouring) in the stream channel. Leaf litter is usually transient or temporary in the flow channel.
6. Wetland or hydrophytic vegetation is usually associated with the stream channel. However, perennial streams with deeply incised or "down-cut" channels will usually have wetland vegetation present along the banks or flood-prone zone. Examples include sedges, rushes, mosses, ferns, and the wetter/riparian grasses and woody species.
7. Soils with gray colors down to a depth of 24 inches with a loamy to clay texture. Red mottles or "specks" are usually present in the gray soil matrix.
8. Usually identified as solid blue-lines on USGS topographic maps and as either solid black lines separated by one dot on NRCS soil maps.
9. Perennial streams are considered "waters of the United States".

Intermittent

Intermittent streams will have seasonal flows usually 30% to 90% of the year under normal climatic conditions. If flow cannot be determined, the presence of five or more of the following characteristics should be helpful in recognizing an intermittent stream.

1. Well-defined channel.
2. Water pools absent during dry conditions but present during wet conditions.
3. A channel that is almost always sinuous. The degree of sinuosity is specific to physiographic regions. For example, in geographic regions that have mountainous terrain, the channels are less sinuous.
4. Evidence of fluctuating high water marks (flood prone width) and/or sediment transport. Indications of a flood prone zone parallel to a stream course are sediment deposits, sediment stained leaves, bare ground and/or drift lines.
5. Evidence of soil and debris movement (scouring) in the stream channel. Leaf litter is usually transient or temporary in the flow channel.
6. Wetland or hydrophytic vegetation is usually associated with the stream channel or flow area. Intermittent streams with deeply incised or "down-cut" channel will usually have wetland vegetation present along the banks of flood prone zone. Wetland vegetation is similar to those discussed in the perennial stream section.
7. Predominately brown soils with inclusions of gray soils (except in soils of deep sands and soils with extreme red soil color). Usually alluvial type soils with loamy to sandy texture.
8. Usually identified as blue lines separated by three dots on USGS topographic maps and as black lines separated by two or more dots on NRCS soil maps.
9. Intermittent streams are considered "waters of the United States".

Ephemeral

Ephemeral streams usually have flow less than 30% of the year. If flow cannot be determined, the presence of three or more of the following characteristics should be helpful in recognizing an ephemeral stream.

1. May have no well-defined channel.
2. Absence of water pools.
3. A flow area that is almost always straight and either "flattens" out at the bottom of the slope or grades into intermittent or perennial streams.
4. Fluctuating high water marks (flood prone width) and/or sediment transport are usually absent.
5. Evidence of leaf litter and/or small debris jams in the flow area.
6. Usually sparse or no wetland (hydrophytic) vegetation present.
7. Side slope soils with characteristics typical of the surrounding landscape. Soil texture usually more loamy than the surrounding upslope landscape and usually has a clay subsurface.
8. Usually not identified on USGS topographic maps or NRCS soil maps.

SALVAGE & SANITATION IN SMZs

Refer to Section 9.0 SMZs

Definition: Harvesting damaged forest products.

Purpose: To utilize forest products which have been damaged by insects, disease, or other factors and to reduce or eliminate insect or disease infestations that threaten adjacent forests.

Conditions Where Practice Applies: Areas where insect or disease problems pose a threat to adjacent timberland.

Recommended Specifications

1. Evaluate the potential threat to neighboring forest resources by surveying potential susceptibility, extent of spread, resource damage and economic costs.

2. Consider alternatives in insect and disease control strategies, which may be more economical and have less potential for site disturbance.

3. Locate salvage haul roads and skid trails outside the SMZ.

4. To minimize risk, manage areas adjacent to the SMZ to remove potential brood trees, susceptible species, low vigor trees and high quality stems at or near maturity.

5. Removal of felled timber in the SMZ should be by the use of dispersed skidding or by cable retrieval. The forest floor should remain virtually undisturbed.

6. Equipment should not be operated in the SMZ for salvage and sanitation purposes when soils are saturated.

7. If salvage operations are to be conducted within an SMZ

following storm, fire, insect, or other damage, every effort should be made to protect and leave those trees not severely damaged to attempt to leave a minimum of 50% crown cover. Where more than 50% of the overstory has to be removed, evaluate the ability of the understory to protect stream temperatures and determine the need for revegetation or reforestation.

8. Small areas or damage spots less than one acre may be completely harvested unless significant water quality problems will be created.

REVEGETATION OF DISTURBED AREAS

Definition: The establishment of grass and/or legume vegetation on disturbed soil areas not expected to naturally revegetate in time to prevent erosion.

Purpose: To stabilize the soil and minimize the chance of erosion with sediment being exported to water courses.

Conditions Where Practice Applies: On areas where activities expose mineral soil and where natural vegetation will not suffice; thus operations may accelerate erosion and contribute sediment to drainages. Other areas to consider are those with highly erodible soils or those severely eroded or gullied.

Recommended Specifications

Site and Seedbed Preparation

1. All disturbed areas with a grade of 5% or greater and/or which are subject to excessive erosion should be seeded within the first 15 days of next seeding season after construction as weather permits. These steep grades and any other area with high erosion potential (landings, skid trails, haul roads, etc.) should be identified as soon as the operation is completed.

2. Water control measures and/or shaping of the land should be completed as the operation is finished to guarantee the stability of the site until a ground cover becomes established.

Seeding

3. Selected seed mixture may be broadcast or drilled. Seeding is usually more successful in the spring and fall. Broadcast seed can be covered by dragging a chain, brush, disk, or harrow or

firming with a roller or cultipacker, or by drilling to ensure seed contact with the soil (½ to 1 inch deep). Permanent grasses may be seeded or sprigged into dead cover provided by temporary cover plants. A long-term perennial, fine-rooted seed mixture should be used for most effective erosion control.

