The Great Trinity Forest Management Plan

Volume 22

Sustainable Forestry Initiative and Best Management Practices

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Volume 22

Table of Contents

SUSTAINABLE FORESTRY INITIATIVE

2005–2009 Standard

INDEX

Principles for Sustainable Forestry

Managed forests make a vital contribution to the world by providing economic, environmental, and social benefits indispensable to the quality of life. Accomplishing *sustainable forestry*, especially on private lands, requires a partnership among landowners, *wood producers*, contractors, and the companies that purchase wood.

Sustainably managed forests provide many benefits to society: employment for hundreds of thousands of workers, a viable tax base that supports thousands of communities, essential building and paper products, and numerous recreational opportunities. A commitment to provide these social benefits extends to promoting human health and safety; providing employee training and education; protecting air and water quality, soil, and *wildlife*; protecting unique resources; and communicating the benefits of the practice of *sustainable forestry* to the general public. The SFI Standard reflects this commitment to social responsibility through a set of *principles*, *objectives*, *performance measures*, and *indicators*.

Program Participants must comply with all portions of the SFI Standard relevant to their operations, taking into account their local conditions and circumstances and the scope and scale of their operations. In addition, the SFI Standard requires *Program Participants* to take their commitment to responsible stewardship beyond the bounds of their own lands and operations by encouraging others to adopt the *principles* and *objectives* of the SFI Standard. *Program Participants* are required to work with their suppliers to make sure they are meeting *program* goals for *best management practices*. And *Program Participants* are required to invest in research to enhance the practice of *sustainable forestry*, add to scientific knowledge, improve *forestry* practices, and increase the overall *productivity* of forests.

The SFI Standard applies to the United States and Canada, where *Program Participants* must comply with numerous federal, provincial, state, and local laws that protect the environment, their workers, and those who live in the communities in which they operate. Such laws include hundreds of thousands of rules that cover a broad range of issues. Just some of the applicable federal, state, provincial, or local forestry-related environmental laws and regulations found in the United States and Canada include the Clean Water Act, Endangered Species Act, Species at Risk Act, and state or provincial forest practice laws. The social laws of the United States and Canada cover civil rights, equal employment opportunities, antidiscrimination and antiharassment measures, workers' compensation, indigenous peoples' rights, workers' and communities' right to know, wages and working hours, and occupational health and safety. Antitrust, business competition, and other laws in the United States and Canada outline business procedures that must be followed. The SFI Program does not try to duplicate *sustainable forestry* processes that are already mandatory in the United States and Canada. Both countries have mature legal systems that consistently discourage and punish illegal behavior. Given the wide range of due process and compliance mechanisms that ensure conformance with applicable laws, the SFI Standard purposefully focuses on continual improvement of the practice of *sustainable forestry*, forest *productivity*, and environmental performance processes that complement the existing legal framework.

In the United States and Canada, family forestland owners play a significant role in supplying wood fiber to the wood products industry. In the United States, more than 10 million such owners account for 60% of the forestland and more than 50% of the raw materials used by *Program Participants*. The percentage of family forestland owners in Canada is smaller, but in some areas these owners provide a large share of the raw materials used by *Program Participants*. These family forestland owners need stable and predictable laws, standards, and business practices.

Program Participants both support *sustainable forestry* practices on forestland they manage and promote it on other lands. Moreover, *Program Participants* support efforts to protect private property rights and the ability of all private landowners to manage their forestland sustainably. This support stems from *Program Participants*' belief that forest landowners have an important stewardship responsibility and a commitment to society, and they recognize the importance of maintaining viable commercial, family forest, and *conservation* forestland bases.

In keeping with this responsibility, *Program Participants* shall have a written *policy* (or *policies*) to implement and achieve the following *principles*:

1. **Sustainable Forestry**
   To practice *sustainable forestry* to meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic that integrates *reforestation* and the managing, growing, nurturing, and harvesting of trees for useful products with the *conservation* of soil, air and water quality, *biological diversity*, *wildlife* and *aquatic habitat*, recreation, and aesthetics.
2. **Responsible Practices**
   To use and to promote among other forest landowners *sustainable forestry* practices that are both scientifically credible and economically, environmentally, and socially responsible.
3. **Reforestation and Productive Capacity**
   To provide for regeneration after harvest and maintain the productive capacity of the forestland base.
4. **Forest Health and Productivity**
   To protect forests from uncharacteristic and economically or environmentally undesirable wildfire, pests, diseases, and other damaging agents and thus maintain and improve long-term *forest health* and *productivity*.
5. **Long-Term Forest and Soil Productivity**
   To protect and maintain long-term forest and soil *productivity*.
6. **Protection of Water Resources**
   To protect water bodies and *riparian* zones.
7. **Protection of Special Sites and Biological Diversity**
   To manage forests and lands of special significance (biologically, geologically, historically or *culturally important*) in a manner that takes into account their unique qualities and to promote a diversity of *wildlife habitats*, forest types, and ecological or natural community types.
8. **Legal Compliance**
   To comply with applicable federal, provincial, state, and local forestry and related environmental laws, statutes, and regulations.
9. **Continual Improvement**
   To continually improve the practice of forest management and also to monitor, measure and report performance in achieving the commitment to *sustainable forestry*.

Objectives for Sustainable Forestry

Some *Program Participants* own forestland, others own forestland and manufacturing facilities, and still others own manufacturing facilities only. As such,

SFIS *objectives* **1–7** provide measures for evaluating *Program Participants*' compliance with the SFI Standard on forestlands they own or control through long-term leases.

SFIS *objective* **8** provides measures for evaluating *Program Participants*' compliance with the SFI Standard through their *procurement* programs.

SFIS *objectives* **9–13** provide measures for evaluating all *Program Participants*' compliance with the SFI Standard for research, training, legal compliance, public and landowner involvement, management review, and continual improvement.

SFIS Objectives for Land Management

Objective 1. **To broaden the implementation of** *sustainable forestry* **by ensuring long-term harvest levels based on the use of the** *best scientific information* **available.**

Performance Measure 1.1. *Program Participants* shall ensure that long-term harvest levels are sustainable and consistent with appropriate *growth-and-yield models* and written plans.

Indicators:

1. A long-term resource analysis to guide forest management planning at a level appropriate to the size and scale of the operation, including
   a. a periodic or ongoing forest *inventory*;
   b. a *land classification* system;
   c. soils *inventory* and maps, where available;
   d. access to *growth-and-yield modeling* capabilities;
   e. up-to-date maps or a *geographic information system (GIS)*;
   f. recommended sustainable harvest levels; and
   g. a review of nontimber issues (e.g., pilot projects and economic incentive programs to promote water protection, carbon storage, or *biological diversity conservation*).
2. Documentation of annual harvest trends in relation to the sustainable forest management plan.
3. A forest *inventory* system and a method to calculate growth.
4. Periodic updates of *inventory* and recalculation of planned harvests.
5. Documentation of forest practices (e.g., planting, fertilization, and thinning) consistent with assumptions in harvest plans.

Objective 2. **To ensure long-term forest** *productivity* **and** *conservation* **of forest resources through prompt** *reforestation*, **soil** *conservation*, *afforestation*, **and other measures.**

Performance Measure 2.1. *Program Participants* shall reforest after final harvest, unless delayed for site-specific environmental or *forest health* considerations, through *artificial regeneration* within two years or two planting seasons, or by planned *natural regeneration* methods within five years.

Indicators:

1. Designation of all management units for either *natural* or *artificial regeneration*.
2. Clear criteria to judge adequate regeneration and appropriate actions to correct understocked areas and achieve acceptable species composition and stocking rates for both *artificial* and *natural regeneration*.
3. *Minimized* plantings of *exotic tree species* and research documentation that *exotic tree species*, planted operationally, pose minimal risk.
4. Protection of desirable or planned advanced *natural regeneration* during harvest.
5. Artificial *reforestation programs* that consider potential ecological impacts of a different species or species mix from that which was harvested.

Performance Measure 2.2. *Program Participants* shall *minimize* chemical use required to achieve management objectives while protecting employees, neighbors, the public, and the forest environment.

Indicators:

1. *Minimized* chemical use required to achieve management objectives.
2. Use of *least-toxic* and *narrowest-spectrum*

pesticides necessary to achieve management objectives.
3. Use of pesticides registered for the intended use and applied in accordance with label requirements.
4. Use of *integrated pest management* where feasible.
5. Supervision of forest chemical applications by state-trained or certified applicators.
6. Use of *best management practices (BMPs)* appropriate to the situation; for example,
a. Notification of adjoining landowners or nearby residents concerning applications and chemicals used;
b. appropriate multilingual signs or oral warnings;
c. control of public road access during and immediately after applications;
d. designation of streamside and other needed buffer strips;
e. use of positive shutoff and minimal-drift spray valves;
f. aerial application of forest chemicals parallel to buffer zones to *minimize* drift;
g. monitoring of water quality or safeguards to ensure proper equipment use and *protection* of streams, lakes, and other water bodies;
i. appropriate storage of chemicals;
j. filing of required state reports; or
k. use of methods to ensure protection of *threatened and endangered* species.

Performance Measure 2.3. *Program Participants* shall implement management practices to protect and maintain forest and soil *productivity*.

Indicators:
1. Use of soils maps where available.
2. Process to identify soils vulnerable to compaction and use of appropriate methods to avoid excessive soil disturbance.
3. Use of erosion control measures to *minimize* the loss of soil and site *productivity*.
4. Post-harvest conditions conducive to maintaining site *productivity* (e.g., limited rutting, retained down woody debris, *minimized skid trails*).
5. Retention of vigorous trees during partial harvesting, consistent with silvicultural norms for the area.
6. Criteria that address harvesting and site preparation to protect soil *productivity*.
7. *Minimize* road construction to meet management objectives efficiently.

Performance Measure 2.4. *Program Participants* shall manage so as to protect forests from damaging agents, such as environmentally or economically undesirable wildfire, pests, and diseases, to maintain and improve long-term *forest health*, *productivity* and *economic viability*.

Indicators:
1. *Program* to protect forests from damaging agents.
2. Management to promote healthy and productive forest conditions to *minimize* susceptibility to damaging agents.
3. Participation in, and support of, fire and pest prevention and control *programs*.

Performance Measure 2.5. *Program Participants* that utilize *improved planting stock*, including trees derived through *biotechnology*, shall use sound scientific methods and follow all applicable laws and international protocols.

Indicator:
1. *Program* for appropriate research, testing, evaluation, and deployment of *improved planting stock*, including trees derived through *biotechnology*.

Objective 3. To protect water quality in streams, lakes, and other water bodies.

Performance Measure 3.1. *Program Participants* shall meet or exceed all applicable federal, provincial, state, and local water quality laws and meet or exceed *best management practices* developed under U.S. Environmental Protection Agency–approved state water quality programs or other federal, provincial, state, or local programs.

Indicators:
1. *Program* to implement state or provincial *BMPs* during all phases of management activities.
2. Contract provisions that specify BMP compliance.
3. Plans that address wet-weather events (e.g., *inventory* systems, wet-weather tracts, definitions of acceptable operating conditions).
4. Monitoring of overall *BMP* implementation.

Performance Measure 3.2. *Program Participants* shall have or develop, implement, and document *riparian protection* measures based on soil type, terrain, vegetation, and other applicable factors.

Indicators:

1. *Program* addressing management and *protection* of streams, lakes, and other water bodies and *riparian* zones.
2. Mapping of streams, lakes, and other water bodies as specified in state or provincial *BMPs* and, where appropriate, identification on the ground.
3. Implementation of plans to manage or protect streams, lakes, and other water bodies.
4. Identification and protection of *nonforested wetlands*, including bogs, fens, vernal pools, and marshes of significant size.
5. Where regulations or *BMPs* do not currently exist to protect riparian areas, use of experts to identify appropriate *protection* measures.

Objective 4.

To manage the quality and distribution of *wildlife habitats* and contribute to the *conservation of biological diversity* by developing and implementing *stand*- and *landscape*-level measures that promote *habitat* diversity and the *conservation* of forest plants and animals, including *aquatic fauna*.

Performance Measure 4.1. *Program Participants* shall have programs to promote *biological diversity* at *stand* and *landscape* levels.

Indicators:

1. *Program* to promote the *conservation* of native *biological diversity*, including species, *wildlife habitats*, and ecological or natural community types, at *stand* and *landscape* levels.
2. *Program* to protect *threatened and endangered* species.
3. Plans to locate and protect known sites associated with viable occurrences of *critically imperiled* and *imperiled* species and communities. Plans for *protection* may be developed independently or collaboratively and may include *Program Participant* management, cooperation with other stakeholders, or use of easements, *conservation* land sales, exchanges, or other *conservation* strategies.
4. Development and implementation of criteria, as guided by regionally appropriate science, for retention of *stand*-level *wildlife habitat* elements (e.g., snags, mast trees, down woody debris, den trees, nest trees).
5. Assessment, conducted individually or collaboratively, of forest cover types and *habitats* at the individual ownership level and, where credible data are available, across the *landscape*, and incorporation of findings into planning and management activities, where practical and when consistent with management objectives.
6. Support of and participation in plans or *programs* for the *conservation* of *old-growth forests* in the region of ownership.
7. Participation in *programs* and demonstration of activities as appropriate to limit the introduction, impact, and spread of invasive exotic plants and animals that directly threaten or are likely to threaten native plant and animal communities.
8. *Program* to incorporate the role of prescribed or natural fire where appropriate.

Performance Measure 4.2. *Program Participants* shall apply knowledge gained through research, science, technology, and field experience to manage *wildlife habitat* and contribute to the *conservation of biological diversity*.

Indicators:

1. Collection of information on *critically imperiled* and *imperiled* species and communities and other *biodiversity*-related data through forest *inventory* processes, mapping, or participation in external programs, such as NatureServe, state or provincial heritage programs, or other credible systems. Such participation may include providing nonproprietary scientific information, time, and assistance by staff, or in-kind or direct financial support.
2. A methodology to incorporate research results and field applications of *biodiversity* and ecosystem research into forest management decisions.

Objective 5.

To manage the visual impact of harvesting and other forest operations.

Performance Measure 5.1. *Program Participants* shall manage the impact of harvesting on *visual quality*.

Indicators:

1. *Program* to address *visual quality management*.

2. Incorporation of aesthetic considerations in harvesting, road, landing design and management, and other management activities where visual impacts are a concern.

Performance Measure 5.2. *Program Participants* shall manage the size, shape, and placement of clearcut harvests.

Indicators:

1. Average size of clearcut harvest areas does not exceed 120 acres, except when necessary to respond to *forest health* emergencies or other natural catastrophes.
2. Documentation through internal records of clearcut size and the process for calculating average size.

Performance Measure 5.3. *Program Participants* shall adopt a *green-up requirement* or alternative methods that provide for *visual quality*.

Indicators:

1. *Program* implementing the *green-up requirement* or alternative methods.
2. Harvest area tracking system to demonstrate compliance with the green-up requirement or alternative methods.
3. Trees in clearcut harvest areas are at least 3 years old or 5 feet high at the desired level of stocking before adjacent areas are clearcut, or as appropriate to address operational and economic considerations, alternative methods to reach the *performance measure* are utilized by the *Program Participant*.

Objective 6. To manage *Program Participant* lands that are ecologically, geologically, historically, or culturally important in a manner that recognizes their special qualities.

Performance Measure 6.1. *Program Participants* shall identify special sites and manage them in a manner appropriate for their unique features.

Indicators:

1. Use of existing natural heritage data and expert advice in identifying or selecting sites for *protection* because of their ecologically, geologically, historically, or *culturally important* qualities.
2. Appropriate mapping, cataloging, and management of identified special sites.

Objective 7. To promote the efficient use of forest resources.

Performance Measure 7.1. *Program Participants* shall employ appropriate forest harvesting technology and "in-woods" manufacturing processes and practices to *minimize* waste and ensure efficient utilization of harvested trees, where consistent with other SFI Standard *objectives*.

Indicator:

1. *Program* or monitoring system to ensure efficient utilization, which may include provisions to ensure
   a. landings left clean with little waste;
   b. residues distributed to add organic and nutrient value to future forests;
   c. training or incentives to encourage loggers to enhance utilization;
   d. cooperation with mill managers for better utilization of species and low-grade material;
   e. merchandizing of harvested material to ensure use for its most beneficial purpose;
   f. development of markets for underutilized species and low-grade wood;
   g. periodic inspections and reports noting utilization and product separation; or
   h. exploration of alternative markets (e.g., energy markets).

SFIS Objectives for Procurement

Objective 8. To broaden the practice of *sustainable forestry* through *procurement programs*.

<u>Procurement from sources within the United States and Canada (8.1–8.4 apply)</u>

Performance Measure 8.1. *Program Participants* shall encourage landowners to *reforest* following harvest, to use *BMPs*, and to identify and protect important habitat elements for *wildlife*, including *critically imperiled* and *imperiled* species and communities.

Indicator:

1. *Program* to supply regionally appropriate information or services to forest landowners, describing the importance and providing implementation guidance on
   a. *BMPs*;
   b. *reforestation*;
   c. *visual quality management*; and

d. *conservation* of critical *wildlife habitat* elements, *threatened and endangered* species, and *critically imperiled* and *imperiled* species and communities.

Performance Measure 8.2. *Program Participants* shall encourage landowners to utilize the services of *qualified resource professionals* and *qualified logging professionals* in applying principles of sustainable forest management on their lands.

Indicators:

1. *Program* to promote the use of *qualified resource professionals* and *qualified logging professionals.*
2. List of *qualified logging professionals* maintained by *Program Participant*, state agency, loggers' association, or other organization.

Performance Measure 8.3. *Program Participants* shall clearly define and implement policies to ensure that mill inventories and *procurement* activities do not compromise adherence to the principles of *sustainable forestry.*

Indicators:

1. *Program* for the purchase of raw material from *qualified logging professionals*, *wood producers*, and *other wood suppliers.*
2. *Program* to ensure that harvests of *purchased stumpage* comply with *BMPs.*
3. *Program* to address adverse weather conditions.

Performance Measure 8.4. *Program Participants* shall monitor the effectiveness of efforts to promote *reforestation* and *BMPs*, using public or private sources of information.

Indicators:

1. A *verifiable monitoring system* to
   a. evaluate the results of promoting *reforestation* across the *wood and fiber supply area*;
   b. monitor the use of *BMPs* by wood producers supplying the *Program Participant*; and
   c. *evaluate* the results of promotion and use of *BMPs* across the *wood and fiber supply area.*
2. Use of information from the *verifiable monitoring system* to set goals to improve, over time, rates of *BMP* compliance.

<u>Procurement by manufacturing facilities enrolled in the SFI Program from sources outside the United States and Canada (8.5 and 8.6 apply)</u>

Performance Measure 8.5 *Program Participants* shall ensure that their *procurement programs* support the principles of *sustainable forestry*, including efforts to thwart *illegal logging* and promote conservation of *biological diversity.*

Indicators:

1. Process to assess the risk that the *Program Participant's procurement program* could acquire material from *illegal logging.* This process may include relying on the adequacy of legal protections in the United States and Canada, where laws against domestic *illegal logging* are enforced.
2. *Program* to address any significant risk identified under 8.5.1.
3. *Procurement* from areas outside the United States and Canada promotes *conservation* of *biodiversity hotspots* and *major tropical wilderness areas.*
4. *Program* with *direct suppliers* to promote the principles of *sustainable forestry.*
5. Knowledge about *direct suppliers*' application of the principles of *sustainable forestry.*

Performance Measure 8.6. *Program Participants* shall encourage economically, environmentally, and socially sound practices.

Indicators:

1. Process to assess the risk that the *Program Participant's procurement* takes place in countries without effective laws addressing the following:
   a. workers' health and safety;
   b. fair labor practices;
   c. indigenous peoples' rights;
   d. antidiscrimination and antiharassment measures;
   e. prevailing wages; and
   f. workers' right to organize.

   This process may include relying on the adequacy of legal protections in countries, such as exist in the United States and Canada, where laws are effective because they are in place, are enforced for wood and fiber originating in those countries, and independent legal processes are available in the case of disputes.
2. *Program* to address any significant risk identified under 8.6.1.

SFIS Objective for Forestry Research, Science, and Technology

Objective 9. **To improve forestry research, science, and technology, upon which sound forest management decisions are based.**

Performance Measure 9.1 *Program Participants* shall individually, through cooperative efforts, or through associations provide in-kind support or funding, in addition to that generated through taxes, for forest research to improve the health, *productivity*, and management of forest resources.

Indicator:

1. Current financial or in-kind support of research to address questions of relevance in the region of operations. The research will include some or all of the following issues:
   a. *forest health*, *productivity*, and ecosystem functions;
   b. chemical efficiency, use rate, and *integrated pest management*;
   c. water quality;
   d. *wildlife* management at *stand* or *landscape* levels;
   e. *conservation* of *biological diversity*; and
   f. effectiveness of *BMPs*.

Performance Measure 9.2. *Program Participants* shall individually, through cooperative efforts, or through associations develop or use state, provincial, or regional analyses in support of their *sustainable forestry programs*.

Indicator:

1. Participation, individually or through cooperative efforts or associations at the state, provincial, or regional level, in the development or use of
   a. regeneration assessments;
   b. *growth-and-drain* assessments;
   c. *BMP* implementation and compliance; and
   d. *biodiversity conservation* information for family forest owners.

SFIS Objective for Training and Education

Objective 10. **To improve the practice of sustainable forest management by resource professionals, logging professionals, and contractors through appropriate training and education** ***programs*****.**

Performance Measure 10.1. *Program Participants* shall require appropriate training of personnel and contractors so that they are competent to fulfill their responsibilities under the SFI Standard.

Indicators:

1. Written statement of commitment to the SFI Standard communicated throughout the organization, particularly to mill and woodland managers, wood *procurement* staff, and field foresters.
2. Assignment and understanding of roles and responsibilities for achieving SFI Standard *objectives*.
3. Staff education and training sufficient to their roles and responsibilities.
4. Contractor education and training sufficient to their roles and responsibilities.

Performance Measure 10.2. *Program Participants* shall work closely with state logging or forestry associations, or appropriate agencies or others in the *forestry* community, to foster improvement in the professionalism of *wood producers*.

Indicator:

1. Participation in or support of *SFI Implementation Committees* to establish criteria and identify delivery mechanisms for *wood producers*' training courses that address
   a. awareness of *sustainable forestry principles* and the SFI Program;
   b. *BMPs*, including streamside management and road construction, maintenance, and retirement;
   c. regeneration, forest resource *conservation*, and aesthetics;
   d. awareness of responsibilities under the U.S. Endangered Species Act, the Canadian Species at Risk Act, and other measures to protect *wildlife habitat*;
   e. logging safety;
   f. U.S. Occupational Safety and Health Administration regulations, wage and hour

rules, and other employment laws;
g. transportation issues;
h. business management; and
i. public policy and outreach.

SFIS Objective for Legal and Regulatory Compliance

Objective 11. Commitment to comply with applicable federal, provincial, state, or local laws and regulations.

Performance Measure 11.1. *Program Participants* shall take appropriate steps to comply with applicable federal, provincial, state, and local forestry and related environmental laws and regulations.

Indicators:
1. Access to relevant laws and regulations in appropriate locations.
2. System to achieve compliance with applicable federal, provincial, state, or local laws and regulations.
3. Demonstration of commitment to legal compliance through *available regulatory action information*.
4. Adherence to all applicable federal, state, and provincial regulations and international protocols for research and deployment of trees derived from *improved planting stock* and *biotechnology*.

Performance Measure 11.2. *Program Participants* shall take appropriate steps to comply with all applicable social laws at the federal, provincial, state, and local levels in the country in which the *Program Participant* operates.

Indicator:
1. Written *policy* demonstrating commitment to comply with social laws, such as those covering civil rights, equal employment opportunities, antidiscrimination and antiharassment measures, workers' compensation, indigenous peoples' rights, workers' and communities' right to know, prevailing wages, workers' right to organize, and occupational health and safety.

SFIS Objective for Public and Landowner Involvement in the Practice of Sustainable Forestry

Objective 12. To broaden the practice of *sustainable forestry* by encouraging the public and forestry community to participate in the commitment to *sustainable forestry* and publicly report progress.

Performance Measure 12.1. *Program Participants* shall support and promote efforts by consulting foresters, state and federal agencies, state or local groups, professional societies, and the *American Tree Farm System®* and other landowner cooperative programs to apply principles of sustainable forest management.

Indicators:
1. Support for efforts of *SFI Implementation Committees*.
2. Support for the development and distribution of educational materials, including information packets for use with forest landowners.
3. Support for the development and distribution of regional or statewide information materials that provide landowners with practical approaches for addressing *biological diversity* issues, such as specific *wildlife habitat*, *critically imperiled* or *imperiled* species, and *threatened and endangered* species.
4. Participation in efforts to support or promote *conservation* of working forests through voluntary market-based incentive *programs* (e.g., current-use taxation programs, Forest Legacy, or conservation easements).
5. *Program Participants* are knowledgeable about credible regional *conservation* planning and priority-setting efforts that include a broad range of stakeholders. Consider the results of these efforts in planning where practical and consistent with management objectives.

Performance Measure 12.2 *Program Participants* shall support and promote, at the state, provincial or other appropriate levels, mechanisms for public outreach, education, and involvement related to forest management.

Indicators:
1. Support for the *SFI Implementation Committee* program to address outreach, education, and

technical assistance (e.g., toll-free numbers, public sector technical assistance programs).
2. Periodic educational opportunities promoting *sustainable forestry*, such as
   a. field tours, seminars, or workshops;
   b. educational trips;
   c. self-guided forest management trails; or
   d. publication of articles, educational pamphlets, or newsletters.
   e. Support for state, provincial, and local forestry organizations and soil and water *conservation* districts.
3. Recreation opportunities for the public, where consistent with forest management objectives.

Performance Measure 12.3. *Program Participants* with forest *management responsibilities on public lands* shall participate in the development of *public land* planning and management processes.

Indicators:
1. Involvement in *public land* planning and management activities with appropriate governmental entities and the public.
2. Appropriate contact with local stakeholders over forest management issues through state, provincial, federal, or independent collaboration.

Performance Measure 12.4. *Program Participants* with forest *management responsibilities on public lands* shall confer with affected indigenous peoples.

Indicator:
1. *Program* that includes communicating with affected indigenous peoples to enable *Program Participants* to
   a. understand and respect *traditional forest-related knowledge*;
   b. identify and protect spiritually, historically, or *culturally important* sites; and
   c. address the sustainable use of nontimber forest products of value to indigenous peoples in areas where *Program Participants* have *management responsibilities on public lands*.

Performance Measure 12.5. *Program Participants* shall establish, at the state, provincial, or other appropriate levels, procedures to address concerns raised by loggers, consulting foresters, employees, the public, or *Program Participants* regarding practices that appear inconsistent with the SFI Standard *principles* and *objectives*.

Indicators:
1. Support for *SFI Implementation Committee* efforts (toll-free numbers and other efforts) to address concerns about apparent nonconforming practices.
2. Process to receive and respond to public inquiries.

Performance Measure 12.6. *Program Participants* shall report annually to the SFI Program on their compliance with the SFI Standard.

Indicators:
1. Prompt response to the SFI annual progress report.
2. Recordkeeping for all the categories of information needed for SFI annual progress reports.
3. Maintenance of copies of past reports to document progress and improvements to demonstrate conformance to the SFI Standard.

SFIS Objective for Management Review and Continual Improvement

Objective 13. **To promote continual improvement in the practice of *sustainable forestry* and monitor, measure, and report performance in achieving the commitment to *sustainable forestry*.**

Performance Measure 13.1. *Program Participants* shall establish a management review system to examine findings and progress in implementing the SFI Standard, to make appropriate improvements in *programs*, and to inform their employees of changes.

Indicators:
1. System to review commitments, *programs*, and procedures to evaluate effectiveness.
2. System for collecting, reviewing, and reporting information to management regarding progress in achieving SFI Standard *objectives* and *performance measures*.
3. Annual review of progress by management and determination of changes and improvements necessary to continually improve SFI conformance.

DEFINITIONS

The following definitions apply to *italicized* words in the SFI Standard and the Audit Procedures and Qualifications.

afforestation: The establishment of a forest or *stand* in an area where the preceding vegetation or land use was not forest.

American Tree Farm System®: A national program that promotes the sustainable management of forests through education and outreach to private forest landowners.

aquatic fauna: Animals that live on or within water during some stage of their development.

aquatic habitat: An area where water is the principal medium and that provides the resources and environmental conditions to support occupancy, survival, and reproduction by individuals of a given species.

artificial regeneration: The establishment of a group or *stand* of young trees created by direct seeding or by planting seedlings or plantlets.

available regulatory action information: Statistics or regulatory compliance data collected by a federal, state, or local government agency. Note: Although conformance with laws is the intent, auditors are directed to look for a spirit and general record of compliance rather than isolated or unusual instances of deviation.

auditor: A person with the competence to conduct an audit (ISO 19011:2002, 3.8).

audit firm: A firm qualified to conduct a certification audit to the SFI Standard according to the standards of ISO 19011 and SFI APQ.

audit team: One or more *auditors* conducting an audit, supported if needed by *technical experts* (ISO 19011:2002, 3.9).

best management practices (BMPs): A practice or combination of practices that is determined by a federal, provincial, state, or local government or other responsible entity, after problem assessment, examination of alternative practices, and appropriate public participation, to be the most effective and practicable (including technological, economic, and institutional considerations) means of conducting a forest management operation while addressing any environmental considerations.

best scientific information: Available factual information that is generally accepted by the broad scientific community, including but not limited to peer-reviewed scientific information obtainable from any source, including government and nongovernmental sources, that has been verified by field testing to the maximum extent feasible.

biodiversity hotspots: A biogeographic conservation region with more than 1,500 endemic plant species and less than 30 percent of its historical extent. (See *Descriptions of Biodiversity Hotspots and Major Tropical Wilderness Areas with Guidance to SFI Program Participants on Their Relation to the SFIS*, available at www.aboutsfb.org.)

biological diversity, biodiversity: The variety and abundance of life forms, processes, functions, and structures of plants, animals, and other living organisms, including the relative complexity of species, communities, gene pools, and ecosystems at spatial scales that range from local to regional to global.

biotechnology: The application of biological engineering at the cellular and molecular level.

conservation: **1.** Protection of plant and animal habitat. **2.** The management of a renewable natural resource with the objective of sustaining its productivity in perpetuity while providing for human use compatible with sustainability of the resource.

critically imperiled: Globally extremely rare or, because of some factor(s), especially vulnerable to extinction. Typically, five or fewer occurrences or populations remain, or very few individuals (<1,000), acres (<2,000), or linear miles (<10) exist. Often referred to as G1. (See *Guidance Document for Biodiversity Hotspots, Major Tropical Wilderness Areas and Forests With Exceptional Conservation Value* available at www.aboutsfb.org.)

culturally important: Significant because of an association with indigenous peoples (e.g., Native Americans or First Nations).

degree: A professional academic degree (e.g., bachelor's) or equivalent.

direct supplier: A procurement source with whom a *Program Participant* has a direct contractual relationship.

economic viability: The economic incentive necessary to keep forest ownerships profitable and competitive and to keep people gainfully employed.

exotic tree species: A tree species introduced from outside its natural range, excluding species that have become "naturalized" in the area and have a naturally reproducing population. (Note: Hybrids of native species or native plants that have been derived from genetic tree improvement and biotechnology programs are not considered exotic species.)

first-party verification: Verification of an organization's performance conducted from within the organization by qualified individuals who are not accountable to those directly responsible for the subject matter being verified. Also called *self-verification.*

forest health: The perceived condition of a forest derived from concerns about such factors as its age, structure, composition, function, vigor, presence of unusual levels of insects or disease, and resilience to disturbance.

forestry: The profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and in a sustainable manner to meet desired goals, needs, and values.

forestry enterprise: A business engaged in the management of forestland, having its own functions and administration and comprising one or more operating units.

geographic information system (GIS): An organized collection of computer systems, personnel, knowledge, and procedures designed to capture, store, update, manipulate, analyze, report, and display forms of geographically referenced information and descriptive information.

green-up requirement: Previously clearcut harvest areas must have trees at least 3 years old or 5 feet high at the desired level of stocking before adjacent areas are clearcut.

growing stock: All the trees growing in a forest or in a specified part of it, meeting specified standards of size, quality and vigor, and generally expressed in terms of number or volume.

growth-and-yield model: A set of relationships, usually expressed as equations and embodied in a computer program or tables, that provides estimates of future stand development given initial stand conditions and a specified management regime.

growth and drain: The average annual net increase in the volume of trees during the period between inventories (including the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year) minus the net volume of *growing stock* trees removed from the *inventory* during a specified year by harvesting, cultural operations such as timber *stand* improvement, or land clearing. From Smith, W. Brad, Patrick D. Miles, John S. Vissage, and Scott A. Pugh. 2003. *Forest Resources of the United States*, 2002. General Technical Report NC-241. St. Paul, MN: USDA Forest Service, North Central Research Station.

habitat: **1.** A unit area of environment. **2.** The place, natural or otherwise (including climate, food, cover, and water) where an individual or population of animals or plants naturally or normally lives and develops.

illegal logging: Theft of timber or logs and cutting in parks, reserves, or other similar areas where otherwise precluded by law.

imperiled: A plant or animal or community, often referred to as G2, that is globally rare or, because of some factor(s), is very vulnerable to extinction or elimination. Typically, six to 20 occurrences, or few remaining individuals (1,000 to 3,000), or acres (2,000 to 10,000), or linear miles (10 to 50) exist. (See *Guidance Document for Biodiversity Hotspots, Major Tropical Wilderness Areas and Forests With Exceptional Conservation ValueI*, available at www.aboutsfb.org.)

improved planting stock: Products of tree improvement programs in which the parent trees were selected through Mendelian crosses for increased growth, pest resistance, or other desirable characteristics.

indicator: In the SFI Program, a specific metric, integral to conformance with the SFI Standard, that provides information about an organization's *forestry* and environmental performance and is used to assess conformance to the SFI Standard *objectives* and *performance measures.*

inventory: **1.** A set of objective sampling methods that quantify the spatial distribution, composition, and rates of change of forest parameters within specified levels of precision for management purposes. **2.** The listing of data from such a survey.

integrated pest management: The maintenance of destructive agents, including insects at tolerable levels, by the planned use of a variety of preventive, suppressive, or regulatory tactics and strategies that are ecologically and economically efficient and socially acceptable.

land classification: The process of generating and applying land strata that are sufficiently homogeneous in their physical, vegetative, and development attributes.

landscape: **1.** A spatial mosaic of several ecosystems, landforms, and plant communities across a defined area irrespective of ownership or other artificial boundaries and repeated in similar form throughout. **2.** An area of land characterized by

- similar biogeoclimatic conditions that influence site potential;
- similar historical disturbance regimes that influence vegetation structure and species composition; and
- sufficient size to provide the range of *habitat* conditions for naturally occurring communities (except for a few megafauna with large spatial needs, e.g. wolves).

lead auditor: An *auditor* appointed to lead an audit team. Also referred to as an *audit team* leader (ISO 19011:2002, 3.9, note 1).

least-toxic and narrowest-spectrum pesticide: A chemical preparation used to control site-specific pests that *minimizes* impact to nontarget organisms and causes the least impact to the site while meeting management objectives. The management objectives should consider the target pest, the degree of control needed, cost, and other issues, such as season and timing of application, rates and methods, terrain, forest conditions, and the presence or absence of water bodies.

licensee: A company, organization, or individual that participates in the SFI Program through a contractual agreement to abide by the SFI Standard *principles* and *objectives*. A licensee is one type of *Program Participant*.

major tropical wilderness areas: The world's largest-remaining tracts of tropical forest that are more than 75 percent intact. These areas are characterized by extraordinary biological richness, including exceptional concentrations of endemic species, and are also of crucial importance to climate regulation, watershed protection, and maintenance of traditional indigenous lifestyles. (See *Descriptions of Biodiversity Hotspots and Major Tropical Wilderness Areas with Guidance to SFI Program Participants on Their Relation to the SFIS*, available at www.aboutsfb.org.)

management responsibilities on public lands: Accountability for developing plans and translating public agencies' missions, goals, and objectives to an organized set of actions.

minimize: To do only that which is necessary and appropriate to accomplish the task or objective described.

major nonconformance: One or more of the SFIS *performance measures* or *indicators* has not been addressed or has not been implemented to the extent that a systematic failure of a *Program Participant's* SFI system to meet an SFI *objective*, *performance measure* or *indicator* occurs.

minor nonconformance: An isolated lapse in SFIS program implementation which does not indicate a systematic failure to consistently meet an SFI objective, performance measure or indicator.

natural regeneration: The establishment of a plant or a plant age class from natural seeding, sprouting, suckering, or layering.

nonforested wetland: A transitional area between aquatic and terrestrial ecosystems that does not support tree cover and is inundated or saturated for periods long enough to produce hydric soils and support hydrophytic vegetation.

objective: In the SFI Program, a fundamental goal of sustainable forest management as embodied in objectives 1–13 of the SFI Standard.

old-growth forests: A forested ecosystem distinguished by old trees and related structural attributes, such as tree size, down woody debris, canopy levels, and species composition. *Program Participants* should utilize a definition specific to their region and particular forest types.

other wood supplier: A person who infrequently supplies wood fiber on a small scale. Examples include farmers and small-scale land-clearing operators.

performance measure: In the SFI Program, a means of judging whether an *objective* has been fulfilled.

policy: A written statement of commitment to meet an *objective* or to implement a defined program or plan to achieve an *objective* or outcome.

principle: In the SFI Program, the vision and direction for sustainable forest management as embodied in principles 1–9 of the SFI Standard.

procurement: Acquisition of roundwood (sawlogs or pulpwood) and field-manufactured or primary-mill residual chips, pulp, and veneer to support a forest products manufacturing facility.

productivity: The inherent capacity of a particular site or ecosystem to produce a crop or tree stand, often measured in volume or height.

program: An organized system, process, or set of activities to achieve an *objective* or *performance measure*.

Program Participant: A member of AF&PA or a *licensee* of the SFI Program.

protection: Maintenance of the status or integrity, over the long-term, of identified attributes or values including management where appropriate and giving consideration to historical disturbance patterns, fire risk and forest health when determining appropriate conservation strategies.

public land: Land enrolled in the SFI Program that is owned or administratively managed by a government entity (federal, state, provincial, or local), excluding easements or other encumbrances held by a government entity on private land.

purchased stumpage: *Procurement* of roundwood directly from a landowner under a contractual agreement that gives the *Program Participant* the right and obligation to harvest the timber.

qualified logging professional: A person with specialized skills in timber harvesting gained through experience or formal training who has successfully completed *wood producer* training programs recognized by *SFI Implementation Committees* as meeting the spirit and intent of performance measure under Objective 8 of the SFI Standard.

qualified resource professional: A person who by training and experience can make forest management recommendations. Examples include foresters, soil scientists, hydrologists, forest engineers, forest ecologists, fishery and wildlife biologists or technically trained specialists in such fields.

reforestation: The reestablishment of forest cover either naturally or artificially.

riparian: Related to, living in, or located in conjunction with a wetland, on the bank of a river or stream or at the edge of a lake or tidewater.

secondary education: High school education, or equivalent, preceding a college or university *degree*.

second-party verification: Verification of an enterprise's performance conducted by an affiliated or interested group, such as a forest products trade association, another forestry enterprise, or a customer.

