FORESTRY BEST MANAGEMENT PRACTICE GUIDELINES FOR WATER QUALITY MANAGEMENT IN OKLAHOMA

Oklahoma Department of Agriculture, Food & Forestry
Forestry Services
Oklahoma City, Oklahoma

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FOREWORD

Forestry Services of the Oklahoma Department of Agriculture is mandated by Title 2, Section 1301-103 of the Oklahoma Statutes to "administer silvicultural best management practices in cooperation with forest land users under the provisions of state and federal water pollution laws ... ." Our Mission is to serve all the citizens of Oklahoma by protecting, improving and developing the State's forest resources and to enhance the benefits to society from those resources. As the lead agency for forestry in the State of Oklahoma, we seek to balance the needs of the state's landowners with the needs of the resource.

Oklahoma Forestry Services' general approach to the development and implementation of Best Management Practice Guidelines is one of education, technical assistance and cooperation. Protection of forest water quality is the responsibility of the landowner, the logger, the land manager, and all others applying practices or using the forest. Through sound and consistent application of Forestry BMP Guidelines, Oklahoma can avoid a costly regulatory program that relies on permits and inspections.

The BMPs lay out a framework of sound stewardship practices that, when consistently applied, will contribute positively to maintaining a high degree of forest water quality. These BMPs are not intended to be all-inclusive. Rational and objective on-site judgment must be applied to insure that water quality standards are maintained.

The most important guidance these BMPs can offer the forestry community is **to think and plan before you act**. Adequate forethought will pay off in two ways: to avoid unnecessary site disturbance or damage in the first place and to minimize the expense of stabilizing or restoring unavoidable disturbances when the operation is finished.

The enclosed BMPs are directed only toward the maintenance of water quality. However, these BMPs will have an indirect positive impact on other forest resource values. Sound stewardship principles that enhance wildlife habitat, clean air, aesthetics and general environmental quality are compatible with water quality BMPs and Oklahoma Forestry Services encourages their use when applicable to the landowner's objectives.

Following sound stewardship principles in carrying out forest practices will insure that our forests continue to meet the needs of their owners, provide jobs, forest products, clean water and a healthy environment without costly regulations. Only through sound stewardship principles will each of these needs be met.

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INTRODUCTION

Forestry Best Management Practice Guidelines, or BMPs, are proposed in this document as (1) a supplement to the technical BMPs on forest practices and road construction now contained in the State Water Quality Management Plan, and (2) for current use by forest owners and operators and by state agencies for BMP implementation.

The Guidelines are based upon a document entitled "BMPs Concerning Forestry and Water Quality in Oklahoma," which was developed by a blue ribbon forest practices committee appointed by former Governor David L. Boren in 1976. The Oklahoma Department of Agriculture-Forestry Services applied the original BMP guidelines in a survey of forest practices in southeastern Oklahoma in 1977-78. The original guidelines were revised for current purposes, primarily by eliminating parts of the original document that dealt with historical background and with wildlife considerations not related to water quality, and by incorporating more recent information.

To understand the technical context of the guidelines and how they are to be used, several basic aspects of their development and use should be considered.

BASIC CONSIDERATIONS IN BMP DEVELOPMENT AND USE

Basis for BMPs

The guidelines are based on research information and on a substantial basis of experience in the application of hydrologic principles in on-the-ground management. Applicable research results include information from previous work in Arkansas on practices in situations similar to Oklahoma conditions, and from recently instituted studies in forested areas of Oklahoma.[1] Applicable research results from other areas have been found useful also.

The available information is sufficient to allow reasonably effective BMP evaluations and choices. It is not sufficient, however, for precise evaluations of long-term effects of management practice choices in many local situations. Important gaps in information and research technology exist. Questions are often complex.

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[1] See description of research in Part IV and Appendix F of the report cited as follows: Miller, Robert L., David Christopher and Kurt Atkinson. Water Quality Management in Ouachita Highland Headwaters of Oklahoma. Forestry Division Resource Bulletin 1. Forestry Division, Oklahoma State Department of Agriculture, Oklahoma City, Okla., February, 1980.

Important considerations in this regard are the necessity for practice design and evaluation from the water quality standpoint on the basis of a complete management unit over the forest rotation, and the need to recognize the dynamic, transitional character of most forestry situations in Oklahoma. In addition, the interrelationships between practices through time should be studied and understood. These considerations are often not recognized by interests who are primarily concerned with forest benefits other than timber products.

Local Application

The guidelines as presented are applicable to forestry operations wherever found in Oklahoma. However, their application on-the-ground is necessarily dependent in considerable degree on technical and cultural factors peculiar to each land resource area or region, and perhaps also to the particular management situation being addressed.

In many cases, the choice of a specific management practice designed to meet the objectives of resource production and downstream water quality must depend to a large degree on experienced judgment. The choice will depend not only on technical information regarding hydrologic and biologic characteristics of the site, but also on such factors as the proposed intensity of production, frequency of cultural operations, the owner's particular management objectives, site location and access. The situation of the owner or operator in terms of financial status, management experience and equipment availability also affect specific management choices. An example of this nature is that of a need for BMPs on a tract held by an absentee owner who is without means for BMP application. Such instances are frequent and present problems not easily resolved.

A state program for implementing BMP guidelines must be designed to deal effectively with such factors and relate to the interests and needs of forest owners in achieving their management objectives. The state program must also take into account changing social and economic conditions.