4. The objective of seeding is to quickly establish a ground cover that will hold the soil together under most conditions. Seed selection should consider the season, the soil type, the availability of sunlight to the area to be seeded, and the cost of the seed. To get the desired results, a combination of seeds may be required.

5. Adapted Plants - See page 67 for a list of plants and their adaptation by soil types.

6. Planting rates and dates - See page 68.

7. When temporary cover plants such as annual, cool season crops are used, a follow-up to determine the need for permanent vegetation is needed.

8. Legumes should always be used in mixes with grasses.

9. Sprigging methods - Sprigged plants such as bermuda grass can be planted by sprigging either by hand or machine, or broadcasting the sprigs and then disking and firming with a roller.

10. Fertilizing - Apply 600 to 650 lbs. of 13-13-13 (or its equivalent) per acre (these rates are double normal rates) and either mix into the top 2-3" during seedbed preparation or at the time of planting. Care should be taken to insure that the fertilizer does not enter a stream. To avoid stream contamination, it is recommended that fertilizer not be applied within the streamside management zone. On small areas, fertilizer may be broadcast manually with a spreader prior to or at the time of seeding.

Vegetation Type	Species	Sands	Loams	Clays
Annual Grass/crops	Millet			
	Brown top	X	X	X
	Foxtail	X	X	X
	Pearl	X	X	X
	Ryegrass		X	X
	Oats	X*	X	X
	Elbon rye	X	X	X
	Wheat	X*	X	X
	Bahia**		X	X
Perennial Grasses	Bermudagrass			
	Alecia	X	X	X
	Coastal	X	X	X
	Selection3	X	X	X
	Sheffield	X	X	X
	Common**		X	X
	NK-37		X	X
	Tall fescue**		X	X
	Lovegrass**			
	Weeping	X	X	X
	Wilman	X	X	X
	Alamo switchgrass		X	X
Legumes	Singletary peas		X	X
	Hairy vetch	X	X	X
	Arrowleaf Clover		X	X
	Subterranean Clover	X	X	X

* Not adapted to very deep sand ** Most shade tolerant

REVEGETATION - PLANTING INFORMATION

Vegetation Type	Species	Season of Growth	Planting Dates	Planting Rate /acre #
Annual Grass/crop	Millet			
	Brown top	Warm	4/15-8/1	40 lbs.
	Foxtail	Warm	4/15-8/1	30 lbs.
	Pearl	Warm	5/15-8/1	40 lbs.
	Ryegrass	Cool	9/1-11/30	24 lbs.
	Oats	Cool	9/1-11/30	128 lbs.
	Elbon rye	Cool	9/1-11/30	112 lbs.
	Wheat	Cool	9/1-11/30	120 lbs.
	Bahia	Warm	**	30 lbs.*
Perennial Grasses	Bermuda			
	Alecia sprigs	Warm	1/15-6/1	48 bu.
	Coastal sprigs	Warm	1/15-6/1	48 bu.
	Selection 3 sprigs	Warm	1/15-6/1	48 bu.
	Sheffield sprigs	Warm	1/15-6/1	48 bu.
	Common seed	Warm	3/15-5/15	4 lbs.*
	NK-37 seed	Warm	3/15-5/15	4 lbs.*
	Tall fescue	Cool	9/15-11/15	20 lbs.*
	Lovegrass			
	Weeping	Warm	3/1-5/1	4 lbs.*
	Wilman	Warm	3/1-5/1	4 lbs.*
	Alamo switchgrass	Warm	3/1-5/31	7 lbs.*
Legumes***	Singletary peas	Cool	9/15-11/30	70 lbs.
	Hairy vetch	Cool	9/15-11/30	40 lbs.
	Arrowleaf clover	Cool	9/15-11/30	20 lbs.
	Subterranean Clover	Cool	9/15-11/30	20 lbs.

* Pure live seed (% germination x % purity = pure live seed)

** Bahia can be planted year round if planted with an appropriate cover.

*** Inoculate legumes before planting.

\# Sowing rates are double normal rates to insure maximum cover.

NOTES

Part III

Best Management Practices

Forest Wetlands

TEXAS
Best Management Practices
for
FOREST WETLANDS

Timber production is recognized as a land use that is compatible with wetland protection. Although wetlands are federally regulated, normal forestry operations in wetlands such as soil bedding, site preparation, harvesting, and minor drainage are exempt from permit requirements under Section 404 of the Clean Water Act Amendments of 1977, as long as the activity 1) qualifies as "normal silviculture," 2) is part of an "established" silvicultural operation, 3) is not part of an activity whose purpose is to convert a water of the United States into a use to which it was not previously subject, 4) follows the fifteen Mandatory Road BMPs (see ACCESS SYSTEMS), and 5) contains no toxic pollutant listed under Section 307 of the Clean Water Act in discharge of dredge or fill materials into waters of the United States.

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

BMPs are designed to help landowners, foresters, loggers and others protect water quality during forestry operations. BMPs can prevent, or greatly reduce, nonpoint source pollution of water from forestry activities. The use of BMPs is non-regulatory in Texas. If the forestry community implements these practices, wetlands and wetland-like areas can be protected without strict government regulation.

LEGAL DEFINITION OF WETLANDS

The U. S. Army Corps of Engineers (Federal Register, 1982) and the Environmental Protection Agency (Federal Register, 1980) jointly define wetlands as:

> "*Those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support and, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*"

The three criteria used by the U.S. Army Corps of Engineers (USACE) in delineating wetlands are: (1) hydrophytic vegetation (plants that have the ability to grow, effectively compete, reproduce, and/or persist in anaerobic soil conditions), (2) hydric soils (soils that are saturated, flooded, or ponded long enough during the growing season for anaerobic conditions to develop), and (3) wetland hydrology (inundation by water sufficient to support hydrophitic vegetation and develop hydric soils). All three must be present under normal circumstances for an area to be identified as a jurisdictional wetland.