SFI certification: A systematic and documented verification process to obtain and evaluate evidence objectively to determine whether a *Program Participant's* SFI Program conforms to the SFI Standard.

SFI Implementation Committee: A state, provincial, or regional committee organized by SFI *Program Participants* to facilitate or manage the programs and alliances that support the growth of the SFI Program, including sustainable forest management.

silviculture: The art and science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

skid trail: A temporary path through the woods to transport felled trees or logs to a collection area for further transportation.

stand: A contiguous group of trees sufficiently uniform in age, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

sustainable forestry: To meet the needs of the present without compromising the ability of future generations to meet their own needs by practicing a land stewardship ethic that integrates *reforestation* and the managing, growing, nurturing, and harvesting of trees for useful products with the *conservation* of soil, air and water quality, *biological diversity*, *wildlife* and *aquatic habitat*, recreation, and aesthetics.

Sustainable Forestry Board (SFB): An independent multistakeholder body that manages the SFI Standard and its associated verification procedures and qualifies certification auditors.

Sustainable Forestry Initiative® Program: The structure, responsibilities, practices, procedures, processes, and time frames by which *Program Participants* implement, maintain, and improve sustainable forest management.

Sustainable Forestry Initiative Standard (SFIS): The *principles*, *policies*, *objectives*, *performance measures*, and *indicators* that detail specific requirements for *Program Participants*.

Sustainable Forestry Initiative Standard Audit Procedures and Qualifications (SFI APQ): The *principles* and guidelines that detail specific requirements to *Program Participants* and *auditors* for conducting audits to the SFI Standard.

technical expert: A person who provides specific knowledge or expertise to the *audit team* (ISO 19011 2002, 3.10).

third-party certification: An assessment of conformance to the SFI Standard conducted according to the standards of the SFI APQ and ISO 19011 by a qualified *audit firm*.

threatened and endangered: Listed under the U.S. Endangered Species Act or the Canadian Species at Risk Act and listed under applicable state or provincial laws requiring protection.

traditional forest-related knowledge: Forest-related knowledge owned and maintained by indigenous peoples as a result of their traditional use of or tenure on forestland.

verifiable monitoring system: A system capable of being audited by a third party that includes (a) a means to characterize the *Program Participant's wood and fiber supply area*, which may include sources certified to a standard that requires *reforestation* and compliance with *BMPs*; (b) a process to identify and use sources of available data (e.g., state monitoring programs, certification status of suppliers) in the use of *BMPs* and rates of *reforestation*; and (c) a method to assess supplier performance, if needed, to supplement available data.

visual quality: The seen aspects of both the land and the activities that occur upon it.

visual quality management: Minimization of the adverse visual effects of forest management activities.

wildlife: Marine and freshwater aquatic and terrestrial fauna.

wood and fiber supply area: The geographic area from which a *Program Participant* procures, over time, most of its wood and fiber from *wood producers.*

wood producer: A person or organization, including loggers and wood dealers, involved in harvesting or regularly supplying wood fiber directly from the forest for commercial purposes.

Reference documents: *Sustainable Forestry Initiative®: Program Overview, Governance and Historical Information, 2005-2009 Sustainable Forestry Initiative® Guidance Document*, and the *Summary of Changes in the 2005 2009 Sustainable Forestry Initiative® Standard*, can be found at www.aboutsfb.org.

SUSTAINABLE FORESTRY INITIATIVE

Audit Procedures and Qualifications (SFI APQ)

2005–2009 Standard

INDEX

INTRODUCTION

Audits for the Sustainable Forestry Initiative Standard® (SFI) should be conducted in accordance with the principles of auditing contained in the International Organization for Standardization (ISO) 19011:2002 guidelines for quality and/or environmental management systems auditing. ISO is a worldwide federation of national standards bodies. The preparation of International Standards is conducted by ISO technical committees. The ISO 19011 guidelines were prepared jointly by Technical Committee ISO/TC 176 for Quality Management and Quality Assurance, and Technical Committee ISO/TC 207 for Environmental Management.

The ISO 19011 guidelines provide direction for conducting management systems audit programs, conducting internal and external audits of management systems, and evaluating and determining competence of *auditors* for a broad range of potential users.

The SFI Audit Procedures and Qualifications (APQ) follow a format similar to that of the ISO 19011 guidelines in giving specific requirements to *Program Participants* and auditors for conducting audits to the SFI Standard. The Sustainable Forestry Board requires that all certification, recertification, or surveillance audits to the SFI Standard conducted by third parties follow the guidelines provided in ISO 19011 document and satisfy the SFI APQ requirements.

1. Scope

This SFI Audit Procedures and Qualifications document supports the International Standard ISO 19011:2002 Guidelines for quality and/or environmental management systems auditing by providing specific requirements to *Program Participants* and *auditors*. It is applicable to all forest management and wood *procurement* organizations when conducting *third-party certification*, recertification, or surveillance audits to the SFI Standard.

Program Participants may decide to seek *first-party verification* (to self-verify), seek second-party verification, or seek independent *third-party certification* of conformance with the SFI Standard requirements. Although this document addresses third-party audits, it may be used as guidance if a *Program Participant* decides to seek *first-* or *second-party verification*.

2. Normative Reference

Audit firms must follow International Standard ISO 19011:2002, *Guidelines for Quality and/or Environmental Management Systems Auditing*, in auditing to the SFI Standard.

3. Terms and Definitions

Definitions of terms can be found in the 2005–2009 edition of the Sustainable Forestry Initiative Standard.

4. Procedures for Implementing the Principles for SFI Auditing

An SFI *audit firm* shall have written procedures to determine how it will meet the principles of ethical conduct, fairness, professionalism, independence, and use of an evidence-based approach in conducting SFI audits. These procedures shall explicitly address *auditor* conflicts of interest and confidentiality in the audit process and be consistent with other authorities under which the *audit firm* operates.

To satisfy the requirements for independence and objectivity, an *auditor* shall ensure that the services it provides are free from conflict of interest and that all information gathered as part of these services is maintained in strict confidence. The *auditor* shall require all members of an *audit team* (including *technical experts*) to sign a confidentiality and nonconflict-of-interest statement. At a minimum, this statement shall include the following:

No person conducting work for and on behalf of an auditor shall accept, from any source, inducements for the purposes of assisting, favoring, hindering, or delaying any transactions between the Program Participant and the auditor. Any actual or potential conflict of interest identified by prospective audit team members shall be disclosed to the auditor. The auditor shall ensure that appropriate action is taken; e.g., a change of personnel for that particular task.

Typical examples of an actual or potential conflict of interest for a member of an SFI *audit team* include the following:

a. financial interest or involvement within the organization being audited;
b. previous employment and or consultancy by the organization being audited within the past three years or since the most recent certification or recertification audit; and
c. direct personal connections or relationships with persons within the organization being audited.

All information and documents, including working drafts and any reports, shall be considered confidential. *Auditors* shall not release any information or documents without the prior written permission of the *Program Participant*. *Auditors* shall conduct themselves in a professional and ethical manner.

Auditor and *audit team* members and their employers shall not participate in an appraisal or advise a potential purchaser or broker a purchase of property audited within the prior three years without the written permission of the audited party. *Auditors*, *audit team* members, and employers shall notify the audited party of participation in such activities after the three-year period immediately upon initiation of such activities for a period of at least 10 years following the audit.

Prior to engaging in an audit and the *Program Participant's* acceptance of the *audit team*, the *auditor* and *audit team* members shall disclose to the party requesting an audit any prior land appraisal or assessment work or land brokerage activity they or their employers conducted related to the property to be audited.

The *audit firm* also shall establish written procedures for implementing the requirements of its audit program as identified in Sections 5, 6, and 7 of the ISO 19011 and the SFI APQ.

5. SFI Audit Program Monitoring

The Sustainable Forestry Board (SFB) provides quality control of the *auditors* and audit procedures through annual peer review. SFB witnesses the execution of at least one certification or recertification audit for each approved *audit firm* each year. The objective of this witnessed audit is to ensure that the *audit firm* is conducting *SFI certification* audits in conformance with the ISO 19011 guidelines and the SFI APQ requirements. SFB has established written procedures for conducting witnessed audits in the field and communicates these to the *auditor* prior to the witnessed audit. *Audit firms* must provide SFB with the dates of all scheduled audits to facilitate peer review. If an *audit firm* does not conduct an audit in a given year, SFB shall prioritize that firm for witnessing of its next audit.

6. SFI Audit Activities

6.1. Initiating the SFI Audit

6.1.1. Prior Notification to SFB

Any organization seeking independent *third-party certification* or recertification to the SFI Standard shall notify the Sustainable Forestry Board a minimum of two weeks prior to undertaking the audit.

6.1.2. Objectives and Scope for SFI Audits

Audit *objectives* and scope are determined jointly by the *audit firm* and the *Program Participant*. The *audit firm* must ensure that the *objectives* and scope of the audit

a. meet the SFI Standard requirements;
b. set an appropriate geographic scale;
c. allow for accurate field determination of conformance for the entire operating unit; and
d. apply all relevant portions of the standard (*principles*, *policies*, *objectives*, *performance measures*, and *indicators*).

Two specific audit objectives shall be accomplished during *SFI certification* audits. An SFI audit shall

a. verify that the *Program Participant's* SFI Program is in conformance with SFI *objectives*, *performance measures*, and *indicators*, and any additional indicators that the *Program Participant* chooses and
b. verify whether the *Program Participant* has effectively implemented its SFI Standard program requirements on the ground.

6.1.3. Substitution and Modification of SFI

Program Participants, with consent of the *audit firm*, may substitute or modify *indicators* to address local conditions based on a thorough analysis and adequate justification to the audit firm, which is responsible for ensuring that revised indicators are consistent with the spirit and intent of the SFI Standard *performance measures* and *indicators*, and that changes are appropriate for the specific local conditions and circumstances and the *Program Participant's* scope of operation.

Additional indicators beyond those identified in the SFI Standard, if included by the *Program Participant*, shall be audited like all other *indicators*.

6.2. Determination of Conformance

The *audit firm* shall assess conformance to each element of the SFI Standard within the scope of the audit. SFI Standard elements are *objectives*, *performance measures*, and *indicators*.

A full and factual determination of findings is possible only when an adequate amount of evidence has been gathered.

Evidence shall be compiled by examination of operating procedures, study of materials relating to forestry practices, and on-the-ground examination of field performance, and through meetings with employees, contractors and other third parties (e.g., government agencies, community groups, conservation organizations), as appropriate, to determine conformance to the Standard.

The certification team must ensure that all sampling and measurement procedures are of high quality.

If a *major nonconformance* is found, a certificate of conformance shall not be issued until the *audit firm* verifies that corrective action approved by the *lead auditor* has been implemented. A revisit may be required to verify implementation of corrective action.

If a *minor nonconformance* is found, a certificate of conformance may be issued only after the *lead auditor* approves a corrective action plan that addresses the nonconformance within an agreed-upon period, not to exceed one year. Verification that the corrective action has been effectively implemented shall occur during the next surveillance audit.

6.3. The SFI Audit Report

The SFI audit report shall cover

a. the audit objectives, scope, time period, and audit plan;
b. identification of the *Program Participant* and *audit team* personnel;
c. a description of the audit process used;
d. documentation of the rationale for the substitution of modification of any *indicators*;
e. audit findings and conclusions;
f. a schedule for surveillance and recertification; and
g. the distribution and confidential nature of the audit report.

See Section 8, below, regarding the development and release of public reports.

6.4. Completing the SFI Audit

The effective date on the certificate of conformance shall be the date of the closing meeting (if there are no nonconformances) or the date when all corrective action plans for *minor nonconformances* have been approved by the *lead auditor* and corrective actions for all *major nonconformances* have been implemented.

6.5. Surveillance Audits

To ensure continued conformance to the SFI Standard, surveillance audits shall normally be annual, consistent with International Accreditation Forum Guidance on the Application of ISO/IEC Guide 66, and the interval shall not exceed 18 months.

If a *Program Participant* wishes to make a public statement on their *SFI certification*, surveillance audit reports shall be submitted to SFB. The content of these reports shall follow the requirements of Section 8.1, below.

6.6. Recertification

To maintain a current SFI certificate, *Program Participants* shall periodically recertify their SFI Programs. Recertification to the SFI Standard can be achieved in two ways as agreed to by the *Program Participant* and the *audit firm*.

6.6.1. Standard Recertification

Under the standard recertification approach, a full recertification audit against all of the SFI Standard *objectives*, *performance measures*, and *indicators* is required every five years.

6.6.2. Continuous Certification

Alternatively, surveillance audits may be used to complete the recertification if, over the five-year period, conformance with each SFI Standard *objective*, *performance measure*, and *indicator* is fully assessed as appropriate to the scope and scale of the certificate at least once during the five-year period.

7. Competence of SFI Audit Firms, Audit Teams, and Auditors

7.1. Qualifications of Audit Firms

Firms that conduct SFI audits must be environmental management system (EMS) registrars and accredited by the American National Standards Institute or the Standards Council of Canada.

7.2. Qualifications of Audit Teams

Audit teams shall have the knowledge and skills to conduct an audit in accordance with the principles of auditing. The *audit firm* shall select *audit team* members appropriate to the scope, scale, and geography of the audit. Additionally, at least one member of the *audit team* shall have knowledge of forestry operations in the region undergoing the audit, at least one member shall have knowledge of applicable laws and regulations, and at least one member shall be a professional forester as defined by the Society of American Foresters (SAF), the Canadian Institute of Forestry, or licensed or registered by the state(s) or province (s) in which the certification is conducted. For forest management audits, the *audit team* shall have expertise that includes plant and *wildlife* ecology, *silviculture*, forest modeling, forest operations, and hydrology. One specialist per discipline is not required to meet any of the above requirements.

7.3. Qualifications of Auditors

Audit team members shall have the education, formal training, and experience that promotes competency in and comprehension of

a. forestry operations as they relate to natural resource management, including *wildlife*, fisheries, recreation, etc.;
b. environmental regulation related to *forestry*;
c. international and domestic *sustainable forestry* management systems and performance standards; and
d. certification requirements related to the SFI.

All *auditors* shall have education, training and experience appropriate to their responsibilities on the *audit team*. At a minimum, *audit team* members shall have completed a *secondary education* or equivalent. *Audit team* members who do not have a professional *degree* in forestry or a closely related field shall have a minimum of five years' work experience. No more than two years of postsecondary education in pursuit of a professional degree can be credited against work experience.

Audit team members who have obtained a professional *degree* in *forestry* or a closely related field shall have a minimum of two years' relevant work experience.

The provisions of Table 1 in ISO 19011 shall not apply to SFI *auditors*.

7.4. Qualifications of Lead Auditors

Lead auditors who conduct *third-party certification* shall have the qualifications in Section 7.3, above, and shall be certified as an environmental management systems *lead auditor*, or equivalent, by a national accreditation body, such as the Registrar Accreditation Board or the Canadian Environmental Auditing Association.

The *lead auditor's* organization or firm shall be accredited to conduct ISO 14001 certifications by the American National Standards Institute or be listed by the Registrar Accreditation Board, or equivalent.

7.5. Maintenance and Improvement of Competence

All *audit team* members shall pursue ongoing personal and professional development in

a. forest management science and technology;
b. sustainable forest management systems and certification programs and standards;
c. understanding and interpretation of federal and state *forestry* and environmental laws and codes of practice; and
d. certification procedures, processes, and techniques, especially as these pertain to the SFI Standard.

An *auditor* who maintains *Certified Forester*, Registrar Accreditation Board, or Canadian Environmental Auditing Association certification, or equivalent, shall be considered to have fulfilled continuing education requirements.

Auditors shall maintain records documenting their hours of education, experience, and training and provide this information to SFB on request.

8. Public Communication and Claims

8.1. Preparing and Submitting a Public Report

A *Program Participant* that wishes to make any public claims or statements about its *SFI certification*, recertification, or surveillance audit shall provide a report to the SFB not less than two weeks before making the report public. The public report will be posted on the SFB website and available for public review.

The auditor shall work with the *Program Participant* to prepare the public report, which shall include, at a minimum,

a. a description of the audit process, objectives, and scope;
b. a description of substitute indicators, if any, used in the audit and a rationale for each;
c. the name of *Program Participant* that was audited, including its SFI representative;
d. a general description of the *Program Participant's* forestland and manufacturing operations included in the audit;
e. the name of the *audit firm* and *lead auditor* (names of the *audit team* members, including *technical experts* may be included at the discretion of the *audit team* and *Program Participant*);

f. the dates the certification was conducted and completed;
g. a summary of the findings, including general descriptions of any nonconformances and corrective action plans to address them, opportunities for improvement, and exceptional practices; and
h. the certification recommendation.

8.2. Public Claims

Any public communication by *Program Participants* shall be accurate and consistent with applicable law and requirements for SFI logo use.

Program Participants are encouraged to consult the U.S. Federal Trade Commission's guidelines on environmental claims in product advertising and communication and the guidelines on environmental labeling and advertising issued by the Fair Business Practices Branch of Industry Canada's Competition Bureau, as appropriate, and to seek additional information and direction from national accreditation bodies, national standards bodies and national, state and provincial consumer protection and competition laws.

9. Interpretations, Feedback, and Disputes and Appeals

9.1. Interpretations

From time to time, a formal process may be needed to interpret the SFI Standard and its supporting documents. As part of SFB's commitment to continual improvement of both the *SFI certification* process and the SFI Standard, such concerns shall be submitted promptly to the SFB Interpretations Committee at the SFB website, contact@aboutsfb.org. The SFB Interpretations Committee shall respond within 45 days of receipt.

It is neither the intent nor the responsibility of the SFB Interpretations Committee to resolve disputes arising through certification; nevertheless, the committee will provide opinions and direction to assist parties in answering interpretive questions. Through this process, the SFI Program shall maintain a record of opinions and concerns available to both *Program Participants* and *auditors* to assist with certification planning. SFB shall periodically review this record and, where appropriate, recommend changes for inclusion in the SFI Standard or SFI APQ.

9.2. Disputes or Appeals between an Auditor and a Program Participant

Auditors shall have an internal dispute resolution process. Resolution of all disputes between an *auditor* and a *Program Participant* shall be addressed via these mechanisms.

9.3. Disputes or Appeals between an External Party and a Program Participant

9.3.1. Disputes or Appeals Regarding a Single Instance or Claim of Nonconformance

Any party with information or claims about a *Program Participant's* individual practices that may be in nonconformance may seek to have those claims investigated.

The complainant shall present specific claims of nonconformance in writing and in sufficient detail to the *Program Participant*. Within 45 days of receipt of the complaint, the *Program Participant* shall respond to the complainant and forward a copy of the complaint and its response to the *Program Participant's auditor* for future review via surveillance or certification audits. The *auditor* shall investigate the validity of the complaint and the *Program Participant's* response and resolution of the claim at the time of the next scheduled surveillance audit.

A complainant who believes the issue has not been satisfactorily resolved may provide its original documentation and the response from the *Program Participant* to the appropriate *SFI Implementation Committee* Inconsistent Practices Program, which shall investigate and respond to the allegations within 45 days of receipt of documentation. If no appropriate *SFI Implementation Committee* Inconsistent Practices Program exists, the complainant may address the issue to the SFI National Inconsistent Practices office via the External Review Panel Secretariat. The *SFI Implementation Committee* or National Inconsistent Practices Program shall provide copies of its findings and any recommended actions to both the *Program Participant* and the complainant.

9.3.2. Disputes or Appeals Questioning the Validity of a Certification

Any party with information or claims that question the validity of an entire certification may seek to have those claims investigated.

The complainant shall document the specific claims of nonconformance in writing and in sufficient detail to the *Program Participant*. Within 45 days of receipt of the complaint, the *Program Participant* shall respond to the complainant in writing and forward a copy of the complaint and its response to the *Program Participant's auditor* for future review via surveillance or certification audits.

A complainant who believes the issue has not been satisfactorily resolved may provide its original documentation and the response from the *Program Participant* to the SFB President for review and consideration by the SFB Certification Appeals Subcommittee, which shall immediately appoint an ad hoc member with appropriate *forestry* expertise. Upon reviewing the information, the SFB Certification Appeals Subcommittee may

a. declare the claim invalid, thus closing the review;
b. seek more information from the complainant or the *Program Participant*; or
c. if, in the view of the SFB Certification Appeals Subcommittee, there is sufficient evidence, if confirmed, to threaten the validity of the certification, refer the case to SFB for possible resolution by an ad hoc certification review task force comprising, at a minimum,
   i. one representative from the certification auditing profession;
   ii. one representative from the professional *forestry* community with expertise and knowledge of forest conditions and practice in the region; and
   iii. one representative from the environmental nongovernmental organization community.

The above representatives may, where appropriate, be drawn from the External Review Panel and SFB, with such representation limited to a single individual from each body. The ad hoc certification review task force shall review all relevant information and if necessary conduct a field visit. Upon review, the task force may

a. find that the case is without merit and no further action is required;
b. find that corrective actions are necessary; or
c. if the *Program Participant* fails to take appropriate corrective measures or if no action would be sufficient to remedy the situation, suspend certification.

SUSTAINABLE FORESTRY INITIATIVE

Great Trinity Forest Management Plan

Sustainable Forestry Initiative and Best Management Practices

15 Federally Mandated BMPs For Roads

15 Federally Mandated BMPs For Roads

1. Permanent roads, temporary access roads, and skid trails in waters of the U.S. shall 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, shall 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 shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows.
4. The fill shall 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 shall 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. shall be kept to a minimum.
7. The design, construction, and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
8. Borrow material shall be taken from upland sources whenever feasible.
9. The discharge shall 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 shall be avoided if practical alternatives exist.
11. The discharge shall not be located in the proximity of a public water supply intake.
12. The discharge shall not occur in areas of concentrated shellfish population.
13. The discharge shall not occur in a component of the National Wild and Scenic River System.
14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts.
15. All temporary fills shall be removed in their entirety and the area restored to its original elevation.

Great Trinity Forest Management Plan

Sustainable Forestry Initiative and Best Management Practices

Managing Forests for Water Quality: Forest Roads

Utah Forest Facts

EXTENSION
UtahState
UNIVERSITY

Rural/Conservation Forestry (pr) NR/FF/010

Managing Forests for Water Quality: Forest Roads

Barbara Daniels, Darren McAvoy, Mike Kuhns, Ron Gropp

> *This fact sheet discusses forest roads as they relate to water quality. Road planning, construction, use, maintenance and removal are covered.*

Forest Roads and Water Quality

Access to privately owned forest land is necessary for many reasons: forest management activities such as site preparation, planting, and harvesting; recreational activities such as hunting, fishing, hiking and camping; fire suppression; and access to home or cabin sites.

Water quality in forested areas can be impacted by many of these activities, including logging, fires, other construction, recreation, and grazing. However, poorly located, constructed or maintained forest roads are the largest source of non-point source pollution on forested lands. The greatest potential for degrading water quality comes from roads on steep slopes or erodible soils, and stream crossings. Research has shown that 90 percent of the sediment that ends up in our nation's waters from forested lands is associated with improperly designed and maintained roads. Sediment in streams leads to a number of problems for fish populations including siltation of spawning beds and aquatic insect habitat, increased water temperature and reduced oxygen.

Water quality of streams, lakes and wetlands can be protected by starting with appropriately locating roads, followed by careful design and construction. Proper planning can help landowners reduce the number, width and length of roads, decrease maintenance requirements and limit visual and physical impacts to the land. Reducing the miles and width of road constructed also shortens construction time and saves money.

This forest road is located well away from water. Its gravel surface promotes drainage and lessens erosion. The road is crowned, so water drains away to both sides.

Road Planning

When determining the need for a road, think *minimize*. Every road constructed, no matter how carefully, will contribute to soil erosion and potential stream sedimentation. Therefore, the road system planned for a parcel of land should be the least amount necessary to accomplish the landowner's goals. When planning, consider the entire site and possible future needs, since a well-placed and constructed road now may prevent the need for less well-planned spurs later.

Sometimes existing roads can be used. Upgrading an existing road may be less costly and damaging than constructing a new road. Any roads already present should be evaluated to determine if they are properly located for long-term needs, have adequate drainage, are suited for expected uses and are properly maintained. Many times, however, existing roads are in poorly chosen locations. Roads may closely parallel streams, have little or no vegetation between the road bank and stream or go straight up a draw or gully. Such roads probably should be moved or obliterated.

In the initial planning stages the type, location and design of any road should be based on:

1. *Future uses of the road*. How heavily will the road be traveled? What types of vehicles will use the road (logging trucks and/or passenger vehicles)? During which seasons will the road be used? Is the planned use temporary or long-term?

2. *Site specifics.* Consider soil types, slopes, geology, vegetation and runoff. Will storm runoff and/or flash flooding be a concern?

3. *Coordination with adjacent landowners.* Will this road connect to a county, state, or Forest Service road? If so, contact them to see if a permit is necessary.

4. *Use of temporary roads whenever possible.* A road used for one year or season can have a much smaller impact on local water quality than a permanent road.

Recommended Road Planning Practices

- Locate roads on well-drained soils whenever possible. Avoid wetlands, seeps and other wet areas. Plan now for drainage features (see "Dealing with Drainage" page).
- Avoid unstable slopes (look for slumps, uneven topography, pistol-butted or J-shaped trees, dips, cracks or previous slides).
- Minimize the number of stream crossings. Identify optimum stream crossing locations first, and then locate roads to accommodate these crossings. (See *Utah Forest Facts #9, Managing Forests for Water Quality: Stream Crossings.*)
- Locate roads outside of streamside management zones. (See *Utah Forest Facts #8, Managing Forests for Water Quality: Streamside Management Zones.*)
- Locate roads to follow natural contours as much as possible. Minimizing cuts and fills will reduce the need for additional fill material or removal of excess material, while decreasing the disturbed area that needs to be revegetated.
- Keep road grades below 10 percent if possible. Roads may exceed 10 percent for short distances but will need drainage features and extra measures to prevent erosion.

Permits May Be Required

Road construction on private lands in Utah may require one or more types of permits, depending on impacts on streams and wetlands. Check with the sources below to determine if you need any of these permits.

Streambank Alteration Permit or Wetlands Individual Permit: Construction of a stream crossing may require a Streambank Alteration Permit. If your road will cross a wetland, you may need a US Army Corps of Engineers Individual Permit. Contact the Utah Division of Water Rights at 801-538-7375, or visit http://waterrights.utah.gov/strmalt/ for more information on both of these permits.

Stormwater Permit: Any construction project greater or equal to 1 acre requires a stormwater permit. Contact the Utah Department of Water Quality at 801-538-6146, or visit http://waterquality.utah.gov/updes/stormwater.htm.

Road Construction

Soil excavation, movement and compaction associated with road construction involves a high risk of soil erosion and stream sedimentation. Follow the guidelines below to minimize those risks. At all times, the goal is to keep soil and other construction materials out of streams and wet areas.

Recommended Road Construction Practices

- Become familiar with the terrain by using topographic maps or aerial photographs and repeatedly walking the proposed road location. Use flagging to designate the road location.
- Avoid construction activities when ground is wet or frozen.
- Install erosion control measures such as hay bales or silt fences as needed. Remove when proper drainage features are in place.
- Construct roads in a manner that prevents debris, overburden and excess materials from entering streams. Deposit excess materials outside of streamside management zones.
- Compact all road fill material. Do not use snow, ice, frozen soil or woody debris as these will eventually melt or rot, causing voids that lead to road failure.
- Install road drainage at time of construction.
- Surface long term or permanent roads. Surface treatments include gravel, chipseal or pavement. On temporary roads, surfacing highly erodible areas (switch backs, steep grades, stream crossings) will reduce erosion.
- Maintain live trees and/or slash rows at the base of fill slopes to filter sediments.
- Avoid leaving berms that may channel water down the road.
- Reseed disturbed areas as soon as possible.

Cuts and Fills – Avoid if Possible

When building a road in steep terrain, it is usually necessary to cut into the hillside to create a flat road surface. The excess material excavated often becomes fill on the downhill side. Cuts and fills can create significant visual scars, are expensive to build and maintain, and should be avoided wherever practical. Both cut and fill slopes should be left no steeper than the angle of repose (the maximum angle that soil or rock will remain on a hillside without sloughing over time). Outslope the road, or construct a ditch along the uphill side and install a cross culvert for drainage.

When slope steepness is less than 50 percent, the material excavated in the cut can be used as fill for the outer portion of road; this is known as the side-cast method. Leave vegetation at the bottom of the fill slope to help stabilize the fill.

If the slope steepness exceeds 50 percent, do not use the side-cast method. Any material excavated for the cut should be hauled away and deposited outside of wet areas and streamside management zones.

Road Surface Drainage

Shape the road surface to divert water off of the road. Three options for road shaping are shown below.

Crowned Road
- *Drains from center to each side.*
- *Use in poorly drained soils, or with heavily traveled roads.*

Out-sloped Road
- *Drains to downhill side.*
- *Use on moderate slopes, stable soils.*
- *Do not out-slope directly into streams.*

In-sloped Road
- *Slopes into uphill side.*
- *Drainage ditch along uphill side.*
- *Use in steep terrain or side slope.*

Dealing with Drainage

The most effective method for controlling erosion on forest roads is to keep water from accumulating on and running down the road surface. Water should be diverted from the road surface and dispersed into vegetation and ground litter with cross culverts, rolling dips, diversion ditches and water bars.

Cross Culvert

Cross culverts should be installed to drain water from either the in-slope road ditch or from natural water sources such as seeps or small springs. Size the cross culvert to adequately handle peak runoff and flood waters. Skew the culvert 15 to 30 degrees toward the inflow ditch to optimize inlet efficiency and reduce maintenance. Protect the upstream end from plugging by armoring with rock, or use a box or screen. If possible, install the culvert at the gradient of the original ground slope. If not, armor the outlet with rocks, logs or other material to dissipate the energy of the emerging water. Never allow the culvert to drain directly into a stream.

Rolling Dip

A rolling dip is a long hump, followed by a long dip, constructed in the road bed to divert water off the road. A proper dip is deep enough to provide adequate drainage and wide and long enough for trucks and equipment to pass safely. The rolling dip is placed at an angle to the direction of the road for ease of travel. The bottom of the dip is sloped to the outside to carry water away from the road. Rolling dips are best suited to road grades of 10 percent or less and each dip should be spread out over a minimum of 150 feet.

Diversion Ditch

A diversion or spreader ditch diverts water from the road into adjacent vegetation. Decreasing the velocity and spreading out the stream of water will allow sediment to settle out and water to be absorbed into the ground. Grade diversion ditches on a 2 to 3 percent slope to allow drainage. These ditches work particularly well when used in with a rolling dip, but can also work with an inside ditch or a cross culvert. A diversion ditch is the least expensive water diversion device.

Water Bar

Water bars are best suited for use on roads that receive little or no use for an extended period of time. To construct a water bar, excavate a trough 1 to 2 feet deep by 3 to 4 feet wide at an angle of 30 to 45 degrees across the road. Connect the uphill end of the water bar to the upper bank of the road. The downhill outlet should allow water to be directed into nearby vegetation. Because water bars are easily ruined when subjected to heavy traffic, minimize road use. Seed and fertilize the water bar to reduce erosion.

Road Use and Maintenance

Once road construction is complete, sensible use and maintenance will help prevent additional erosion. One of the most important aspects of road maintenance is keeping ditches and culverts operational and free of debris. Ditches on newly constructed roads may require frequent cleaning and checking after each major storm until vegetation has been established. Grading to maintain road shape and drainage also is important.

Recommended Use and Maintenance Practices

- Avoid travel during wet conditions if practical.
- If a wet spot develops on a road, do not increase the problem by driving around it, thereby widening the wet spot. Instead, lay geotextile material over the area, followed by a 4 to 6 inch layer of gravel, to allow drainage.

Geotextile is being used to strengthen this road through a wet area. Rock is laid on the wet surface, followed by geotextile and gravel on top.

- Clean culverts and ditches blocked by debris.
- Maintain water bars and rolling dips.
- Avoid undercutting the toe of cut slopes when grading roads or clearing ditches.
- Leave grass in the ditch unless it has filled with sediment and is no longer functioning.
- Grade roads only as often as needed to maintain a stable road surface and to maintain proper surface drainage. Unnecessary grading creates a source of sediment from the newly disturbed surface.
- When grading, avoid leaving berms that channel water down the road.
- Reduce dust by applying water, rock, or other appropriate road treatments.
- Close all roads that are unstable, erodible or unnecessary.

Winter Use and Maintenance

Winter provides an opportunity to conduct harvest operations in areas that might be sensitive during warmer, drier times. For example, wetlands and other wet areas can be accessed with less damage when covered by frozen snow pack. If properly maintained during winter months, road usage can extend harvest season without creating excessive impacts. Some recommendations for winter operation are:

- Remove snow from roads initially, to allow deep freezing which will increase stability of the road base.
- After roads have frozen solidly, keep 2 to 3 inches of packed snow on the road to insulate the frozen road base.
- Locate and mark existing culverts so they will be visible in deep snow and storm conditions.
- Keep all drainages open and culverts unplugged.
- Plow away snow berms or provide breaks in snow berms to allow road drainage, particularly as spring thaw occurs.
- During times of alternating freezing and thawing, suspend road use if deeply frozen road base begins to thaw.
- If ice bridges have been built to provide temporary stream crossings in winter, they must be removed prior to spring runoff.

Road Closure

When harvest and other forest management activities are concluded, the future need for the road system-should be evaluated. If not needed, many roads can be closed, either temporarily or permanently, when management operations cease. Closing and rehabilitating roads can do much to prevent lake and stream sedimentation.

Recommended Road Closure Practices

- If closure is permanent, remove culverts and replace with water bars or rolling dips.
- Remove stream crossing structures. Stream courses and other drainages should be restored to their natural channels.
- Roads should be ripped or loosened so vegetation can grow. If natural revegetation is inadequate, plant with appropriate local species.
- If possible and appropriate, re-contour the road-bed to the original slope of the land.
- Barricade roads with logs, rocks, vandal-proof gates, or tank traps (very deep water bars) to prevent or control use by vehicles while revegetation occurs.
- If closure is temporary, do not remove drainage structures. Periodically inspect the road and drainage structures to ensure drainage is maintained.

Rocks and logs have been placed to block access to this closed road.

This road has been ripped and seeded, and access blocked with logs.

Forest Water Quality Guidelines

Utah's Forest Water Quality Guidelines (FWQGs) are a collection of voluntary, field-applicable practices for use during forestry activities to protect soil and water resources. They are designed to minimize non-point source pollution such as sedimentation and erosion associated with forestry activities. For more information about the FWQGs and their application, contact your local Forestry, Fire and State Lands area office. A technical guide of the FWQGs is on the Utah State University Forestry Extension website at: http://extension.usu.edu/forestry/management/MA_BMPs.htm.

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Great Trinity Forest Management Plan

Sustainable Forestry Initiative and Best Management Practices

Forest Road Construction and Maintenance

Forest Road Construction and Maintenance

CONTENTS

2 Forest Roads

FIGURES

TABLES

REMEMBER:

Guidelines help with *how* to manage, not *whether* to manage.

These guidelines focus on **how** to protect the functions and values of forest resources during forest management activities. They **do not** provide advice on **whether** to manage or **which** management activities are needed.

Guidelines provide a *menu*, not a *mandate.*

Site-level resource management decisions are based on many different factors, including resource needs, landowner objectives, site capabilities, existing regulations, economics and the best information available at any given time. **No one will apply all of the guidelines** related to a particular activity. Instead, the landowner, resource manager or logger will consider many different factors in determining which combination of guidelines provides the best "fit" for a particular site at a particular time. The intent of having multiple guidelines is to provide decision-makers with as much flexibility—and as much choice—as possible in taking steps to effectively balance forest management needs and resource sustainability.

General guidelines and *activity-specific* guidelines are closely related.

Frequent references from activity-specific guidelines back to the general guidelines will make it easy for landowners, resource managers, loggers and others to consider all of the related guidelines—both general and specific—that apply to a particular management activity.

Guidelines are supplemented from time to time by "Additional Considerations."

The guidelines are supplemented from time to time by "Additional Considerations," which provide additional guidance to further promote the sustainability of forest resources.

INTRODUCTION

Forest roads connect the most remote parts of the forest to existing township, county and state roads and highways, providing access to forest lands for timber management, fish and wildlife habitat improvement, fire control, hunting and a variety of recreational activities. For the purpose of these guidelines, road construction includes excavation of gravel quarries and borrow pits.

Permanent roads are intended for long-term use. They include all-season roads and seasonal roads.

- **All-season roads** are designed for use all year long, though there may be some restrictions on vehicle weight at times during spring breakup or wet periods. There is a great range in design standards and road surfacing in this type of road, depending on the traffic load anticipated.

- **Seasonal roads** are designed for long-term periodic use, such as during dry and frozen periods. These roads are built to lower engineering standards and have minimal material surfacing.

Temporary roads are generally minimum-standard roads designed for short-term use during a specific project, such as a timber harvest. Many of these temporary roads are little more than a bladed lane pushed into the harvest site. Use of these roads is typically limited to dry or frozen conditions to minimize rutting and compaction. See Figure ROAD-1.

The Benefits of Guidelines

Benefits to cultural resources: Forest road construction guidelines can minimize the potential effects of road building and maintenance activities on cultural resources that can result from removing or altering natural soils that contain cultural deposits, damaging features of archaeological sites or cemeteries, and destabilizing historic buildings and structures.

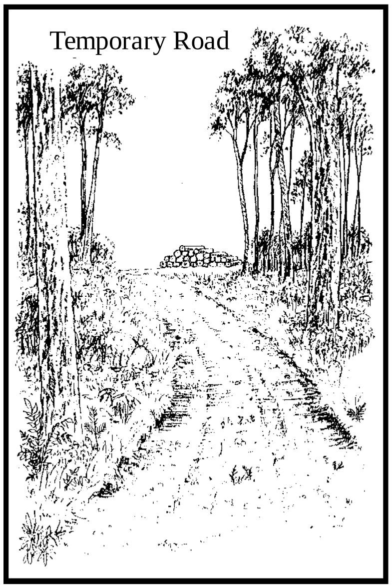


Figure ROAD-1

Guidelines for earth-moving activities, excavation of borrow areas, and practices that cause soil disturbance or erosion can help protect cultural resources, and guidelines for controlling accesses into formerly remote areas can reduce the potential for deliberate vandalism of sensitive sites.

Benefits to forest soils: Forest road construction guidelines support the development of a safe and efficient access system that services many acres with as few roads as possible while impacting the smallest percentage of the site necessary. Guidelines address compaction, erosion and indirect impacts to surrounding soils caused by disruption to water flows and sedimentation.

Benefits to riparian areas: Forest road construction guidelines can minimize alterations of vegetation within the riparian area. That vegetation is important for providing inputs of coarse woody debris and fine litter to water bodies; retaining nutrients, sediment and energy; bank and shoreline stabilization; maintenance of moderate water temperatures through shading; and wildlife habitat. Guidelines for retaining vegetation can also have a positive impact on aesthetics, wood products and recreation.

Benefits to visual quality: Forest road construction guidelines can reduce the visual impacts associated with poor design, construction and maintenance of forest roads. Guidelines can also reduce noise and unsightliness related to gravel pits.