These include the rural emigration of the recent past, which was accompanied by an increase in absenteeism and ownership consolidation, and by changes in land use; the more recent movement back to the land, often under new ownership; and the development on larger ownerships of intensive and in some cases highly innovative practices. Available information indicates that, with respect to management interests and capabilities, private forest owners in Oklahoma can logically be differentiated into three principal classes. These are industrial owners, resident non-industrial private owners and non-resident owners of the latter type. About two-thirds of the commercial forest area in Oklahoma are in small farm and other non-industrial private ownerships. Resident and absentee owners differ in problems they have in management, and often differ in objectives and in financial capability. Each ownership class will present substantially different problems in BMP education and implementation.

The design of an effective program of BMP education and implementation must relate to these basic differences in ownership and to the social, economic and cultural changes in process, as well as to the technical needs and objectives.

A COMMON GROUND FOR BMP IMPLEMENTATION

A basic and significantly favorable aspect of BMP implementation is the common interest of a forest landowner's long-term objective and the public interest in water quality. Because of the interrelationship of these interests, the sound management of soil, timber and water resources is inseparable. The future productivity and the value of the landowner's forest property are directly related to the condition of his soil, and soil conservation determines water quality to a large degree in forested areas of Oklahoma. Sound management of the soil, timber and water resources is in the best interest of the forest landowner and forest-using public.

In the vast majority of cases, forestry BMPs involve the application of the principles of sound land stewardship. When applied with care and common sense the result not only minimizes water pollution problems but is compatible with the economic objectives of forest landowners. Because the control of soil erosion is also in the best interest of forest landowners, their management objectives are:

1. To preserve the soil resource so as to sustain production of wood fiber and forest benefits from the soil.

2. To minimize damage to road systems and other capital facilities, thus reducing long-term maintenance costs.

3. To manage their lands in compliance with state and federal laws relating to water quality in an economically efficient and productive manner.

Thus, common objectives of the landowner and of the state and federal pollution-control laws provide a sound foundation for voluntary application of BMPs and the minimization of compliance costs. It is the objective of the state to meet our water quality goals through a cooperative effort by forest owners and public agencies on this common ground in a voluntary (nonregulatory) BMP program. To reduce the impacts of forestry activities on water quality in this way will serve the public interest in maintaining the quality of our water resource, will recognize other social objectives and will maintain the rights of the forest landowner to manage his land in an economically feasible manner.

FORESTRY BEST MANAGEMENT PRACTICE GUIDELINES

Water quality management guidelines that should be followed in the application of forest practices in Oklahoma are presented below. These guidelines are based on research findings and practical experience. As written, they presuppose technical competence and the exercise of experienced judgment in their application. When forestry practices are applied in accordance with these guidelines, they will constitute "Best Management Practices" (BMPs) in the existing state of the art. The guidelines are presented for these practice categories: streamside management, overall management and compartment planning, forest roads, harvesting, forest site preparation, application of forest chemicals and fire-line practices. The guidelines are followed by a list of Definitions (Appendix A) and a discussion of Major Water Quality Influences (Appendix B).

Streamside Management

Forest management within areas immediately adjacent to waters of the state should be applied with specific attention to measures that can be taken to protect local and downstream water quality. With proper management, the two objectives of timber production and water quality can be achieved. The most important considerations within the streamside management area (SMA) are maintenance and protection of the streambed and streambanks. Maintenance or quick revegetation of an additional zone beyond the streambank is important to insure against creation of sediment source areas during short periods of high stream flow. It should be noted that this does not necessitate the leaving of overstory vegetation. It does, however, require careful removal of overstory vegetation to insure protection of understory vegetation.

The real key to maintaining water quality is contained within the concept of BMPs, of which the Streamside Management Area is a component part. Sediment production is best controlled at the source. If movement of sediment from sideslopes is controlled through BMPs the role of the SMA will be limited to protection of streambanks and streambeds.

Streambank integrity can best be protected by maintaining a reasonable operating distance away from the streambank in the use of mobile equipment; for example, by using skidding line to remove trees near the streambank.

Overall Management and Compartment Planning

Forest ownerships in Oklahoma exhibit a wide variety in size, configuration, forest cover, accessibility and landowner objectives. Appropriate management plans will also vary accordingly. Nonetheless, regardless of type of ownership, advance planning of forest practice activities and field layout with erosion and water quality concerns in mind can contribute significantly to minimizing adverse environmental impacts. A logical progression in forest practices is:

1. Planning and layout of harvest areas and access;
2. Road location, construction and maintenance;
3. Harvest, including landings and skid trails;
4. Site preparation, including prescribed burning;
5. Reforestation; and
6. Silvicultural and protective treatments subsequent to reforestation, including use of forest chemicals.

The guidelines in this section focus primarily on the first item, because this establishes the physical on-the-ground pattern for subsequent forest practice activities. Harvest operations planning should encompass consideration for future silvicultural treatments and for fire-protection accessibility.