"All three criteria (hydric vegetation, hydric soils, and wetland hydrology) MUST be present in order for a site to be determined a jurisdictional wetland!"

BENEFITS AND FUNCTIONS OF WETLANDS

Wetlands are among the most productive ecosystems in the world. As a valuable natural resource component of the Texas landscape, forest wetlands can improve water quality by filtering sediment and other pollutants, by reducing the potential for erosion, and by controlling flooding during periods of heavy rain. Wetlands also provide valuable products for human use such as lumber, wildlife, recreation, and aesthetics.

POTENTIAL IMPACTS OF FORESTRY ACTIVITY ON WETLANDS

Forest wetlands are environmentally sensitive areas. Special attention to the proper use of BMPs is essential if water quality is to be protected. Forest road construction has the potential to disrupt normal drainage patterns and produce sediment that may reach streams and sloughs. Tree tops or other logging debris left in streams can obstruct water flow, increase erosion of stream banks, and decrease dissolved oxygen in the water. Normal wetland drainage patterns can be altered by severe rutting or by improperly constructed windrows. Excessive soil compaction caused by careless logging can reduce water infiltration, reduce soil moisture available to tree roots, and decrease site quality.

PLANNING

Planning for timber harvesting is an often overlooked step in silvicultural activities. When working in wetlands or wetland-like areas, planning is essential. Aerial photographs, topographic maps, and soil surveys are indispensable when planning activities in and adjacent to wetlands.

- ***Identify and mark locations of water bodies and other sensitive areas.***

- ***In choosing a silvicultural system, assess the potential impacts on***

water quality, erosion, sedimentation, and overall wetland function.

• Locate log landings on slightly-sloped areas before establishing a new road system and keep the number and size of roads and landings to a minimum.

• Schedule operations to take advantage of dry periods to avoid rutting and puddling of soils.

• Consider use of special equipment such as wide-tire skidders, forwarders, etc. to minimize soil damage andlor rutting.

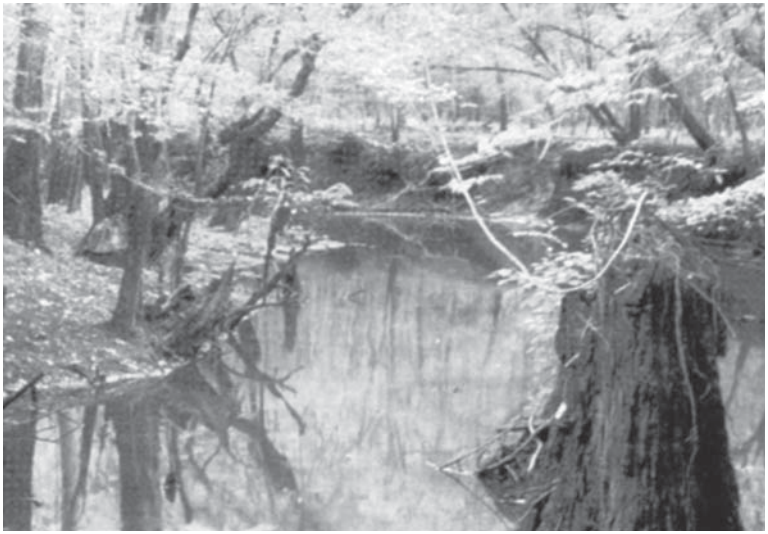
STREAMSIDE MANAGEMENT ZONES (SMZs) and RIPARIAN AREAS

One major function of an SMZ is to protect a body of water from possible pollution from adjacent forestry activities. Since this type of pollution often results from the downhill movement of soil and water from a nearby upland source, the functions of an SMZ in relatively flat wetland and wetland-like areas can be different from SMZ functions in typical uplands with sloping terrain. Because of the flat terrain and relatively-low erosion potential of wetland or wetland-like areas, SMZ widths can sometimes be reduced from the 50-foot recommended width on either side of the stream for upland streams (see ***Intermittent Streams***). The entire riparian area (area that includes the stream, banks, and adjacent land) must be considered when determining SMZ width. Determining factors include depth to water table, riparian vegetation present, soil type, the nature of the hydrologic connectivity of stream systems, and other site-specific conditions.

BOTTOMLAND SYSTEMS

East Texas contains approximately two million acres of bottomland hardwood forests. ***Bottomlands systems***, which

may or may not be jurisdictional wetlands, include a major water course (either a perennial or intermittent stream) and associated floodplains, tributary water courses, sloughs, and ephemeral drains. The predominant timber type is hardwood, but usually includes some pine. Common species found in bottomland systems include baldcypress, water tupelo, swamp tupelo, red maple, overcup oak, willow oak, cherrybark oak, white oaks, loblolly pine and sweetgum.



Perennial streams such as this one require a 50-foot SMZ.

Perennial Streams

Perennial streams (streams that flow at least 90% of the year in a continuous, well-defined channel) need the protection of SMZs. Because of the potential for water quality impacts from forestry operations near perennial streams, SMZ width should be no less than 50 feet. Thinning in SMZs according to BMP guidelines is acceptable; a minimum of 50% of the original crown cover or 50 square feet of basal area per acre should be retained in the SMZ. As with all silvicultural activities in wetland or wetland-like areas, these thinning operations must occur in accordance with all other BMP guidelines. This includes minimizing rutting (see RUTTING, page 85) and removing logging debris immediately

Tips for Marking SMZ's

Following are two tips that may help in marking SMZ's:

1. Use temporary flagging, ribbon, tape, etc. rather than paint to mark the preliminary SMZ boundary. Flagging can be moved and re-tied should you mark a tree too close to the stream. This way, the SMZ is more likely to be marked at the correct distance from the stream. Then paint a permanent SMZ boundary.