Benefits to water quality and wetlands: Forest road construction guidelines can protect water quality and wetlands, particularly in areas having steep slopes with erodible soils, and in areas where forest roads are located near water or wetlands. Guidelines can also help to maintain natural flow patterns across the landscape, avoid concentration of water flows, and minimize sedimentation to water bodies and wetlands. Guidelines for the use of fuels and lubricants can protect water quality and wetlands from the toxic effects of potential spills. Guidelines that address equipment operations and maintenance can help protect water quality.

Benefits to wildlife habitat: Forest road construction guidelines suggest management approaches that help protect sensitive sites, rare species, water features and unique habitats in forests. Guidelines for controlling access into remote areas can minimize human activity that may be detrimental to some forest wildlife species.

Considerations

A well-planned access system is a sound method of reducing erosion and sedimentation in areas requiring frequent or temporary access. Proper location and construction of roads will provide for safety, longer operating periods, lower maintenance and operating costs, and minimal impacts to forest resources. Servicing as many acres of forest with as few roads as possible is a sound method of reducing impacts to forest resources from road construction.

Factors in decision-making

❒ **The number, size and design of forest access roads** will be influenced by the frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns.

❒ **Distribution of necessary management activities** will affect the number and location of access roads.

Crowned Road Cross-Section

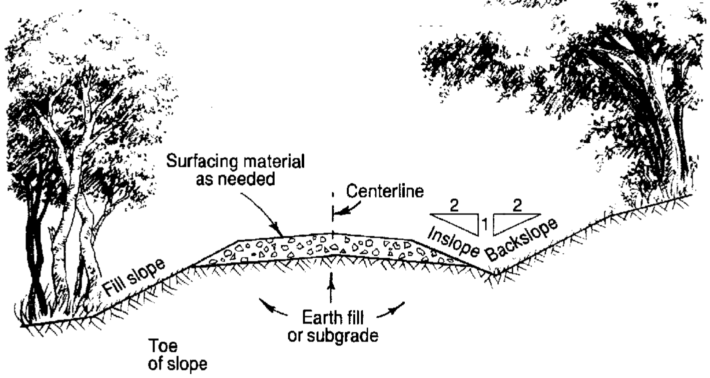


Figure ROAD-2

❒ **Choices regarding road construction standards** and maintenance activities will be influenced by site characteristics and the value of the resources served. Culverts and ditches may be necessary with any road construction technique. See Figure ROAD-2.

❒ **Surfacing can be the major cost of low-volume road construction.** Alternatives should be evaluated according to expected use and potential impact on sediment load. Where grades make the potential for surface erosion significant, the road should be surfaced with materials that will minimize potential water quality and soil productivity impacts (such as crushed rock, compacted gravel, sod or asphalt).

❒ **Visual impacts and the concentration of forest management activities** can result from poor design, construction and maintenance of forest access roads. Take into account the following considerations when planning to reduce noise and visual impacts associated with the design and use of forest access roads:

- Noise from traffic, especially large trucks, buses and heavy equipment operating on access roads

- Potential increased costs of building forest access roads to accommodate visual quality concerns, and potential increased costs of using existing roads that require traveling greater distances

• The limited road construction season that generally coincides with the tourist season

• Traffic during wet periods that can increase maintenance needs and create unsightly ruts and mudholes

❒ Visual impacts and noise impacts created by gravel pits are not compatible with recreational user sensitivities. Take into account the following considerations when planning to reduce noise and unsightliness related to gravel pits:

• Local sources of gravel are necessary for efficient, cost-effective road building and maintenance.

• Recreational use of gravel pits may cause conflicts.

❒ Site-specific soil, topographic and forest inventory information will assist resource managers or landowners in planning road location and layout. For information and assistance, see *Resource Directory.*

Minimizing impacts from roads

❒ Because roads take soils out of production, effort should be made to keep the length and width of roads to a minimum without sacrificing safety.

❒ To minimize road mileage and reduce costs, coordination with adjacent landowners may be desirable.

❒ The greatest potential for soil erosion occurs immediately after construction. Disturbed areas should be shaped and stabilized as soon as possible to minimize erosion potential.

Maintenance needs

❒ The purpose of maintenance procedures is to ensure that measures taken to minimize impacts on forest resources are working and will continue to work for the life of the road. Surfacing materials and the amount of use will determine the level of maintenance required.

❒ **Roads that are open for use require more maintenance** than roads that are closed to vehicular traffic. Inactive roads (roads currently not in use), whether closed temporarily or permanently, require occasional work to reduce potential impacts on streams, lakes, wetlands and seasonal ponds.

❒ **Road layout, construction methods and erosion and access control** all contribute to the longevity, utility, safety and maintenance costs of road systems.

Protecting water quality and water flow

❒ **Incorporating guidelines to protect water quality** into overall road project design can minimize the potential impact of wetland roads on water quality, as well as alterations to normal water flow patterns.

❒ **Effective road construction techniques** minimize the disturbance to the natural flow of water over the landscape and ensure the structural integrity of the road embankment.

The goal is to provide a simple road structure of adequate strength to support heavy vehicle traffic and provide drainage structures to pass water at its normal level through the road corridor.

Design Outcomes To Maintain Soil Productivity

To protect soil productivity, the design, construction and maintenance of forest roads should achieve the following beneficial outcomes:

- A well-planned road system that efficiently accesses as many acres as possible with the least amount of site occupied over the long term, with no more than 1-2% of the management area occupied by roads

- A road system built to adequate specifications for the season, duration and level of use
- Proper location and construction of roads that provide for safety, longer operating periods, and lower maintenance and operating costs
- Road surfaces, ditches and bare soil areas stabilized from future erosion, with soil erosion control structures properly installed, functional and in good condition

UPLAND FOREST ROADS

, Have you identified your goals and objectives?

See *Identifying Goals and Objectives* in General Guidelines.

, Have you conducted a site inventory?

See *Conducting a Site Inventory* in General Guidelines.

Design of Upland Forest Roads

IMPORTANT! Review General Guidelines:

- Incorporating Sustainability into Forest Management Plans
- Maintaining Filter Strips
- Managing Riparian Areas

Landowners may need the services of a forester, engineer or other qualified individual to provide complete design and construction specifications. This professional assistance is particularly important when constructing permanent all-season roads. For sources of professional assistance, see *Resource Directory*.

Design Considerations

- **Examine existing access routes** to determine whether they are the best routes to improve. Consider whether relocation would provide a better long-term access route.
- **Consider future management activities** that may utilize common roads for adjacent stands or ownerships.
- **Minimize total road mileage and ground disturbance** required to meet landowner objectives.
- **Plan to limit the area disturbed by roads** to less than 1-2% of the management area (defined as the specific site where activities are taking place). Slightly different percentage goals may be appropriate when considering a larger land area, such as a landscape.
- **Establish appropriate stabilization,** drainage and erosion control measures, to be applied on a daily basis during all phases of an operation.
- **Minimize road width** consistent with road safety and design considerations.

Additional Consideration

K **If road closure is anticipated,** consider designing road approaches to facilitate effective closure after completion of management activities.

Alignment and Location

STOP! U Contact Gopher State One Call at (800) 252-1166 or (612) 454-0002 **at least one week prior to** the start of excavation activities when crossing pipelines or other underground utilities.

U Prior to construction, identify locations of new roads, borrow areas and gravel pits to avoid cultural resources and other sensitive areas.

U Locate roads to minimize the amount of cut-and-fill and the number of water crossings.

U Locate roads away from streams, lakes, open water wetlands, wetland inclusions, seasonal ponds, seeps and springs whenever possible, to provide adequate filter strips.

U Wherever practical, locate roads (those that do not cross a stream, lake or open water wetland) outside of filter strips or the riparian management zone (RMZ), whichever is wider. See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

U Locate roads to avoid concentrating runoff and reduce the potential for nonpoint source pollution.

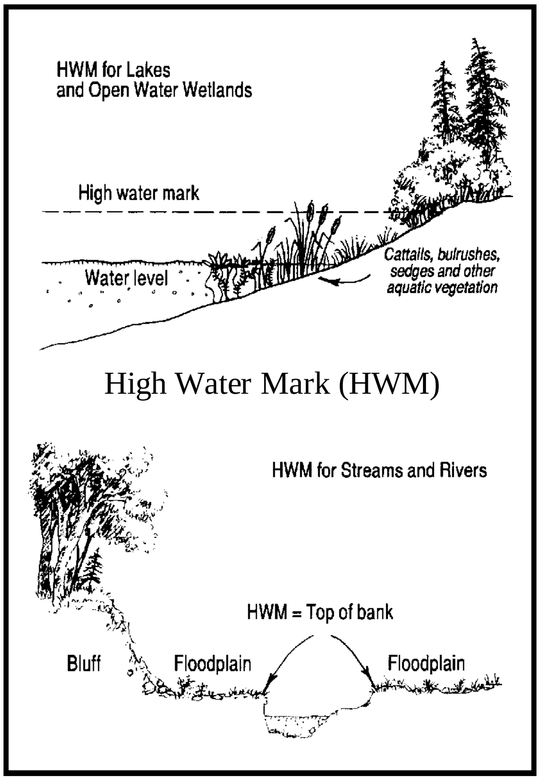


Figure ROAD-3

U **Avoid locating roads below the high water mark** of streams, lakes, wetlands and seasonal ponds whenever possible. See Figure ROAD-3.

U **Avoid locating roads on unstable slopes** subject to slumping or creep whenever practical.

U **Avoid constructing roads with grades in excess of 10%.** On highly erodible soils, maximum grades of 5% are recommended. See Figure ROAD-4.

U **Minimize down-road flow and ponding** by constructing roads with a slight grade of 1% or 2% and with appropriate ditches where practical.

Reducing Visual Impacts Due to Alignment and Location of Roads

*In areas classified as most sensitive:**

- Minimize the number of roads approaching travel routes or recreation areas.

*In areas classified as most sensitive or moderately sensitive:**

- Locate roads and trails to minimize visibility from nearby vantage points, such as scenic overlooks, streams and lakes.
- Reduce visual penetration with appropriate curves in the road alignment.
- Minimize total road mileage and ground disturbance required to meet landowner objectives and anticipated traffic loads.
- Avoid tracking mud onto highways by using appropriate road surface material.

*In areas classified as less sensitive:**

- Consider visual quality to the extent possible.
- Minimize total road mileage and ground disturbance required to meet landowner objectives and anticipated traffic loads.

*See *Part 2, Visual Quality: Visual Sensitivity Classifications* for information related to how classifications are determined and which Minnesota counties have developed visual sensitivity classification maps.

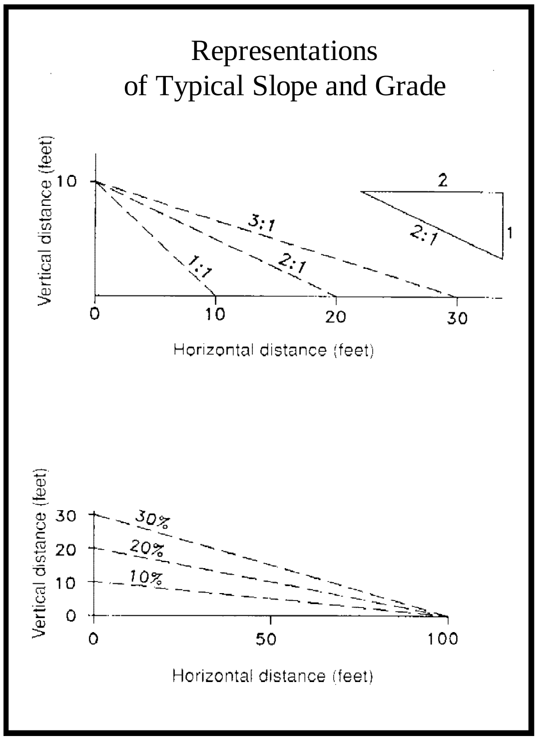


Figure ROAD-4

Reduce visual penetration into clearcuts or landing areas by designing curves in the road alignment. *Photo courtesy of Minnesota DNR*

Water Crossings

Water crossings present a high risk to water quality and should be avoided when practical. Bridges or culverts are preferred for road crossings that are used frequently or for extended periods. Low-water fords should be used for infrequent crossings and short-term operations. Fords should have a firm base installed to minimize potential impacts to water quality or wetlands.

U **Contact an SWCD office or DNR hydrologist** to determine whether the proposed road will cross a water or wetland designated on the Protected Waters Inventory maps. If so, secure the required permit from the DNR Division of Waters to work in public waters (Minn. Statute 103G.245). For a listing of DNR regional offices, see *Resource Directory*. See also *Appendix H: Work Activities That Do Not Require a DNR Protected Waters Permit.*

U **Minimize the number of water crossings.**

U **Give preference to crossing locations where:**

- Streambed and banks are composed of firm, cohesive soils or rock
- Approaches to streambanks have low-percent slopes and short slope lengths
- Construction will disrupt a minimum amount of natural stream channel

U **Maintain crossings as close to a 90-degree angle** as possible to the streambed.

U **Construct crossings** so as not to change the cross-sectional area of the stream channel or impede fish migration.

U **Construct low-water ford crossings** with materials that will not degrade water quality. These materials include (but are not limited to) concrete, coarse rock, riprap and gabions.

U **Minimize construction disturbance** to the natural flow of water.

U **Restrict activity in the water** to periods of low flow.

❑ **Design culverts and bridges for minimal impact** on water quality. Permanently installed culverts should be at least 12 inches in diameter for ease of maintenance. Putting in culverts and drainage structures that are too small could result in the road washing out. Lay culvert on the same slope (gradient) as the stream, but bury culvert about 17% (one-sixth of diameter). For sources of information on sizing culverts, contact local SWCD offices, local NRCS offices or county highway departments.

❑ **When installing culverts and bridges,** make sure that materials used within the stream are clean, non-erodible and non-toxic to aquatic life. Such materials include compacted fill, riprap, concrete and treated timbers. When using chemically treated timber below or near the water level, it should be reasonably dry and free of excessive surface oils when installed.

❑ **Anchor temporary structures at one end** to allow the structure to move aside during high water flows.

❑ **Remove temporary fills and structures** to the extent practical when use is complete.

Work Activities That Do Not Require A DNR Protected Waters Permit

As long as specific detailed conditions are met (see *Appendix H*), the following work activities do not require a DNR Protected Waters Permit:

❑ Low-water ford crossings (on streams only)

❑ Temporary bridges (on streams only)

❑ Water level control structures (on streams only)

❑ Constructing a bridge or culvert, of filling or excavating the bed of a protected watercourse (for streams with a watershed less than 5 square miles only)

❑ Removal of existing structures

❑ Removal of debris (as long as original alignment, slope or cross-section of lake, marsh or streambed is not altered)

Refer to *Appendix H* for conditions that must be met to conduct these activities without a permit.

Winter Roads

Winter roads provide access under frozen ground conditions for timber harvesting and other timber management activities. Like all other roads, winter roads need to have provisions for adequate drainage to prevent or minimize erosion and sedimentation into wetlands and open water. With much of the timber harvesting in Minnesota occurring during January, February and March, properly constructed winter roads are an important component of timber management.

U **Construct temporary crossings for winter roads** where practical. Examples of preferred temporary crossings include ice bridges, temporarily installed culverts and bridges (including use of native log materials). Soil fill should not be used on these temporary structures. See Figure ROAD-5.

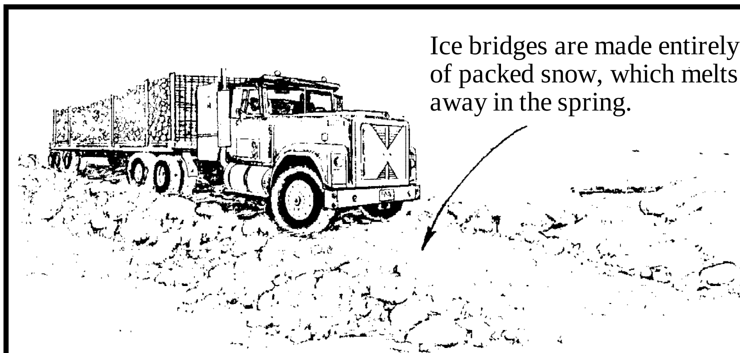
U **Construct crossings** to prevent water from backing up.

U **Consider using culverts or bridges** to cross defined drainages where winter roads are to be used for five years or longer. For information on sizing culverts, contact local SWCD offices, local NRCS offices or county highway departments.

U **Anchor temporary structures at one end** to allow the structure to move aside during high water flows.

U **Install all temporary structures** that could potentially block water flow in such a manner that they can be easily removed prior to breakup.

Figure ROAD-5

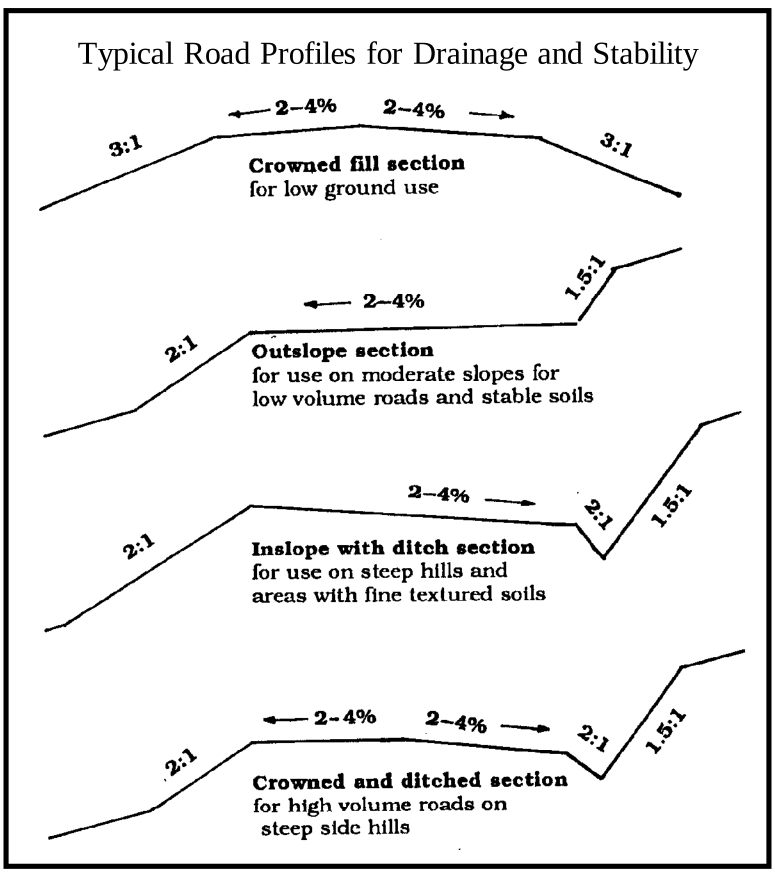


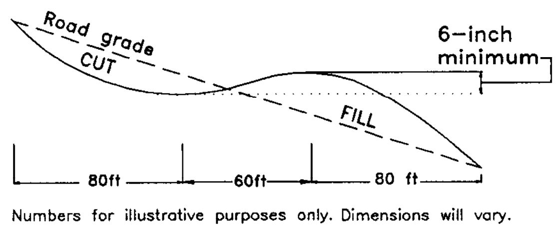
Drainage

Water entering onto or adjacent to the road must be diverted away from the road before gaining sufficient flow and velocity to cause significant erosion of the road and ditch.

U Control down-road flow of surface water by using a combination of the appropriate road cross-section (see Figure ROAD-6) and appropriate water diversion structures within the roadbed itself, such as broad-based dips (see Figure ROAD-7 and Table ROAD-1) or grade rolls, open-top culverts and water bars (see Figure ROAD-8 and Table ROAD-2).

Figure ROAD-6





Broad-Based Dip Installation

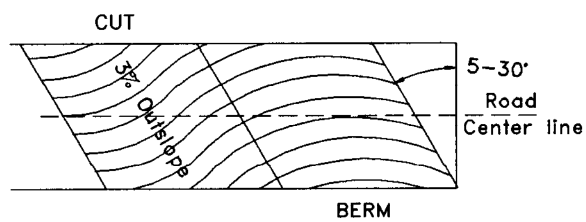


Figure ROAD-7

Table ROAD-1

Cross-Drain Spacing for Broad-Based Dips and Upland Culverts

Grade	Spacing between dips or upland culverts
0-2%	500 ft
3-4%	300 ft
5-7%	180 ft
8-10%	150 ft
11-15%	130 ft
16%+	110 ft

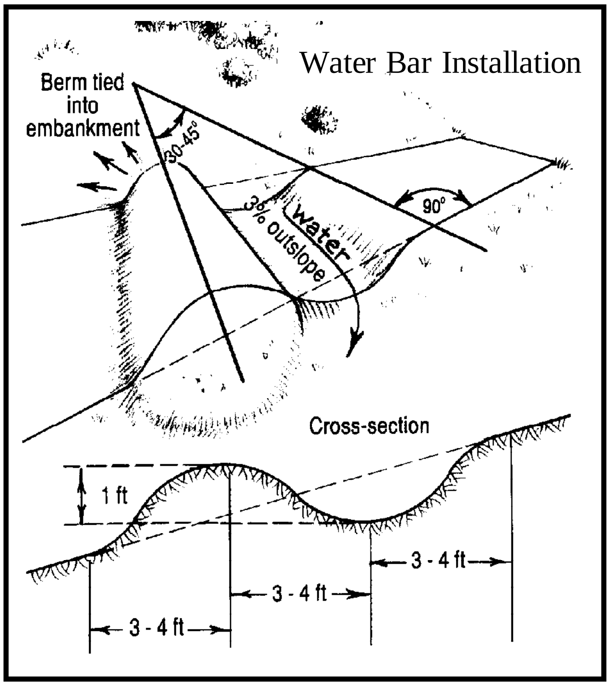


Figure ROAD-8

Table ROAD-2

Water Bar Spacing

Grade	Spacing between dips or upland culverts
2%	250 ft
5%	130 ft
10%	80 ft
15%	50 ft
25%+	40 ft

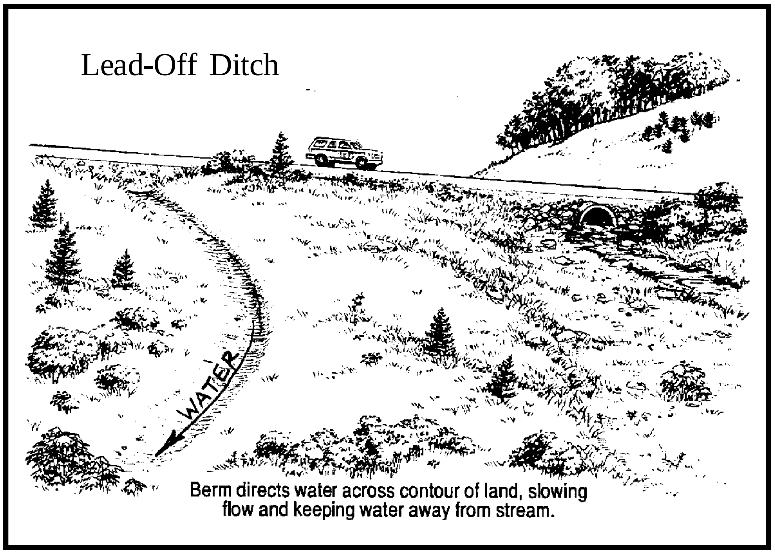


Figure ROAD-9

U Drain surface water that is diverted from roads into the filter strip or vegetative area, rather than directly into streams, lakes, open water wetlands, wetland inclusions or seasonal ponds.

U Use diversion structures on approaches to water crossings or on roads and trails found within the riparian management zone to divert water off of the right-of-way before it reaches the water body.

U Install cross drains and lead-off ditches to avoid carrying water long distances in roadside ditches. (See Figure ROAD-9.) Cross drains may include open-top culverts, pipe culverts and bridges.

Construction of Upland Forest Roads

IMPORTANT! Review General Guidelines:

- Protecting Cultural Resources
- Managing Equipment, Fuel and Lubricants
- Protecting the Normal Flow of Streams and Wetlands
- Protecting Wetland Inclusions and Seasonal Ponds
- Retaining Leave Trees
- Providing Coarse Woody Debris

U **Conduct on-site meetings** with the logger, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, road construction standards or specifications, and site conditions.

Clearing

Clearing widths will vary depending on the needs of both the owner and the user of the road. Consideration should be given to the necessity for roadway drying, as well as to the safety, cost and aesthetics of narrow rights-of-way.

U **Place clearing debris** in a manner that will not impede water flow or potentially increase sedimentation of waters.

U **Provide periodic breaks in the windrows** of clearing debris to allow for free movement of water.

U **Avoid placing clearing debris** in filter strips.

Reducing Visual Impacts of Road Clearings

*In areas classified as most sensitive:**

- U Utilize merchantable timber within road clearings.
- U Burn, screen or bury road-clearing debris, such as stumps, rocks and boulders, so that it is not visible from travel routes or recreation areas.

*In areas classified as moderately sensitive:**

- U Utilize merchantable timber within road clearings.
- U Move cleared debris outside of the travel route right-of-way so that it is minimally apparent.

*In areas classified as less sensitive:**

- U Encourage utilization of all merchantable right-of-way timber.
- U Avoid creating a corridor of debris.
- U Do not leave jackstrawed or overturned stumps in immediate foreground.
- U Reduce height of dozed clearing debris during road construction.

*See *Part 2, Visual Quality: Visual Sensitivity Classifications* for information related to how classifications are determined and which Minnesota counties have developed visual sensitivity classification maps.

Excavation

In most cases, material must be brought in to provide an adequate road for even a minimal amount of hauling. Such material should be obtained from the closest available source, which is often the ditch.

During work on new projects, loose exposed mineral soil is the most critical factor affecting siltation of waters.

U **Place excavated material** in a manner that will not impede water flow or potentially increase sedimentation of waters.

U **Avoid placing excavated material in filter strips.**

U **Shape inslopes and backslopes** to promote revegetation and soil stabilization. Slopes of 1.5:1 or flatter are preferred if terrain permits.

U **Compact fill material** to reduce entry of water, increase load-carrying capacity and minimize settling.

U **Deposit excess material in stable locations** away from streams, lakes, wetlands and seasonal ponds.

U **Shape and stabilize borrow pits** and excess material.

U **Limit the area excavated** to that which can be properly shaped and compacted within a day, with provisions for storm drainage and sedimentation control.

Reducing Noise and Visual Impacts of Gravel Pits and Borrow Areas

*In areas classified as most sensitive or moderately sensitive:**

- **Locate borrow pits and crushing operations out of the visible corridor** as much as possible.

- **Screen pits from travel routes or recreation areas** using existing vegetation or landscape berms.

- **Reduce noise** in early morning, late evening and other appropriate times whenever possible.

- **Develop gravel or borrow pits from the back to the front** of pits (moving toward the predominant view or vantage point). See Figure ROAD-10.

- **Rehabilitate pits upon completion of use** as per guidelines In the Minnesota Department of Natural Resources *Handbook for Reclaiming Sand and Gravel Pits in Minnesota* (C.G. Buttleman, 1992). Available by calling the Minnesota DNR Division of Minerals at (651) 296-4807 or the DNR toll-free hotline at (800) 766-6000 (Greater Minnesota only).

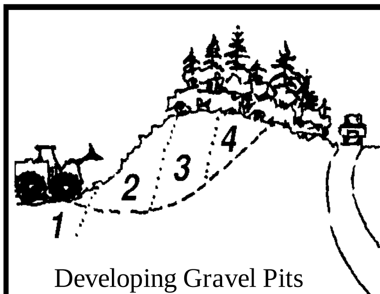
*In areas classified as less sensitive:**

- **Use methods and applications** consistent with integrated resource management principles.

- **Rehabilitate pits upon completion of use** as per guidelines in the Minnesota Department of Natural Resources *Handbook for Reclaiming Sand and Gravel Pits in Minnesota* (C.G. Buttleman, 1992). (See ordering information above.)

*See *Part 2, Visual Quality: Visual Sensitivity Classifications* for information related to how classifications are determined and which Minnesota counties have developed visual sensitivity classification maps.

Rehabilitate gravel pits upon completion of use. *Photo courtesy of Superior National Forest*



Developing Gravel Pits from Back to Front

Figure ROAD-10: Develop gravel pits from back to front, moving toward predominant viewer or vantage point. In this illustration, Stage 1 has been completed, Stage 2 is in process, and Stages 3 and 4 will follow. Leaving the area adjacent to the road beyond Stage 4 untouched could result in no negative visual impact on the travel route.

Drainage

Site drainage and cross-drainage are important for controlling sedimentation. Proper handling of water during construction will minimize potential impacts on water quality.

U **Install drainage structures** as construction proceeds.

U **Install culverts** at grades 2% more than the ditch grade and angled at least 30 degrees from perpendicular to the flow of water to improve inlet efficiency. See Figure ROAD-11.

Typical Upland Cross-Drainage Culvert

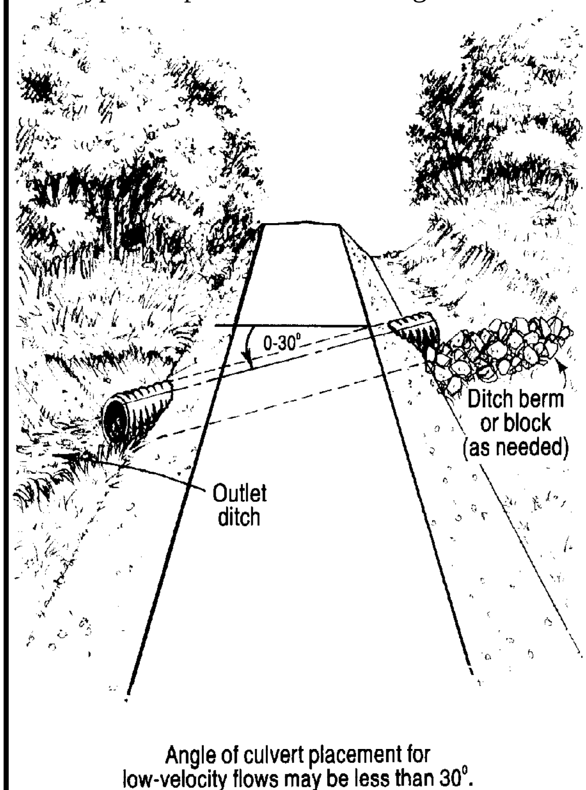


Figure ROAD-11

U Size culverts and other drainage structures large enough to minimize impacts on water quality. Putting in culverts and drainage structures that are too small could result in washing out of the road. For sources of technical assistance, contact local SWCD offices, local NRCS offices or county highway departments.

U Compact fill firmly around culverts, paying special attention to the sides and lower portion. Cover the top of culverts with fill to a depth of one-half the pipe diameter or 12 inches, whichever is greater. Culvert lengths should reach to the toe of the fill without changing the sideslopes of the fill. See Figure ROAD-12.

Typical Culvert Installation
for Uplands and Mineral Soil Wetlands

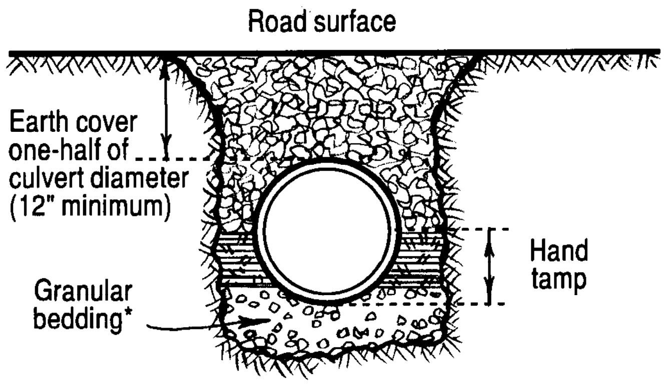


Figure ROAD-12

U Armor culvert inlets and outlets to reduce bank and channel erosion and sedimentation where appropriate.

U Provide adequate drainage for road grades during construction to minimize erosion of unconsolidated materials.

U Retain outslope drainage and minimize berms on the outside edge during construction operations, except those intentionally constructed for protection of road grade fills.

U Provide temporary cross-drainage structures (such as water bars) during construction where needed. See *Drainage*, pages 20-23.

U Install siltation barriers, such as silt fences and straw bales, during construction in sites where roads and water have close contact for long periods.

Protecting Resources

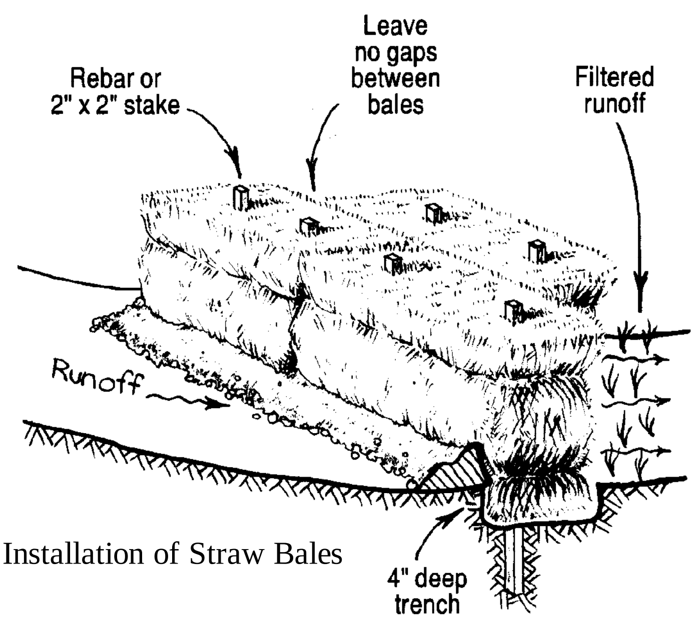
U Stabilize bare soil areas to reduce erosion. A vegetative cover is recommended along all roadsides. Where necessary, mulch and seed disturbed soil as soon as practical after construction. For sources of recommendations for seed mixes and fertilizer use, see *Resource Directory*.

U Install temporary erosion control devices, such as straw bales, mulch or woody debris, to help stabilize soils prior to establishment of vegetative cover. See Figure ROAD-13.

U Inspect and repair erosion control measures on a regular basis to ensure that they remain functional.

U If road construction will take place in the area of a cultural resource, consider construction when the ground is sufficiently frozen or snow depth is sufficient so that soil disturbance is minimized.

Figure ROAD-13



Installation of Straw Bales

WETLAND FOREST ROADS

Have you identified your goals and objectives?

See *Identifying Goals and Objectives* in General Guidelines.

Have you conducted a site inventory?

See *Conducting a Site Inventory* in General Guidelines.

Design of Wetland Forest Roads

IMPORTANT! Review General Guidelines:

- Incorporating Sustainability into Forest Management Plans
- Maintaining Filter Strips
- Managing Riparian Areas

Landowners may need the services of a forester, engineer or other qualified individual to provide complete design and construction specifications. This professional assistance is particularly important when constructing permanent all-season roads. For sources of professional assistance, see *Resource Directory*.

U Contact an SWCD office or DNR hydrologist to determine whether the proposed road will cross a water or wetland designated on the Protected Waters Inventory maps. If so, secure the required permit from the DNR Division of Waters to work in public waters (Minn. Statute 103G.245). For a listing of DNR regional offices, see *Resource Directory.* See also *Appendix H: Work Activities That Do Not Require a DNR Protected Waters Permit.*

U Contact a county planning and zoning office or local SWCD office to determine whether the local government unit requires a certificate of exemption for forest management activities related to forest road construction. See *Resource Directory.*

U Wherever practical, place fueling and maintenance areas, landings and roads (those that do not cross a stream, lake or open water wetland) outside of filter strips or the riparian management zone, whichever is wider. See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

U Avoid crossing wetlands wherever possible.

U Minimize total wetland road mileage when wetlands must be crossed, while still meeting landowner objectives.

U Determine the type and depth of wetland subsoils to ensure proper design and construction.

U Minimize width of roads consistent with maintaining safety and road design considerations. Provide turnouts, as appropriate, placed at intervals to accommodate two-way traffic. On deep peat wetlands, road fill slopes should be 3:1 or flatter to spread out road loading and minimize failure. (See Figure ROAD-4, page 16.)

U Design upland road approaches to wetlands so that surface runoff is diverted before entering the wetland.

Construction of Wetland Forest Roads

IMPORTANT! Review General Guidelines:

- Protecting Cultural Resources
- Managing Equipment, Fuel and Lubricants
- Protecting the Normal Flow of Streams and Wetlands
- Protecting Wetland Inclusions and Seasonal Ponds
- Retaining Leave Trees
- Providing Coarse Woody Debris

U **Conduct on-site meetings** with the logger, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, timber harvesting regulations and site conditions.

Choosing the appropriate road construction technique will depend on a knowledge of water table position, zone of water flow, type of wetland soils, and the strength of wetland soils. With any road construction technique, culverts or ditches (or both) may be necessary.

General Construction Considerations

U **Prior to construction, identify locations** of new roads, borrow areas and gravel pits to avoid cultural resource areas.

U **Construct all road embankment fills** with clean fill or other suitable native materials.

U **Anchor temporary structures at one end** to allow the structure to move aside during high water flows.

U **Employ sediment control techniques** (such as silt curtains) to prevent movement to open water when placing fill during construction.

U Provide adequate cross-drainage by employing one or both of the following techniques:

- Use construction methods that allow free water flow throughout the entire roadbed. See Figure ROAD-14.

- Place culverts or other cross-drain structures at each end of each wetland crossing and at intermediate low points. Space culverts or other cross-drain structures at maximum 300-foot intervals to ensure adequate cross-drainage through the roadbed. See Figure ROAD-15.

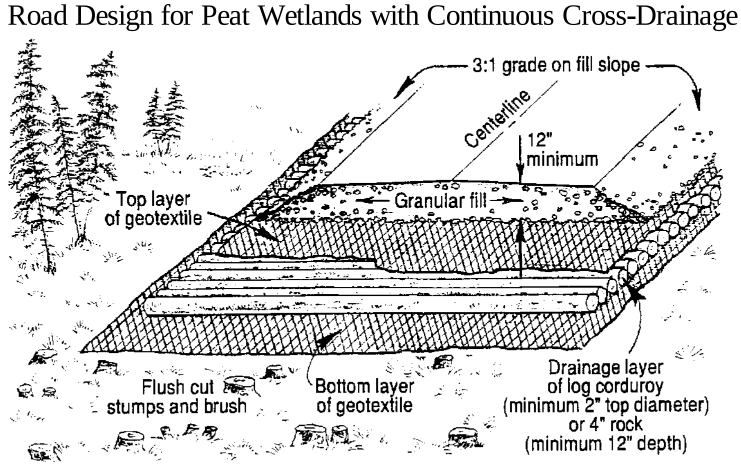
U Shape and stabilize borrow pits and excess material.

U Construct ditches in wetland crossings, where necessary, to intercept and carry surface and subsurface water (the top 12 inches) to, through and away from the culverts. Unditched breaks should be left midway between culverts. Additional ditching practices are listed under specific guidelines for various wetland types.

U Avoid having ditches create additional outlets that will result in drainage of the wetland or seasonal pond. Additional ditching practices are listed under specific guidelines for various wetland types.