Setting layout and timber harvest operations which maximize efficiency and economy of motion and at the same time recognize the long-term values of preserving the integrity of the soil generally will also provide for the preservation of water quality. Desirable practices include:

1. Fully recognizing available topographic maps, aerial photographs and soil surveys, and combining these with local knowledge or field reconnaissance to ascertain on-the-ground conditions.
2. Wherever practical, use of perennial streams as harvest setting boundaries, with skidding planned away from these streams.
3. Location of setting boundaries to utilize roads, forest type, soil types, streams and changes in topography where ownership patterns permit, and to provide a harvest-area size consistent with economical skidding, available logging equipment, the existing and/or proposed road system, silvicultural requirements and other management objectives.
4. Design of settings to optimize economic skidding distances, to minimize road densities and unnecessary road construction, and for efficient establishment and management of subsequent forest crops.
5. Layout of settings to avoid leaving narrow, unmanageable strips of timber susceptible to windthrow and other storm damage.
6. On wet soils with seasonal water problems, scheduling the timing of operations to minimize adverse impact on soils and water quality.

Forest Roads

Forest roads have been established in Oklahoma over a long period of time with wide variation in standards. Future forest operations will involve the use, rebuilding or upgrading of existing roads and the construction of new roads in combination with existing roads.

A system of forest roads that is well designed, well located and constructed and maintained in accordance with sound principles and practices is essential to forest management. This section deals with these aspects and characteristics of forest roads.

The appropriate design standard and the road location should be chosen to achieve the best balance of economics and water quality objectives, including the following considerations:

A. Location

1. Use of the minimum design standard that produces a road sufficient to carry the anticipated traffic load with reasonable safety and with minimum environmental impact.
2. Full use of available soil surveys, topographic maps and aerial photographs to achieve the most practical road location.
3. Minimum use of road locations in narrow canyons, marshes, wet meadows, natural drainage channels and in streamside management areas.
4. Minimum number of stream crossings.
5. Where practical, crossing streams at right angles to the main channel.
6. Where topography permits, location of roads along the crests of ridges.
7. Where feasible, location of roads on the contour and at a reasonable distance from perennial streams.

B. Spacing

1. Location of roads resulting in spacing and density, which strikes a logical balance between the variables of topography, soils, economics and harvest equipment available.
2. Avoid duplicative roads.

C. Construction

1. Removal or decking of right-of-way timber in suitable locations so that the decks will not be covered by fill material or act as support for fill or embankment.
2. Keeping right-of-way clearing and road construction to a width commensurate with the planned use of the road.
3. Balancing excavation and embankments so that as much of the excavated material as is practical will be deposited in the roadway fill sections and thereby minimize the need for borrow pits.
4. Construction of road cut slopes on the basis of the topography and soils involved.
    a. Benching or staggered ditching of road cut slopes along the contour where needed and where soil material is stable and resistant to erosion.
    b. Construction of road cut slopes with the objective to minimize the potential for bank failures.
5. Avoiding placement of side-cast or fill material below the ordinary high water mark of any stream, except at stream crossings.
6. Exclusion of stumps, logs or slash in the load-bearing portion of the roadway, except as puncheon across swampy ground or for culvert protection.
7. Seeding and mulching wherever necessary to mitigate potential for mass failure or excessive erosion.
8. To the extent practical, planning and conducting construction work to minimize the adverse impact from heavy rain.
9. Placing logs and slash at the foot of fill slopes, as a means of slowing runoff and trapping sediment.
10. In general, emphasizing the principle that erosion can best be controlled at the time of construction.

D. Drainage

1. Installation of ditches, culverts, cross drains, drainage dips, water bars and diversion ditches concurrently with the construction of the roadway.
2. Planning ahead so that uncompleted road construction will not be left over a winter season or other extended wet periods. Should it be necessary to leave an unfinished road, out-sloping or cross draining of the roadway may be necessary. Water bars and/or dispersion ditches also may be used to minimize erosion and stream siltation.
3. Avoiding discharge of cross-drains, relief culverts and diversion ditches onto erodible soils or over fill slopes unless outfall protection is provided.
4. Making effective use of diversion or wing ditches wherever possible to carry road drainage water away from the road and onto the undisturbed forest floor.
5. Installation of adequate cross drains, culverts or diversion ditches to minimize erosion of the roadbed and cut bank. Drainage structures should be installed at low points in the road gradient.
6. Providing culvert size adequate to carry the water flow anticipated, unless soil and stream conditions require culvert sizing for maximum flow conditions.
7. Road ditching as necessary or where topography requires. Catch basins, broad-based dips or other alternatives, should be installed at cross-drainage culvert inlets in highly erodible soils and on steep grades.
8. Providing adequate drainage of landings to eliminate concentration of water. Where feasible, out-slope roads and skid trails above landings, and divert drainage water so that it will spread out onto the forest floor.

E. Water Crossings

1. Using bridges or culverts where a ford or crossing cannot be found that would minimize rutting or siltation.
2. Construction of low-water bridges and overflow culverts so as to cause no more than minimal changes in natural streambeds during high water periods.
3. Low-water bridge fills and earth embankments constructed for use as bridge approaches should be protected from erosion by high water. Methods of protection may include use of rocky fill material, planted or seeded ground cover, rock riprap, concrete surfacing and retaining walls or bulkheads.
4. If slash or debris from road operations is deposited in a stream channel, it should be removed prior to removal of equipment from the area.
5. Bridges should not constrict clearly defined stream channels. Permanent bridges should be designed to pass the normal flood level, or else the road approach should be constructed to provide erosion protection from overflow floodwaters that exceed the water carrying capacity of the drainage structure.

F. Maintenance

1. Road surfaces should be crowned, out-sloped or water-barred to dissipate surface runoff and minimize erosion of the roadbed.
2. Ditches should be kept free of blockages.
3. Culverts should be open and clean to allow free passage of water.
4. Exposed soil areas or slopes that are subject to erosion should be revegetated or otherwise stabilized.
5. Roads not currently in use should be periodically inspected to insure their integrity.