2. In the flat terrain of bottomland systems, there is often an area next to some streams that is covered with water for too long during the year for grass to grow successfully. The boundary where it becomes dry enough for the grass to grow forms a line with grass on one side and no grass on the other. If you're unsure about exactly where the SMZ boundary needs to be marked, try using this line as the appropriate point. Just make sure this boundary line meets minimum SMZ width requirements.

Intermittent Streams

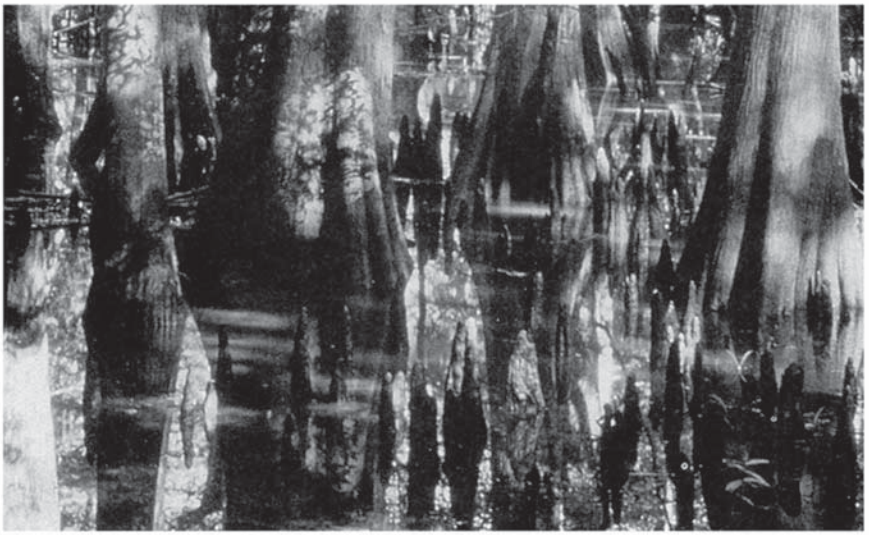
Intermittent streams flow 30-90% of the year in continuous, well-defined channels. As in uplands, intermittent streams (which themselves are most likely wetlands) in wetlands or wetland-like areas need the protection of SMZs. Since SMZs on this type of stream in bottomlands with wide floodplains may function more to reduce thermal pollution (provide shade to the water) and provide bank stability, SMZ widths of less than 50 feet are acceptable. Widths can be judged on a site-specific basis by a forester or other qualified individual and must adequately protect the stream water quality. For example, an intermittent stream running through flat woods with little or no slope may need an SMZ only 20 feet wide on either side of the stream. However, an intermittent stream with narrow floodplains and possible impacts from adjacent upslope areas may require a 50-foot wide SMZ for adequate protection. Trees should not be harvested from the stream channel itself, and bank stability should not be jeopardized. Logging debris should be removed from the stream channel immediately. These and all other silvicultural activities must occur in accordance with all other BMP guidelines, including those related to stream crossings.

EPHEMERAL WATER COURSES

Ephemeral water courses (ephemeral means short-lived or, in this case, carrying water for less than 30% of the year) that are forested **DO NOT** require the protection of SMZs. However, timber should not be cut within the water course if there is a likelihood of disturbing the water course by rutting. The flow of *ephemeral water courses* is rain-dependent. They are usually recognized by lack of scouring caused by water flow, and by the presence of leaf litter in the water course due to lack of consistent and continuous water flow.

BACKWATER BASINS

Backwater basins, areas that hold water from backwater flooding when adjacent water bodies overflow, likewise **DO NOT** require the protection of SMZs. Be aware that it is sometimes difficult to distinguish between *backwater basins* and intermittent streams (which actually flow water downstream and therefore do require SMZ protection) and intermittent ponds. If there is a question on which type of water body is present, an SMZ should be designated.



Where *backwater basins* have well-defined banks, trees should be left or selectively thinned on the banks and inside the basin.

In cases where *backwater basins* have well-defined banks, trees should be left or selectively thinned on the bank and inside the basin to maintain bank stability and thermal protection. Even in *backwater basins* that do not have well-defined banks, trees should not be cut within the basin if there is a possibility of disturbing the *backwater basin's* natural flow by rutting or jeopardizing soil stability. Severe rutting can change the drainage pattern in *backwater basins*. It is important to recognize the water quality functions of bankless *backwater basins* and to consider that group selection, patch clear-cutting (patch clear-cuts are relatively small clear-cuts that are spaced apart from each other, creating a mosaic or patchwork-type pattern), and selective thinning may be prudent. Again, it is the forester's or other qualified person's responsibility to ensure that harvest intensity in *backwater basins* maintains the protection of water quality.

FOREST SWAMPS

Forest swamps are defined as forested areas that have water at or above the soil surface for at least four months of the typical year, usually during the winter. These areas will have water flowing during and immediately after rainfall, but it is normally just standing. The source of water in *forest swamps* is ponding or groundwater saturation.

All operations in *forest swamps* should be conducted as if they were within an SMZ, including thinning using recommended guidelines. Group selection or properly-spaced patch clear-cuts may be prudent in forest swamps. Group selection and patch clear-cutting may be conducted (while adhering to all other BMP guidelines) only when the site is dry enough to prevent rutting to the extent that natural water flow and drainage are not changed (see RUTTING, page 85). A forester or other qualified individual must ensure that the harvest intensity in *forest swamps* maintains the protection of water quality. *Forest swamps* are not necessarily jurisdictional wetlands. Common forest swamp species include willow oak, black willow, green ash, overcup oak, baldcypress and tupelo.

FLATWOODS

Flatwoods are forested areas with slopes of 1% or less and usually contain mixed pine and hardwood timber. Historically, *bottomland systems* and *flatwoods* contained much more pine than the current composition. During wet seasons, the soil is often saturated, having water at or near the soil surface. These forests may include complexes of mounds and intermounded soils. *Flatwoods* **DO NOT** require SMZs. *Flatwoods* are not necessarily jurisdictional wetlands. Common *flatwoods* species include pine (loblolly, longleaf, and slash), sweetgum, willow oak, sweetbay, redbay, red maple, water oak, cherrybark oak, and white oaks.