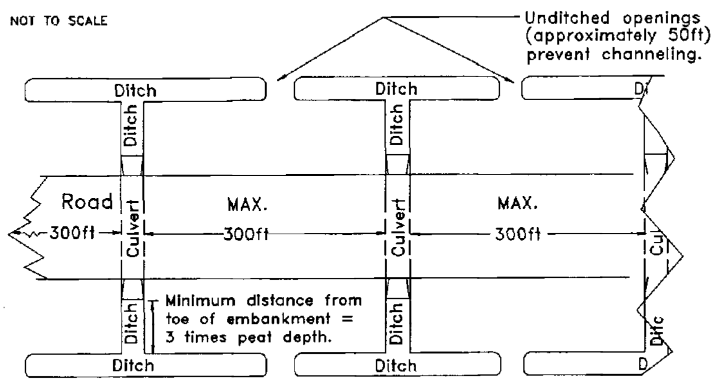
Figure ROAD-14

Road Design for Peat Wetlands with Continuous Cross-Drainage



Drainage layers may be used as an alternative to culverts, or in combination with culverts, to provide adequate cross-drainage.

Deep Peat Wetlands Culvert and Ditch Spacing



Culverts may be used as an alternative to drainage layers, or in combination with drainage layers, to provide adequate cross-drainage. When needed, parallel ditches should be spaced as shown.

Figure ROAD-15

The following guidelines address four kinds of wetland road construction approaches:

- ❒ Crossing mineral soil wetlands
- ❒ Crossing shallow peat wetlands
- ❒ Crossing deep peat wetlands
- ❒ Crossing wetlands in winter

Crossing Mineral Soil Wetlands

Wetlands with mineral soils include those wetlands having fine-textured (clay or silt), slowly permeable soils to sandy soils overlaying impervious subsoils or hardpans. Road building across these wetland types employs conventional road construction techniques for road fill and drainage structures.

Weak mineral soils can be excavated and backfilled with clean granular soils, or they can be filled over with clean granular fill and allowed to compress and displace. Additional fill is added to keep the road bed at the desired grade.

Culverts and ditches are installed to minimize disruption of normal water flow across the landscape and transport it through and away from the roadbed.

Fill areas in floodplains should be designed to allow high flows to pass unimpeded.

U Install culverts of sufficient size to handle hydrologic flows for the site and for long-term maintenance needs. If ditches are needed, construct them immediately adjacent to the toe of the fill slope. For sources of technical assistance, contact local SWCD offices, local NRCS offices or county highway departments.

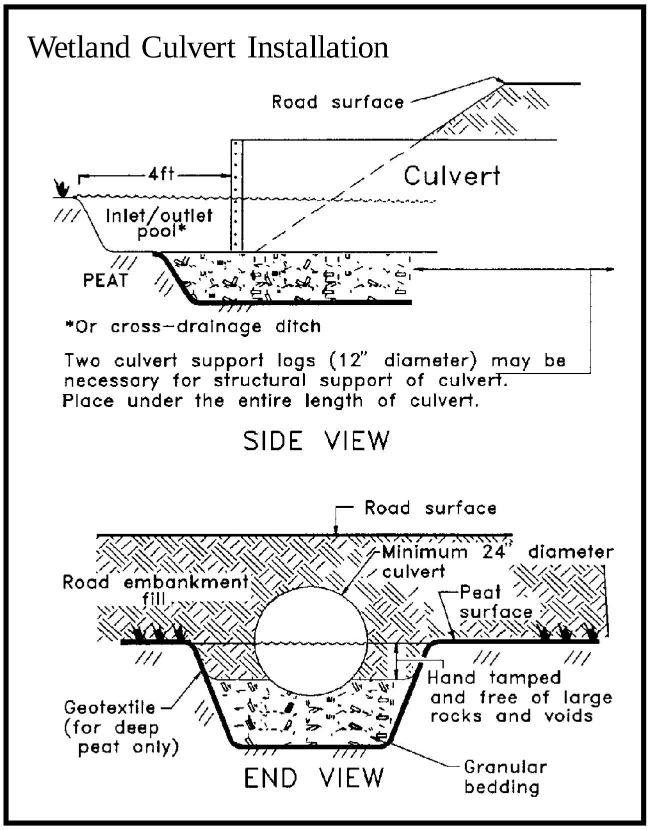
Crossing Shallow Peat Wetlands

Wetland crossings of shallow peat less than 4 feet deep may be constructed using conventional road construction methods:

- **The conventional road construction method** consists of excavating the shallow peat and then backfilling with clean granular backfill material. The excavated peat can be used to flatten the roadbed fill slope. Excess peat should be hauled away and disposed of at an approved upland disposal site.

- **Another accepted road construction method** involves placing granular fill material directly onto the peat surface. The weight of the fill material displaces (or pushes aside) the weaker peat until the strength of the subsoils is sufficient to bear the weight of the fill material and vehicle loadings. As final settling occurs, additional fill may be needed to maintain the desired road grade.

With both methods, the installation of culverts and ditches intercepts surface and subsurface water flow, transporting it through and away from the roadbed. (Most subsurface flow occurs in the top 12 inches of the peat).



Wetland Culvert Installation

Figure ROAD-16

Follow these guidelines when placing culverts:

U Install culverts that are a minimum of 24 inches in diameter buried halfway below the soil surface. The upper half will handle surface storm flows and the lower half will handle normal subsurface flows. Failure to bury the lower half of the culvert will cause subsurface water to pond on the upstream side of the road and kill trees. See Figure ROAD-16.

U Place culverts at the low points of the wetland to pass surface water flows though the road embankments. If ditches are needed, construct them immediately adjacent to the toe of the fill slope. For sources of technical assistance, contact local SWCD offices, local NRCS offices or county highway departments.

Crossing Deep Peat Wetlands

Crossing wetlands with peat soils greater than 4 feet deep can be done using special road construction methods that do not require excavation and backfill. These methods make use of geotextile fabrics, special embankment structures (such as lightweight road fills, extra-wide road bases or log corduroy layers), and the inherent strength of the underlying peat layers to resist slip failure and resultant road failure. (See Figure ROAD-14, page 35.)

Such failures can range from the gradual sinking to the sudden loss of the road into the wetland. When such failures occur, the peat water flow through the wetland is greatly disturbed, which can result in large areas of flooding.

These methods generally specify that a layer of geotextile be placed on the peat surface. Road fill is then placed over the geotextile. To provide additional strength and adequate cross-drainage, special materials such as log corduroy, wood chips or drainage rock may be added in the lower portion of the fill. (See Figure ROAD-14, page 35.)

The specific road structure needed depends on the strength of the peat layers below the road. The determination of shear strength is critical in designing a sound, safe and economical road crossing. The landowner or resource manager is strongly advised to consult a registered civil engineer to accurately determine shear strengths, conduct field testing and provide design specifications.

Some deep peat wetlands with peat layers that are too weak to support a roadbed will require traditional excavation and backfill methods. Because of the high cost of traditional construction methods, as well as environmental effects, it is best to avoid building on these weak peat wetlands.

Cross-drainage through the roadbed in a deep peat wetland is normally slowed or halted as a result of the compression of the peat layers by the road embankment, equipment rutting of the peat surface, or road failure. This can cause flooding on the upslope side of the wetland and drying on the downslope side.

Cross-drainage can be maintained by the proper installation of culvert and drainage layers. In all cases, the construction objective is to provide a stable road surface while maintaining free flow of water though the roadbed.

The following techniques can prevent or minimize impacts to deep peat wetlands:

- **Construct road embankments across wetlands** with deep peat subsoils when the peat is frozen. Construction on frozen peat avoids rutting and other damage of the topmost root mat layer, which normally contains considerable shear strength. Such damage can greatly reduce the strength of the upper peat layers and reduce the ability of the wetland subsoils to hold up the weight of the roadbed and vehicle loads.

- **Install culverts that are a minimum of 24 inches in diameter** buried halfway below the soil surface. The upper half will handle surface storm flows, and the lower half will handle everyday subsurface flows. Failure to bury the lower half of the culvert will cause subsurface water to pond on the upstream side of the road and kill trees. See Figure ROAD-16, page 38.

- **Maintain a separation** between the toe of the embankment fill slope and the ditch when constructing ditches parallel to the roadway. The separation distance should be at least three times the depth of the peat, which will prevent or minimize disturbance of the inherent strength of the top layer of peat containing the root mat. See Figure ROAD-15, page 36.

- **Provide ditches to facilitate flow** into and out of culverts.

- **Construct ditches using flotation devices** (such as timber mats)or schedule construction to occur during frozen conditions, to prevent or minimize impacts on wetlands and minimize damage to construction equipment.

- **Obtain professional engineering advice** on design of cross-drainage ditches for permanent roads across deep peat wetlands.

Specific design techniques for crossing deep peat wetlands

Roadbeds that use geotextile fabrics should be prepared to protect the woody root mat by flush-cutting trees and brush and leaving non-merchantable material in place. The first geotextile fabric should be laid loosely over the cut material. Then proceed with one of the following three wetland road construction techniques:

Technique #1: Corduroy

- Place trees parallel to each other, side by side and perpendicular to the roadbed direction

- Cover as needed with clean road fill or gravel.

- If log corduroy is to be used for cross-drainage, apply geotextile both above and below the corduroy. If log corduroy is not to be used for cross-drainage, other cross-drainage structures should be considered. See Figure ROAD-14, page 35.

Technique #2: Rock drainage layer

- Place 12 inches of rock (4 inches or less in diameter) over the geotextile, followed by another layer of geotextile. The rock layer will settle into the top 12 inches of the wetland, providing the pore space for water passage through the roadbed.

- Place clean road fill or gravel on top (typically 18 inches deep).

Technique #3: Lightweight road fills

Lightweight materials may be incorporated into the core of the road embankment fill to lessen the total weight of the road embankment when constructing on weak peat wetlands.

Lightweight materials include wood chips and sawmill residues, among other materials. Materials with known potential to leach toxic substances (such as construction debris, treated wood, tires, asphalt or other petroleum-laden materials) are not suitable for use.

• Place the lightweight materials over the fabric to form the core of the road embankment fill, followed by another layer of geotextile fabric over the lightweight materials.

• Cover the core with at least 18 inches of granular sand or gravel road fill.

• Install culverts and ditches, if necessary, to pass surface and subsurface waters through the road embankment. See Figure ROAD-15, page 36.

Crossing Wetlands in Winter

Roads across wetlands or seasonal ponds are often designed to take advantage of frozen ground conditions. The following guidelines apply to design of roads across all wetland types.

U **Plan the layout to maximize operating efficiency** and minimize site disturbance.

U **Select the shortest routes practical** that minimize potential problems with drifting snow and the crossing of open water.

U **Tramp and pack the wetland area wider than needed** for the driving and working area if sufficient frost is not present. This additional space will allow for turnouts, snow removal and parking.

U **Avoid crossing open water or active springs.** If unavoidable, temporary crossings are preferred. These can be ice bridges, temporarily installed bridges or culverts, or timber mats.

U **Avoid using soil fill.**

U **Install all structures that block water flow** so that they can be easily removed prior to breakup. If the streams are navigable or require a DNR permit to cross, removal may be necessary at the end of each winter of operation, not just at the end of the timber contract.

U Use planking, timber mats or other support alternatives to improve the ability to support heavy traffic where conditions are inadequate to stay within the stated guidelines. If removal would cause more damage than leaving them in place, these areas may be left as permanent sections on frozen roads.

U Anchor temporary structures at one end to allow the structure to move aside during high water flows.

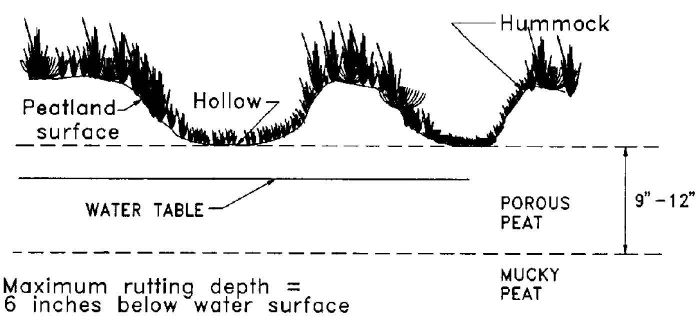
U Avoid clearing practices that result in berms of soil or organic debris building up on either side of the road clearing. Such berms can disrupt normal water flow.

U Provide adequate filter strips near open water. (See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

U When rutting exceeds 6 inches in depth for continuous distances greater than 300 feet on any portion of the road, cease equipment operations on that portion of road. Resume operations only when conditions are adequate to support equipment. This practice will minimize blockage of cross-drainage and prevent or minimize down-road channelization. See Figure ROAD-17.

Figure ROAD-17

Peat Wetland Surface in Relation to Water Table



The water table (solid line) is near the bottom of the hollows (upper dotted line). Operations should stop when ruts reach 6 inches below the water table or 6 inches below the bottom of the hollows, whichever is lower. Peat is usually still porous 9 inches below the hollows, and ruts will heal in 2 to 3 years. Deep ruts (more than 12 inches below the hollows) will bring up well-decomposed, mucky peat and may take more than 20 years to heal.

MAINTAINING AND CLOSING ALL FOREST ROADS

IMPORTANT! Review General Guidelines:

, Post-Operational Activities and Followup Visits

Maintenance Measures for All Roads

U Clean debris from culverts, ditches, dips and other structures as needed to diminish the danger of clogging and the possibility of washouts. Any debris should be placed away from the water-course and stabilized, if necessary.

U Restrict use of roads during times when the road is especially susceptible to damage, including wet periods and spring breakup.

Maintaining Active Roads

U Fill in ruts and holes that develop during road use. Use a suitable material (such as gravel or compacted fill), and fill as soon as possible to reduce the potential for erosion.

U Grade road surface periodically to maintain proper surface drainage and eliminate small wheel ruts.

U Minimize berms along the edge of the road that will trap water on the road surface. Feather material out on the road surface.

U Minimize entry of dust control agents into water. For example, do not apply an excess of chemicals to the road that could potentially be transported to surface water through erosion and surface runoff.

U Do not treat roads with calcium chloride as this chemical causes physiological distress for amphibians crossing them.

U Implement stabilization methods so that the shape, slope, elevation and contours of archaeological sites and other cultural features are preserved. Stabilization should not alter the historic character of the cultural resource.

U Avoid impacting cultural resources within existing road corridors when reconstructing or maintaining forest roads. Management options include the following:

- Limit or eliminate maintenance (including regrading or widening) in or near cultural resource areas.
- Use "fill only" techniques to improve roads that cross subsurface cultural resources.
- Reroute roads that cross cultural resource areas.

Closing Inactive Roads

U Remove flagging, signs or other markings in cultural resource areas after road closure, except in those cases where signs are appropriate long-term protection or interpretation tools.

U Remove temporary fill and structures to the extent practical when use is completed.

U Close or obliterate temporary forest access roads after management activities are complete if continued access might result in damage to endangered, threatened and special concern species (ETS species), sensitive communities, cultural resources or water features. If temporary roads will be obliterated, earthwork should be confined to the road corridor.

U Provide appropriate access control to minimize unauthorized traffic during use and especially after completion of activity.

U Ensure that the road surface is in stable condition when the road is closed. Seed and fertilize disturbed surfaces as necessary. To facilitate regeneration, back blade or otherwise scarify road beds where appropriate. Use native grass or forb mixes if available. For sources of recommendations for seeding and fertilization, see *Resource Directory*.

Seeding forest access roads after completion of use provides multiple benefits, including stabilizing the road and protecting it from erosion, and providing food and cover for wildlife. Seeding also eliminates negative visual impacts. *Photo courtesy of Minnesota DNR*

For temporary closure:

- **Control access** to minimize maintenance requirements.
- **Install appropriate drainage structures** as necessary and maintain in working order.
- **Place a barrier to traffic,** and post "Road Closed" signs at the beginning of the road when closing roads.
- **Provide periodic inspection and maintenance** of road surfaces as necessary.

For permanent closure:

U Place a barrier to traffic, such as a berm, and post "Road Closed" signs at the beginning of the road when closing roads. See Figure ROAD-18.

U Place water bars where necessary. See Figure ROAD-8, page 22.

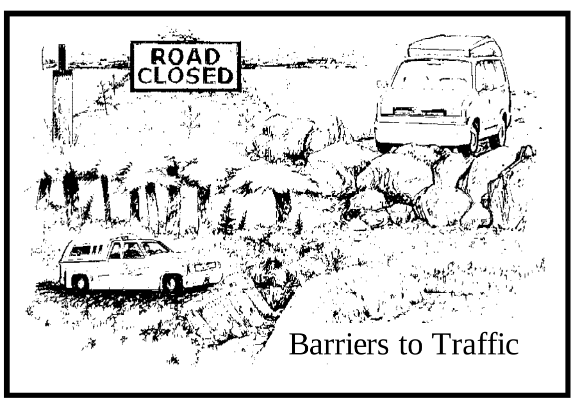
U Remove structures that would require continuing maintenance (such as culverts and bridges) even after a road is abandoned.

U Reshape stream crossings to approximate original channel contour when removing water crossing structures, and stabilize the structure site.

U Provide breaks in extended fills in flood-prone areas at intervals no greater than 300 feet to accommodate high flows and debris.

Providing appropriate access control eliminates motorized vehicle use (which can lead to erosion) while also encouraging hunters and hikers. *Photo courtesy of Itasca County Land Department*

Figure ROAD-18



TEXAS
FORESTRY
BEST MANAGEMENT PRACTICES

Texas Forestry Association

TEXAS FOREST SERVICE
The Texas A&M University System

August 2004

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

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

Texas Forestry Association
P.O. Box 1488
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
701 N. First Street
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
Linden	(903) 756-8170
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

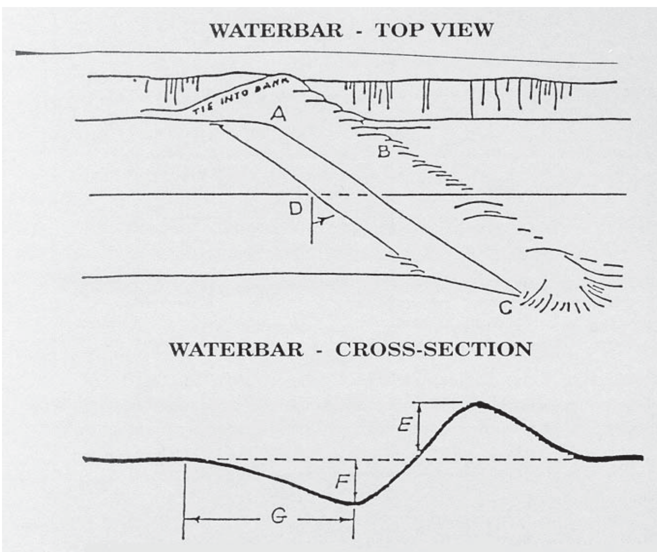
6. To fully intercept any ditch flows, the uphill end of the bar should extend beyond the side ditch line of the road and tie into the bank.

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.

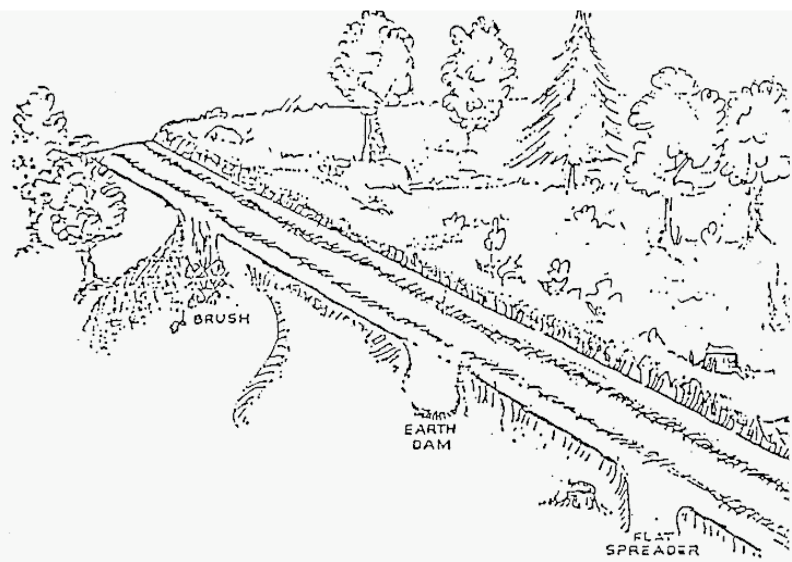
4. Wing ditches should be spaced to permit the roadbed to dry and reduce the volume and velocity of side ditch waters.

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.



Dispersal turns water down slope

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:

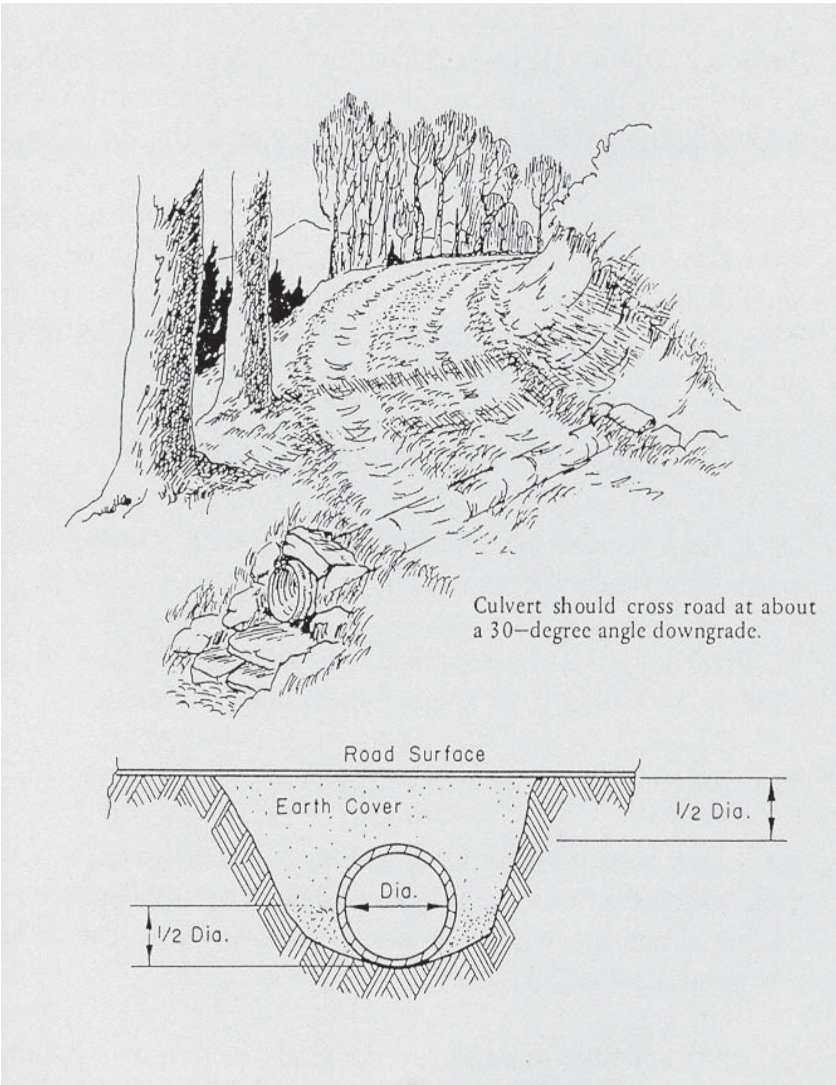
$$Spacing = \frac{400'}{Slope\ \%} + 100'$$

*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

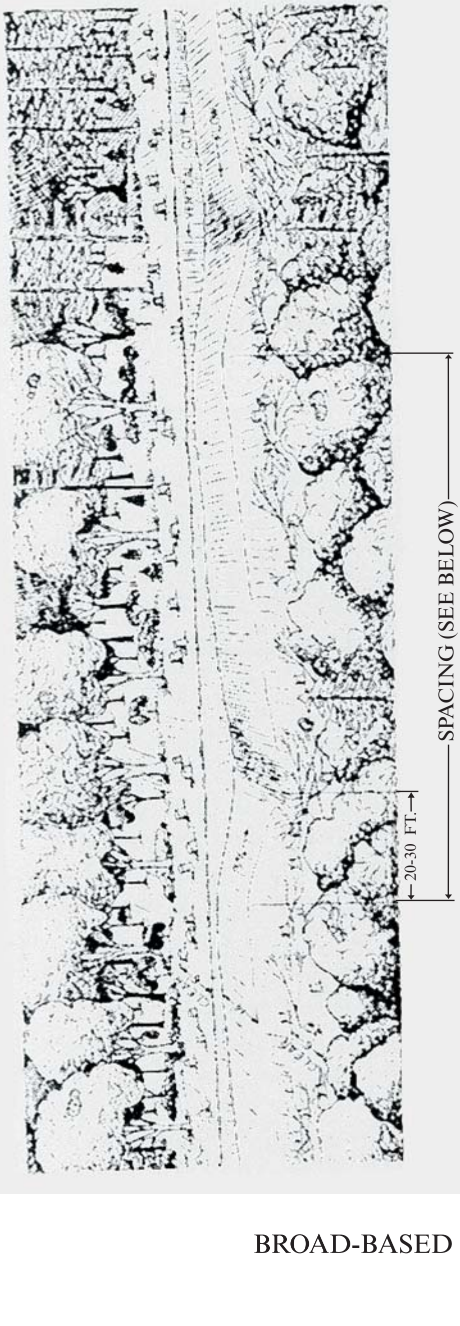
5. On some soils the dip and reverse grade section may require bedding with 3 inch crushed stone to avoid rutting the road surface.

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

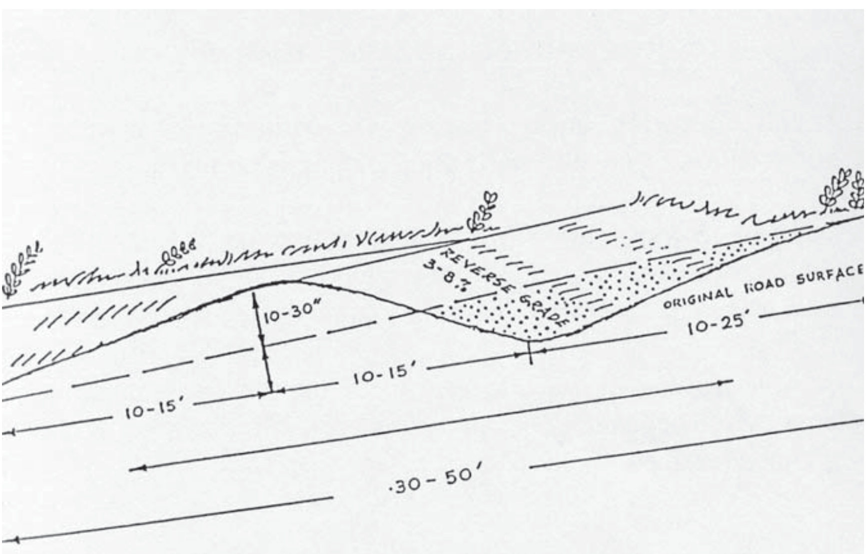
1. Install following basic clearing and grading for roadbed construction or on skid trails after logging is completed.

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.

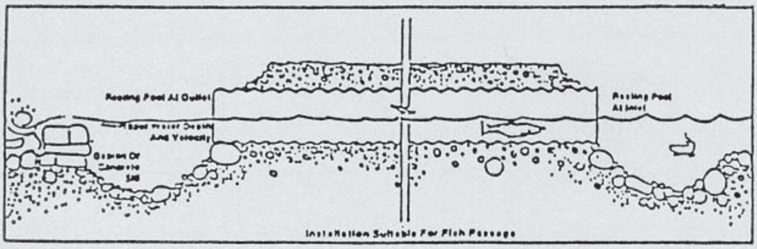
2. Pipe culverts should be of the proper type, size, and material to handle maximum stream flow. See Culvert Size Chart on page 51.

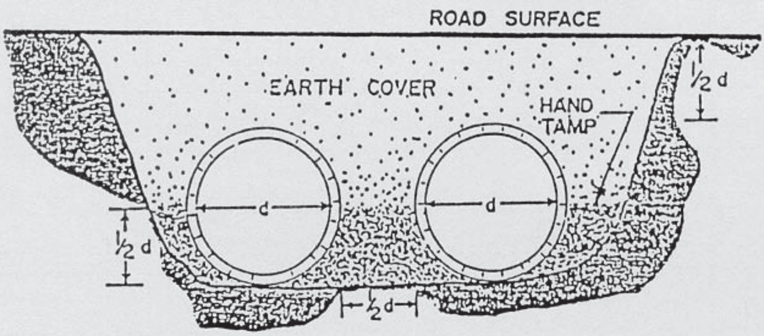
3. The culvert should be placed on a 1% to 2% downgrade to prevent clogging, but laid as closely as possible to the natural grade of the drain.

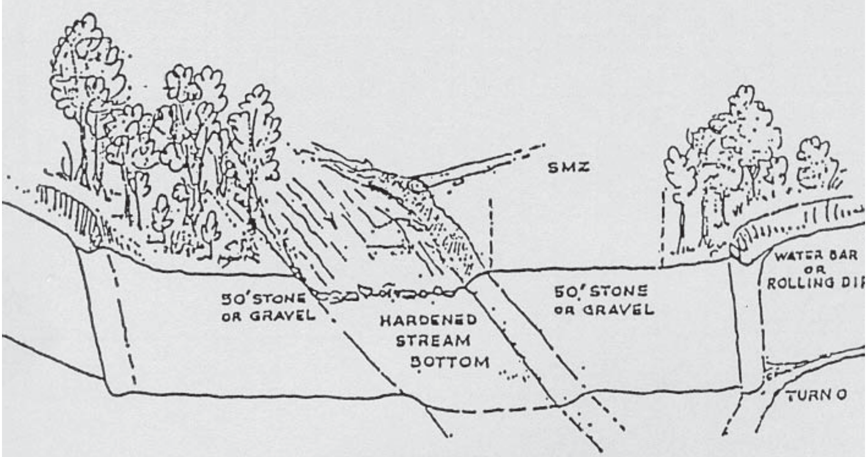
4. Erosion protection measures can be installed at the culvert outlet to minimize downstream erosion. This protection might include rip-rap, geo-textile filter cloth, large stone, prefabricated outflow devices, velocity reducers, etc. Rip-rap, etc. may be necessary on the downstream and upstream edge 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	Mod.	Steep	Medium Soils Flat	Mod.	Steep	Heavy Soils (Clays) Flat	Mod.	Steep
	0-5%	5-15%	15%+	0-5%	5-15%	15%+	0-5%	5-15%	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.

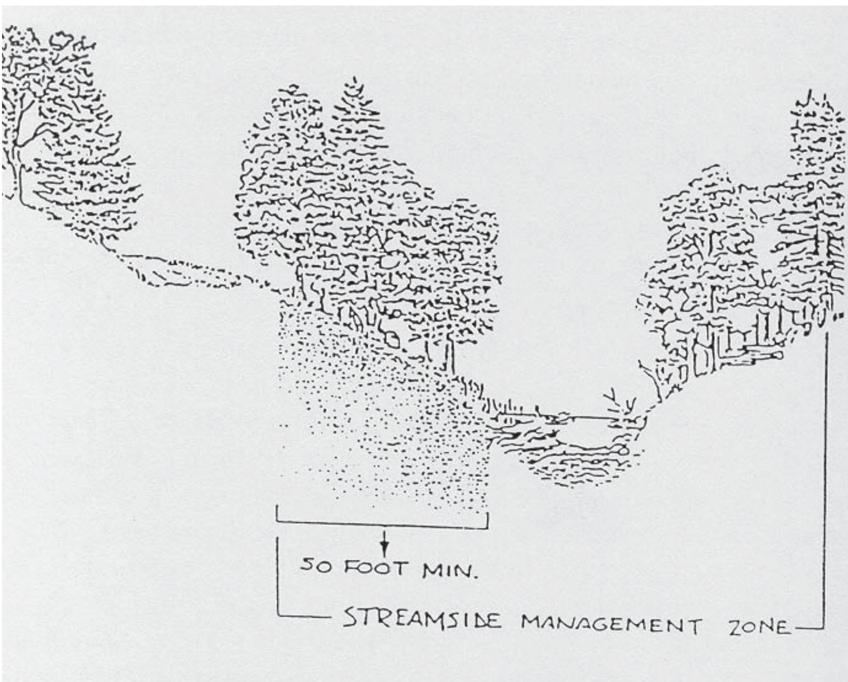
10. SMZ horizontal width is measured in linear feet from the pond, lake or stream bank to the toe of road, skid trail, or other surface disturbance. See Illustration on page 59.

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.

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.***

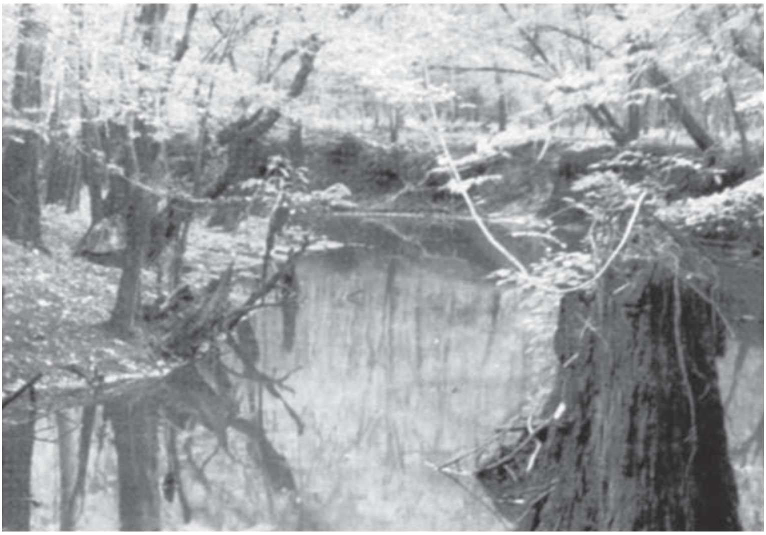
• ***Consider use of special equipment such as wide-tire skidders, forwarders, etc. to minimize soil damage and/or rutting.***

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

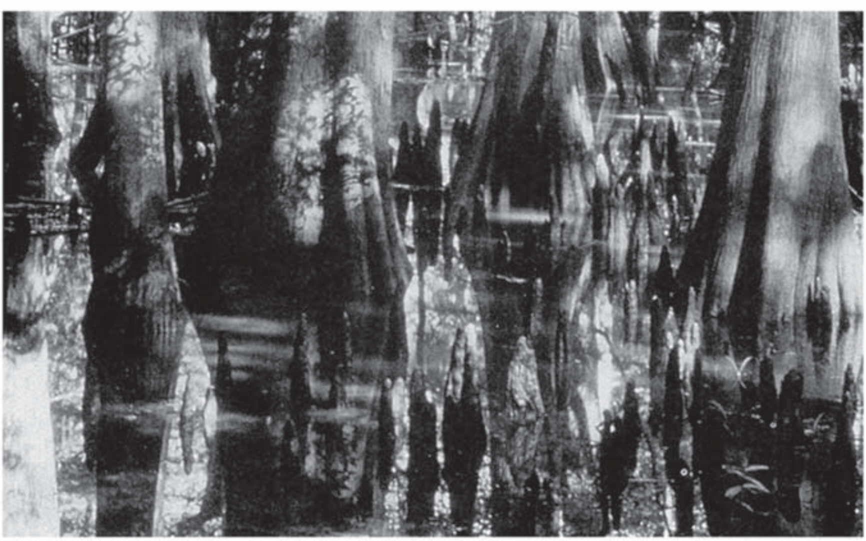
Intermittent streams flow 30-90% of the year in continuous, well-defined channels. As in uplands, intermittent streams (which themselves are most likely wetlands) in wetlands or wetland-like areas need the protection of SMZs. Since SMZs on this type of stream in bottomlands with wide floodplains may 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:

BA factor = $0.005454(DBH)^2$

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.

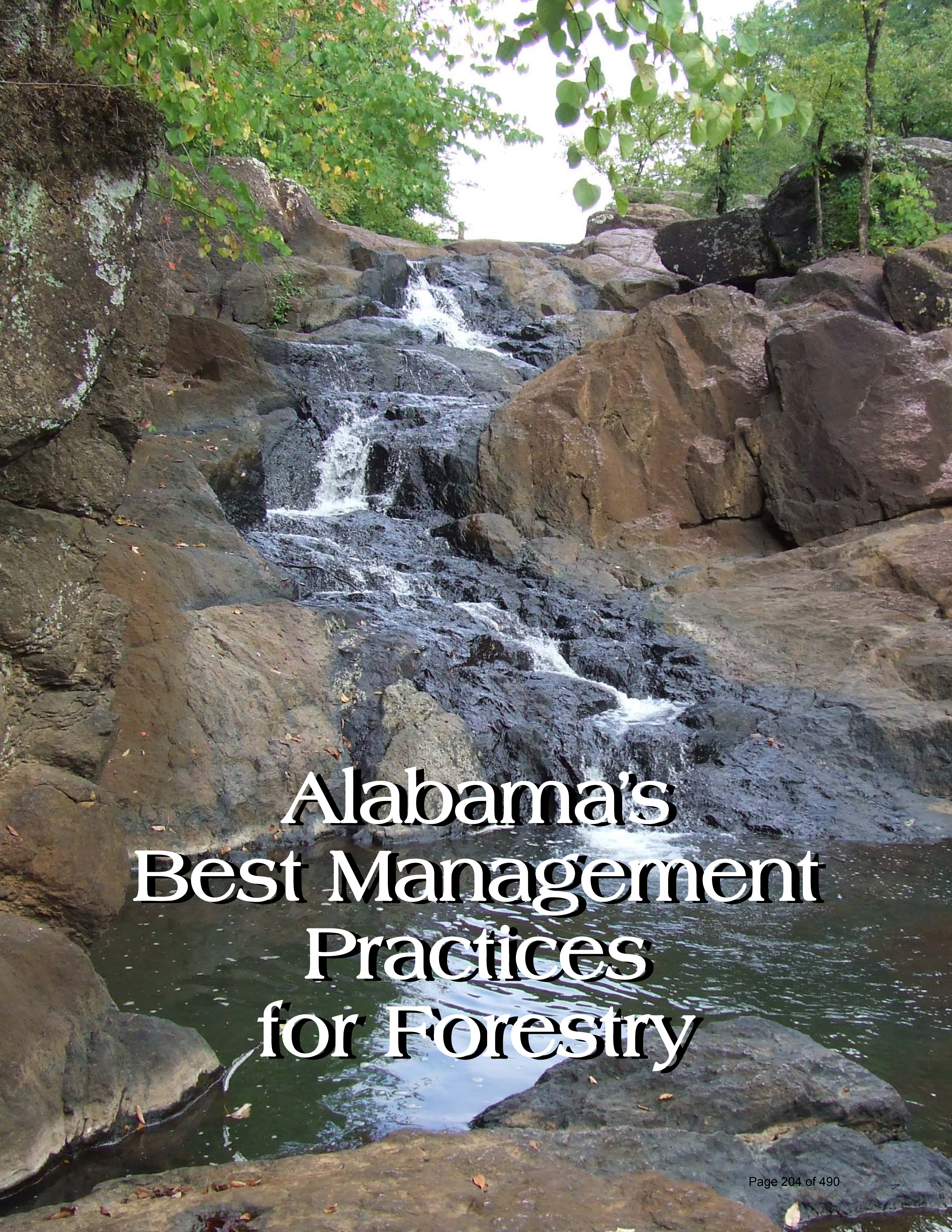
The following table represents how many trees it takes per DBH class to achieve a determined BA.

Trees Per Acre by Basal Area and DBH

DBH (inches)	Basal Area (sq. ft.) 20	30	40	50	60	70	80	90	100	110
	Trees Per Acre									
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



Alabama's Best Management Practices for Forestry

PHOTOGRAPHS CONTRIBUTED BY:

Jeremy Lowery, Alabama Forestry Commission

Stephen Hudson, Auburn University,
School of Forestry & Wildlife Sciences

Lacy Kendrick, Buchanan Forest Products,
Selma, Alabama

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Turton, et al., 1992.