Timber Harvesting

Timber harvesting is the primary means of converting timber resources to fulfill society's needs for wood products and to provide an economic return to the landowner. Harvesting is basic to good silviculture, as a means to improving conditions for forest growth and to provide for regeneration. Harvest activities can be conducted to protect soil productivity for the next crop and to insure maintenance of water quality over the long term. The following guidelines are aimed at achieving these objectives.

A. Landings

1. Landings should be located to minimize adverse impact of skidding on the natural water drainage pattern.
2. Landings, if possible, should be on firm ground outside streamside management areas of perennial streams and above the ordinary high water mark of intermittent streams.
3. Location should take advantage of topography to minimize accumulation of water on the landing and to permit diversion of water onto the forest floor.
4. Landings should be kept to the smallest size compatible with efficient and safe logging operation.
5. When the operation is completed, any impounded water on or around the landing should be drained and provision made for diversion of any water flowing down the road into or away from the landing.

B. Cutting

1. Careful felling can improve environmental performance by protecting residual trees and reproduction and by minimizing the number of trees felled into water areas.
2. Trees should not be felled into streams except for those trees that cannot otherwise be practically and safely felled outside the stream. Such trees should be removed promptly.
3. Directional felling should be practiced near perennial streams to minimize debris entering the stream, to facilitate disposal of logging debris and to reduce damage to residual trees in partial cuts.
4. Felling trees parallel to the skidding direction and with butts toward the landing to the extent feasible can facilitate skidding and minimize soil disturbance.

C. Skidding Operations

1. Harvest operations should match available equipment with the terrain, soils and weather conditions to minimize soil compaction and disturbance.
2. Skid trails should be laid out to avoid disrupting natural drainage channels, to take advantage of topography, to minimize steep gradients and to keep soil displacement to a minimum.
3. Where practical, skidding should be upslope or on the contour to disperse downhill water flow.
4. Stream channels should not be used as skid trails.
5. Crossings of streams should be minimized with the direction of log movement between streambanks kept as close to a right angle to the stream channel as practical.
6. Temporary crossings utilizing culverts, logs or portable bridges may be necessary at stream crossings to protect streambeds and banks and to prevent creating sediment.

7. The number of skidding routes through streamside management areas should be minimized and use of skidding equipment in the SMA avoided to the fullest practical extent.
8. Under story vegetation along the banks of perennial streams should be left undisturbed to the maximum degree possible to protect the integrity of streambanks.
9. Any felled or downed tree in a flowing stream should be promptly removed. To the extent practical, the entire tree should be skidded out of the stream or streamside management area prior to limbing and bucking.
10. Skid trails on slopes should have occasional breaks in grade to facilitate diversion of water. Upon completion of use, trails should be water-barred when necessary to prevent soil erosion.
11. Servicing of equipment should be carried out away from streams, and fuel and lubricant storage tanks or containers should be located where an accidental spill would not result in stream contamination.

D. <u>Disposal</u> <u>of</u> <u>Debris</u> <u>and</u> <u>Litter</u>

1. Logging debris, which is accidentally deposited in streams, should be removed during harvest operations.
2. Logging debris accumulations in intermittent streams which have potential for blocking the stream or for subsequent slide or debris avalanche occurrence should be removed from the channel in conjunction with harvest operations.
3. Debris accumulations on the remaining harvested area should be scattered to the maximum extent possible during harvest operations unless site preparation plans for the area indicate otherwise.
4. Where feasible, scattering of limbs and logging debris on skid roads and exposed soil areas will retard water flow and reduce soil movement.
5. Debris on landings should be piled where burning is anticipated and should not be shoved into drainages or streams.
6. Erosion-prone areas can be mulched or seeded to help establish permanent vegetative cover.
7. Logging litter, such as oil cans, grease containers, crankcase oil, filters, old tires, broken cable, paper and other trash must be kept out of streams. All debris should be hauled to designated legal disposal sites.

Forest Site Preparation

Preparation of the forest site is often necessary following total harvest to dispose of logging residues, to eliminate remaining undesirable trees and vegetation and to prepare the soil for reforestation by seeding or planting. Site preparation methods range from prescribed burning to a variety of mechanical treatments often followed by burning. Choice of method is dependent on choice of species (as determined by management objectives), soil characteristics, topography and consideration for protection of the soil and runoff water quality. Prompt regeneration following harvest is essential to effectively realize the productive capacity of the forest soil and mitigate soil erosion.

This section presents guidelines for mechanical site preparation. These operations should be conducted in a manner to:

1. Minimize soil displacement or compaction;
2. Minimize soil erosion on slopes and sediment movement into waters; and
3. Prevent accumulation of debris in creek bottoms, ponds, streams or rivers.

Mechanical site preparation methods include: Shearing, K-G Blading and Piling; Chopping and Brush-Crushing; Disk-Harrowing, Bedding and Furrowing; and Ripping.

Combinations of treatments may be used on some sites. Guidelines for the various methods to minimize adverse impact on water quality are listed below. Skillful equipment operators made aware of these desirable practices can reduce adverse environmental impacts of site preparation. The degree of site preparation should be limited to the amount necessary on a given soil type to achieve a well-stocked stand of the desired species.