Flatwoods, mixed pine-hardwood areas with slopes of 1% or less, do not require protection by SMZs.

DRAINAGE DITCHES

Drainage ditches that were formerly natural streams and have been dredged and/or straightened need the protection of an SMZ only if they meet the flowing water criteria for perennial or intermittent streams.

ACCESS SYSTEMS

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

MANDATORY ROAD BMPS

As mandated by Amendments to the Clean Water Act, forest roads in jurisdictional wetlands including "waters of the United States" must be constructed and maintained in accordance with the following Best Management Practices to retain Section 404 exemption status:

1. Permanent roads, temporary access roads, and skid trails in waters of the U.S. should be held to the minimum feasible number, width, and total length consistent with the purpose of specific silvicultural operations and local topographic and climatic conditions.

2. All roads, temporary or permanent, should be located sufficiently far from streams or other water bodies (except portions of such roads that must cross water bodies) to minimize discharge of dredged or fill material into waters of the U.S.

3. The road fill should be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows.

4. The fill should be properly stabilized and maintained to prevent erosion during and following construction.

5. Discharges of dredged or fill material into waters of the U.S. to construct a road fill should be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the U.S. (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself.

6. In designing, constructing, and maintaining roads, vegetative disturbance in the waters of the U.S. should be kept to a minimum.

7. The design, construction, and maintenance of the road crossing should not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.

8. Borrow material should be taken from upland sources whenever feasible.

9. The discharge should not take, or jeopardize the continued existence of, a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species.

10. Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands should be avoided if practical alternatives exist.

11. The discharge should not be located in the proximity of a public water supply intake.

12. The discharge should not occur in areas of concentrated shellfish population.

13. The discharge should not occur in a component of the National Wild and Scenic River System.

14. The discharge of material should consist of suitable material free from toxic pollutants in toxic amounts.

15. All temporary fills should be removed in their entirety and the area restored to its original elevation.

Permanent Roads

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

· ***Plan the access system prior to construction. Whenever possible, avoid crossing streams, sloughs, sensitive areas, etc.***

· ***Consider relocating poorly designed or constructed section(s) of an established road system that that may lead to water quality pollution during and after the management activity.***

· ***If applicable, construct roads well before the management activity to allow roads to stabilize.***

· ***Construct fill roads only when necessary. Road fills should be as low as possible to natural ground level and should include adequate cross-drains for surface water flow.***

· ***Borrow pits should be located outside of SMZs and wetlands.***

· ***Stabilize soils around bridges, culverts, low-water crossings, etc. When natural stabilization will not occur quickly, fill material should be stabilized with grass, rip-rap, etc.***

· ***Construct fill roads parallel to water flow, where possible.***

· ***Use of a geo-textile or a geo-grid fabric can increase soil bearing capacity and reduce rutting.***

· ***Use board-road or wooden mats where needed to minimize rutting.***

· ***Stream crossings should be made at right angles to the channel and should not impede stream flow.***

· ***Minimize sediment production when installing stream crossings.***

· ***Use gates or otherwise restrict traffic on wet roads.***

· ***Road ditches should not directly feed into stream channels.***

Use board road or wooden mats where needed to minimize rutting.

Temporary Roads and Skid Trails

· ***Favor temporary roads over permanent roads when possible. When properly constructed, temporary roads will have less impact on the hydrology of forested wetlands than permanent roads.***

· ***Temporary road fill should be removed and the area restored to its original elevation upon completion of operations.***

· ***Concentrate skid trails when soils are saturated to minimize overall soil compaction and disturbance.***

Road Maintenance

· ***All drainage structures should be inspected and maintained, especially following unusually heavy rains.***

· ***Ditches, culverts, and other water flow structures should be kept free of any debris.***

HARVEST OPERATIONS

Harvesting should be done with consideration to season, stand composition, soil type, soil moisture, and type of equipment used. When done correctly, harvesting can benefit site productivity for future forests, improve regeneration, and benefit the overall hydrologic function of a wetland site.

· ***Limb, top, merchandise, etc. at the stump.***

· ***Harvest during dry periods if possible to minimize rutting.***

· ***Use low pressure/high flotation tires or wide tracks where possible (i.e., where excessive damage to residual stand will not occur).***

· ***Keep skidder loads light when rutting is evident.***

· ***Fell trees away from watercourses if possible.***

· ***After harvesting, immediately remove all obstructions in channels that might restrict water flow.***

· ***Limit operations on sensitive sites and in SMZs during periods of wet weather. Heavy rutting is indicative of site damage, which is a signal to shut down operations.***

· ***All trash (filters, oil cans, etc.) should be removed from the site.***

Rutting should not impede, restrict, or change natural water flows.

RUTTING

Ruts should not be present to the extent that they impede, restrict, or change natural water flows and drainages. The determination of excessive rutting is highly subjective and must be made only by a forester or other qualified individual who evaluates rutting extent, depth, soil type, direction and position, and other local factors.

SITE PREPARATION

The major problems associated with mechanical site preparation involve soil erosion and potential sedimentation from runoff. The following guidelines recognize that erosion and sedimentation may result from site preparation activities and are designed to protect site and water quality.

· ***Conduct ground disturbing site-preparation activities such as bedding on the contour of the terrain where slopes are greater than 1%. Otherwise, bed in the direction of sheet water flow.***

· ***Do not conduct mechanical tree planting or site preparation within an SMZ.***

· ***Locate windrows a safe distance from drainages to avoid material movement into the drainages during high-runoff conditions.***

· ***Conduct bedding operations during dry periods of the year.***

· ***Minimize soil movement when shearing, piling, or raking.***

· ***Do not push or pile any debris into SMZs or stream channels.***

FIRE MANAGEMENT

Even in the flat terrain of East Texas, there is a chance for soil movement, especially if the organic layer of the forest floor is removed by fire. Site preparation burns are often the most severe (hottest) and have great potential for increasing surface runoff and soil erosion.