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ALABAMA FORESTRY COMMISSION

STATE LANDS DIVISION

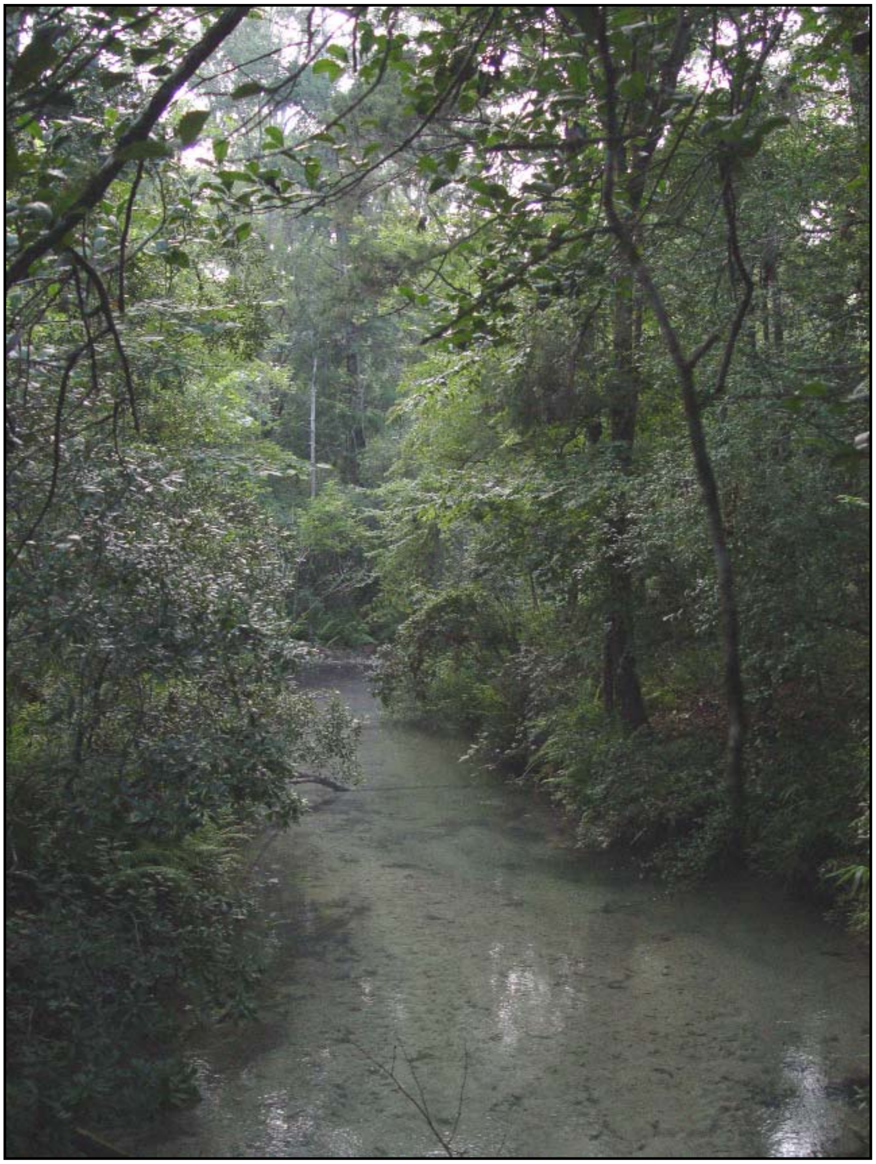
TABLE OF CONTENTS

FOREWORD

Water Quality Management in Alabama

The Alabama Environmental Management Act authorizes the Alabama Department of Environmental Management (ADEM) to establish and enforce water quality standards, regulations and penalties in order to carry out the provisions of state and federal water quality laws. From that authorization, ADEM Administrative Code prohibits the deposition of pollutants into or the degradation of the physical, chemical, or biological integrity of waters of the state (see glossary for definitions). With regard to silviculture, nonpoint source pollutants include, but are not limited to, sediment, organic materials, temperature, trash, pesticides and nutrients (see glossary for definitions and impacts) that are man induced.

In addition, the Alabama Water Pollution Control Act states that ADEM shall have the authority to propose remedial measures necessary to clean up waters that have been determined to be polluted. ADEM advocates, however, that avoiding environmental problems through voluntary application of preventative techniques is much less expensive, more cost effective and practical than restoration after the fact.



The Alabama Forestry Commission's Role in Best Management Practices

The Alabama Forestry Commission was established and is mandated by Code of Alabama, 1975, Section 9-3-4 (1), to protect, conserve, and increase the timber and forest resources of the state. All citizens of Alabama are our valued customers. However, as the lead agency for forestry in the state, we seek to strike a balance between serving Alabama forest owners' needs and enhancing the benefits flowing to society from their forests. Our mission is to promote environmentally and economically sound forestry practices, and we are committed to optimizing available resources to achieve this mission.

The Alabama Forestry Commission is not an environmental regulatory or enforcement agency, but it does accept the responsibility to maintain and update *Alabama's Best Management Practices (BMPs) for Forestry* whenever necessary to help Alabama's forestry community meet state water quality needs. The Commission will work in a cooperative manner with all state and federal agencies concerned, and is determined to utilize technical expertise from within and without the forestry community in any BMP revision process.

The Alabama Forestry Commission also accepts responsibility to provide education and technical assistance to landowners, loggers, foresters, vendors and the general public to ensure that good stewardship principles are understood and used.

Purpose of Best Management Practices

Alabama's Best Management Practices for Forestry are **non-regulatory guidelines** (except for the U.S. Army Corps of Engineer's baseline BMPs on pages 16 and 17 which are mandatory) suggested to help Alabama's forestry community maintain and protect the physical, chemical and biological integrity of waters of the state as required by the Federal Water Pollution Control Act, the Alabama Water Pollution Control Act, the Clean Water Act, the Water Quality Act, and the Coastal Zone Management Act.

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

The most important guidance that 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 the Alabama Forestry Commission encourages their use when applicable to the landowner's objectives.

Following sound stewardship principles in carrying out forestry practices will ensure 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 all of these needs be met.

Responsibility

Responsibility for maintaining water quality standards during a forestry operation has been broadly interpreted to include all parties involved in the authorization, planning or implementation of the operation. **The responsible parties may include professional forestry practitioner(s) such as forest resource managers, timber purchasers, loggers, vendors, forest engineers or others.**

Due to this inherent responsibility it is in the best interest of all those involved in silvicultural operations to make every effort to prevent and correct violations of state and federal water quality laws, regulations and standards by consistently implementing BMPs.

SPECIFICATIONS FOR INDIVIDUAL BMPs

1. STREAMSIDE MANAGEMENT ZONES

Landowners should have adequate streamside management zones marked before negotiating bids for timber sales.

A streamside management zone (SMZ) is a strip of land immediately adjacent to a water of the state where soils, organic matter and vegetation are managed to protect the physical, chemical and biological integrity of surface water adjacent to and downstream from forestry operations. Table 1 provides guidelines for protecting the critical area within a SMZ.

Harvesting in streamside management zones should be done so as to protect the forest floor and under story vegetation from damage. Do not remove (harvest) trees from banks, beds, or steep slopes if it will destabilize the soil and cause degradation of the water. Trees on the south and west banks provide the most critical shading of water. Fell and skid trees directly away from waters of the state. According to Alabama Department of Environmental Management (ADEM) regulations, any tops or other logging debris dropped into the water or channel must be removed; **however, organic debris in the water prior to harvest should not be removed from the stream.** Stabilize wheel ruts if they could carry sediment into waters of the state. Locate log decks and roads outside of SMZs (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ).

Table 1: SMZ Minimum Standards[1]

Management	Perennial Stream	Intermittent Stream
Purpose:	Protect banks, bed, and floodplains from erosion; control direct deposition of pollutants; provide shade, food, and cover for aquatic ecosystems; filter out pollutants from uplands.	
Minimum width on each side of channel	In no cases should SMZs be less than 35 feet from a definable bank.[2] A landowner's personal management objectives, on-site condition or stream sensitivity may require wider SMZs and more stringent control of forestry operations within the SMZ. For example, width should be extended to account for erodibility of soil, steepness of slopes and activities to be performed outside of the SMZ.[3] SMZs must always be wide enough to maintain water quality standards.	
Delineation	Outside boundaries should be well marked before operations begin.	
Roads	Follow state and federal BMPs (see Sections 2, 3, and 6) for roads and stream crossings.	
Harvesting Method	Partial cut only within minimum of 35 feet; partial cut or regeneration cut can take place beyond 35 feet.	Partial cut or regeneration cut when water quality degradation can be avoided.
Minimum Residual Cover	50% Crown cover	Vegetative[4]
Reforestation	Natural regeneration, hand planting, direct seeding.	
Mechanical Site Preparation	No	
Herbicide	If herbicide is used, adhere strictly to label restrictions. Direct application is preferred over broadcast spraying.	
Fertilizer	No	

1 In cases where the stream channel is significantly braided, the forest should be managed under wetland BMP management recommendations (Section 6).

2 If wildlife is a major objective, a minimum SMZ of 50 feet is recommended.

3 USDA Natural Resources Conservation Service can provide information on soil erodibility.

4 Permanent residual tree cover is not required along intermittent streams as long as other vegetation and organic debris are left to protect the forest floor during regeneration.

2. STREAM CROSSINGS

The crossing of streams by roads, skid trails, or firebreaks should be avoided. Stream crossings cause a break in the canopy and filtration strip provided by an SMZ. It may take a large amount of time and effort to stabilize water quality impairment from excessive stream crossings. If stream crossings are unavoidable, use the fewest number, cross the stream/SMZ by the least disruptive manner possible, and control sediment and other pollutants.

In general, stream crossings should be located where the bank and SMZ will be least disturbed. They should be installed at right angles to the stream where the stream channel is straight, and should have gentle slopes and straight paths in and out of the SMZ. Water diversions should divert upland runoff so that sediment and other pollutants can be filtered out on the forest floor before reaching the stream. At no time should a perennial or intermittent stream be crossed without providing a way for normal passage of water or aquatic animals within the channel. **Follow mandatory federal BMPs listed on pages 19 and 20 when roads cross streams or any other wetlands.**

Log crossings involve placing hollow or solid logs into shallow channels. Green and/or small diameter tops, limbs and brush should not be used for this purpose. The surface can be improved by use of secured decking or portable logging mats; do not use fill dirt. All log crossings must be removed when the logging operation is complete.

Fords can be used where the stream bed is firm, banks are low and stream is shallow. Banks should be back bladed away from water and used to improve the approaches. Rock may be brought in to stabilize the approaches and stream bottom.

Culverts, properly sized and installed, should be used to reduce road washouts and impoundments of water. Culvert sizes in Table II are best estimates for normal rainfall but may not handle the largest storm events. One large pipe is better than several smaller pipes. Culverts should be long enough to extend at least one foot beyond the fill on either end. Fill material upstream and down must be stabilized. Possible techniques include use of sand bags, concrete, rip-rap, hay bales, mulch, and vegetation. Culverts should be cleaned out regularly.

Proper culvert installation.

After an operation or phase of an operation has been completed or is going into a period of inactivity, all temporary crossings must be removed and the site stabilized; all permanent crossings must be stabilized and maintained.

Table II

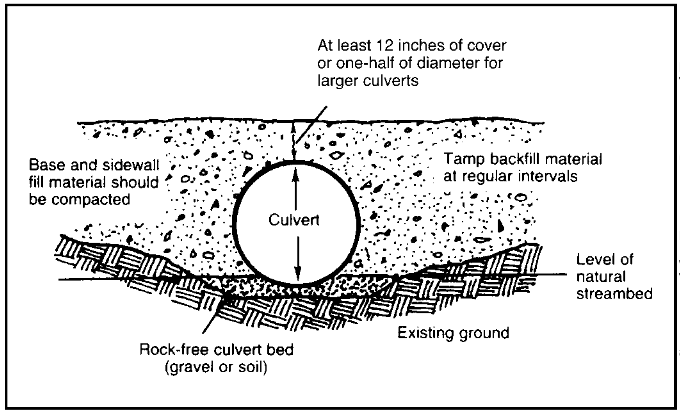
Recommended Diameters for Culverts

Drain Area (acres)	Lower Coastal Plain	Upper Coastal Plain	Piedmont	Mountains
10	12”	12”	12”	18”
50	30”	18”	30”	36”
100	48’’	30”	42”	48”
200	60”	42”	54”	two 48” pipes

Cleared stream crossing, stabilized with hay.

Culvert Installation

- Place culvert on stream bottom; do not dig below natural stream level to bury pipe.
- Culvert should have 2-3% pitch down-stream for self-cleaning.
- Compact lower half of fill during installation.
- Earth cover over pipe should be a minimum of 12” or half the culvert’s diameter, whichever is greater. Make fill over a culvert the high spot in the stream crossing.
- Provide for stream overflow away from culvert fill to prevent blowouts.



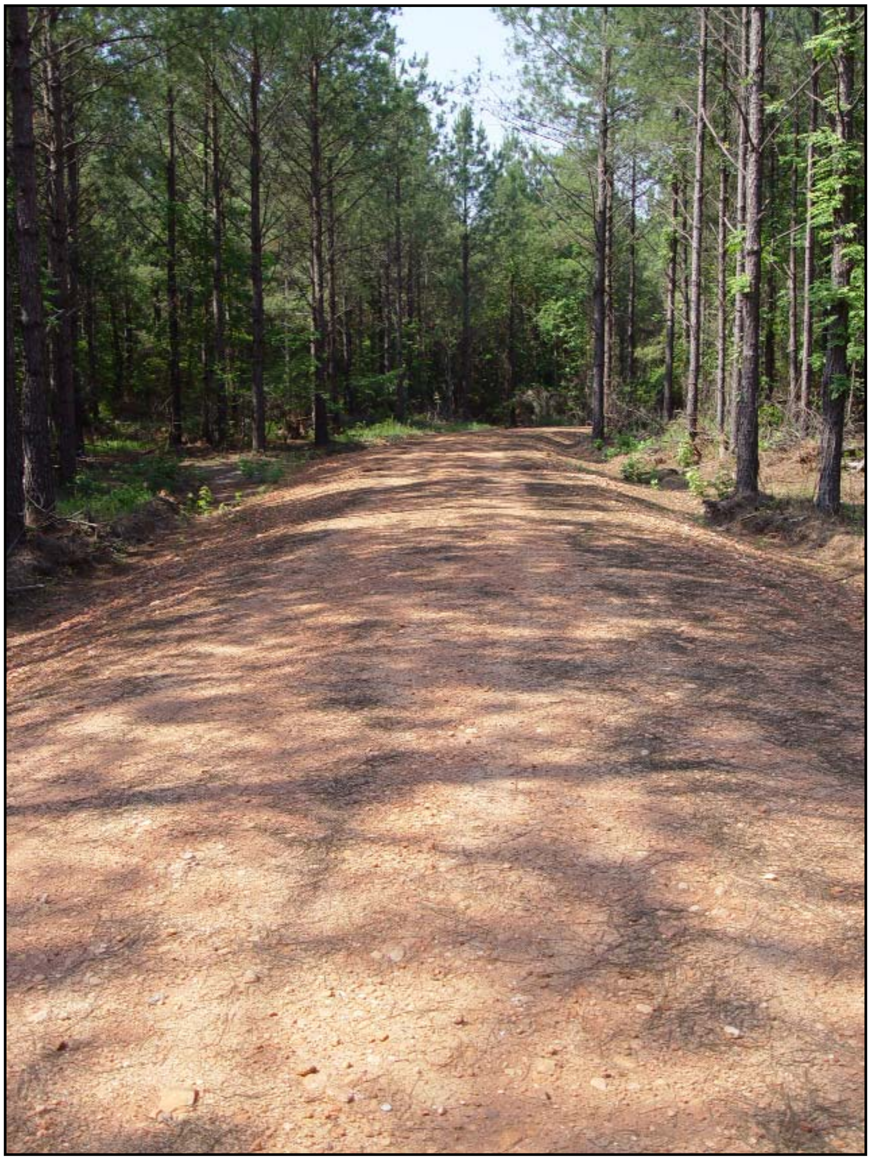
Courtesy of the Tennessee Division of Forestry

Proper installation prevents culverts from being crushed by heavy roads.

***Bridges** create the least disruption to stream flow. According to the Alabama Department of Environmental Management (ADEM) and Corps of Engineer regulations, banks and fill material must be stabilized and protected from erosion. Spans must be installed to permit passage of all expected high flow.*

Portable bridges can be used in a way that protects water quality and reduces effort and expense in the long run.

3. FOREST ROADS



Crowned forest road.

Proper planning and location of roads will minimize the potential for deposition of pollutants into waters of the state, future maintenance and expense, and the amount of land taken out of production. Old roads should be reopened only if they are properly located and drainage devices will function properly. New roads must avoid streamside management zones (except at proper stream crossings and access points or unless steep topography/wetland conditions necessitate location within the SMZ), troublesome or sensitive moisture-laden soils, eroded gullies, etc. Road grades should also be minimized where soils are highly erodible and/or topography is steep. Dredge and fill operations which may alter the flow, circulation or reach of waters of the state, especially wetlands, may require a permit from the Corps of Engineers.

Adequate drainage is the most important factor in controlling soil erosion and keeping roads in a serviceable condition. Construction techniques such as crowned roads, turnout ditches, out-sloping and in-sloping should be used to provide some slope to flat roads which would hold water.

Crowned roads are designed to quickly drain road surfaces from the center of the road to side ditches. This technique helps to prevent water from soaking into the road and making it soft and muddy.

Turnout ditches should be installed at appropriate intervals to disperse water collected in roadside ditches away from the road base into surrounding vegetation.

Outsloped roads in hilly or mountainous terrain are graded at a 2-4% pitch to the downhill side of the road to drain off water as quickly as possible. Avoid berms of dirt along the outer edge of outsloped roads because they hold water in the road.

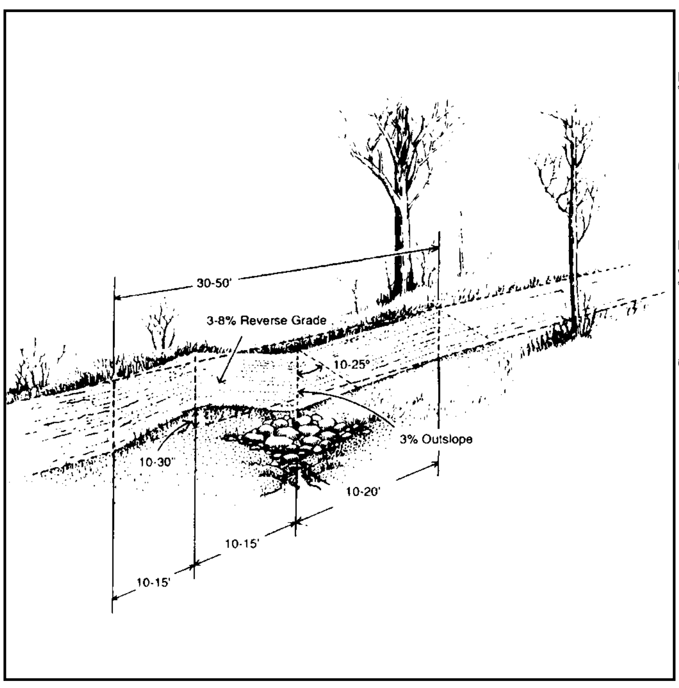
Insloped roads may be preferable when roads are built on side slopes with slippery soils and/or in steep terrain. Water collecting in the inside ditch, however, will have to be drained under the roads through culverts and be dispersed into vegetation on the outside of the road.

Construction of permanent roads should take place with the following considerations:

- Use at least the minimum design standard consistent with anticipated traffic and reasonable safety.
- Merchantable timber should be cleared from the right of way before the arrival of grubbing equipment.
- Stumps, logs, slash and other organic debris should not be covered with fill material and incorporated into road beds.
- Minimize the amount of soil on the road banks or roadsides that is exposed to soil erosion. Balancing cuts and fills whenever practical is one means of minimizing soil exposure. Stabilize these areas as they are created to minimize any problems.
- Functional water diversion techniques or devices should be installed at the same time that roads are constructed. Drainage water should be dispersed onto the undisturbed forest floor whenever possible.

Excessive road steepness, on the other hand, may allow surface water to build up velocity and cause erosion. A variety of water diversion devices can be used to direct water from roads and ditches into vegetated areas upslope from streams in order to slow water down and filter out sediment.

Broad-based dips are an effective means of diverting water off a permanent road without interfering with truck or skidder traffic. They hold up well and remain effective under traffic as long as the outfall remains below the dip in the road grade. Gravel in the bottom of the dip may be necessary on some soils to hold up vehicles operating in wet conditions.



Courtesy of the Tennessee Division of Forestry

Broad-based dips are designed to move water off roads and facilitate the ease of vehicle use.

Water bars (and turnouts) installed at 30-45 degree angles are best used to stabilize temporary roads and skid trails that will no longer be used. Water bars may not hold up well or maintain their effectiveness when they are packed down or rutted by truck, skidder or four-wheeler traffic. A series of small water bars, well anchored into the hillside, can be constructed by a skidder or bulldozer.

Maintenance of permanent roads should take place with the following considerations:

- Regular periodic inspection should start immediately after construction to determine maintenance requirements that prevent excessive erosion, impairment of natural drainage, or water quality problems.
- After an operation is completed, rutted or channeled roads should be reshaped and stabilized with functional water diversion devices to allow good drainage and control erosion.
- Seeding and mulching may be necessary to stabilize roadsides and closed temporary roads.
- Special soil stabilizing materials are available for particularly vulnerable areas (see USDA Natural Resources Conservation Service for dealers).

Outfall protection should be provided to prevent erosion by absorbing the energy of water falling from the outlet end of water diversion devices. Use rocks, concrete, mulch, woody debris or dense vegetation. Outfalls must never be installed where runoff can be discharged or flushed directly into waters of the state.

Table III

Diversion devices can generally be installed using the following spacing guide. However, soil erodibility and natural drainage opportunities should also be considered for determining appropriate spacings. The USDA Natural Resources Conservation Service can provide information about the erodibility of soils.

% Slope	Distance between water bars	Distance between broad-base dips and turnouts
3%	200’	235’
5%	135’	180’
10%	80’	140’
15%	60’	125’
20%	45’	
30%	35’	
40%	30’	

Control non-essential traffic during wet weather on roads which have a high potential for erosion; particularly immediately following construction.

A single large water bar constructed by a bulldozer can be used to close temporary roads to any further two-wheel drive traffic.

4. TIMBER HARVESTING

Harvesting activities should be conducted to ensure long-term maintenance of water quality. The following suggestions will help timber harvesters achieve this objective.

Temporary access roads (logging roads) and landing locations should be planned before operations begin to minimize soil disturbance. Road construction should be kept to a minimum, consistent with reasonable skidding distance. Spring heads, natural drainages and gullies should be avoided. Landings should also be kept as small as possible, consistent with safe and efficient operation. Logging roads and landings must be located on firm ground, outside of Streamside Management Zones and above the ordinary high water mark of streams.

Landings must be located to prevent the adverse impact of skidding on water quality. Locating logging decks uphill and skidding up to them results in a cone-shaped pattern of skid trails which disperses water running downhill. If the logging deck is on the lower slope, the V-shaped pattern of skid trails could concentrate runoff and erode the logging deck areas. If the trees must be skidded downhill, erosion can be minimized by using several, smaller logging decks with fewer, smaller skid trails leading to any one.

When operations are completed, landings and temporary roads should be stabilized with water diversion devices and/or vegetation where there is a possibility of significant erosion and/or water quality degradation.

Felling should be done carefully to minimize the impact of subsequent phases of logging operations on water quality. Timber cut in Streamside Management Zones should be harvested in accordance with recommended guidelines on pages 4 and 5.

Skidding should be done to avoid disrupting natural drainages, prevent excessive soil displacement, and minimize impacts of rutting, compaction, and puddling on water quality and soil stability.

Stream channels and natural drainages must not be used as skid trails. They should be crossed following guidelines in Section 2.

Where slopes are steep but short in duration, trees can be felled uphill and winched to the skidder. Skid trails on steep slopes should have occasional breaks in grade and upon completion of use, must be water barred. Erosion in skid trails can sometimes be reduced by covering them with logging slash. Logging slash can also be scattered over temporary landings to help stabilize them.

When wet and/or soft ground conditions cannot be avoided, it is better to concentrate soil compaction from skidder traffic on a few trails that can be stabilized rather than disperse the effects over many trails.

Cut-to-length harvesting systems offer state-of-the-art equipment and best available technology to maximize timber production and protect water quality and other forest resources at the same time.

Primary benefits of this system are from forwarders (or prehaulers) which can haul wood off the ground for long distances and need only minimum skid trails or landings. Less soil is displaced, rutted, and compacted. The on-board loader can be used to place logs for stream crossings and easily remove them when the crossing is no longer needed. In addition to high initial costs, however, this equipment is also limited by very steep terrain.

Trash disposal must be properly handled throughout the operation in accordance with all applicable laws. Fuel, lubricants and other toxic chemicals must never be drained into the soil. Food and drink containers, discarded equipment parts, and used fluids must be properly removed and disposed of. Trash must not be burned or buried on site.

5. REFORESTATION / STAND MANAGEMENT

Bedding on a contour.

Mechanical site preparation treatments must be used in such a manner as to minimize displacement of forest litter and topsoil, soil compaction and erosion, stream sedimentation and the deposition of debris into waters of the state. The degree of mechanical site preparation should be limited to the amount that is needed to get a well stocked stand of desirable trees. In general, mechanical site preparation should be excluded from soils with slopes exceeding 25%. No mechanical site preparation should be used in SMZs.

Drum chopping is one of the most desirable methods of mechanical site preparation for the protection of soil and water quality. When chopping is done on steep slopes it should always be done up and down hill so that sediment can be trapped in the slits created by the chopper blades.

Bedding on slopes exceeding 2% should follow the contour. On slopes 2% or less, beds should follow the natural drainage of the land. *Ripping and/or sub-soiling* should be done on the contour.

Disking should be done on the contour and restricted to areas with slopes 10% or less.

Shearing requires that the operator keep the blade out of the soil to minimize soil disturbance. Avoid over-raking the area. The retention of small limbs, twigs, bark and rock on the ground surface helps reduce soil erosion.

Windrows should be laid out on the contour of the land 100 to 300 feet apart depending upon the slope of the land and erodibility of the soil. Topsoil should not be pushed into windrows. Debris may not be piled into any water of the state.

Straight blade bulldozing is the least desirable method of mechanical site preparation.

Windrows.

Chemical site preparation, with or without the use of fire, can duplicate or surpass mechanical site preparation results with less water quality impact.

Herbicide applications must follow the manufacturer's label instructions, EPA guidelines and Alabama State Law. Herbicides should not be aerially or broadcast applied in SMZs. Under no circumstances should herbicides be applied directly onto or allowed to drift or wash into surface waters unless labeled for such applications. Do not mix or clean equipment or herbicide containers in or near streams or water bodies. Frequent inspection of equipment is recommended.

Prescribed burning should be designed and managed to minimize adverse environmental effects. Avoid intense spray and burns on steep slopes and highly erodible soils if water quality would be impacted.

Constructed firebreaks can be tied into existing natural barriers to minimize the need for fresh soil disturbances. Firebreaks should be stabilized with water diversion devices to minimize erosion and conveyance of sediment laden runoff into waters of the state. Vegetating firebreaks can further reduce erosion and the movement of sediment and other pollutants into waters of the state.

Wildfires demand that the primary objective of firebreak construction is to bring the fire under control.

Tree planting with a furrow type machine should be done on the contour.

Planting on a contour.

Constructed firebreak.

6. FORESTED WETLAND MANAGEMENT

Wetlands are 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.

The U.S. Army Corps of Engineers, using the *Federal Manual for Delineating Jurisdictional Wetlands*, determines under which conditions hydrophytic vegetation, hydric soils, and wetland hydrology must be present on the same site, under normal circumstances, for an area to be classified as a wetland. Jurisdictional wetlands may be found in the following

- Coves and lower slopes
- Branch bottoms
- Creek bottoms
- River bottoms
- Muck swamps
- Peat swamps and cypress/gum ponds
- Wet flats

Section 404 of the Clean Water Act usually requires that a permit be obtained from the Corps of Engineers before a discharge of dredged or fill materials can be made into waters of the United States (U.S.), including wetlands. A regulated discharge occurs when fill or dredged material is deposited into wetlands.

Exemptions for forestry activities from having to obtain an individual Section 404 permit from the Corps of Engineers may apply if the activities meet the following conditions:

1. It is not part of an activity whose purpose is to convert a wetland into an upland, where the flow or circulation of the waters of the U.S. may be impaired or the reach of water reduced; and

2. It is part of an established (i.e. ongoing) silvicultural, farming or ranching operation and not a new use to which the wetland was not previously subject; and

3. It uses "normal" silvicultural, farming or ranching activities which are in compliance with federal BMPs (listed under "Roads and Stream Crossings . . ." on, pages 19 and 20); and

4. It has not lain idle for so long that hydrological modifications will be necessary to resume operations; and

5. It does not contain any toxic pollutant listed under Section 307 of the Clean Water Act.

What is an established silvicultural operation? Established or ongoing operations are included in a management system (not necessarily written) which is planned over conventional rotation cycles for a property or are introduced as part of an ongoing operation.

Evidence of use of the property may be used to determine whether an operation is ongoing. Such evidence includes the following:

1) a history of harvesting with either natural or artificial regeneration; 2) a history of fire, insect, and disease control to protect the maturing timber; and 3) the presence of stumps, logging roads, landings, or other indications of established silvicultural operations that will continue on the site.

While past management may have been relatively non-intensive, intensification of management involving artificial regeneration and other practices can occur as part of a conventional rotation and be considered an established operation.

Although wetland regulations do not require a written forest management plan, it is in a landowner's best interest to have one to document that operations are established, that BMPs are implemented and effective, and that all activities are consistent with other Section 404 exemption criteria.

A change in ownership between landowners (both of which manage forested wetlands for silvicultural purposes) has no bearing on whether a forestry operation is part of an established ongoing activity. Continuation or strict adherence to a management plan written for the previous owner is not required by Section 404 silvicultural exemptions.

"Normal" silvicultural activities (such as road construction, timber harvesting, mechanical or chemical site preparation, reforestation, timber stand improvement, and minor drainage) conducted as part of established ongoing silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Those measures are listed under "Roads and Stream Crossings. . ." on pages 19-20. *Alabama's Best Management Practices for Forestry* are not required for exemption from Section 404 Corps of Engineer permit requirements; they are, however, **strongly** recommended to minimize nonpoint source pollution of waters of the state and/or waters of the U.S.

A forestry activity or operation WILL require a 404 permit from the Corps of Engineers when the following applies:

1. The activity results in the immediate or gradual conversion of a wetland to an upland as a consequence of altering the flow and circulation or reducing the reach of waters of the U.S.

   Changes in flow, circulation or reach of waters can be affected by permanent major drainage such as channelization or by placement of fill material. A discharge which changes the bottom elevation of waters of the U.S., without converting it to dry land, does not reduce the reach of waters but may alter flow or circulation and therefore may be subject to permitting requirements.

   The criteria that are used to determine if a wetland has been converted include a change in hydrology, soils and vegetation to such an extent that the area no longer qualifies as a jurisdictional wetland according to the *Federal Manual for Delineating Jurisdictional Wetlands.*

2. A new activity results in a change from the past, historical use of the wetland into a different use to which it was not previously subject where the flow or circulation of waters is impaired or the reach of the water is reduced. Such a change does not meet the established, ongoing requirement and causes the activity or operation to lose its exemption.

   Examples of this situation are areas where tree harvesting has been the established use and the landowner wishes to convert the site for use as pasture, green tree reservoir, agriculture, real estate or aquaculture. In such cases the landowner must first obtain a 404 permit before proceeding with the change. (Changes of use to farm stock ponds may be exempt under a nationwide Corps of Engineers permit).

3. Roads and stream crossings are constructed in a wetland without following the mandatory, federal BMPs listed under the wetland road regulations.

4. The area has lain idle for so long that hydrologic modifications are necessary to resume operations. This does not refer to temporary water management techniques such as minor drainage, plowing, bedding and seeding which exempt, normal silvicultural activities as long as they don't result in the conversion of wetlands to uplands. However, it does apply to reopening ditches which were once established as permanent wetland drainage structures but have lost their effectiveness for this purpose as they filled in with soil and vegetation.

BMPs for wetlands are not intended to make up for uncontrolled negative impacts on uplands but are part of the overall management of the full landscape to protect water quality.

Streamside management zones should be established and managed around the perimeter of all major drainages and open bodies of water (i.e., main stream courses, oxbow lakes, sloughs) contained within wetlands.

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

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

Roads and stream crossings within wetlands and other waters of the U.S. *must* be constructed and maintained in accordance with the following U.S. Army Corps of Engineer baseline BMPs (from Section 404, Corps of Engineers Permit Requirements, 40 CFR Part 233.22) in order to retain exemption status for the road operation:

1. Permanent roads, temporary access roads and skid trails (all for forestry) in waters of the U.S. shall 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, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;

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

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

5. Discharges of dredged or fill material into waters of the U.S. to construct a road fill shall 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. shall be kept to a minimum;

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

8. Borrow material shall be taken from upland sources whenever feasible;

9. The discharge shall 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 water fowl, spawning, and wetlands shall be avoided if less harmful alternatives exist;

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

12. The discharge shall not occur in areas of concentrated shellfish production;

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

14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts; and

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

Timber harvesting using normal methods and equipment may be appropriate if harvesting is timed during dry periods.

Harvesting during wet periods or sites that remain wet require special precautions and harvesting systems to minimize water quality hazards and other negative site impacts. Site damaging effects from harvesting equipment such as rutting, puddling and compaction should be controlled and minimized. For example, concentrate skidder traffic on a few trails rather than over the entire area. Do not harvest sites during periods of flowing water whether from overbank flooding or other water accumulation.

Roads must be constructed and maintained in accordance with BMPs to assure that flow and circulation pattern and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. is not reduced and that any adverse effect on the aquatic environment will be otherwise minimized.

Minor drainage is allowed (i.e., to maintain a dry road bed) unless it becomes obvious that BMPs have not been followed or that the road is serving some function other than conveyance of vehicles (i.e., a continuous roadside barrow ditch may not be used to drain adjacent wetlands.

Reforestation in wetlands is not much different from regenerating uplands in regards to water quality; the main factors to consider are the site's potential for erosion/sedimentation and hydrology.

Land clearing is an exempt silvicultural activity if it is associated with timber harvesting or reforestation operations. However, land clearing using mechanical equipment for purpose of removing vegetation in preparation for converting the site to a different land use is not part of an established silvicultural operation and is not exempt from having to go through the Corps of Engineer permitting process.

Herbicides bearing the "wetlands" warning on the label can be applied to vegetation on dry soils of jurisdictional wetland areas but must not be applied directly to surface water or to inter-tidal areas below the main high water mark.

Bedding is the construction of earthen mounds from surrounding soil resulting in adjacent and alternating "beds" and furrows. Seedling beds create temporary elevated soil conditions which allow seedlings to escape saturated soil conditions and have a greater opportunity to survive and grow.

Bedding is considered a normal silvicultural activity that is exempt from Section 404 permitting requirements if the following conditions exist:

- The bedding does not result in the gradual or immediate conversion of a wetland to upland as a consequence of impairing the flow or circulation or reducing the reach of waters of the U.S.; and
- It is performed as part of an established, ongoing silvicultural operation.

However, if bedding were to significantly alter the flow, circulation, or reach of waters of the U.S. and consequently result in conversion of a wetland to an upland, the exemption would no longer apply.

Species composition change (i.e., bottomland hardwood to pine plantation) resulting from intensification of management is considered a normal, silvicultural activity that is exempt from 404 permitting if the property is in silvicultural usage before and after the harvesting and planting.

However, a species composition change is not exempt if the activities used to clear, prepare or plant the site would result in a change in use that is accompanied by an impairment of the flow or circulation or the reduction of the reach of waters. An example of such a new use situation would be where the change in species composition would cause a conversion of wetlands to uplands.

Removal of beaver dams and other blockages to remove impounded surface water is considered exempt from 404 permitting as long as the process does not include enlarging or extending the dimension or changing the bottom elevation of the affected drainage way as it existed prior to the formation of the blockage, or without changing the use of the land in question.

Beaver dams can be dismantled by hand without any problems. Dynamite and heavy equipment can also be used to destroy dams as long as they are not used to construct drainage channels that will result in conversion of wetlands to uplands. However, when dynamite or heavy equipment is to be used to remove beaver dams or other blockages, the Corps of Engineers should be contacted for possible permit requirements.

***Before and After**: Top photo shows blockage caused by beaver dam. Bottom photo illustrates flow restored.*

7. Revegetation/Stabilization

Skid trail stabilized with logging slash.

As already pointed out in previous sections, some temporary haul roads, skid trails, log landings, fire-breaks and other forestry related soil disturbing activities require the establishment of a vegetative cover to stabilize mineral soil surfaces so as to reduce erosion and runoff of sediment into state waters. The USDA Natural Resources Conservation Service can provide a detailed plan for establishing vegetation on these disturbed sites.

Site preparation, such as smoothing or reshaping rutted roads and landings, may be required before conventional equipment can be used for seedbed preparation, seeding, mulching and drainage improvement. Heavily compacted areas may require ripping and/or disking to allow water infiltration and provide a suitable seedbed for root growth.

Agricultural limestone and fertilizer may be needed to ensure success in establishing a vegetative cover. Soil tests are recommended. Incorporate lime and fertilizer into the top 2-4" of soil on slopes less than 6%; into the top 2"of soil on slopes of 6-10%; and onto the surface only on slopes greater than 10%.

Plant species recommendations can be obtained from the local county office of the USDA Natural Resources Conservation Service or Cooperative Extension Service. Areas treated by temporary seeding or mulch should be reseeded with permanent vegetative species as soon as possible during the correct growing season to ensure stabilization of disturbed areas. Disking or mowing of temporary cover is recommended before application of permanent seed and fertilizer.

Mulch is recommended for critical situations to hold seed, lime and fertilizer in place, maintain moisture and prevent extreme temperatures on the soil surface. Mulch needs to be applied immediately after seeding to provide best benefits.

Vegetative establishment for control of erosion and sedimentation can be considered successful once a 75% cover has been obtained. Within one

Vegetated forest road.

year of establishment, a second broadcast application of fertilizer at half the original rate is recommended to ensure plant survival and growth.

Silt screen and hay bales can be used to filter runoff water from closed roads and skid trails to prevent or stop sediment from flowing downslope into waters of the state. When using silt screen, 5-6 foot-long posts should be staked 5-10 feet apart across the problem area. The porous material is stapled 3 feet high on the post and excess material at the bottom of the screen is folded uphill and anchored down with rocks or fill material. Hog wire can be stapled to the stakes before the material is attached to give strength to the silt screen as intercepted sediment builds up.

Square hay bales can be used for the same purpose by lining them up across the road, end to end and one to two bales high. Stake the bales in place on their sides with the strings off the ground to prevent rotting.