A. Shearing, K-G Blading and Piling

Shearing or K-G Blading involves cutting of trees and vegetation at the ground line using tractors equipped with angled or V-shaped shearing blades. These blades have straight or serrated edges and have a stinger for splitting larger trees or stumps. The blades have a flat sole to allow "floating" on the surface of the ground without digging. Following shearing, the woody material is pushed into windrows (piled) by bulldozer. In some conditions a rootrake blade is preferable to a solid blade because it can allow topsoil and organic matter to sift between the tines of the rootrake, rather than being pushed into the windrow along with the woody material. Where soils are highly erodible, low in nutrients or on slopes greater than 10 percent, the adverse effects of the shearing-windrowing practice may outweigh any advantage. Where soils are relatively stable, the practice may be acceptable on steeper slopes when applied with particular care. It is best suited to relatively rock-free areas with little slope and relatively large amounts of unmerchantable material to be removed. When using shearing techniques:

1. Protect streamside management areas and intermittent stream channels by planning equipment operation to minimize soil disturbance in these areas.
2. Use care in equipment operation to minimize soil disturbance and displacement.
3. Windrows and their spacing should be such that soil exposure and soil movement is minimized.
4. On slopes, locate windrows on the contour.
5. Keep soil in windrows to a minimum.
6. If at all possible, windrows should not be placed in SMAs or intermittent stream channels.

B. Chopping and Brush-Crushing

Rolling drum choppers pulled behind tractors and mechanical brush-crushers are effective in reducing woody competition with a minimum of soil disturbance. These machines uproot, chop and compact woody material without moving it across the surface. Alternate methods for slopes include chopping, tree crushing and herbicides. Prescribed burning normally follows chopping to complete the site preparation.

C. Disk-Harrowing, Bedding and Furrowing

Disk-harrowing with heavy disks pulled by tractors is an effective treatment against vegetation, which forms a dense root mat just below the soil surface. This method is often used in flatwoods situations and on other flat to gentle topography. On poorly drained sites, bedding with special disking equipment is used to concentrate surface soil and litter into small ridges. Furrowing is the opposite of bedding and provides plowed furrows as planting sites. When using these techniques:

1. Avoid complete disking of steep slopes with extremely erodible soils. Disking of alternate strips on the contour may be an acceptable practice on certain side slopes.
2. Provide water outlets on bedded or furrowed areas at locations that will minimize movement of sediment. Wherever possible, discharge water onto vegetated surfaces.

D. Ripping

Ripping involves cultivation of compacted or impermeable soils by tractors equipped with heavy teeth or rippers. It is a desirable practice on soils with high clay content that have been compacted or on soils with a hardpan or cemented layer below the surface, or on shale or soft rock formations. Ripping on the contour is highly effective in reducing runoff and in facilitating maximum absorption of rainfall into the soil along the planting row. When ripping is employed:

1. Protect streamside management areas and intermittent stream channels by planning equipment operation to minimize disturbance of these areas.
2. Follow the contour to minimize erosion.
3. When ripping up and back on a compacted or puddled skid road, offset the return trip to maximize the amount of ripped or cultivated area.
4. Set rippers to the maximum depth that the power unit will handle to improve aeration and water percolation capacity of the treated area.
5. Wherever practical, provide for discharge of drainage water onto vegetated surfaces.

E. Site Drainage

On some poorly drained sites on flat topography, drainage is necessary for the establishment and growth of commercial tree species. This involves construction of ditches and drainage canals to lower the surface water table. Normally, the excavated soil is utilized from drainage canals to construct an adjacent forest roadbed. Where drainage is used:

1. The drainage system should be planned and designed to fit the topography and the seasonal flow variations of the area and to take advantage of the natural drainage pattern.
2. Ditch design will depend upon the surface soil type, slope, depth to hardpan and the volume of water to be controlled.
3. Cofferdams and other devices should be utilized where necessary to allow for gradual delivery of initial discharges into natural waterways.
4. Ditch spoil materials should be placed far enough away from the edge of the ditch to prevent sloughing.
5. The drainage system should be kept clear of logging debris.

6. Culverts or portable bridges should be utilized for temporary crossing of drainage ditches in preference to dirt fills. Permanent crossings of drainage ditches should be planned, where necessary, to provide prompt access in the event of fire.
7. Drainage ditch bank failure and erosion from side-cast material should be promptly repaired and/or revegetated or otherwise stabilized.

Application of Forest Chemicals

Chemicals perform important functions in forest management. Chemicals may be used for control of insects, diseases, weed trees and rodents; site preparation; repellents; in nursery operations; fire suppression; and fertilization. Chemicals must be used only in accordance with the manufacturer's label instructions and applicable federal and state regulations.

These guidelines cover the handling and application of forest chemicals in such a way that public health and aquatic habitat will not be endangered by contamination water.

A. Maintenance of Equipment

1. No significant leakage of chemicals should be permitted from equipment used for transportation, storage, mixing or application.

B. Mixing

1. When water is used in mixing, provide an air gap or reservoir between the water source and the mixing tank.
2. Use uncontaminated pumps, hoses and screens.
3. Mix chemicals and clean tanks only where possible spills would not enter a stream, lake or pond.

C. Aerial Application

1. Avoid direct entry of chemicals into SMZs, flowing waters and stock ponds.
2. Use a bucket or spray device capable of immediate shutoff.
3. Shut off chemical application during turns and over open water.