· ***Conduct burns in a manner that does not remove the organic layer of the forest floor.***

· ***Do not construct firelines that may drain wetlands.***

· ***During wildfire emergencies, firelines, road construction, and stream crossings are unrestricted by BMPs. However, BMPs should be installed and remediation begun as soon as possible after the emergency is controlled***

BMPs should be installed and remediation begun as soon as possible after a wildfire is controlled.

SILVICULTURAL CHEMICALS

The following guidelines cover the handling and application of silvicultural chemicals to prevent their direct or indirect application to open water sources. These guidelines complement state or local regulations relating to the sale, transport, and use of chemicals.

· ***Follow all label instructions to the letter. Be aware that some chemicals are labeled for use in wetlands and some are not.***

· ***Use skilled and, if required, licensed applicants.***

· ***Identify and establish buffer areas for moving surface waters, especially for aerial applications.***

· ***Do not allow spray or rinse water to enter SMZs.***

MORE INFORMATION IS AVAILABLE

For more help or information on wetlands, forestry, or BMPs, contact one of the following agencies:

U.S. Army Corps of Engineers
Galveston District
P.O. Box 1229-298D
Galveston, TX 77553
(409) 766-3899

U.S. Army Corps of Engineers
Ft. Worth District
P.O. Box 17300
Ft. Worth, TX 76102-0300
(817) 334-3990

Texas Forest Service (TFS)
BMP Project
P.O. Box 310
Lufkin, TX 75902-0310
(936) 639-8180

USDA Natural Resources Conservation Service (NRCS)
Usually located in the county seat

Environmental Protection Agency (EPA)
Nonpoint Source
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 665-2200

Texas Forestry Association (TFA)
P.O. Box 1488
Lufkin, TX 75902-1488
(936) 632-8733

Part IV

Appendix

11.0 GLOSSARY OF FORESTRY TERMINOLOGY

Access Road - A temporary or permanent access route for vehicles into forestland.

Basal Area - The cross section area of a tree stem in square feet commonly measured at breast height (4.5 feet above ground) and inclusive of bark. Basal area is usually the collective measurement of trees in order to establish density. Located in the How To section of the Appendix is a chart designed to aid in the calculation of basal area.

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

Bearing Capacity - Maximum load that a material (soil) can support before failing.

Bedding - A site preparation method in which special disking equipment is used to concentrate surface soil and forest litter into a ridge or bed elevated six to ten inches (6-10) above the normal soil level on which forest seedlings are to be planted.

Below Grade Road - Occurs when the road surface becomes lower than the sides (shoulder) of the road. This can occur as a result of natural wear or the practice of continually grading the road down (usually due to wet conditions) to reach a hard surface sufficient to handle the desired traffic.

Best Management Practices (BMPs) - A practice or combination of practices (including technological, economical, and institutional considerations) determined to be an effective and practicable means of preventing or reducing the amount of water pollution generated by non-point sources.

Borrow Pit - That area, usually adjacent and parallel to a road, from which soil is removed to build up the road bed.

Bottom Lands - A term often used to define lowlands adjacent to streams and rivers.

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

Buck - To saw felled trees into predetermined lengths.

Channel - A natural stream that conveys water; or a ditch excavated for the flow of water.

Check Dam - A small dam constructed in a gully or other small watercourse to decrease the stream flow velocity, minimize channel scour and promote deposition of sediment.

Commercial Timber Land - Land capable of producing industrial crops of timber and not excluded from such use by legislation or regulation.

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

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

Crown Cover - The percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants.

Culvert - A conduit or pipe through which surface water can flow under roads.

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

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

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

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

Ephemeral - That part of the drainage network, that may or may not have a clearly defined stream channel, that flows only for short periods of time following percipitation.

Erosion - The process by which soil particles are detached and transported by water and gravity to some downslope or downstream deposition point.

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

Felling - The process of severing trees from stumps.

Fill Slope - The surface area formed where soil is deposited to build a road or trail.

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

Firelane - A permanent barrier to the spread of fire which will be maintained over time for the specific purpose of stopping the spread of fire or for access to an area for the control of a fire.

Fireline - A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel inflammable by using water or fire retardants.

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

Forest Chemicals - Chemical substances or formulations that perform important functions in forest management, and include fertilizers, herbicides, repellents, and other chemicals.

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

Forest Road - An access route for vehicles into forest land.

Forestry - The science, the art and the practice of managing and using for human benefit the natural resources that occur on and in association with forest lands. (SAF Interpretation)

Furrowing - A site preparation method involving plowing of a trench in preparation for reforestation.

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

Gully Erosion - Erosion process whereby water accumulates in narrow channels, and over short periods of time removes soil from this narrow area to substantial depths (one foot plus).

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

Haul road - Road used to haul wood products. May vary from paved to primitive but are permanent woods (tertiary) roads.

Headwaters (Head) - The point on a stream above which the average annual flow is less than five (5) cubic feet per second.

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

Hydrophytic Vegetation – Vegetation growing wholly or partially in water or in soil too waterlogged for most vegetation to survive.

Intermittent - That part of the drainage network, with a clearly defined stream channel, which provides flow continuously during some seasons of the year, but little or no flow during the remainder of the year.

Landing (Decks, Sets) - A place where logs are assembled for temporary storage, loading, and subsequent transportation.

Logging - The felling and transportation of wood products from the forest to a delivery location.

Logging Debris/Slash - The unwanted, or unutilized and generally unmarketable accumulation of woody material such as large limbs, tops, cull logs, and stumps that remain in the forest as residue after logging.