Gully stabilization should receive high priority during all land management activities. The most effective way to reduce sediment production and/or reduce the change of reactivating the erosion process in healed gully systems is to avoid operating in them and maintain all existing vegetation. Site preparation, including herbicide and burning, should be excluded.

Actively eroding gully systems need to be stabilized. The USDA Natural Resources Conservation Service can provide technical assistance in planning and installing gully stabilization measures.

APPENDICES

Glossary

ADEM – The state regulatory agency (Alabama Department of Environmental Management) which administers and enforces the Alabama Water Pollution Control Act.

Approaches – The entry and exit of a road or skid trail through a stream crossing.

Aquatic ecosystem – An interacting community of plants and animals (i.e., insects, crayfish, fish and amphibians) requiring an abundance of water during some part of their life cycle.

Backblade – To pull dirt by dropping a dozer blade into the soil and operating the tractor in reverse.

Back slope – The soil profile in the side of a hill that is exposed from cut and fill type road construction.

Banks – The sides of a channel which holds or carries water.

Bed – The bottom of a stream.

Bedding – A mechanical site preparation technique where top soil is mounded into rows. Trees planted on top of the row will be well drained and will benefit from a concentration of nutrients and organic matter during initial stages of growth.

Biological integrity of waters of the state – The ability of a body of water to support the natural level of diverse plants and animals that would normally occur without man-made disturbance or manipulation of the landscape.

Broad based dip – An alteration of a road grade to intercept water from the surface and dispel it to the side without seriously interfering with vehicular traffic.

Canopy – The upper leafy branches of dominant and codominant trees and shrubs which intercept sunlight and shade the ground.

Chemical integrity of waters of the state – The natural range of nutrient and pH levels which would normally occur in waters passing through an undisturbed site.

Compaction – The result of all air and moisture holding spaces being squeezed out from between soil particles by operation of heavy equipment during unfavorable ground conditions. All soils are generally more easily compacted when wet. Compacted soil is less productive and more erodible.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation.

Corps of Engineers – The federal regulatory agency, a branch of the U.S. Army, which administers and enforces the Section 404 permitting program of the Clean Water Act.

Critical shading of water – Shading when water receives the greatest protection from overheating and ultraviolet exposure caused by solar radiation.

Cross drain – A pipe, ditch or channel which safely conveys water from one side of the road to the other.

Crown – The top of a tree consisting of trunk and expanding branches.

Culverts – Usually metal or plastic pipe but can be a constructed wooden trough.

Cut and fill – Earthen material which is dug out of a hill and placed down slope to provide a relatively level road bed.

Deck – An area cleared to provide a site for loading logs onto a transport vehicle.

Decking – Rough or unfinished lumber used to provide a stable surface for roads, stream crossings or landings.

Definable bank – The bounds of a water body at or below its normal flow level which is usually devoid of terrestrial plants and accumulations of light organic debris.

Deposition – The act of depositing or putting into.

Destabilize (the soil) – To expose and/or loosen soil thus making it more susceptible to erosion.

Direct seeding – Artificially placing seed by hand, land machine or aircraft onto a germination surface.

Disking – Breaking up plants (above and below ground portions), organic matter and soil in preparation to improve the ground for replanting and to reduce plant competition.

Diversion device – A structure to intercept and re-route water from a road surface.

Drainage device – Same as diversion device.

Dredge – Earthen material that is dug from a channel or removed from the bottom of a water body, often to improve drainage.

Ephemeral streams – Low places in the landscape that only flow shortly after significant rainfall. Does not have a well defined channel.

EPA – The U.S. Environmental Protection Agency. The federal agency created and mandated by the U.S. Congress to administer and enforce the Clean Water Act upon waters of the United States.

Erosion – The dislodging and carrying away of soil particles by wind or water.

Fell – To cut or knock down standing trees or other vegetation.

Fill – To raise the elevation of a surface by depositing dredged or excavated material onto it.

Filtration strip – A strip of land where vegetation, mulch, or fabric is maintained or placed to intercept and prevent upland sediment and other pollutants from flowing into water.

Firebreaks – Natural or artificially constructed barriers to the spread of fire.

Floodplain – Areas adjacent to bodies of water that are most prone to flooding when the water overflows its banks.

Forest floor – Accumulations of organic debris and low vegetation on the ground beneath a stand of trees.

Forest resource managers – This group includes foresters, wildlife biologists, recreational planners and other developers.

Fragile area – Areas that are easily altered physically, biologically, or chemically, and are difficult or slow to recover.

Grade – The steepness of rise or fall of a road surface.

Ground cover – Low growing vegetation such as grass, forbs, vines, or shrubs.

Ground water – Water stored and/or flowing out of sight under the surface of the ground.

Hand planting – Re-establishing vegetation by planting seed or seedlings into prepared planting holes in the ground.

Harvests – Gathering merchantable portions of trees for commercial or domestic use.

Herbicide – a natural or synthetic chemical pesticide applied specifically to control competition from undesirable plant species.

High flow – The increased volume and speed of water that exceeds a stream's normal rate of flow.

High water mark – Physical evidence of past flooding such as discoloration of the lower portions of vegetation or debris suspended in branches off the ground.

Implementation – The carrying out of instructions contained in a management plan, harvest plan or reforestation plan (written or verbal).

Impoundments – An accumulation of water into pools or ponds formed by blocking the natural drainage.

Inslope – Sloping of a road surface so drainage is toward a ditch between the road and hill.

Intermittent bodies of water – Contain water within well defined channels during part of the year.

Label restrictions – Explicit instructions from the manufacturer with approval from federal and state authorities on when, where, and how a particular pesticide may be applied. Instructions also usually include worker and environmental safety precautions.

Landing - A site where logs are sorted and loaded onto trucks for hauling to handling or processing facilities.

Litter Layer – The natural buildup of dead leaves, branches and stems of dead trees and other forest vegetation which accumulate on the ground and then decay with time.

Log decks – Same as landings.

Mechanical planter – A tree planting machine pulled by a tractor and manned by a person who places trees into the ground.

Mechanical site preparation – Use of heavy machinery such as bulldozers with special attachments that clear debris or incorporate it into the soil to improve planting, sprouting, growth and or survival conditions for new forest trees.

Minimum residual cover - The fewest number of trees necessary to provide shade, natural recruitment of organic material, and soil holding capability for protection of the biological integrity of aquatic ecosystems.

Mulch – A coarse material used to protect soil from rainfall impact and erosion and to improve germination and growth of vegetation. Examples are hay, straw, bark and geotextile fabric.

Natural barrier – Areas that are devoid of fuel or food to support a spreading fire or insect or disease epidemic.

Natural drainage – Perennial, intermittent and ephemeral stream courses in a watershed that collect and expel runoff water.

Natural regeneration – Young trees that originate from seed or sprouts of trees that do or did grow on the site.

Nonpoint source – Water pollution which is not traceable to any discrete or identifiable facility but comes from a broad treatment area.

Normal passage of water and/or aquatic animals – Movement of water or animals which has not been obstructed or inhibited as the result of man-made activity.

Nutrients – Substances that nourish such as nitrogen, potassium and phosphorus in fertilizer. Excess nutrients can destabilize aquatic ecosystems.

Organic debris – Refuse such as tree tops, limbs or severely damaged tree stems which are left following road construction, logging, or site preparation.

Organic matter – Dead plant parts or animals. While natural recruitment of organic matter is part of the energy and nutrient cycles of an aquatic ecosystem, decay of excess amounts in water depletes oxygen needed by fish and other aquatic animals. Tops and other debris can sometimes block and divert the flow of streams causing additional erosion.

Partial cut – A selective timber harvest method where particular trees are usually designated to remain in the stand and the rest are removed in a thinning harvest.

Perennial bodies of water – Contain water within well defined channels virtually year round under normal climate conditions.

Permanent road – A road constructed, used and maintained beyond the time period of a single operation such as a timber sale.

Pesticide - See herbicide for specific application.

Physical integrity of waters of the state – The retention of water in its natural condition without alteration of stream course, depth, clarity or freedom of obstructions that might occur as the direct result of man-made activity.

Plowed fire control line – A man-made fire break constructed by a heavy piece of equipment such as a small bulldozer pushing or pulling a heavy duty plow designed for cutting through the forest floor and root mat to clear combustible material and expose mineral soil.

Pollutants – Man-induced elements such as sediment, organic debris, increased temperature, nutrients, chemicals, trash and soil degradation which exceed a water's natural ability to neutralize before changes in the physical, chemical or biological integrity of waters of the state occur.

Portable bridge – a stream crossing device that is preassembled, installed across a channel and removed following completion of an activity with minimum adverse impact to water quality.

Portable logging mats – Temporary road or stream crossing surface constructed of rough cut lumber nailed or bolted together. These are usually expected to be removed and reused following completion of a particular operation.

Prescribed burning – Preplanned fire that is deliberately set in a time and manner when prescribed conditions will allow accomplishment of specific objectives and is under control until it burns out or is extinguished.

Puddling – The destruction of root systems and soil structure by the tearing and churning action of heavy equipment operating in saturated soils. Puddled soils are more susceptible to erosion than undisturbed soils.

Reforestation – The restocking of a forest stand through natural regeneration or artificially planted seed or seedlings.

Regeneration – A young stand of a forest.

Regeneration cut – Either partial harvests where selected trees are left to provide adequate seed or silvicultural clearcuts where all merchantable and non-merchantable tree stems are removed or felled to encourage sprouting of desirable tree species.

Riprap – Large stones which are arranged over loose soil to protect it from erosion.

Rutting – Impression left in the ground after soil is compacted by the wheels or tracks of heavy equipment operating in soft earth. Deep rutting can disrupt surface and subsurface hydrology on flat lands and cause soil erosion on steep lands by concentrating surface runoff.

Sediment – Accumulations of loose soil particles. Excessive amounts of sediment can pollute water needed for aquatic ecosystems, drinking, wildlife, outdoor recreation, and industrial use.

Shearing and raking – A site preparation technique that uses a large tractor equipped with a special cutting blade to cut down trees just above the ground surface and a second tractor equipped with a specialized raking blade that pushes the felled trees and other debris into piles or windrows.

Side bank – Same as back slope.

Silviculture – The care and cultivation of forest trees; forestry.

Site preparation – Use of machines, herbicides, fire or combinations thereof to dispose of slash, improve planting conditions and provide initial control of competing vegetation.

Skid – To drag logs with a specialized tractor to a landing.

Skid trails – Paths where logs have been dragged.

Slash – Unmerchantable debris such as brush or tree stems, tops, branches or leaves that are left following a commercial timber harvest operation.

Slough – An open water inlet from a larger body of water.

Soil stabilizing materials – Silt fencing, straw blankets, geotextile fabric, geoweb, etc., applied to protect soil from erosion.

Soil type – Consistent characteristics of an identifiable soil such as particle sizes, moisture holding capacity, plasticity and ease of compaction.

Span – A structural beam designed to hold other bridge components and traffic above a stream or channel.

Steep gradient – A high rate of ascent or descent on a road.

Stringent – Tightly regulated or controlled.

Surface water – Exposed water above the ground surface.

Temperature – The degree of hotness or coldness of an environment. Removal of vegetative shade from banks of streams and shores will directly raise water temperature and indirectly result in lower dissolved oxygen levels. These influences place some fish and other organisms under stress.

Temporary access roads – Roads not expected to be maintained much longer than the activity for which they were installed to support.

Timber purchasers – Agents who locate commercial stands of timber and negotiate terms of purchase on either their own behalf or on the behalf of timber brokerage or forest product companies.

Topography – The lay of the land.

Tops – The upper (usually referring to unmerchantable) portions of trees.

Trash – Unnaturally occurring, man-made refuse or discarded substances. Openly discarded trash and petroleum wastes may be carried into waters of the state by storm runoff and is unsightly.

Understory vegetation – Small trees, shrubs or other plants which grow beneath the canopy of more dominant trees.

Upland runoff – Surface drainage water which flows from higher elevations of a landscape into the natural drainage system of a watershed.

Vendors – Contractors who provide tree harvesting, site preparation, tree planting or other forestry services for a fee.

Washouts – Clearing of natural or man made obstructions of drainage systems during high stream flows.

Water bar – A long mound of dirt constructed to prevent soil erosion and water pollution by diverting drainage from a road or skid trail into a filter strip.

Water bodies – Branches, creeks, rivers, ponds, lakes, bays, etc.

Water diversions – Structures or devices which change the direction of drainage flow.

Water quality impairment – The reduction of water quality below established water quality standards.

Waters of the State – Include every watercourse, stream, river, wetland, pond, lake, coastal, ground or surface water, wholly or partially in the state, natural or artificial which is not entirely confined and retained on the property of a single landowner.

Waters of the United States (U.S.) – Include all waters such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands and sloughs which are susceptible to use in interstate or foreign commerce, recreation, fish and shellfish production and industrial use; impoundments of waters just described; tributaries of waters just described (other than waters that are themselves wetlands).

Wildfire – Fires burning without the control of a responsible person.

Windrows – Long piles of accumulated debris.

Wing ditch – A secondary “turn out” ditch that diverts drainage water from primary roadside ditches, to be filtered out into the surrounding area.

Additional Resources

Additional information pertaining to silvicultural BMPs and water quality is available from the following publications and sources of assistance:

Streamside Management Zones

Comerford, N.B., D.G. Neary and R.S Mansel. *The Utility of Buffer Strips to Protect Forested Wetlands from Impacts Due to Forest Silvicultural Operations,* Gainesville, FL, National Council of the Paper Industry for Air and Stream Improvement, In Press.

Dickson, J.G. and J.C. Huntley. "Riparian Zones and Wildlife in Southern Forests," *Managing Southern Forests for Wildlife and Fish*, Ed. J. Dickson and O. Maughan, USDA Forest Service General Technical Report 50-65, (1987), 37-39.

Helfrich, L.A. et al. *Landowner's Guide to Managing Streams in the Eastern United States,* Virginia Cooperative Extension Service Publication 420-141, 1986.

James, B.R. "Riparian Vegetation Effects on Nitrate Removal from Groundwater," *Journal of Environmental Quality*, University of Maryland, In Press.

Kundt, J.F. et al. *Streamside Forests: The Vital Beneficial Resource*, Maryland Cooperative Extension Service, 1988.

Miller, E. "Effects of Forest Practices on Relationships Between Riparian Areas and Aquatic Ecosystems," *Managing Southern Forests for Wildlife and Fish*, Ed. J. Dickson and O. Maughan, USDA Forest Service General Technical Report 50-65, (1987), 40-47.

Practical Approaches to Riparian Resource Management: An Educational Workshop, Billings, MT, US Bureau of Land Management BLM-MT-PT-89-001-4351, 1989.

Rudolph, D.G and J.G. Dickinson. "Streamside Zone Width and Amphibian and Reptile Abundance," *The Southwestern Naturalist,* 35, (1990), 472-476.

Schilling, Erik B. and B. Graeme Lockaby. *Streamside Management Zones in Alabama: Functions and Management,* Auburn University Center for Forest Sustainability.

Swift, L.W. "Filter Strip Widths for Forest Roads in Southern Appalachians," *Southern Journal of Applied Forestry*, 10 (1984), 27-34.

Warmwater Streams Symposium: A National Symposium on Fisheries Aspects of Warmwater Streams, Southern Division American Fisheries Society, (1980).

Stream Crossings

Baker, C.O. and F.E. Votapka. "Fish Passage Through Culverts," *USDA Forest Service Technology and Development Center Report No. FHWA-FL-90-006*, 1990.

Mason, L. *Portable Wetland Area and Stream Crossings*, USDA Forest Service Technology and Development Center, 1990.

Forest Roads

Kochenderfer, J.N. *Cost of and Soil Loss in "Minimum-Standard" Forest Truck Roads Constructed in the Central Appalachians,* USDA Forest Service Research Paper NE-544, 1984.

Swift, L.W. "Soil Losses from Roadbeds and Cut and Fill Slopes in the Slopes in the Southern Appalachian Mountains," *Southern Journal of Applied Forestry,* 8, (1984), 209-215.

Swift, L.W. "Gravel and Grass Surfacing Reduces Soil Loss from Mountain Roads," *Forest Science,* 30, (1984), 656-670.

The Layman's Guide to Private Access Road Construction in the Southern Appalachian Mountains, Tennessee Valley Authority, Waynesville, N. C.: Haywood Press, Inc. 1985.

Wallbridge, T.A., Jr. *The Paper Location of Forest Roads*, Blackburge, AA, Virginia Polytechnical Institute and State University, 1989.

Wallbridge, T.A., Jr. *The Direct Location of Forest Roads*, Blacksburg, VA, Virginia Polytechnical Institute State University, 1990.

Timber Harvesting

Brinker, R.W. *Best Management Practices for Timber Harvesters*, Alabama Cooperative Extension Service Circular ANR-539, 1989.

Simmons, F.C. *Handbook for Eastern Timber Harvesting,* USDA Forest Service Northeastern Area State and Private Forestry, 1979.

Swindel, B.F. "Multi-Resource Effects of Harvest, Site Preparation and Planting in Flatwoods," *Southern Journal of Applied Forestry*, 7, (1983), 6-15.

Reforestation/Stand Management

Beasley, R.S., and A. Granillo, "Water Yields and Sediment Losses from Chemical and Mechnical Site Preparation in Southwest Arkansas," *Forestry and Water Quality. A Mid-South Symposium*, Arkansas Cooperative Extension Service, 1985.

Wetlands

Gosselink, J.G. and L.C. Lee. *Cumulative Impact Assessment in Bottomland Hardwood Forest*, Baton Rouge, LA, Center for Wetlands Resources, Louisiana State University LSU-CEI-86-09, 1987.

Federal Manual for Identifying and Delineating Jurisdictional Wetlands, Federal Interagency Committee for Wetland Delineation, 1989.

Forested Wetlands of the Southeast: Review of Major Characteristics and Role in Maintaining Water Quality, USDI Fish and Wildlife Service Publication 163, 1986.

Forested Wetlands of the United States: Proceedings of the Symposium, USDA Forest Service Southeastern Forest Experiment Station General Technical Report SE-50, 1988.

Good, R.E., D.F. Whigham and R. L. Simpson. *Freshwater Wetlands: Ecological Processes and Management Potential*, New York, Academic Press, 1978.

Kellison, R.C. et al. *Regenerating and Managing Natural Stands of Bottomland Hardwoods,* American Pulpwood Association, 88-A-6, 1988.

Kibby, H.V. "Effects of Wetlands on Water Quality," *Proceedings of the Symposium on Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems,* USDA Forest Service Publication GTR-WO-12, 1978.

Larson, J.S. "Wetland Value Assessment: State of the Art," *National Wetlands Newsletter*, Vol. 3, No. 2, Mar-Apr 1981.

National List of Plant Species That Occur in Wetlands: Southeast (Region 2), U.S. Fish and Wildlife Service, Biological Report 88 (26.2), 1988.

National Wetlands Policy Forum, The Conservation Foundation, 1989.

Wharton, C. H. et al. *Forested Wetlands of Florida, Their Management and Use,* Gainesville, FL, Center for Wetlands, University of Florida, 1977.

General BMPs

Alabama Nonpoint Source Management Program, Montgomery, Alabama. Alabama Department of Environmental Management. October 2000. http://www.adem.state.al.us/Education%20Div/Nonpoint%20Program/ManagePlan/partIIsi.pdf

Best Management Practices for Silvicultural Activities on TVA Lands, Norris, TN, Division of Land Resources, Tennessee Valley Authority, 1990.

Burns, R.G., and J.D. Hewlett. "A Decision Model to Predict Sediment Yield from Forest Practices," *Water Resources Bulletin 19*, (1983), 9-14.

Dissmeyer, G.E. and G.R. Foster. *A Guide for Predicting Sheet and Rill Erosion on Forest Land,* USDA Forest Service State and Private Forestry Southeastern Area, Technical Publication SA-TP 11, 1980.

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Erosion Control on Forest Land in Georgia, Georgia Cooperative Extension Service, 1979.

Forestry and Water Quality: A mid-south symposium, Arkansas Cooperative Extension Service, 1985.

Glasser, S.P. *Summary of Water Quality Effects from Forest Practices in the South*, Atlanta, GA, USDA Forest Service Southern Region, 1982.

Golden, M.S. et al. *Forestry Activities and Water Quality in Alabama: Effects, Recommended Practices, and an Erosion Classification System,* Alabama Agricultural Experimental Station Auburn University, Bulletin 555, 1984.

Golden, M.S. et al. *Guidelines for Refinement of Best Management Practices in Alabama*, Auburn University, AL, Department of Forestry, 1984.

National Management Measures to Control Nonpoint Source Pollution from Forestry, U.S. Environmental Protection Agency, Office of Water, Washington DC 20460 (4503F) EPA-841-B-05-001 April 2005. http://www.epa.gov/owow/nps/forestrymgmt/ (May 2005).

Sources of Technical Assistance

Technical assistance and/or additional information may be available from the following agencies and organizations to help you plan forestry operations that may affect water quality.

Alabama Department of Conservation and Natural Resources
64 North Union Street, Suite 468
Montgomery, AL 36130
(334) 242-3465
www.outdooralabama.com

Alabama Department of Environmental Management (ADEM)
1400 Coliseum Boulevard
Montgomery, AL 36110-2059
or
P. O. Box 301463
Montgomery, AL 36130-1463
(334) 271-7700
http://www.adem.alabama.gov

Alabama Cooperative Extension System
109-D Duncan Hall
Auburn University, AL 36849
(334) 844-4444
www.aces.edu

Alabama Forestry Association
555 Alabama Street
Montgomery, AL 36104
(334) 265-8733
www.alaforestry.org

Alabama Forestry Commission
513 Madison Avenue
Montgomery, AL 36130
(334) 240-9365 or 240-9332
www.forestry.state.al.us

American Forest and Paper Association
1111 19th St. NW, Suite 800
Washington, DC 20036
(800) 878-8878
www.afandpa.org

U.S. Army Corps of Engineers
Mobile District
P.O. Box 2288
Mobile, AL 36628
(251) 471-5966
www.sam.usace.army.mil

Nashville District
P.O. Box 1070
Nashville, TN 37202
(615) 736-7161
www.orn.usace.army.mil

U.S. Environmental Protection Agency (EPA)
Region 4
Sam Nunn Atlanta Federal Center
61 Forsyth Street SW
Atlanta, GA 30303-8960
(404) 562-9900 or 1-800-241-1754
http://www.epa.gov/region04/about/index.html

USDA Forest Service
2946 Chestnut Street
Montgomery, AL 36107
(334) 832-4470
www.fs.fed.us

USDA Natural Resources Conservation Service
P.O. Box 311
Auburn, AL 36830
(334) 887-4560
www.nrcs.usda.gov/programs

U.S. Fish and Wildlife Service
1208-B Main Street
Daphne, AL 36526-4419
(251) 441-5181
www.fws.gov

Alabama Forestry Commission
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ARKANSAS
FORESTRY
BEST MANAGEMENT PRACTICES
FOR
WATER QUALITY PROTECTION

ARKANSAS FORESTRY COMMISSION

March 16, 2002

TABLE OF CONTENTS
Forestry Best Management Practices

APPENDIX

INTRODUCTION

Arkansas is fortunate to have vast, healthy, diverse, and productive forests. These forests are a tremendous asset to our environment and economy, providing wood products, recreation, and wildlife habitat. Forests processes maintain clean water. Sound management of forests is compatible with these values.

Silvicultural practices can cause soil to move into streams. Implementing Best Management Practices (BMPs) is an effective way to protect forest water quality. The purpose of this BMP booklet is to help forest landowners and forestry practitioners understand what BMPs are, why BMPs are important, and how to implement BMPs.

Forestry BMPs are important practices, which prevent or reduce the amount of erosion generated by silviculture. BMPs include structural and nonstructural controls, operations, and maintenance procedures that can be applied before, during, and after silvicultural activities.

Implementation of Arkansas' forestry BMPs is voluntary and the Arkansas Forestry Commission strongly encourages implementation. The Arkansas Forestry Commission adopted these BMPs in response to the Clean Water Act of 1977 and the Water Quality Act of 1987. The goals of these federal laws are to protect and improve the quality of America's water.

Forest wetlands are environmentally sensitive areas that are protected from nonpoint source pollution by Section 404 of the Clean Water Act Amendments of 1977. Normal forestry activities are exempt from National Pollution Discharge Elimination System (NPDES) permitting requirements within jurisdictional wetlands. Forest managers and landowners should become familiar with requirements that may exist, especially on jurisdictional wetlands. The Natural Resource Conservation Service (NRCS) and the U.S. Army Corps of Engineers can provide additional information.

A thorough understanding of the BMPs and flexibility in their application are of vital importance in selecting BMPs that 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 forestland.

Use sound technical judgment and common sense when applying these guidelines, because a wide variety of topography, soils, climate, and other factors exists.

The Arkansas Forestry Commission is the lead agency in Arkansas in establishing, interpreting, monitoring, and updating forestry BMPs.

1.0 PLANNING

Careful planning is an essential first step to environmentally sound forest management. Seeking professional assistance during planning can be critical in protecting water quality. The selection of silvicultural operators (loggers, site preparation contractors, foresters, etc.) who have received BMP training can help ensure that BMP plans are prepared and understood before starting silvicultural activities.

The first step in planning is to meet with the landowner and/or forester to determine appropriate BMPs. One of the final critical steps is to ensure the proper and timely implementation of pertinent BMPs.

1.10 General Guidelines

Resources available for planning a silvicultural project include aerial photographs, topographic maps, and soil surveys. These tools help identify sensitive areas including steep slopes and poorly drained or highly erosive soils. These tools can also help in efficient road and skid trail layout. They also assist in the identification of stream types (ephemeral or non-ephemeral), which is important in prescribing the level of protection. (See Streamside Management Zone, Section 2.0, page 6.)

Use available topographic maps, aerial photographs and site visits to locate and plan protection for the following:

- Streams, drainage, and crossings
- Critical areas subject to rutting and/or erosion
- Existing roads and trails
- Proposed haul roads and skid trails
- Log landing locations
- Buffer zones for streams

Other planning considerations may include road and trail specifications, harvesting equipment needed, the best time of year to conduct the activity, timber sale contract requirements, special planning for wet areas, obstructions, and areas to avoid. Planning assistance is available from the AFC, consulting foresters, and public agencies identified in the Appendix, Section 15.0, page 34. Topographic maps can be obtained from the Arkansas Geological Commission (See Technical Assistance Providers, Section 15.0, page 34). Soil maps can be viewed at county NRCS offices. Aerial photographs may also be available or viewed at NRCS or Farm Service Administration offices.

Effective planning for soil stabilization during all phases of silviculture is important. Planning and preparation result in the effective and timely implementation of BMPs and the protection of water quality. (See Soil Stabilization, Appendix, Section 11.0, page 24).

2.0 STREAMSIDE MANAGEMENT ZONES

Vegetation and soils adjacent to waterbodies are critical for maintaining healthy aquatic systems. Streamside Management Zones (SMZs) are buffer areas, strips of land immediately adjacent to waterbodies where timber management activities are designed to protect water quality.

SMZs are established on both sides of streams.

SMZs:

- Slow and spread water flow
- Serve as a filter, which reduces movement of sediment and nutrients into waterbodies
- Stabilize stream banks
- Minimize logging debris from reaching the waterbody
- Act as a buffer strip separating the waterbody from areas that receive silvicultural chemicals

The SMZ provides water quality protection to adjacent waterbodies by maintaining bank stability and by filtering water moving into the waterbody. Only non-intensive forest management activities should be practiced in the SMZ. SMZ boundaries should be determined before operations begin. Recommended SMZ widths are surface distance not horizontal distance.

For the purpose of establishing SMZ guidelines, the Arkansas Forestry Commission recognizes two types of streams:

- Ephemeral streams have a defined channel but no banks. Water flows only during or immediately after rain. SMZs are not required.

- Non-ephemeral streams (perennial or intermittent) have a defined channel and often have banks. Water flows more than immediately after a rain. SMZs are recommended.

2.10 Non-ephemeral

.11 For slopes less than 7 percent the minimum SMZ width should be 35 feet on each side.

.12 For slopes 7 percent to 20 percent the minimum SMZ width should be 50 feet on each side.

.13 For slopes greater than 20 percent the minimum SMZ width should be 80 feet on each side.

.14 Select individual trees for harvest. Retain a minimum of 50 square feet of basal area per acre. Leave all trees if less than 50 square feet of basal area per acre exists. Trees should be evenly spaced throughout the SMZ to maintain bank stability and protect water quality.

.15 Fell trees away from the stream except where safety is a concern.

.16 Remove trees in a manner that minimizes disturbance to the forest floor, exposure of mineral soil, or reduction of stream bank stability.

.17 Plant seedlings or direct seed by hand.

.18 Remove significant logging debris dropped into stream channels.

.19 Do not handle or store toxic and hazardous materials such as fuels, lubricants, and solvents in SMZs.

2.20 Ephemeral Streams

.21 The optimal vegetated condition along ephemeral streams is overstory vegetation or trees. If this is not possible, lower lying vegetation and an intact forest floor is desirable.

.22 All harvest systems are allowed.

.23 Mechanical site preparation should not disrupt the ephemeral stream channel.

2.30 Braided Streams

Braided Streams are stream systems with multiple and frequently interconnected channels. Generally these streams have a very low gradient (<0.5% channel slope), broad valleys, and well- defined floodplains. Occasionally similar multiple channel streams can be found in higher areas with higher gradients.

.31 Consider the multiple channels as one stream. The SMZ includes all the land between the channels as well as the prescribed SMZ width adjacent to the most exterior channels.

.32 Follow other applicable SMZ guidelines for non-ephemeral streams.

2.40 Lakes and Ponds

SMZs should surround lakes and ponds.

.41 Minimum width of the SMZ should be 35 feet. The SMZ is measured beginning at the break in slope at the top of the shoreline.

.42 Follow SMZ guidelines for non-ephemeral streams. (See Section 2.10, page 6).

2.50 Activities Discouraged in SMZs

.51 Harvesting trees growing directly on the bank or overhanging a water body.

.52 Prescribed fires that burn to mineral soil. Light, cool burns are permitted.

.53 Locating portable sawmills or log decks.

.54 Creating excessive rutting, especially where ruts run perpendicular to a stream.

.55 Leaving logging debris in front of cave entrances and in sinkholes if the effect is to change the natural flow of water.

ROADS

Proper road construction and maintenance protects water quality during and after silvicultural activities. BMP Implementation Surveys conducted by the Arkansas Forestry Commission indicate that practitioners should focus more attention on implementing forest road BMPs.

The Arkansas Forestry Commission distinguishes active roads (permanent or temporary) from inactive roads. BMP recommendations are different for active and inactive roads.

3.0 ACTIVE ROADS

Roads are active if they are subjected to vehicular traffic. Active roads may require implementation of BMPs during construction and maintenance.

3.10 Road Location/Planning

.11 Use soil surveys, topographic maps, aerial photographs or site visits to plan road locations to protect water quality.

.12 Design roads to avoid or minimize stream crossings.

.13 Cross streams at right angles.

.14 Where topography permits, locate roads along the contour and along the crest of long ridges.

.15 There should be sufficient distance between the SMZ boundary and roadway to allow right-of-way maintenance.

3.20 Road Construction

.21 Use at least the minimum design standard that produces a road sufficient to carry the anticipated traffic load with minimum environmental impact.

.22 Remove timber from rights-of-way and deck it outside SMZs.

.23 Design roads no wider than necessary to accommodate the anticipated use.

.24 Balance cuts and fills to minimize excess excavated material.

.25 Place sidecast or fill material above the ordinary high water mark of any stream except where necessary to stabilize stream crossings.

.26 Plan and conduct work so that water quality is protected during heavy rain. (See Soil Stabilization Appendix, Section 11.10, Page 24.)

.27 When needed, use seeding and mulching in a timely manner to reduce erosion. (See Seed Table 11.1 Appendix, Section 11.10, Page 25).

.28 Implement appropriate BMPs during road construction.

3.30 Road Drainage

.31 Ensure good road drainage with a combination of 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 not cut channels across the SMZ. At cross drains (culverts or dips) install rip-rap or other devices at the outlets to absorb and spread water. Use brush barriers or check dams along road fill areas or other sensitive areas.

.32 Install ditches, culverts, cross drains, and wing ditches at low points in the road. Use crowning, ditching, culverts, and/or out-sloping to drain roads naturally. Provide cross drainage on temporary roads. Provide out-fall protection if cross drains, relief culverts, and wing ditches discharge onto erodible soils or over erodible fill slopes. Use diversion or wing ditches wherever possible to carry road drainage water onto the undisturbed forest floor. Use adequate sized culverts to carry the anticipated flow of water (See Appendix, Sec. 12.40, table 12.40, page 30).

.33 A road grade of less than 10 percent is preferred. Changing grade frequently, with rolling or broad-based dips, protects water quality better than by using long, straight, continuous grades.

.34 On highly erodible soils, grades should not exceed 8 percent. Grades exceeding 8 percent for 150 feet may be acceptable as long as appropriate BMPs are implemented.

.35 Graveling the road surface can help maintain stability.

.36 Install water turnouts, broad-based dips or rolling dips before a stream crossing to direct road runoff water into undisturbed areas of the SMZ. With the exception of stream crossings, roads should be located outside the SMZ.

.37 Out-slope the entire width of the road where road gradient and soil type permit. Use cross drainage on in-sloped or crowned roads to limit travel distance of runoff water.

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

.39 Road bank cuts normally should not exceed five feet in height, should be sloped, and the soil stabilized to prevent erosion. Cuts may need to be fertilized, limed, seeded, and mulched to establish cover. (See Seed Table 11.1 Appendix, Section 11.0, page 25).

3.40 Road Maintenance

.41 Crown or out-slope the road surface to disperse surface runoff and minimize erosion of the roadbed. Keep wing ditches free of blockages and keep culverts open and clean to allow unrestricted passage of water.

.42 Revegetate or stabilize erodible areas where natural vegetation is not sufficient to stabilize the soil. Minimize traffic on roads during wet conditions. Consider using geomat or rock to reduce road damage.

.43 Periodically inspect roads to see if BMPs remain effective.

.44 Re-establish vegetation as needed.

.45 Minimize traffic following maintenance work on sensitive road sections to allow them to stabilize.

.46 Keep roads free of obstructions to allow free flow of water from the road to the forest floor.

.47 Rework roads if road conditions deteriorate and may harm water quality.

.48 When all forestry activities are completed, reshape the roadbed if needed. Open all drainage systems. Stabilize erosion-prone areas. (See Soil Stabilization, Appendix, Section 11.0, Page 24).

3.50 Stream Crossings

Crossing streams can cause water turbidity and can destabilize stream banks.

.51 Cross streams only if the harvest site cannot reasonably be accessed otherwise.

.52 Remove temporary crossing structures after use. Stabilize and restore the streambanks. (See Soil Stabilization Appendix, Section 11.0, Page 24).

.53 Permanent stream crossing should use bridges, culverts, shelf-rock fords, geoweb, concrete slabs, or other materials.

.54 Low water fords may be used if excessive turbidity is not created. Stream banks should be stable and stream bottoms should be hard. If not naturally stable, use materials such as geotextiles or temporary bridges. Use planking, geoweb, rock or other nonerosive material to reduce disturbance to unstable streambeds and streambed approaches.

.55 Except for crossings, equipment should stay out of streambeds.

.56. Design bridges to protect stream-crossing approaches from erosion. The stream bank, stream channel and adjacent SMZ should have minimum disturbance. Construct stream crossings during periods of dry weather when stream flow is low and the chance of erosion is minimal. Concrete slabs should be excavated so that the surface is level with the stream bottom and at the same slope. Concrete slab approaches should extend beyond the stream channel to prevent scour around the ends of the slab.

.57 Remove from streams excess material and woody debris generated during road construction. Deposit this material above the ordinary high water mark. Stabilize the material. Use head walls, wing walls, rip-rap, or geomat if necessary.

.58 Inspect stream crossings frequently during operations to determine if erosion is being controlled. Stream banks should be stable and soil movement into the stream should be minimal. Correct erosion problems by implementing the BMPs discussed at Section 11.

.59 Bridges should not constrict clearly defined stream channels. Bridges should allow bankfull discharge to pass under the bridge unrestricted when bankfull water levels are anticipated.

3.60 Broad-Based Dips

.61 Broad-based dips are recommended for roads with less than 10 percent grade.

.62 Installation should take place after basic clearing and grading for roadbed construction. (See Appendix, Section 12.1, page 28.)

.63 An energy absorber such as rip-rap and, in some cases, a level area where the water can spread, can be installed at the out-fall of the dip to reduce water velocity.

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

.65 Broad-based dips should be placed cross the road in the direction of water flow.

.66 Broad-based dips are not recommended for constantly flowing water.

3.70 Rolling Dips

Rolling dips are a cross between water bars and broad-based dips. Like broad-based dips, they have a reverse grade (except it is shorter) and they tip water off the road. Like water bars, they may also rely on a mound of soil at the downhill side. Rolling dips can be used on haul roads having a slope of 10 percent and greater.

.71 Rolling dips can be used after basic clearing and grading for roadbed construction after logging is completed.

.72 A 10 to 15-foot long, 3 - 8 percent 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.

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

.74 Rolling dips are not suitable for constantly flowing water.

3.80 Wing Ditches

Wing ditches collect and direct road surface runoff from one or both sides of the road away from the roadway and into undisturbed areas. Wing ditches move water from roadside ditches and disperse it onto undisturbed areas adjacent to the road.

.81 The wing ditch should intersect the ditch line at the same depth and have a low-gradient outslope.

.82 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.

.83 The spacing of wing ditches will be determined by the topography of the area.

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

.85 Wing ditches should not feed directly into adjacent drainage, gullies or channels.
.86 Three types of wing ditch outlets can be used. (See Appendix, figure 12.3, page 30)

3.90 Pipe Culverts

Road and stream crossing culverts collect and transmit water safely from side ditches, seeps, natural drains, or streams under haul roads and skid trails without eroding the drainage system or road surface. (See Appendix, Section 12.4, page 30 for culvert size and spacing.)

.91 The pipe should be long enough so both ends extend at least one foot beyond the side slope of fill material. Culverts should be designed to carry the anticipated flow.

.92 The culvert should be placed with a 1 - 2 percent downgrade to prevent clogging.

.93 Lay the bottom of the culvert as close as possible to the natural grade of the ground or drain. Firmly seat the culvert and compact earth at least halfway up the side of the pipe.

.94 Cover, equal to a minimum of half the culvert diameter (preferably 1 foot of fill per 1 foot of culvert diameter), should be placed above the culvert

.95 The distance between pipe in a multiple culvert application should be half the pipe diameter.

.96 Provide erosion protection for culverts. This protection can be in the form of headwalls, rip-rap, geo-textile filter cloth, large stone, or prefabricated outflow and inflow devices.

.97 Lay aggregate or other suitable material on approaches to fords, bridges, and culvert crossings if needed to ensure a stable roadbed approach and reduce sediment in the stream.

.98 Fill for temporary culverts can be washed rock. Washed rock may remain in the channel when the culvert is removed. Remove culverts, bridges, and fill material other than washed rock from temporary stream crossings upon completion of operations and return the crossing as close as possible to its original condition.

.99 Install erosion protection measures such as rip-rap, geo-textile filter cloth, large stone, prefabricated outflow devices, or velocity reducers at the culvert outlet as needed to minimize downstream erosion. Rip-rap or other devices may be necessary on the downstream and upstream edge of fill or roadbed to prevent washout during floods.