D. Ground Application

1. Avoid direct entry of chemicals into SMZs, flowing waters and stock ponds.
2. Exercise care to not exceed intended or allowable dosage.
3. Utilize injection or stump treatment herbicide methods, where feasible, in areas immediately adjacent to open water.

E. Limitations on Application

Chemicals should be used only in accordance with:

1. All limitations printed on the Environmental Protection Agency container registration label; and
2. State requirements for registration and regulation of sale or use of pesticides and for licensing of custom applicators and of aerial applicators.

F. Container Disposal

1. Chemical containers should be removed from the forest and disposed of in a manner conforming to state regulations and label directions.
2. Chemical containers should not be reused if prohibited by label directions.

G. Equipment Cleanup

1. Cleanup should be accomplished in a location where chemicals will not enter any stream, lake or pond.
2. Cleanup residues should not be permitted to collect in hazardous concentrations, and disposal should be in conformity with state requirements.

Fire-Line Practices

Fire-line practices were not addressed in the original forestry BMPs. However, unless precautions are taken, they may become a source of sediment, particularly on slopes in erodible soils. Fire-lines are constructed primarily by a crawler-tractor using a blade or pulling a fire plow clearing a line 4 to 6 feet wide, exposing mineral soil to hinder fire spread. Lines are needed during prescribed burning to limit the fire to a defined area, and in wildfire suppression to stop its spread. If available, they are often tied into roads, drainages or other natural features.

Frequently, these lines come directly down slope from ridge to drainage, creating an ideal channel for water movement and soil erosion similar to a drainage ditch along a road. Practices should be installed to prevent channelized flow, improve drainage and stabilize bare soil.

Fire-lines constructed during planned prescribed burning activities, or routine fire protection, should be water-barred immediately. During wildfire suppression, time does not permit water barring. However, these should be checked when the fire is controlled.

Construction of the water bars is similar to those for roads, but on a smaller scale. Spacing will depend primarily on slope, and again will be similar to the recommendations for roads.

In some cases, rock check dams constructed with hand labor may be a satisfactory and less costly alternative to constructing water bars with heavy equipment.

Bare areas will generally revegetate naturally in a short period of time. However, on steeper slopes, or where a green strip is desired for fire protection, these areas can be seeded with rye or fescue. Follow NRCS seeding guidelines.

APPENDIX A

Definitions

Bedding is a site preparation method in which special disking equipment is used to concentrate surface soil and forest litter into a ridge or bed, elevated from 6 to 10 inches above the normal forest floor, on which forest seedlings are to be planted.

Best Management Practices (BMPs) are practices or combinations of practices that are established by a state or designated management agency, after problem assessment, examination of alternative practices and appropriate public participation. BMPs are designed to be the most effective and practicable (including technological, economic and institutional considerations) for preventing or reducing the amount of pollution generated by non-point sources, thus maintaining a level compatible with water quality goals.

Borrow Pits are areas from which soil is removed to build up the roadbed during construction.

Broad-Based Dips are long and wide humps or grade changes in a road to divert runoff water away from the road onto the forest floor.

Bucking means to saw felled trees into predetermined lengths.

Chopping is a site preparation method in which brush species and logging debris are pushed down and flattened by the use of rolling drum choppers or mechanical brush choppers in preparation for reforestation.

Commercial Forest Land is forest land with these characteristics:

(1) Bearing or capable of bearing timber of commercial character;
(2) Economically available now or prospectively available for commercial use; and
(3) Not otherwise withdrawn from such use.

Cross-Drain Culverts are pipes or wooden structures designed to carry upslope ditch runoff under the road and onto the forest floor.

Delayed Setting means a logically planned logging area or unit located in or around other harvest areas, in which logging is deferred for a period time to accomplish specific management objectives.

Disk-Harrowing is a site preparation method of cultivating the soil and breaking up surface vegetation by using heavy disking equipment.

Erosion is the process by which soil particles in situ are detached and transported by water and gravity to some downslope or downstream deposition point.

Felling is the process of severing trees from stumps.

Forest Chemicals refer to chemical substances or formulations that perform important functions in forest management, and include fertilizers, insecticides, herbicides, repellents and other chemicals.

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

Forest Landowner means an individual, combination of individuals, partnership, corporation, non-federal government agency or association of whatever nature that holds ownership interest in forest land.

Forest Practice is an activity relating to the growing, harvesting or processing of forest tree species on the land.

Forest Road is an access route for vehicles into forest land.

Furrowing is a site preparation method involving the plowing of a trench in preparation for reforestation.

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

Landing is a place where logs are assembled for temporary storage, loading and subsequent transportation.

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

Logging Debris or **Slash** means the unwanted or unutilized and generally unmarketable accumulation of woody material, such as large limbs, tops, cull logs and stumps that remain as forest residue on the land after logging.

Low Water Bridge is a stream crossing structure built with the expectation that during periods of high water or floods the water will flow over the structure.

Mulching means 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.

Non-Point Source (NPS) Pollution refers to sources of water pollution which:

1. Are induced by natural processes, including precipitation, seepage, percolation and runoff;
2. Are not traceable to any discrete or identifiable facility; and
3. Are better controlled through the utilization of best management practices, including processes and planning techniques.

In contrast to these criteria identifying non-point sources, **Point Sources** of water pollution are generally characterized by discrete and confined conveyances from which discharges of pollutants into navigable waters can be controlled by effluent limitations.