Low Water Bridge - A stream crossing structure built with the expectation that, during periods of high water or flood, water will flow over the structure.

Mineral Soil - Organic free soil that contains rock less than 2 inches in maximum dimension.

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

Mulching - Providing any loose covering for exposed forest soil, using organic residues, such as grass, straw or wood fibers to protect exposed soil and help control erosion.

Municipal Water Supply – Any surface or ground water source that can be treated and piped for public consumption.

Nonpoint Sources - Sources of water pollution which are: (1) induced by natural process, including precipitation, seepage, percolation, and runoff; (2) not traceable to any discrete or identifiable point; and (3) best controlled through the utilization of Best Management Practices, including planning and processes techniques.

Nutrients - Mineral elements in the forest ecosystem such as nitrogen, phosphorus, and potassium usually in soluble compounds that are present naturally or they may be added to the forest environment as forest chemicals, such as fertilizer.

Ordinary High Water Mark - The mark on the shores of all waters, which will be found by examining the beds and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a distinct character.

Organics - Particles of vegetative material in the water which can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Outfall Protection - A rip-rap or aggregate placed at the outlet of a culvert or water-control device to protect that area from erosion damage due to the force or velocity of the outlet of water.

Outslope - The downhill side of a road where the side of the road slopes with the hill at or near the natural contour and runoff is allowed to drain down the hill without being channeled into a ditch or other water-control device. s are usually associated with a road in steep terrain which is literally cut into the side of the hill.

Perennial - That part of the drainage network which provides water flow at all times except during extreme drought.

Pesticides - Any herbicide, insecticide, or rodenticide, but does not include non-toxic repellents or other chemicals.

Point Source Pollution - Sources of water pollution (generally a man-caused pollutant) which can be traced to a specific place or location (i.e. a pipe).

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

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

Prescribed Burning - Controlled application of fire to wildland fuels under such conditions of weather, fuel moisture, etc. which allows the fire to be confined to a predetermined area and at the same time to produce the intensity of heat and rate of spread needed to further certain planned objectives (of silviculture, wildlife habitat management, grazing, fire hazard reduction, etc).

Primary Road - A high specification permanent road which is maintained periodically and serves as a main artery in a network of roads.

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

Residual Trees - Live trees left standing after the completion of harvesting.

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

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

Rolling Dip - A shallow depression built diagonally across a light duty road or trail to divert surface water runoff from the road or trail.

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

Ruts - Depressions made by the tires of vehicles such as skidders, log trucks, pickups, etc. usually under wet conditions.

Salvage Harvest - Removal of trees that are dead or imminently threatened with death in order to utilize their wood before it is ruined by natural decay agents.

Sanitation Harvest - Removal of trees that are under attack by or highly susceptible to insects and disease in an effort to check the spread of such agents.

Scarify - To break up the forest floor and top soil preparatory to natural or direct seeding (or the planting of seedlings).

Secondary Road - A road constructed for a specific use or single operation and normally abandoned upon completion of the operation.

Sediment - Solid material in suspension, being transported or moved from its original site.

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

Setting - The forest land area within an individual harvesting unit in which skidding is directed to one or more landings on a forest road.

Shearing - A site preparation method that involves cutting brush, trees, and other vegetation at the ground level using tractors equipped with angled or v-shaped cutting blades.

Sheet Erosion - The removal of a fairly uniform layer of soil removed from the soil surface by water runoff.

Sheet Flow - Runoff from a rainstorm intense enough to cause direct overland flow of water before entering a receiving stream.

Sidecast - The material or the act of moving excavated material to the side and depositing such material laterally to the line of movement of the excavating machine.

Silvics - The study of the life history and general characteristics of forest trees and stands with particular reference to locality factors, as a basis for the practice of silviculture. (SAF Interpretation)

Silvicultural Activities - All forest management activities, including intermediate cuttings, harvest, log transport, and forest road construction (EPA Interpretation).

Silviculture - Generally, the science and art of cultivating (i.e. growing and tending) forest crops, based on a knowledge of silvics; and more particularly, the theory and practice of controlling the establishment, composition, constitution and growth of forests. (SAF Interpretation)

Sinuosity – Curved or curving; refers to the curviness or winding of a stream channel.

Site Preparation - A general term for removing unwanted vegetation and other material if necessary and any soil preparation carried out before reforestation.

Skid Trail - A route over which logs are moved to a landing or road.

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

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

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

Soil Productivity - The output or productive capability of a forest soil to grow timber crops.

Stream - A well-defined natural channel that has a flow anywhere below its headwaters greater than 5 cfs at least 50% of the time (EPA - Army Corp Section 404). A permanently or intermittently flowing body of water that follows a defined course.

a. "Ephemeral stream" (or drain) means a stream that flows only during and for short periods following precipitation and flows in low areas that may or may not have a well-defined channel.

b. "Intermittent stream" means a stream that flows only during wet periods of the year (30-90% of the time) and flows in a continuous, well-defined channel.

c. "Perennial stream" means a stream that flows throughout a majority of the year (greater than 90% of the time) and flows in a well-defined channel.

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

Streamside Management Zone (SMZ) - Forested area immediately adjacent to stream channels. Managed for forest resources with specific attention given to measures that can be taken to protect both instream and downstream water quality as well as other beneficial uses. The purpose of an SMZ is to reduce the quantity of sediment and logging wastes reaching the streams and to provide shade to prevent water temperature increases.

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

Turnout - (1.) A widened space in a road to allow vehicles to pass one another. (2.) A drainage ditch which drains water away from roads.

Waste - Materials and substances discarded as worthless to the user.

Waterbar - A cross drainage diversion ditch and/or hump in a trail or road for the purpose of diverting surface water runoff into roadside vegetation, duff, ditch or dispersion area to minimize the volume and velocity which can cause soil movement and erosion.