4.0 INACTIVE ROADS

Roads are inactive if they will not be subjected to vehicular use. Inactive roads should be closed and BMPs installed.

4.10 Stabilization

Waterbars are recommended for stabilizing inactive roads, firelines, and trails. Logging slash may also be effective. They act to divert side ditch and surface runoff, which minimizes erosion, and provides conditions suitable for revegetation.

.11 Waterbars should be placed at an angle to the road, firebreak or skidtrail. The greater the percent slope, the less angle the waterbar should be to the road surface.

.12 To prevent additional erosion, waterbars may be revegetated. See Seeding Table. (Appendix, Table 11.1, page 25)

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

.14 Leave sufficient distance between outflow discharge and stream to allow “sediment fallout” before silt laden water reaches the waterbody.

.15 The outflow end of the waterbar should be fully open and extend beyond the edge of the road to disperse runoff water onto the undisturbed forest floor.

.16 Waterbars should be inspected after significant rainstorms. Repair damage or breeches.

.17 Ensure that the outlet is open. Consider the need for energy absorbers (brush or rock) at or below the drain outlet.

4.20 Revegetation

Covering bare soil is the first line of defense in preventing erosion. Revegetation is recommended for bare soil. Recommended seed types, sowing rates, and fertilizers are in Appendix, Table 11.1, Page 25.

.21 Schedule revegetation when soil and weather conditions promote rapid germination of seeds and development of the plants.

.22 Plant seed to the proper depth, fertilize where needed, and use adequate seeding rates.

.23 Periodically inspect areas of revegetation to ensure successful reestablishment of the intended ground cover.

4.30 Protection

Waterbars are essential to controlling soil erosion due to excessive water volume and velocity of road's runoff. Successful stabilization depends upon water control.

.31 Block vehicular traffic at entrances and exits of retired roads, firebreaks, and trails where vehicular traffic is expected. Use gating, large earthen berms, ditching, fencing, and similar barricades.

5.0 HARVESTING

Harvesting timber is more than cutting trees. It includes layout and construction of access roads, skid trails for moving logs, and strategic location of landings for transporting products out of the woods.

Timber harvesting activities should be conducted to minimized the effects on soil and water. Special care should be taken on steeper slopes and near bodies of water. If possible, schedule harvests during periods of dry weather to reduce sedimentation.

5.10 Design of Harvest Site

The design of the harvest site can protect water quality.

.11 Plan harvest site, skid trails, and landing locations to reduce the area of ground disturbed.

.12 For areas subject to excessive erosion, plan harvest activities to enable revegetation efforts to occur during times of the year that favor successful revegetation.

.13 Sites should be inspected frequently during harvesting to identify soil movement into water bodies.

.14 If erosion is occurring, promptly implement corrective BMPs.

.15 When harvesting is completed, disperse water from landings and skid trails using water bars, logging slash, or vegetative cover. Be prepared to control and limit off-site soil movement. See Soil Stabilization, Appendix, Section 11.0 page 24.

.16 If revegetation or stabilization is needed, do this work as soon as possible after harvesting is complete. Compacted soils may need to be disked or scarified to improve water infiltration and create a suitable seedbed.

.17 Construct water bars on skid trails and firelines per specifications in Table 13.1, page 32 and Figure 13.1, page 31, as needed. Pay attention to slope and soil type as it pertains to type of structure and spacing requirements. Where skid trails cross streams install waterbars or turnouts to divert all runoff away from stream channel.

.18 Remove temporary fill and stabilize streambanks. See section 11 for details.

.19 All areas to be seeded and/or mulched should be stable. Install traffic barriers to prevent off-road vehicle damage to recently stabilized areas.

5.20 Log Landings

Log landings or log decks are areas of concentrated equipment use and traffic. Well-planned and managed log landings will protect water quality. Take precautions to reduce rutting, soil compaction, and/or interference with water flow. For example, if soils are wet, use special techniques such as logging mats and mulch.

.21 Locate landings to avoid or reduce stream crossings.

.22 Locate landings as part of planning the road system.

.23 Minimize the size and number of log landings.

.24 Locate landings away from SMZs on firm, level ground.

.25 Locate landings on dry sites so natural drainage disperses water onto the forest floor but not into a stream.

.26 Restrict fueling and equipment maintenance work to designated areas of landings. Do not do this work near streams.

5.30 Felling & Bucking

.31 Fell trees away from a stream and keep debris out of the stream whenever possible.

.32 If a tree is felled into a stream, protect the stream banks during tree removal.

.33 Fell trees so the butts face the direction of skid whenever possible.

.34 Promptly remove significant logging debris from streams. Significant debris can alter the flow of the water and scour banks.

5.40 Skidding

Skid trails serve as transport routes for equipment moving trees, logs, or other material from the place of felling to a log landing or deck where they are stored or loaded for transport. Because heavy equipment is usually used in skidding, soil disturbance may occur. Plan skid trail layout to protect water quality.

.41 Follow the contour to the greatest extent possible. Timber should be skidded uphill either to a contour skid trail or more level ground.

.42 On slopes of 20 percent or greater, skid uphill.

.43 Skid trails on slopes should have occasional breaks in grade or logging slash that disperse water.

.44 Where stream crossings are planned, use portable crossing structures, culverts, poles or natural fords with firm bottoms, stable banks and gentle slopes. Do not use soil as a temporary fill material when water is in the stream.

.45 If a ford or crossing will cause excessive rutting or turbidity, then bridges, culverts, concrete slabs or other constructed fords should be used.

.46 Minimize the number of stream crossings. Skid across a stream only at stable locations identified during harvest planning.

.47 Upon completion of skidding, remove all temporary fill material from streambeds. If the banks are crushed or if soil is eroding, stabilize the stream banks.

.48 Do not use stream channels as skid trails.

5.50 Wet Weather Skidding

Avoid logging in excessively wet areas or during excessively wet weather. If skidding in wet weather, take the following precautions to protect water quality.

.51 Stabilize bare areas during any temporary shut-downs in logging operation if needed to protect water quality.

.52 Minimize skid trail construction at grades greater than 30 percent. With grades greater than 30 percent, install frequent rolling dips and follow contours. Stabilize these skid trails.

.53 If off-site soil movement occurs, control it with rolling dips, temporary water bars, and prompt revegetation.

.54 Minimize straight runs of 300 feet or more at grades greater than 20 percent.

5.60 Harvest Site Closeout

To ensure proper implementation of BMPs, a helpful final step is an on-site examination of the harvest area. This procedure is referred to as a “walkout.” Review contracts or other documents that set-out BMPs required for the harvest area.

.61 Stabilize roads, skid trails, and log landings by using revegetation techniques if needed.

.62 Clean up spills. Haul litter, such as oil cans, grease containers, crankcase oil filters, old tires, and used fluids to a proper disposal facility.

.63 Remove significant logging debris from streams. Significant debris can alter the flow of the water and scour banks.

.64 Scatter woody debris above the high water mark of stream.

.65 Perform closeout erosion control on erodible areas before equipment is moved off the site.

6.0 MECHANICAL SITE PREPARATION

Mechanical site preparation involves the use of ground contact equipment to manipulate vegetation and soil conditions before reforestation. Methods most commonly used are shearing, raking, subsoiling, disking, chopping, windrow/piling, and bedding. Shearing, raking, windrow/piling, bedding, and disking are high intensity methods of mechanical site preparation that expose a greater percentage of the soil on the treated site. Subsoiling and chopping are lower intensity methods. Erosion potential increases with the higher intensity methods, especially in areas with steep slopes.

6.10 Guidelines

.11 Choose a site preparation method that exposes and disturbs the minimum mineral soil necessary to meet the desired reforestation objective.

.12 The boundaries of all SMZs should be defined before site preparation begins

.13 Do not conduct mechanical site preparation in SMZs.

.14 Minimize crossing streams. If stream crossings are necessary they should be kept to a minimum, and made at right angles to the stream.

.15 Avoid intensive site preparation on soils the NRCS has identified as highly erodible.

.16 Do not damage water control devices (i.e. culverts, wing ditches). When damage occurs, repair or replace the device promptly.

.17 Avoid heavy equipment operations in wet soil conditions.

.18 Intensive site preparation should follow the contour of the land.

7.00 FOREST CHEMICALS

Pesticides, herbicides, and fertilizers are forest chemicals. The following guidelines for the handling and application of forest chemicals will help prevent their translocation to open water sources.

If any hazardous chemical of reportable quantity is accidentally spilled during normal working hours, notify the Department of Environmental Quality at (501) 682-0744. Outside of normal working hours, notify the Department of Emergency Management at (501) 682-0716. Take immediate measures to contain all chemical spills. Communicate spills to appropriate supervisors, landowners, and authorities.

7.10 Guidelines

.11 Follow label instructions. Do not aerially apply forest chemicals to SMZs unless labeled for open water application or during a forest health emergency (e.g., gypsy moth).

.12 Chemicals should not be allowed to leak from equipment. Do not service equipment near streams or other water sources. Properly dispose of empty containers.

.13 Minimize the use of streams, lakes, ponds or rivers as water sources. When this water is used to mix chemicals, do not contaminate water source.

.14 Chemicals should not be applied when water contamination is likely to occur from physical spray drift.

.15 Chemicals should not be applied immediately before precipitation, or after a rain if there is still runoff. Consider upcoming storm predictions to time chemical application.

.16 Label containers according to state and federal regulations.

.17 Apply fertilizer at appropriate rates. Seek professional advice on application rates. (See Technical Assistance Providers, Appendix, Section 15.0, page 34).

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8.0 REFORESTATION

Reforestation should be completed as soon as practical after harvesting. Seek professional advice on reforestation options.

8.10 Guidelines

.11 Machine plant along the contour of the land.

.12 Repair and stabilize any damage from machine planting that will cause erosion.

.13 Machine planting equipment should avoid crossing or turning around in roads, road ditches and wing ditches.

.14 Use existing access and stream crossing areas when planting. Preserve and replace all BMP harvesting or site preparation installations.

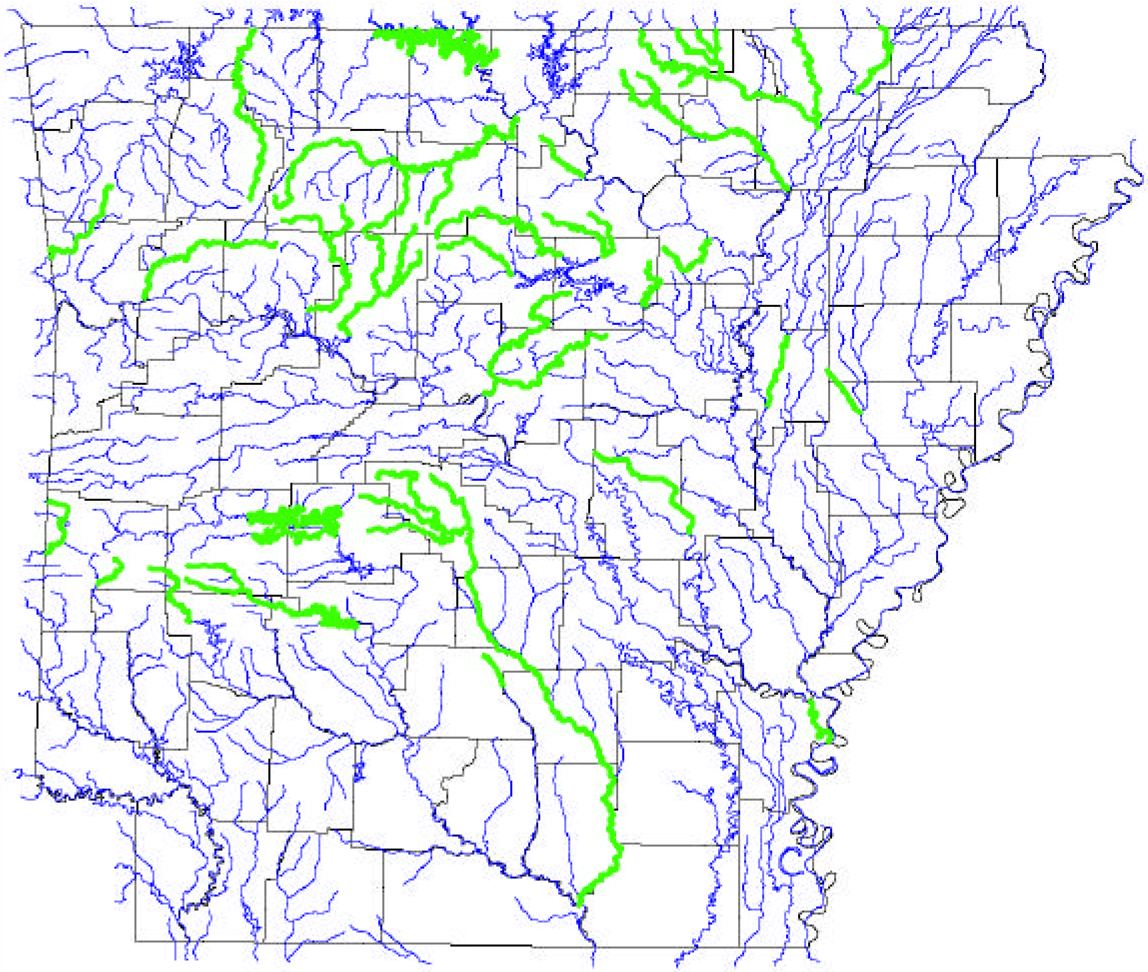
9.0 DESIGNATED WATERBODIES

9.10 Guidelines

.11 Arkansas Pollution Control and Ecology Commission has designated certain waterbodies as Extraordinary Resource Waters (PC&E Regulation 2). Take special precautions along these waters. Less intensive silvicultural practices are preferred. The table and map (B-2) on the following page list currently designated Extraordinary Resource Waters. An up-to-date list of Extraordinary Resource Waters can be viewed at www.adeq.state.ar.us.

.12 The Arkansas Pollution Control & Ecology Commission has identified waterbodies impaired by sedimentation. Take special precautions along these waters. Less intensive silvicultural practices are preferred. An up-to-date list of waterbodies can be viewed at www.adeq.state.ar.us.

Extraordinary Resource Waters



Prepared by ADPC&E GIS team using extres02.aml

Lake Ouachita
DeGray Reservoir
Saline River
North Folk Saline River
Alum Fork Saline River
Middle Fork Saline River
South Fork Saline River
Moro Creek
Caddo River
South Fork Caddo River
Cossatot River
*Caney Creek
Little Missouri River
Mountain Fork River
*Big Fork Creek
Cadron Creek
Mulberry River
Big Creek
Devils Fork Little Red River
Beech Creek
*Tomahawk Creek
*Turkey Creek
*Lick Creek
North Sylamore Creek
Kings River
Bull Shoals Reservoir
Middle Fork Little Red River
Archey Creek
Illinois Bayou
North Fork Illinois Bayou
Middle Fork Illinois Bayou
East Fork Illinois Bayou
Piney Creek
Hurricane Creek
Lee Creek
Salado Creek
Richland Creek
*Falling Water Creek
Buffalo River
Current River
Eleven Point River
Strawberry River
Spring River
*Field Creek
*Big Creek
*Cut Creek
Racoon Creek
Myatt Creek
South Fork Spring River
Two Prairie Bayou
Second Creek
Cache River
Arkansas River (below Dam #2)

B-2

10.0 FIRE

If a fire becomes “too hot”, the entire humus layer can be consumed, exposing the underlying mineral soil to erosion.

Arkansas Forestry Commission BMP Implementation Surveys have found that the erosion potential from sites burned too hot increases as slope increases. Extreme caution should be used when burning on slopes exceeding 20 percent.

10.10 Prescribed Fire

.11 Before ignition, moisture levels within the soil, forest fuels, and the air should be sufficient to prevent major exposure or damage to the mineral soil, especially on moderate to severely erosive soils.

.12 Install firelines parallel to streams and outside the SMZ. Do not plow firelines through the SMZ. Firelines within the SMZ should be constructed by hand.

.13 On final harvest cuts, when slopes of the site exceed 20 percent, individual fire strips should not exceed 300’ in width between ignition and burnout.

10.20 Wildfire Suppression and Reclamation

.21 During wildfire emergencies, firefighting activities are not restricted by BMPs. Potential erosion problems should be corrected soon after a wildfire is suppressed.

.22 Actively eroding gullies should be stabilized as part of wildfire reclamation.

.23 Inspect fire lines periodically and stabilize as needed to minimize runoff entering streams.

10.30 Firelines

Control practices can be implemented during fireline construction to prevent erosion. Periodic inspection and proper maintenance can minimize erosion on established firelines.

.31 Use barriers such as roads, rights-of-way, and plowed fields as firelines.

.32 Install firelines on the contour as much as possible.

.33 Use bladed or harrowed firelines instead of plowed firelines whenever possible.

.34 On slopes exceeding 5 percent, and at approaches to streams and roads, install water bars in firelines according to the BMP recommendations for skid trails. (See Section 5.40, Page 17)

.35 Use hand tools or back blade firelines away from the edge of gullies, streams, or roads.

10.40 Fireline Maintenance

.41 Mowing or disking, rather than blading, should be used to maintain firelines to reduce exposing mineral soil.

APPENDIX

This section contains additional specifications for BMPs. Practitioners should develop “Site- specific” specifications based on BMP implementation, observations, and site-specific experiences.

11.0 SOIL STABILIZATION

Soil stabilization practices are used where soil is exposed and natural revegetation is inadequate to prevent excessive soil erosion. This erosion occurs primarily during road and skid trail construction and use. This erosion also occurs from inactive road and skid trails that aren’t properly closed-out.

11.10 Mulching & Seeding

Mulch retains soil moisture, important for seed germination, and protects the soil from erosion. Mulch can be used to: (1) promote natural revegetation or (2) protect seeds and fertilizers that have been spread over an area. If you broadcast seed and fertilizers, mulching may be needed to prevent washing before germination and rooting. In most situations, seed can be “incorporated” into the soil, an action that enables the seed to remain in place without mulch or netting. Netting may be necessary to hold mulch in place on extreme steep slopes or on areas where water flow concentrates.

Seed mixtures should include fast germinating and growing species for quick soil protection plus perennial species for longer soil protection until native vegetation returns to the site.

Timing of seeding is critical in successful revegetation efforts. Professional advice can facilitate successful revegetation.

Information concerning recommended seed mixtures, including prices and availability, can be obtained from the USDA Plant Material Center at Booneville, AR. See Technical Assistance Providers in Appendix, Section 15.0, page 34.

Table 11.1 Recommended Seeding Rates

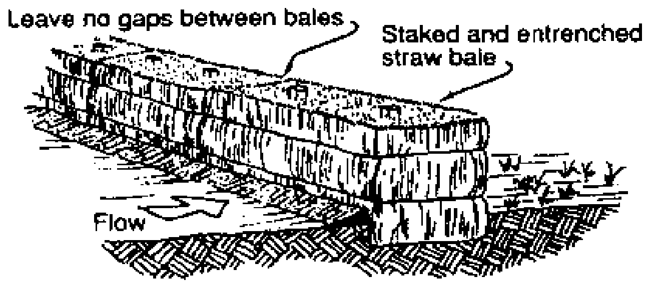
Area	Spring and Early Summer (March – June)	Seeding rate	Late Summer, Fall and early Winter (August – February)	Seeding rate
	Seed Mixture	**(lbs/acre)**	**Seed Mixture**	**(lbs/ac)**
Mountains	Orchard Grass (late spring) Browntop Millet	12 40	Annual Ryegrass	24
Statewide	Elbon Rye ; Winter Wheat	80*	Elbon Rye; Winter Wheat	80*
Gulf Coast or Delta	Bahia Browntop Millet	25 10	Bahia or Annual Ryegrass	30 20

- *Broadcast Application; a soil pH of 6.5 to 7.5 is best; One ton of limestone equivalent to 1 point Soil pH+ (plus); One ton Sulphur Equivalent to 1 point Soil pH-(minus).
- Fertilize with 200 lbs per acre of 15-15-15
- Mulch slopes with 4,000 lbs of straw per acre

11.20 Sediment Control Structures

Sediment control structures can control off-site movement of excessive soil, especially during major storm events. Install sediment control structures to slow the flow of runoff and to trap sediment until vegetation is established at the sediment source. Sediment control structures include straw bale fencing, logging slash, silt fencing, and sediment traps (see figures 11.1, 11.2 and 11.3 below). Maintain sediment-control structures until areas of exposed soil are stable.

Figure 11.1. Straw bale fencing to slow runoff and trap sediment for sheet flow or channelized flow



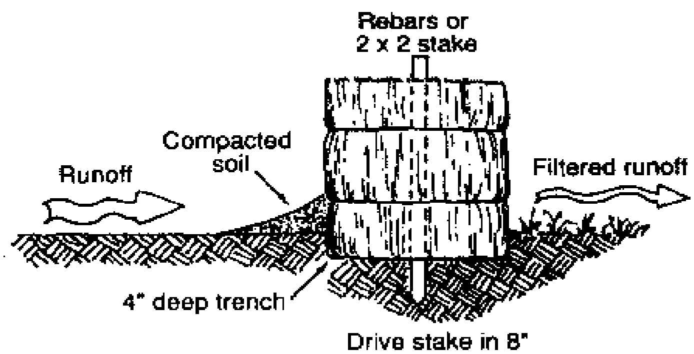


Figure 11.2. Silt fencing to slow runoff and trap sediment primarily for sheet flow, not

channelized flow.

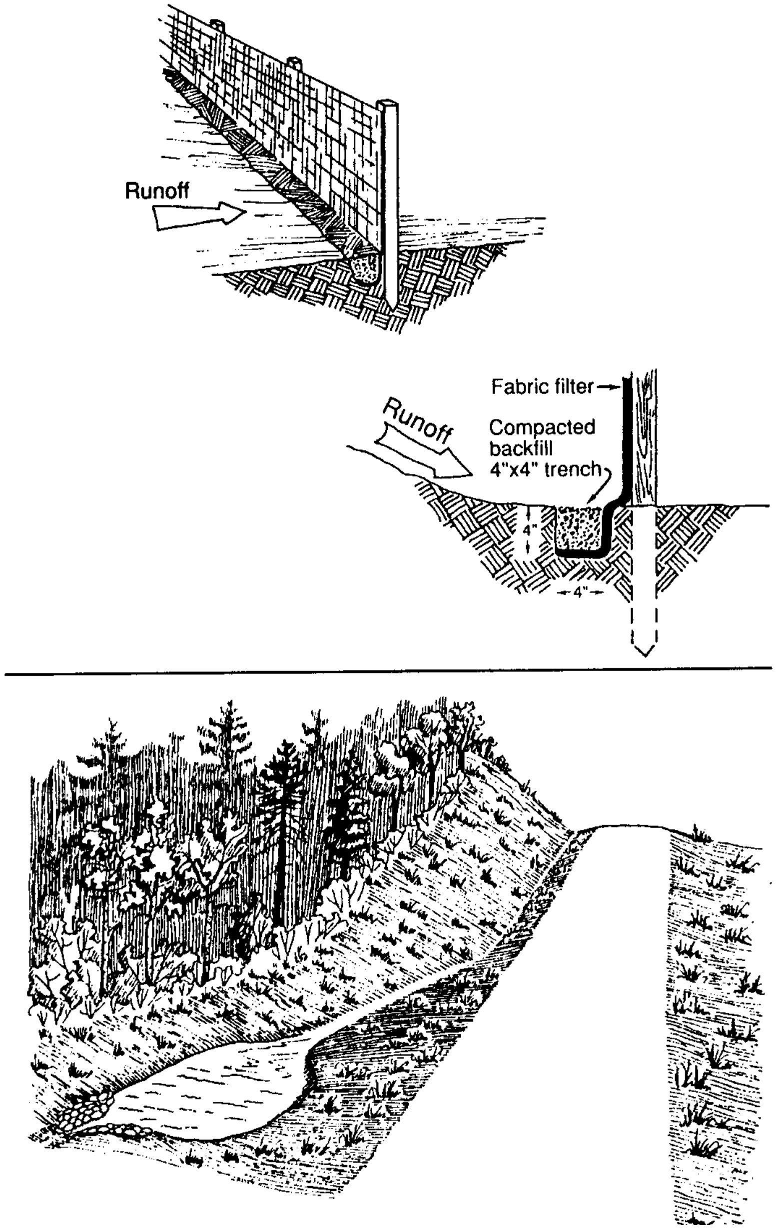


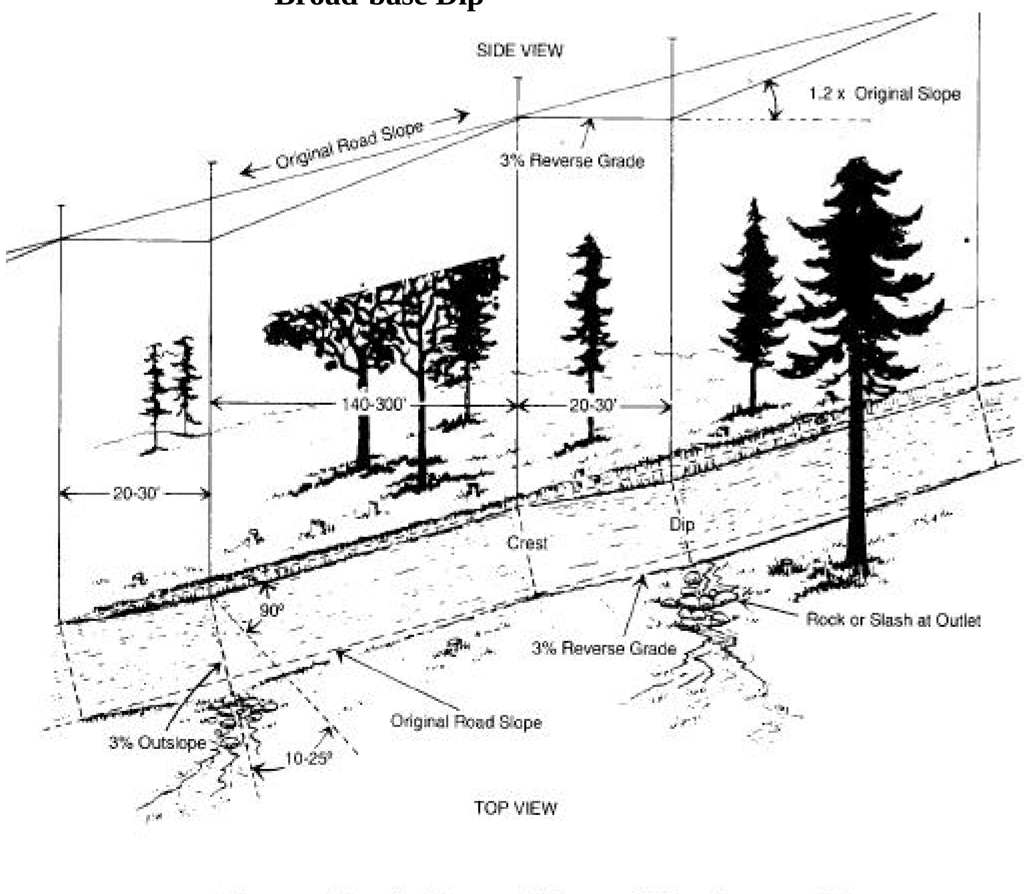
Figure 11.3 A sediment trap to slow runoff and trap sediment for Channelized flow.

12.0 ACTIVE FOREST ROADS

12.1 Broad-Based Dips

Figure 12.1 Broad-based Dip.

Broad-base Dip



The following table lists the approximate spacing for broad-based dips

Table 12.1 The following table lists the approximate spacing for broad-based dips:

Road Grade (percent)	Distance between dips (feet)
2	300
4	200
6	165
8	150

10	140

NOTE: An inherent problem in construction of a broad-based dip is 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 downgrade 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. Twenty-foot long, 3 percent reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location. The cross drain out-slope will be 2-3 percent maximum.

12.20 Rolling Dips

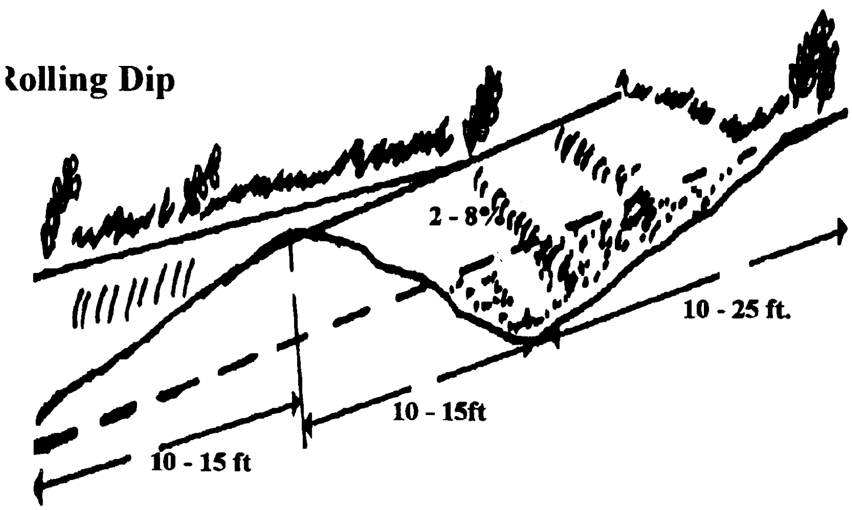
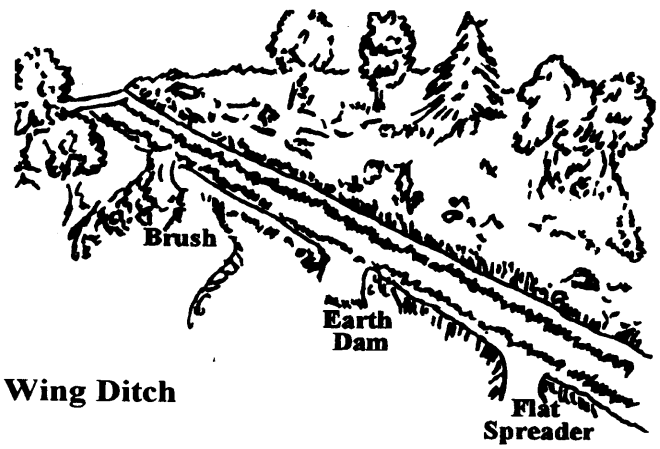


Table 12.2 Spacing between rolling dips can be determined from the following Table:

Road Grade (percent)	Distance between Dips (feet)
10-15	135
15+	120

12.30 Wing Ditches

Figure 12.3 Wing Ditch



Wing ditches into brush.

Wing ditches into a well designed Earthen dam.

Wing ditches into a flat spreader that distributes water on the undisturbed forest floor

Table 12.3 The following table lists the approximate spacing for wing ditches:

Road Grade	Distance between wing ditches
2-5	200
5-10	100
>10	75

12.40 Pipe Culverts

Table 12.4 Recommended diameters of culverts based on drainage area: *

Area above pipe (acres)	Pipe Diameter (inches)
5	18
10	24
20	27
30	30
40	36
50	36
75	42
100	48
150	54

Culvert diameter recommendations are based on medium soils. Light sandy soils would require smaller culverts and heavy clay soils would require larger culverts.

Culvert spacing can be determined by the following formula:

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

Slope in percent expressed as a whole number (ie: 15% = 15)

EXAMPLE:

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

or

Spacing = 127'

Table 12.5. The following Table is a guide for spacing between culverts:

Grade as %	Spacing in feet
1	500
2	300
4	200
6	167
8	150
10	140
12	133
14	129
16	125

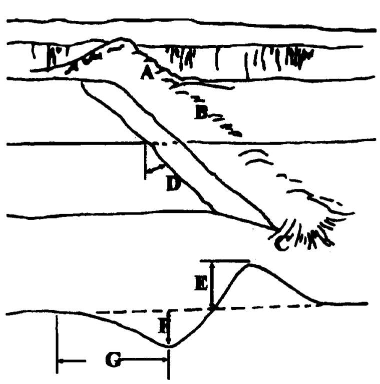
13.0 INACTIVE ROADS

13.10 Stabilization

Figure13.1 Water Bar

Waterbar

Waterbar specifications must be site-specific and suitable for the soil and slope.



A - Bank tie-in point, cut 1 to 2 feet into the roadbed.
B - Cross drain berm height 3 feet above the roadbed.
C - Drain outlet cut 1 to 3 feet into roadbed
D - Angle drain 30 to 45 degrees downgrade with road centerline.
E - Approximately 3 feet in height.
F -Depth I to 2 feet.
G - 3 to 4 feet.
H – where the waterbar is tied into the cut

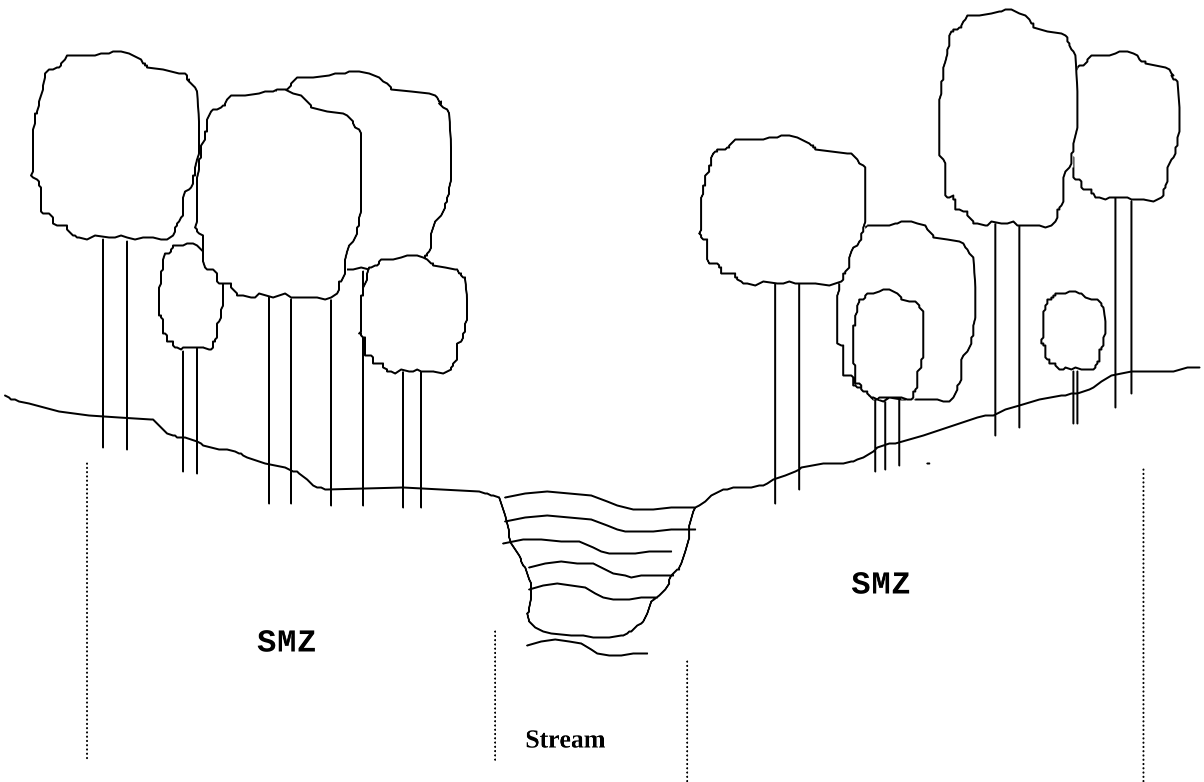
bank blocking the ditch

Table 13.1 The following Table is a guide for spacing between waterbars:

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

14.0 STREAMSIDE MANAGEMENT ZONES

Figure 14.1 Recommended SMZ widths.



Slope	**Primary SMZ**
<7%	35’
7%-20%	50’
>20%	80’

15.0 TECHNICAL ASSISTANCE PROVIDERS

For additional sources of information and technical assistance on BMPs, Forestry, or Wetlands contact one of the following agencies:

State Agencies	Federal Agencies	Private Organizations
Arkansas Forestry Commission Best Management Practice Section P.O. Box 10 Greenbrier, AR 71082 501/679-3581 Ext. 41	U. S. Army Corp. of Engineers Vicksburg District 4155 Clay Street Vicksburg, MS 39183 601/ 631-5052	Arkansas Forestry Association 410 South Cross Street Little Rock, AR 72201 501/ 374-2441
Arkansas Department of Environmental Quality P.O. Box 8913 Little Rock, AR 72219-8913 501/682-0744	U.S. Army Corp. of Engineers Little Rock District 700 West Capitol PO Box 876 Little Rock, AR 72203 501/ 324-5551	Arkansas Timber Producers Association 2311 Biscayne Dr. Little Rock, AR 72227 501/ 224-2232
Arkansas Game & Fish Commission Two Natural Resources Drive Little Rock, AR 72205 501/223-6300	Natural Resource Conservation Service 700 West Capitol, Room 3416 Little Rock, AR 72201 501/ 301-3100	Local consulting foresters
Arkansas Cooperative Extension Service 2301 South University Ave. Little Rock, AR 72204 501/671-2000	USDA Natural Resource Cons. Serv. Plant Material Center 6883 So. St. Hwy. 23 Booneville, AR 72927 501/ 675-5182	Local forest products companies
Arkansas Natural Heritage Commission 1500 Tower Building, 323 Center Little Rock, AR 72201 501/324-9150	USDA Forest Service Ozark St.-Francis National Forest 605 West Main Russellville, AR 72801 501/ 968-2354	
Arkansas State Plant Board One Natural Resources Drive Little Rock, AR 72205 501/225-1598	USDA Forest Service Ouachita National Forest PO Box 1270 Hot Springs, AR 71902 501/ 321-5202	

Arkansas Geological Commission 3815 West Roosevelt Road Little Rock, AR 72204 501/296-1877	Environmental Protection Agency Region 6 Office Fountain Place 1445 Ross Ave., Suite 1200 Dallas, TX 75202-2733 214/665-6497	

GLOSSARY

Definitions of Forestry BMP Terminology

Active Road – A road that can be either temporary or permanent that allows vehicle movement in and out of forestland.

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 above the normal forest floor on which seedlings are to be planted.

Best Management Practices (BMPs) – A practice, or combination of practices, determined to be an effective, and practical means of controlling the amount of water pollution generated by nonpoint sources

Braided Streams – Stream systems with multiple and frequently interconnected channels. Generally these streams have a very low gradient (<0.5% channel slope), broad valleys, and well-defined floodplains. Occasionally similar multiple channel streams can be found in higher areas with higher gradients.

Broad-based Dip – A forest road surface drainage design for **active** roadways. Directs rainfall runoff from road surfaces, and at the same time allows normal vehicle movement over roads.

Buck – To saw felled trees into predetermined lengths.

Channel – A well defined, measurable area, either natural or man made which collects and conveys water.

Chopping – A form of site preparation in which a large, heavy cylindrical drum with cutting blades mounted parallel to its' axis is drawn across a site to break up, slash, or crush vegetation prior to (usually) burning and planting.

Contour – An imaginary line along the side of a slope that connects points of the same elevation.

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

Cut – A location on the surface from which earth has been removed by excavation.

Disking – A form of site preparation in which a plow having one or more heavy, round, concave, sharpened, freely rotating steel disks angled to cut and turn a furrow is drawn across a site prior to (usually) planting.

Diversion Ditch – A shallow channel, which had been cut across the top of a slope, or the side of a hill for the purpose of diverting surface runoff.