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

Organics refer to particles of vegetative material in water that can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Pesticide means any herbicide, insecticide or rodenticide but does not include non-toxic repellents or other chemicals.

Puncheon refers to logs or slash placed in a roadbed or trail for stability on swampy ground.

Right-of-Way Timber refers to the logs cut on rights-of-way in the construction of forest roads, drainage ditches, pipelines or power lines.

Rill is a small channel on slopes where excess water collects and flows into larger channels. Channelized flow is the normal flow pattern on forest lands, rather than sheet flow.

Ripping is a site preparation method using tractor-drawn or mounted equipment with heavy teeth to break up compacted or impermeable soils or soft rock to aerate and loosen the soil and otherwise improve the site for reforestation.

Rootraking is a site preparation method using a heavy-toothed implement mounted on a tractor for collecting logging debris into piles or windrows in preparation for reforestation.

Scarify means to break up the forest floor and topsoil preparatory to natural or direct seeding, or the planting of seedlings.

Sediment is suspended or deposited soil and organic material in water originating from erosion.

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

Shearing is a site preparation method which involves the cutting of brush, trees and other vegetation at the ground line using tractors equipped with angled or V-shaped cutting blades.

Sheet Flow is runoff from a rainfall event that is intense enough to cause direct overland flow prior to entry to a receiving stream.

Side-cast refers to the act of moving excavated material to the side and depositing such material laterally to the line of movement of the excavating machine. It also refers to such excavated material.

Silvicultural Activities (EPA interpretation) refers to all forest management activities, including intermediate cuttings, harvesting, log transportation and forest road construction.

Site Preparation is a general term for removing unwanted vegetation and other material when necessary, and any soil preparation, carried out before reforestation.

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

Soil Productivity refers to the output or productive capability of a forest soil to grow timber crops.

Streamside Management Area (SMA) means an area adjacent to the banks of perennial streams where extra precaution is necessary in carrying out forest practices in order to protect streambank integrity and water quality.

Stream Classification is a classification of waters by flow variation and other pertinent hydrologic and physical characteristics essential to the development of BMPs, due to the variable nature of stream systems and forest practices. Realistic BMPs can only be developed when consideration is given to the hydrologic nature of individual systems. Guidelines developed without such a classification will have to be so general as to provide for overprotection of small headwater streams and/or under-protection of streams at the lower end of drainage systems. Four classes of flow are recognized within the State of Oklahoma.

1. **Perennial** means that part of the drainage network that provides flow at all times except during extreme drought.

2. **Intermittent** means that part of the drainage network that provides flow continuously during some seasons of the year but little or no flow during other seasons.

3. **Ephemeral** means that part of the drainage network that provides flow only during or immediately after periods of rainfall.

4. **Ponded** means those sections of streams or bodies of water with no noticeable flow.

Water Bar means a 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 causes soil movement and erosion.

Water Pollution (EPA definition) is 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 which will or is likely to create a nuisance or render such water 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.

Water Quality Standards (EPA definition) are established state requirements for water quality management, containing three major elements:

1. The use(s) to be made of the water (e.g., recreation, drinking water, fish and wildlife propagation, industrial or agriculture);
2. Criteria to protect those uses; and
3. An anti-degradation statement for protecting existing high quality waters.

Wing Ditches or **Turnouts** are drainage structures on roads that provide ditch relief of runoff onto the forest floor.

APPENDIX B

<u>Major Water Quality Influences</u>

For non-point sources of pollution, designing a control program is difficult. The addition of pollutants to receiving water is seldom traceable to a distinct source that is easily identified. Stream systems draining agricultural and forestry operations are usually small streams in headwater areas. The highly variable nature of these streams makes it difficult to determine natural levels of water quality. Also, severe storms with heavy rain and rapid runoff are uncontrollable variables influencing natural erosion. In the absence of knowledge concerning natural background levels, it is difficult to establish acceptable levels of change in water quality that might result from land management activity. Due to the high variability in the natural system, and to the complex relationships between man's activity, geologic and other natural conditions, and subsequent storms and other weather events, water quality impacts from an activity are more often than not very hard to measure.

The problems associated with utilizing water quality standards as a means of assessing the impact of land management activities have led to the concept of Best Management Practices (BMPs). It must be noted, however, that the variability of the system that makes water quality standards difficult to use has an impact on BMP development. BMPs must reflect typical types of situations and give the individual landowner or manager flexibility to exercise the necessary discretion required for the proper controls on a specific site.

Of the many water quality influences utilized to determine impact of land management activity, there are five of major importance as related to silvicultural activity: sediment, nutrients, organics, pesticides and temperature. It should be noted that four of these five influences can be altered naturally as well as by man.

This happens quite often and sometimes a natural change in one or more influences over background levels can be beneficial to a stream. Any attempt at developing BMPs must necessarily consider the inherent variability in these influences, the natural mechanisms of change to them and the consequent delivery rate of any or all of these influences, on water quality.