Water Body - An area of standing water with relatively little or slow movement (ponds, lakes, bays).

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

Water Pollution - Contamination or other alteration of the physical, chemical or biological properties of any natural waters of the state, or other such discharge of any liquid, gaseous or

solid substance into any waters of the state, as well, or is likely to create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life (EPA definition).

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

Water Quality Standards - Texas Water Quality Standards and criteria contained therein.

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

Waterway - A way or channel for water or the movement of water.

Wetlands - The U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency jointly define wetlands as "*Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.*"

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

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

Windrow - Slash, residue, and debris raked into piles or rows.

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

Yarding - Method of log transport from harvest area to storage landing.

12.0 GLOSSARY OF WETLAND TERMINOLOGY

Backwater Basin- area that holds water from backwater flooding when adjacent water bodies overflow.

Best Management Practices- (BMPs) those practices determined to be an effective and practical means of preventing or reducing non-point source water pollution.

Ephemeral Water Course- drain that carries water less than 30% of the year. Water flow in ephemeral water courses is rain-dependent.

Established or On-going Silviculture- an operation whose primary purpose is the production, harvesting, and reproduction of forest crops. Indicators may include, among others, evidence of a written management plan; evidence of past harvesting with regeneration; and evidence of fire, insect, or disease control to protect timber.

Flatwoods- forested areas with slopes of 1% or less that usually contain mixed pine and hardwood.

Forest Swamp- forested area that has water at or above the soil surface for at least four months of the year.

Intermittent Stream- stream that flows 30-90% of the year in a continuous, well-defined channel.

Hydrophytic Vegetation – Vegetation growing wholly or partially in water or in soil too waterlogged for most vegetation to survive.

Normal Silviculture- may include activities such as forest road construction, timber harvesting, mechanical or chemical site preparation, bedding, tree planting, timber stand improvement, fire protection, and minor (temporary) drainage.

Perennial Stream- stream that flows at least 90% of the year in a continuous, well-defined channel.

Riparian Area- land that borders a creek, stream, or other water body.

Streamside Management Zone- forested area immediately adjacent to stream channels and other water bodies. Managed with specific attention given to protect instream and downstream water quality as well as other benefits.

Waters of the United States - The U.S. Army Corps of Engineers defines waters of the United States as all surface waters such as all navigable waters and their tributaries, all interstate waters and their tributaries, all wetlands adjacent to these waters, and all impoundments of these waters.

Wetlands- *"Those areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support and, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."*

13.0 How To Calculate Basal Area

Step 1) Choose plot: The plot should be representative of the entire tract. For this example the plot size is 1/25 or 0.04 acre, which is equivalent to a circle area with a 23'6" radius.

Step 2) Measure the DBH (Diameter at Breast Height) of each tree within the plot. DBH is measured in inches at 4 ½ feet above the ground. Write down the number of trees found in each diameter or DBH class. For example:

DBH Class (inches)	Number of Trees Found
4"	2
6"	1
8"	3
10"	5

Step 3) Calculate the basal area (BA) for each plot taken. This is done by multiplying the number of tress per DBH class by the BA factor for each DBH class and adding up the individual sums for a total BA for the plot. The BA factor can be found by using the following formula:

$$\textbf{BA factor} = 0.005454(\text{DBH})^2$$

DBH Class	Number of Trees	BA Factor	Total BA per Class
4"	2	0.087	0.174
6"	1	0.196	0.196
8"	3	0.349	1.047
10"	5	0.545	2.725

Total BA for Plot = 4.142 sq. ft.

Step 4) Repeat steps 1-3 until enough plots have been measured to achieve the proper sampling percentage and then use this data to calculate the BA per acre.
Continue example assuming that two more plots have been measured:

Plot	BA per Plot
Plot 1	4.142 sq. ft.
Plot 2	6.233 sq. ft.
Plot 3	4.589 sq. ft.

Average BA per Plot = (4.142 + 6.233 + 4.589)/3 = 14.964/3 = **4.988 sq. ft.**

BA per Acre = 4.988 x 25 = **124.7 sq. ft. per Acre** (25 equals the number of 1/25 plots needed to make one acre)

Through these calculations it can be determined that this tract has an average BA of 124.7 sq. ft. per acre.

The following table represents how many trees it takes per DBH class to achieve a determined BA.

Trees Per Acre by Basal Area and DBH

DBH (inches)	Basal Area (sq. ft.) Trees Per Acre									
	20	30	40	50	60	70	80	90	100	110
4	229	344	458	573	688	802	917	1031	1146	1261
5	146	220	293	367	440	513	587	660	733	806
6	102	153	204	255	306	357	408	458	509	560
7	75	112	150	187	224	262	299	337	374	412
8	57	86	115	143	172	201	229	258	286	315
9	45	68	91	113	136	158	181	204	226	250
10	37	55	73	92	110	128	147	165	183	202
11	30	45	61	76	91	106	121	136	152	167
12	25	38	51	64	76	89	102	115	127	140
13	22	33	43	54	65	76	97	98	108	119
14	19	28	37	47	56	65	75	84	94	103
15	16	24	33	41	49	57	65	73	81	90
16	14	21	29	36	43	50	57	64	72	79
17	13	19	25	32	38	44	51	57	63	70
18	11	17	23	28	34	10	45	51	57	62
19	10	15	20	25	30	36	41	46	51	56
20	9	14	18	23	28	32	37	41	46	50
21	8	12	17	21	25	29	33	37	42	46
22	8	11	15	19	23	27	30	34	38	42
23	7	10	14	17	21	24	28	31	35	38
24	6	10	13	16	19	22	25	29	32	35
25	6	9	12	15	18	21	23	26	29	32
26	5	8	11	14	16	19	22	24	27	30
27	5	8	10	13	15	18	20	23	25	28

14.0 Index

NOTES