<u>**Sediment**</u>: One of the more important water quality considerations as related to silvicultural practices is that of sediment production and movement and the impact of downstream deposition. Due to the importance of sedimentation, it is necessary to understand the mechanism of delivery in developing and utilizing BMPs. Unless the forest floor has been altered so that infiltration rates are less than precipitation rates, sheet flow does not normally occur. Movement of water from sloping land characteristic of much of the forest environment usually is in some form of channelized flow. Water collects in small rivulets or rills, these collect into small channels and these into larger streams or rivers. With this type of flow, a strip of vegetation can act as an effective impediment to stream sedimentation only in the initial stage of water movement. <u>The only way that a vegetative strip can serve as a filter for sediment-laden water is under conditions of sheet flow and, as pointed out, this rarely occurs in the well-managed</u>

forest environment. The key in prevention of sediment movement is prevention of sheet and/or channelized flow over exposed soil through the maintenance of high infiltration rates on the forest floor. The emphasis should be placed on preventing or reducing sediment production at its source and not reliance on a vegetative strip to filter the sediment just before it enters the stream course.

Nutrients: To a limited extent, phosphorus and nitrogen fertilizers are applied in the forest environment to stimulate tree growth. Phosphorus and nitrogen are constituents of the natural system. An important consideration in controlling this potential source of pollution is an understanding of the impact of management practices on the nutrient cycle. Of the two nutrients, nitrogen is the most susceptible to leaching. When applied as urea or ammonium salts, however, movement is restricted. These forms are quickly hydrolyzed to ammonium ions (NH_4^+) that are retained on soil particles. Thus, unless the soil moves, there is little movement of the nutrient. The use of phosphorus in phosphate form is normally confined to poorly-drained sandy soils along the Gulf Coast area. Although phosphates are water-soluble, they are generally fixed in the upper soil horizons as insoluble iron and aluminum reaction products. Research has not found a large increase in nutrient level in runoff from forests that have been artificially fertilized above that for natural forest stands except where fertilizer was allowed to drop onto the water surface. Guidelines developed to prevent application of nutrients to water surfaces will solve the principal problem related to increase in nutrient level in surface waters.

Organics: The incorporation of small organic debris into stream channels and subsequent oxidation of these materials can, in some cases, result in reduced dissolved oxygen concentration. This may be noted particularly in very slow-moving streams or streams that are in a ponded condition. Most forest streams have medium to high re-aeration coefficients, and oxygen removed in the oxidation process is readily replaced from the atmosphere.

Pesticides: The impact of pesticide application on water quality, as in the case of nutrients, can be controlled in most cases through operational safeguards. Unlike nutrients, which are in a form that can be leached from the system, most currently used pesticides break down rapidly and are attracted to soil particles, rendering them relatively stable within the soil profile.

Temperature: The impact of shade removal on increasing stream temperature is not only dependent upon physical characteristics of the stream in question (surface area, volume of flow, channel gradient and streambed material) but also upon the aquatic life present in that stream. Surface area, volume and rate of flow determine the impact on waters exposed to solar loading. As area increases for constant volume and flow, there is an increase in water temperature. Volume of stream flow is inversely related to temperature change; i.e., as discharge increases, the expected change in temperature decreases. Thus, vegetative removal may produce relatively large changes in stream temperature for small streams and almost no impact for large streams. However, small streams can be shaded by low vegetation, such as sapling trees or other understory growth. Therefore, the duration of any temperature increase because of vegetative removal tends to be shorter in the streams having the greatest temperature increase.

Stream gradient affects the amount of time that water is exposed to solar loading as it flows through an unshaded portion of the stream course. Steep channel gradients reduce travel time, thereby reducing solar loading impact and producing small increases in stream temperatures. Increasing the channel roughness increases travel time, which may result in increased stream temperature. This also, however, increases water surface exposure to the air. The type of channel bottom is also an important consideration. Solid rock bottoms tend to both heat and cool more slowly than bottoms of fluvial materials, with a corresponding impact on water temperature.

The actual amount of shading offered by streamside vegetation is dependent on both stream orientation and vegetative height. Vegetation on the north side of east-west streams will provide only minimal shade for the water surface. The effect of vegetation is often reduced on north-south streams. This is especially true for larger streams where the proportion of surface under over-hanging vegetation is relatively low. The actual amount of shade provided also depends upon characteristics of the vegetation. Characteristics playing an important role include crown density and depth, age, species and understory type. Shadow length is related to vegetative height and is, therefore, an important feature.

Because of those relationships, a sparse stand of large trees may be relatively ineffective in providing shade to the surface of small streams. Understory vegetation, however, may be of adequate height to provide the shade necessary to these same small streams.

A point often minimized in the consideration of vegetation's role for prevention of undesirable increases in stream temperature is prompt vegetative regrowth. Often it is assumed that the increases in temperature noted will carry into the future for a significant length of time. In actuality, the small streams that are the most highly sensitive to changes in stream temperature are shaded in a relatively short time with fast-growing understory vegetation, reinforced shortly thereafter by forest tree seedlings. The impact may be relatively short-lived in terms of years, occurring only once in a rotation period of 25 years or longer. In addition, there is a real lack of information concerning the actual impact of temperature changes on the aquatic environment. Almost all research has been conducted at static levels. In the natural environment, these maximums do not last for a 24-hour period, but rather drop back to some lower level during the nighttime period.

Another important consideration lies in the effect of an overstory removal on low flows. After the recession flow of storm runoff eases, stream flow is supplied from groundwater. When the deeper-rooted overstory is removed, more groundwater becomes available for stream flow. Of particular importance is the resulting possibility of increased volume and duration of flow during dry periods with associated lower temperatures, and higher pool levels in intermittent streams.

Compared to other forms of silvicultural non-point source pollution, such as sediment and organic pollution, the cost/benefit ratio of thermal pollution controls is not so easily discernible. Whether thermal pollution is a potential problem is highly situation-dependent.