Ephemeral Stream – Water courses generally with a defined channel, but no banks, that flow only during or immediately after rain.

Erosion – The process by which soil particles are detached, and transported by water, and gravity to some down-slope, or down-stream deposition point.

Felling – The process of severing trees from the ground and leaving a stump.

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

Fireline – A barrier used to stop or contain a wildfire or control burn. Usually constructed by use of bulldozer by which the fuel is removed down to mineral soil.

Forest Chemicals – Chemical substances or formulations that include fertilizers, herbicides, insecticides, fungicides, repellants, and other pesticides.

Forest Land – Land bearing forest growth, or land from which the forest has been removed, and is in any stage of forest growth, or production, or maintains the potential for forest growth.

Forest Road – An access route for vehicles into forestland.

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

Geomat - Artificial base structure for stabilization of streambeds and roads in wet areas. Usually installed as a base for Geoweb.

Geotextile – A synthetic fabric utilized in soil stabilization and reinforcement of roads and streambeds.

Geoweb – Artificial geotextile structure of modular cells for stabilizing stream beds.

Grade – The slope of a road or trail, expressed as a percent.

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

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).
Inactive Road – Roads not subject to vehicular use. Former active roads.

Landing – A location where felled logs are skidded to and assembled for temporary storage, loading, and subsequent transportation.

Logging – The felling and transportation of trees from the forest to a delivery location.

Logging Slash – The unused portions of woody material that remain as forest residue after logging.

Mulching – Providing covering for exposed forest soil, using organic residue, such as logging slash, grass, straw, or wood fibers to control erosion and enhance revegetation.

Nonpoint Source Pollution – Pollution which is (1) materials such as chemicals, nutrients, and soil carried into water bodies by precipitation, seepage, percolation, and runoff; (2) not traceable to any discrete or identifiable point source; and (3) controllable through the implementation of BMPs.

Nutrients – 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.

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.

Pesticides – Any herbicide, insecticide, rodenticide, or fungicide including non-toxic repellents or other chemicals.

Raking – Raking is an operation in which debris and vegetation is removed from the site through windrowing or piling. Tooth-type root rakes will be favored over straight and KG blades for raking and piling. Minimize top soil removal and displacement when piling.

Revegetate – To cover bare mineral soil with plant re-growth. In BMP application, this refers to the expeditious establishment of grasses to minimize soil erosion.

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

Rolling Dip - A forest road surface drainage design for **active** roadways. Directs rainfall runoff from road surfaces, and at the same time allow vehicle movement over roads and skid trails. Recommended for grades in excess of 10 percent slope.

Rutting – Depressions made by the tires or tracks of equipment such as skidders, log trucks, pickups, etc. usually under wet conditions.

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

Sediment – Soil particles that have been detached and transported into water during erosion.

Shearing – A site preparation method which involves cutting brush, trees, and other vegetation at the ground line using tractors equipped with angle, or V-shaped cutting blades.

Sheet Flow – Runoff from a rainfall event intense enough to cause direct overland flow prior to entry to 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.

Silvicultural Activities – All forest management activities, including intermediate cutting, cultural practice, harvest, log transport and forest road construction.

Site Preparation – Removing unwanted vegetation and other material when necessary and soil preparation carried out before reforestation.

Skid Trail – A route over which logs are moved, usually dragged by a skidder, to a setting (landing) or truck loading zone.

Slope – The steepness of the land expressed as the amount (in percent) of vertical fall per 100' of horizontal run. For example, a 3 percent slope means that over a distance of 100', the ground drops 3' from the horizontal.

Streamside Management Zone (SMZ) – A strip of land immediately adjacent to waterbodies where timber management activities are designed to protect water quality.

Subsoiling – or "ripping", is a method for conditioning compacted soils, hard pans, and plow pans. Subsoiling is a "row" type activity and should be performed on contour.

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.

Walkout – Onsite inspection by foot of the entire area under silvicultural exam and activity. Often referred to as a closeout.

Waterbar – A cross drainage diversion structure for inactive roads, firelines, and trails. Acts to divert surface water runoff into side vegetation, ditch, or dispersion area to reduce water volume and velocity.

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 as, or is likely to create any 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.

Water Turbidity – A measurement of water clarity.

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."

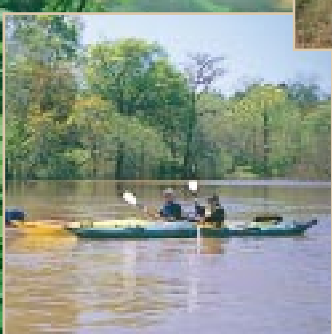
Windrow – Slash, residue, and debris raked together into piles or rows normally by use of bulldozers. Part of the mechanical site preparation process that occurs after a forest harvesting activity and before reforestation.

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.

INDEX

Georgia's

Best Management Practices



For Forestry

Georgia's

Best Management Practices

For Forestry

Foreword

Georgia's Best Management Practices for Forestry

The purpose of this manual is to inform landowners, foresters, timber buyers, loggers, *site preparation* and reforestation contractors, and others involved with *silvicultural* operations about commonsense, economical, and effective practices to minimize *nonpoint source pollution* (soil *erosion* and stream sedimentation) and thermal pollution. These minimum practices are called ***Best Management Practices*** and are commonly referred to as **BMPs**. They were initially developed in 1981 by a *Forestry Nonpoint Source Pollution* Technical Task Force as required by the Federal Water Pollution Control Act. That act mandated states to develop a program to protect and improve the physical, chemical, and biological integrity of the nation's waters so they remain "fishable" and "swimmable" for today's and future generations.

Due to changes in technology and the rules and regulations governing land disturbing activities, the forestry community and regulators encouraged a revision of the BMPs. A task force was convened in 1997 to revise the original BMPs and combine them with the 1989 wetland BMPs into one comprehensive document. This manual represents the collective best efforts to establish sound, responsible, guiding principles for *silvicultural* operations in the State of Georgia.

Note: Words in I*talics* are found in the glossary.

Legal justice scale denotes mandated law or requirement.

A "no" symbol indicates practices to avoid.

ACKNOWLEDGMENTS

The Georgia Environmental Protection Division, the Georgia Forestry Commission, and the Georgia Forestry Association wish to express appreciation to those organizations and individuals that contributed to the development and review of this publication. These individuals are listed under Contributors and Sources of Information (See page 64).

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JANUARY 1999

Table of Contents

Section I:
Introduction

Georgia's 23.6 million acres of *commercial forests* provide a variety of benefits for the people of the state and region. In addition to forest products, forests provide clean water, clean air, soil conservation, wildlife habitat, *flora* and *fauna*, and opportunities for recreation, *aesthetics*, education, and research. These forests are managed by landowners with varying objectives and their individual management decisions may be designed to support a broad variety of specific focused benefits related to the list above and others from Section 7.0, pg 44. Figure 1-A shows the percentage of land in the state. Figure 1-B indicates commercial ownership of that land.

Figure 1-A. Georgia's Land Use

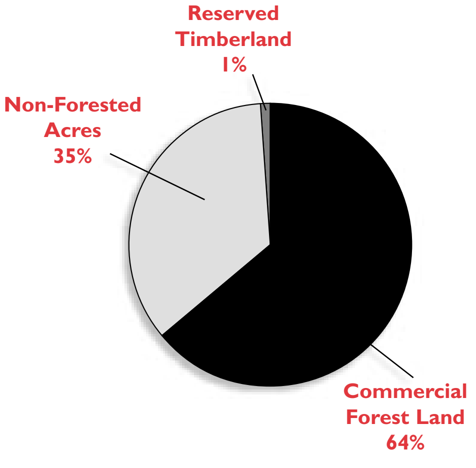
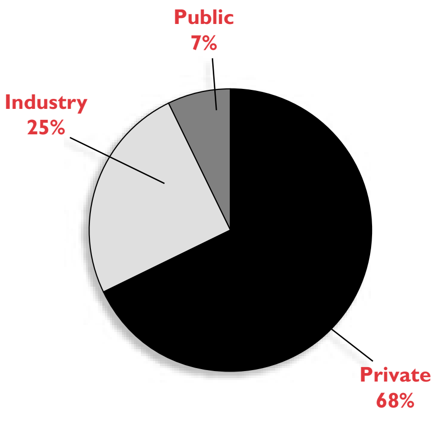


Figure 1-B. Georgia's Commercial Forest Ownership



BMPs are the most appropriate or applicable forest practices or activities to attain a silvicultural goal while protecting the chemical, physical, and biological integrity of the state's waters. Therefore, this document emphasizes the protection of water resources. Georgia has 44,056 miles of *perennial streams* (approximately 4,000 miles of which are designated as mountain *trout waters*), 23,906 miles of *intermittent streams* and 603 miles of *ditches and canals*. The state also has 425,382 acres of public lakes and reservoirs, 4.8 million acres of *wetlands* (9% tidally affected), 854 square miles of *estuaries* and 100 miles of coastline.

This document emphasizes the protection of water resources when conducting forestry operations, through BMPs in controlling or minimizing soil erosion and stream sedimentation.

By using proper forest management and sound conservation practices and techniques, including BMPs, forests can continue to provide benefits for future generations. Failure to follow BMPs may result in civil and criminal fines and penalties. Some counties already require plan reviews, permits, fees, performance bonds and compliance audits (See Section 8.0, pg 46). Therefore, it is in the best interest of everyone involved in *silvicultural* operations to properly plan and supervise their operations by consistently following BMPs to prevent any potential water quality problems. Unanticipated problems should be corrected as soon as possible.

"It is in the best interest of everyone involved in silvicultural operations to properly plan and supervise their operations by consistently following BMPs to prevent any potential water quality problems."

Since 1978, the Georgia Forestry Commission (GFC) has been designated by the Georgia Environmental Protection Division (GAEPD) as the lead agency to coordinate the forest water quality program. A statewide coordinator and district coordinators in each of the twelve GFC districts conduct their program. The program's primary responsibilities include: educating the forestry community on BMPs through training and demonstrations; conducting BMP use and effectiveness monitoring surveys; and investigating and mediating forestry water quality complaints.

Section 2:
Planning for Water Quality

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

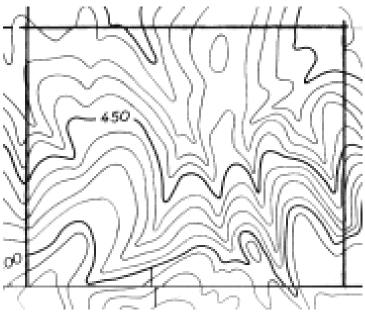
Plans should consider:
- history of the site including past land use;
- sensitive areas such as *perennial* and *intermittent streams*, *ephemeral areas*, lakes, ponds, *wetlands*, steep slopes, highly erosive or hydric soils, active *gully* systems, etc.;
- regulations and/or permitting requirements; and,
- location, type, timing and logistics of each activity.

Useful resources for planning forest operations include United States Geologic Survey (USGS) topographic maps, Natural Resource Conservation Service (NRCS) county soil survey maps with interpretations, aerial photographs, and tax maps. They can help locate tract boundaries and sensitive areas. Because no map is 100 percent accurate, they should be used as a reference to identify potentially sensitive areas that must then be verified and plotted during field reconnaissance to minimize impacts on them before *silvicultural* operations begin. Except for tax maps, the GFC maintains these documents at all District Offices. The NRCS maintains soil and topographic maps at local field offices where field personnel can assist in map and resource information interpretation.

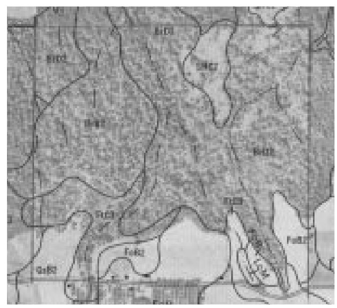
Water quality protection begins with recognizing watercourses and water bodies. According to the federal Clean Water Act, "*waters of the* U.S." include lakes, rivers, *perennial* and *intermittent streams*, *wetlands*, *sloughs* or natural ponds. Georgia law (OCGA 12-7-3.13) defines "waters of the state" to mean all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, *springs*, wells, and other bodies of surface or subsurface water, natural or artificial, lying within or forming part of the boundaries of the state that are not entirely confined and retained completely upon the property of a single individual, partnership or corporation.

Identifying stream types (*perennial*, *intermittent*, or *ephemeral*) is important in prescribing the level of protection through the implementation of BMPs listed in this manual. USGS topographic maps and NRCS county soil maps can be used as a reference to identify stream types. Where available they should be cross-referenced and field verified (See Figure 2-A).

***Figure* 2-A. Comparison *of* Topo Map *and* Soils Map *of* Same Tract**



Topo map showing no streams



Soils map showing streams

Stream Types

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

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

Ephemeral areas, commonly referred to as drains, draws, or *dry washes*, typically have no well-defined *channels* and flow only during and for short periods following *precipitation*. They typically flow into *intermittent* or *perennial streams*. Leaf, straw, and other forest litter is typically present in the *ephemeral* area. They are usually not identified on topographic maps or NRCS soil maps. Aquatic organisms are not present in these areas.

The landowner or manager may be familiar with a stream's flow characteristics and make the determination of stream type. In some cases there may be uncertainty. For example, *ephemeral areas* may be difficult to locate when they are not actively flowing. In such situations, consult a *qualified professional*.

Other Sensitive Areas

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

Benefits of Planning

The benefits of a well written plan and or written contract include: better communications of expectations between the landowner and forestry professionals; maximum return from the harvest; potential long term benefits in terms of productivity; better infrastructure; economic efficiency; minimal environmental impacts; compliance with Federal, State and local laws; and avoidance of fines or penalties. For information regarding sample contracts and management planning, contact the GFC. Planning for the protection of water quality makes good sense.

2.1 STREAMSIDE MANAGEMENT ZONES (SMZs)

Streamside Management Zones (SMZs) are *buffer strips* adjacent to *perennial* or *intermittent streams* or other bodies of water (lakes, ponds, reservoirs, etc.) that should be managed with special considerations to protect water quality. Trees and other vegetation in the SMZ provide shade that buffers water temperatures, woody debris vital to the aquatic ecosystem, natural filtration of *sediment* and other *pollutants* (nutrients and pesticides), and travel corridors and habitat for wildlife. SMZs also provide some flood protection by dissipating the velocity of moving water.

Note: Words in italics are found in the glossary.

When planning and laying out harvest or treatment areas, SMZs should be identified on maps or aerial photos and clearly designated in the field with paint or flagging. Identify local, state or federal regulations that may supersede or mandate the use of BMPs, such as those for protected *water-supply reservoirs/watersheds* or *protected river corridors*.

2.1.1 Perennial and Intermittent Stream SMZ Width Recommendations

There is no uniform formula to determine the appropriate width of an SMZ. In general, however, the steeper the slope and more erosive the soil, the wider the SMZ. Slopes should be determined from a point 100 feet perpendicular to the streambank. Therefore, SMZ widths may vary along a stream's course and on opposite sides of the same stream. SMZs should be measured along the ground from the stream bank on each side of the stream and not from the centerline of the stream (See Figure 2-B and Table 2-A).

Figure 2-B. Diagram Showing How to Determine Slope

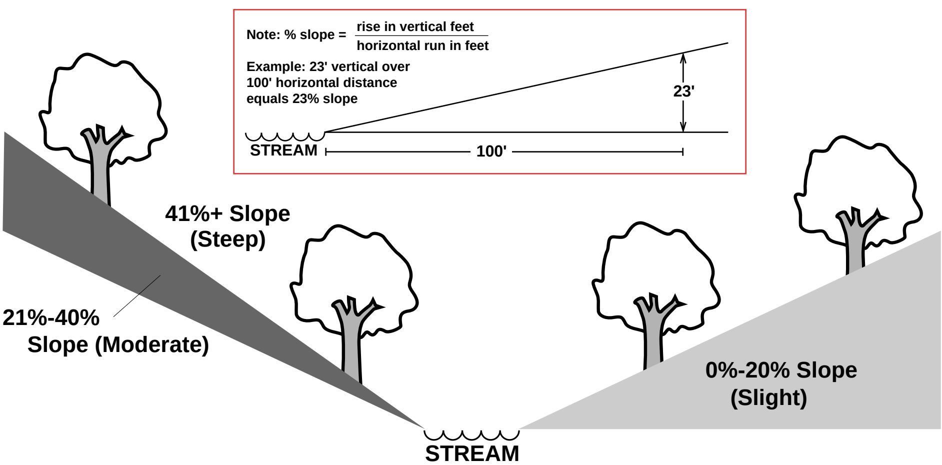


Table 2-A. SMZ Widths by Slope Class and Stream Type

Slope Class	Minimum Width (ft) of SMZ on Each Side		
	Perennial (feet)	*Intermittent (feet)*	*Trout (feet)*
Slight (<20%)	40	20	100
Moderate (21-40%)	70	35	100
Steep (>40%)	100	50	100

Remember that these are recommended minimum widths, and conditions such as unstable or erosive soils or lack of ground cover may warrant a wider SMZ for adequate water quality protection. Also SMZs have a limited filtering capacity and are not intended to correct problems created by poor upslope or adjacent practices.

2.1.1.1 BMPs for Perennial and Intermittent Stream SMZs

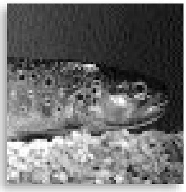
(Does NOT include trout streams. Trout stream BMPs are discussed in Section 2.1.2)

Management activities may occur within an SMZ provided that the disturbance to soil or ground cover is minimized. Water quality objectives should prevent movement of soil or other potential *pollutants* from within the SMZ into the watercourse and protect stream bank integrity. The BMPs associated with typical *silvicultural* activities are listed below.

- Identify any local, State, or Federal regulations that may supersede or mandate the use of BMPs.
- Determine and designate the appropriate SMZ widths on site prior to conducting any timber sale or forest practice.
- Along *perennial streams*, leave an average of 50 square feet of *basal area* per acre evenly distributed throughout the zone or at least 50% *canopy cover* after a harvest to provide shade.
- Along *intermittent streams*, leave an average of 25 square feet of *basal area* per acre evenly distributed throughout the zone or at least 25% *canopy cover* after a harvest to provide shade.
- Minimize stream crossings (See Section 3.3, pg 18 and 4.3, pg 28).
- Except at planned stream crossings, locate new access roads outside the SMZ.
- Maintain existing roads within SMZs with adequate *water control structures* and stabilization measures as needed (See Section 3.2, pg 15). If not possible, consider relocating road.
- Locate *log decks*, *staging areas*, and *skid trails* outside the SMZ, preferably on well-drained, stable soils.
- Where used, firebreaks should be installed parallel to streams and outside SMZs (See Section 5.5, pg 37).
- Minimize the intensity of a prescribed fire in the SMZ to maintain forest floor cover and protect the soil surface.
- Periodically inspect the SMZ, evaluate the effectiveness of the BMPs, and adjust practices when necessary.

2.1.1.2 Practices to Avoid Within SMZs of Perennial and Intermittent Streams

- Cutting stream bank trees.
- Unnecessary *access roads* and main *skid trails*.
- *Log decks*.
- Portable sawmills.
- Significant soil compaction and rutting by harvesting equipment.
- Removal of ground cover or understory vegetation.
- *Felling* trees into the streambed or leaving *logging debris* in the stream.
- Servicing or refueling equipment.
- Mechanical *site preparation* and *site preparation* burning.
- Mechanical tree planting.
- Broadcast application of *pesticides* or *fertilizers*.
- Handling, mixing, or storing toxic or hazardous materials (fuels, lubricants, solvents, *pesticides*, or *fertilizers*).



Trout are extremely sensitive to sediment and thermal pollution.

2.1.2 Trout Streams

Trout require cool (less than 70˚F), high-quality water. They, and the insects they eat, are extremely sensitive to *sediment* and *thermal pollution* (elevated water temperatures). Therefore, *trout streams* require additional protection. Waters designated as Primary *Trout Streams* support a self-sustaining population of rainbow, brown, or brook trout. Streams designated as Secondary *Trout Streams* are those where trout can survive, but there is no evidence of natural trout reproduction. See Section 8, pg 48-53, for a county listing of *trout streams* or refer to GFC's brochure, "Georgia's Best Management Practices for Forestry: Trout Streams of Georgia."

2.1.2.1 SMZ Width Recommendations and BMPs For Trout Streams

- Establish 100 foot SMZs on both sides of designated streams and tributaries according to the following options:

  Option A:

  A minimum 100 foot SMZ that includes a no-harvest zone within the first 25 feet of primary or secondary *trout streams*. Timber harvests within the remaining 75 feet of the SMZ should leave an average of 50 square feet of *basal area* per acre or at least 50% *canopy cover*.

  Option B:

  Within the 100 foot SMZ, leave an average of 50 square feet of basal area per acre evenly distributed throughout the zone to provide shade. Option B may be selected if a *qualified professional* is consulted.
- Follow all other BMPs for perennial and intermittent streams noting the 100 foot zone.

2.1.2.2 Practices to Avoid Within SMZ of Trout Streams

- Any forest activity within 25 feet of the stream, unless using Option B above.
- Mechanical *site preparation* and high intensity burns on *ephemeral areas* above trout waters.

2.1.3 Ephemeral Areas

Since *ephemeral areas* can direct stormflow into *intermittent stream channels*, care should be taken to minimize disturbing the soil in these areas. Where *ephemeral areas* transition into well-defined *intermittent* or *perennial streams*, those areas should be treated as an *intermittent stream* (See Section 2.1, pg 8).

2.2 SPECIAL MANAGEMENT AREAS

2.2.1 Braided streams - Treat each *channel* individually, depending upon whether the stream is *perennial*, *intermittent*, or *ephemeral*. These unique streams require highly site-specific management planning and recommendations. In some cases, the potential for wind throw of trees left in the SMZ will dictate variances in the removal of the *canopy cover*. Seek the assistance of a *qualified professional*.

2.2.2 Canals and Ditches - Minor drainage to temporarily lower the water level on a wetland site during road construction, timber harvesting, and site preparation is considered normal and exempt from Section 404 permitting if it does not result in the immediate or gradual conversion of a wetland to an upland or other land use. Minor drainage does not include the construction of a canal, dike or any other structure which continuously drains or significantly modifies a wetland or other waterbody. If the ditches could potentially move *sediment* or other *pollutants* off site, provide appropriate water protection. D*itches* should not empty directly into streams. Do not locate new drainage *ditches* in the SMZ.

2.2.3 Gullies - Many old gullies have healed and are not active as *ephemeral areas*. Care should be taken not to re-activate gullies. If the practice(s) lead to re-activation of flow, then the gullies must be treated as *ephemeral areas*.

2.2.4 Lakes, ponds, and other bodies of flowing water - Follow the BMPs recommended for *perennial streams* if they could potentially move *sediments* or other *pollutants* off site.

2.2.5 Protected Mountain Tops - Forestry activities on mountain tops above 2,200 feet elevation with slopes greater than 25% including the reforestation requirement shall comply with BMPs (See Section 8.2.3.4, pg 56 and Figure 8-C, pg 57).

2.2.6 Protected River Corridors - Forestry activities within the 100 foot buffers along those rivers at a point and below where the flow is 400 cubic feet per second (cfs) shall comply with BMPs (See Section 8.2.3.3, pg 55 and Figure 8-B, pg 56).

2.2.7 Seeps and springs - Treat as *perennial streams* if they flow all year long or *intermittent* otherwise.

2.2.8 Sinkhole - A geologic feature, typically found in Karst geology, that might provide a direct connection between land surface and groundwater. Treat as *perennial streams*.

2.2.9 Slough - (Sometimes referred to as an oxbow.) Treat as *perennial* or *intermittent stream* if they could potentially move *sediment* or other *pollutants* off site.

2.2.10 Water Supply Reservoir/Watershed (See Section 8.2.3.1 and Figures 8-A, pg 54-55).

- For governmentally owned impoundments or intakes occurring within a 100 square mile or larger *watershed*, forestry activities within a 150 foot buffer adjacent to all reservoirs and 100 foot buffer adjacent to all *perennial streams* within a seven-mile radius above intakes shall comply with BMPs.
- For governmentally owned impoundments or intakes within a *watershed* of less than 100 square miles, forestry activities within a 150 foot buffer adjacent to the reservoir, a 100 foot buffer adjacent to *perennial streams* within a seven-mile radius, and a 50 foot buffer adjacent to all *perennial streams* above the seven-mile radius shall comply with BMPs.

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

To properly manage forested *wetlands*: plan for *regeneration*; consider the areas beyond the actual harvest site; and remember that special harvesting techniques may be necessary to protect water quality. Any stream *channels* should be identified and the appropriate SMZs established. The BMPs that apply to any other forest type generally apply to forested *wetlands*. For more information on harvesting and site-preparing *wetlands*, refer to Section 4.7, pg 31 and Section 5.2, pg 34.

Section 3:
Road Location, Construction, Stream Crossings, Maintenance, Retirement

Access roads are an essential part of any forest management operation and provide access for other activities on forestland. With proper planning, location, construction, and maintenance techniques, well-constructed *access roads* allow for productive operations and cause minimal soil and water quality impacts. However, poorly located, poorly constructed, or poorly maintained *access roads*, especially at stream crossings, can result in *sediment* reaching streams; changing stream flow patterns, degrading fish and aquatic organism habitat, and adversely affecting *aesthetics*.

There are two types of *access roads* typically constructed in the state. In mountainous and hilly terrain, the *broad-based dip* road is commonly used. In the flatwoods and along major flood plains, the *crown and ditch* road is commonly used.

3.1 BMPS FOR ROAD LOCATION

- Identify Federal, State and local laws, regulations or ordinances that apply to road purpose, construction, and maintenance prior to construction and operation. Include needed considerations and measures to meet requirements.
- Use soil surveys and topographic maps to identify soils, stream locations and other natural features (rocky areas, steep slopes, wet areas, etc.) on the property that might pose problems.
- Locate potential control points i.e. *log decks* and stream crossings on topographic maps prior to designing *access roads* in the field.
- New permanent *access roads* should follow the *contour* of the land as much as possible with grades ideally kept below 10%. An engineer's divider can be used to lay roads out with the desired grade on a topographic map. Grades can run up to 12% for short distances. If soil is highly erosive, reduce grades and install *water control structures*.
- Temporary *access roads* should follow the *contour* of the land as much as possible. Grades can run up to 25% for short distances provided that *water control structures* are properly installed.
- Except for planned stream crossings, locate new roads outside of SMZs.
- Minimize stream crossings. Where crossings are necessary see Section 3.3, pg 18.
- Minimize the number, length, and width of *access roads*.
- Locate new *access roads* on high ground, preferably on the sides of ridges, for

proper surface drainage.

- Locate new *access roads* on southern or western sides (*aspect*) of ridges if possible to expose the roadbed to more sunlight.
- Conduct site reconnaissance to verify road layout with potential soil problems, stream locations, sensitive areas (See Section 7.4, pg 45), and *watershed* conditions.
- Evaluate the condition of existing roads and potential water quality impacts. If necessary, plan for improvements or replace with new routes.

3.2 BMPS FOR ROAD CONSTRUCTION

Note: Words in italics are found in the glossary.

- Construct *access roads* only wide enough (usually 12-16 feet) to safely handle equipment that will use the road.
- Schedule construction during favorable weather.
- Maximize sunlight exposure along roadsides where surface drainage is a problem.
- On permanent *access roads* with 3% or more grade, *broad-based dips* should be installed at proper intervals (30°angles across road surfaces), have reverse grades of 3%, and the bottom of the dips should be *outsloped* about 3%. If necessary, outfall of dips may need sediment barriers such as rock, hay bales, or silt fence installed (See Figure 3-A for a schematic of a *broad-based dip* road and Table 3-A for recommended spacing of dips).
- On temporary access or spur roads that have little traffic at low speeds, rolling dips can be installed. They resemble "stretched out" water bars (See Figure 3-B and Table 3-A for spacing of rolling dips).

Figure 3-A. Broad-based Dip Road

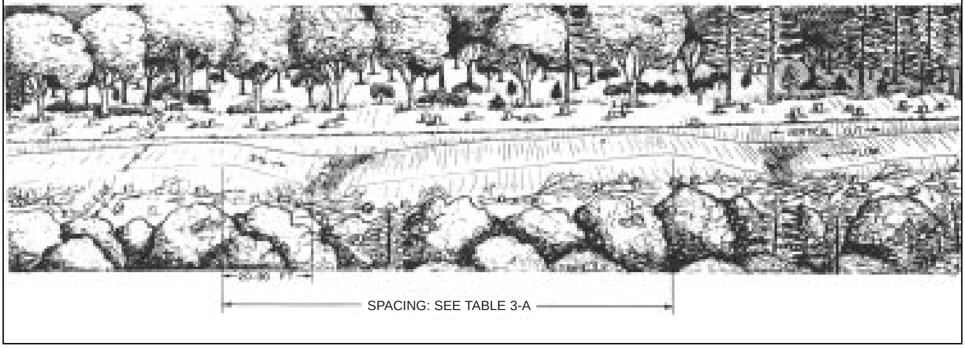
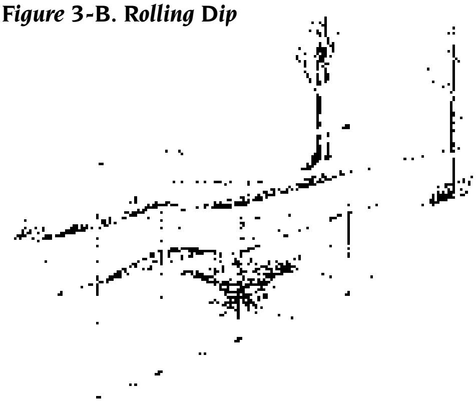


Table 3-A.
Recommended Spacing for Broad-based Dips in Permanent Access Roads and Rolling Dips in Temporary Access Roads

Road Grade (percent)	Distance Between Dips and Turnouts (feet)
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135

Figure 3-B. Rolling Dip



Source: Cooperative Extension Service Division of Agricultural Sciences and Natural Resources, Oklahoma State University

- On *crown and ditched* roads, install *water turnouts* at proper intervals (See Figure 3-C and Table 3-B). Turnouts should never tie directly into streams or water bodies. If necessary, outfall of turnouts may need sediment barriers such as rock, hay bales, or silt fence installed.

Figure 3-C. Design and Installation of Turnouts

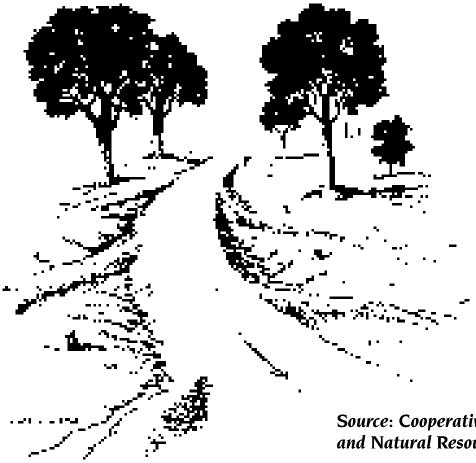


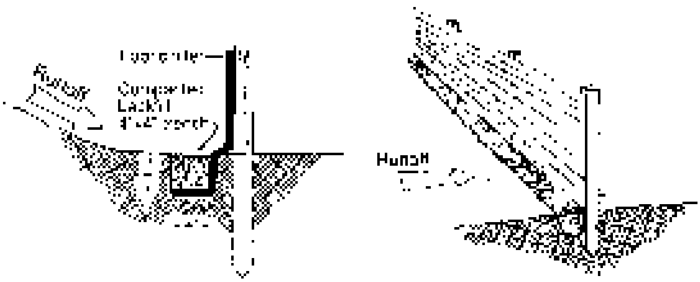
Table 3-B.
Spacing of Turnouts

Road Grade (percent)	Spacing (feet)
2 - 5	500-300
6 - 10	300-200
11 - 15	200-100
16-20	100

Source: Cooperative Extension Service Division of Agricultural Sciences and Natural Resources, Oklahoma State University

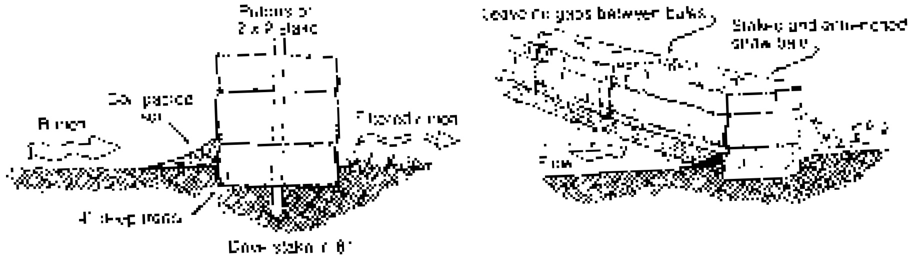
- Keep roads free from obstructions and *logging debris*.
- Roadbeds on erosive soils should be stabilized with appropriate measures.
- Stabilize exposed soil on shoulders of permanent or temporary *access roads* located within SMZs, *wetlands*, or at stream crossings as soon as possible with any one or combination of the following: seed and mulch, *silt fence*, hay bales, *excelsior blankets*, or *geotextiles*.
    1. See Section 6.4 for grassing recommendations.
    2. Type A (36 inch) or Type B (22 inch) *silt fence* can be used. Wooden stakes should be fastened to the fence every 6 feet on the down slope side. The bottom edge of the fence should be installed in a 4 inch deep trench with the bottom two inches of the fence facing upslope in the trench (See Figure 3-D).
    3. Hay bales should be placed on sides in 4 inch deep trenches and staked down (See Figure 3-E).

Figure 3-D. Silt Fence Installation



Source: Bureau of Forestry, Wisconsin Department of Natural Resources

Figure 3-E. Installation of Hay Bales



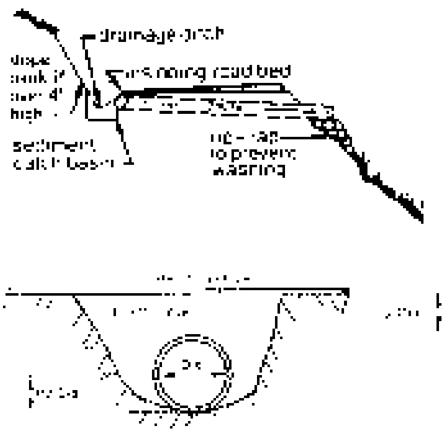
Source: Bureau of Forestry, Wisconsin Department of Natural Resources

- For more information refer to Georgia Soil and Water Conservation Commission's Field Manual for Erosion and Sediment Control in Georgia, pg 79.

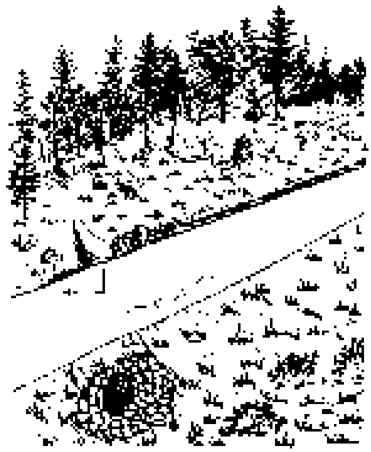
3.2.1 Practices to Avoid During Road Construction

- Except at planned stream crossings, road construction inside the SMZ.
- Insloping of roads. Where unavoidable, use *cross-drain culverts* positioned under the road at a 30° angle and spacing as in Table 3-B for proper inside road drainage. Place *rip-rap* at *culvert* outfall to prevent washing (See Figure 3-F).

Figure 3-F. Cross-drain Culvert Design and Installation



Source: Georgia Forestry Commission



Source: Bureau of Forestry, Wisconsin Department of Natural Resources

- Using *ditches* on steep roads. Some *ditches* may have to be lined with rock to prevent gullying and sedimentation.
- Turnouts tied directly into *perennial* and *intermittent streams* or *ephemeral areas*.

3.3 STREAM CROSSINGS FOR ROADS

Stream crossings are often necessary for access to forestlands. From a water quality standpoint, stream crossings are the most critical aspect of the road system. Failure of a stream crossing, due to improper planning or construction, can result in *erosion* and introduction of sediment into a stream, which can possibly affect water quality. Therefore, stream crossings should be avoided, if possible, through pre-harvest planning.

Where crossings are necessary, planning should address the type of road and road-use pattern, stream *channel* characteristics, stream flow levels, and the aquatic organisms in the stream. Minimizing impacts is critical. Permanent and temporary stream crossings should be based on expected applicable storm flow return intervals and watershed acreage above the crossing (See Table 3-C, pg 22).

3.3.1 Clean Water Act Provisions and Requirements for Stream Crossings

The Federal Clean Water Act, Section 404 (40 CFR Part 232.3), exempts normal, established, ongoing *silvicultural* activities from the permitting process for discharges of dredged or fill material in jurisdictional *wetlands*. However, fifteen (15) baseline provisions for forest road construction and maintenance in and across *waters of the* U.S. (lakes, rivers, *perennial* and *intermittent streams*, *wetlands*, *sloughs* and natural ponds) are mandated to qualify for the forest road exemption:

1. Permanent roads, temporary access roads and *skid trails* (all for forestry) in *waters of the* U.S. shall 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, shall be located sufficiently far from streams or other water bodies (except for portions of such roads that must cross water bodies) to minimize discharges of dredged or fill material into *waters of the* U.S.;
3. The road fill shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows;
4. The fill shall be properly stabilized and maintained during and following construction to prevent *erosion*;
5. Discharges of dredged or fill material into *waters of the* U.S. to construct a road fill shall 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 disturbances in the *waters of the* U.S. shall be kept to a minimum;
7. The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body;
8. Borrow material shall be taken from upland sources wherever feasible;
9. The discharges shall 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 waterfowl, spawning areas, and *wetlands* shall be avoided if less harmful alternatives exist;
11. The discharge shall not be located in the proximity of a public water supply intake;
12. The discharge shall not occur in areas of concentrated shellfish production;
13. The discharge shall not occur in a component of the National Wild and Scenic River System;
14. The discharge of material shall consist of suitable material free from toxic *pollutants* in toxic amounts; and,
15. All temporary fills shall be removed in their entirety and the area restored to its original elevation.

There are three types of stream crossings to consider in forest management operations: bridges, *culverts*, and fords.

Bridges, whether permanent or temporary, typically create the least disruption to stream flow and have less effect on fisheries than other stream-crossing methods. Pole bridges can be used for temporary crossings under certain conditions.

Pole bridges can be used for temporary crossings under certain conditions.

Culverts can be either temporary or permanent. Culvert sizing is critical to minimizing problems. Consider both the purpose of the crossing and the duration of use. Sizing may increase if the need is permanent.

Fords can be used for haul roads only where the streambed is firm, banks are low and stable and the stream is shallow.

3.3.2 General BMPs For Stream Crossings

In addition to the fifteen CWA mandated provisions:

- Approaches to all permanent or temporary stream crossings should be made at gentle grades of slope (3% or less) wherever possible.
- Approaches should be made at right angles to stream flow where practical.
- Approaches should have *water control structures*, such as *water turnouts* or *broad-based dips*, on both sides of a crossing to prevent road runoff from entering the stream.
- Stabilize approaches, if necessary, with rock extending at least 50 feet from both sides of the stream bank during the operation.

- For temporary *access roads*, temporary bridges or spans are favored over *culverts* or fords.
- Build *wetlands* fill roads outside the SMZ, except when crossing the *channel*. Cross-drainage structures (*culverts*, bridges, portable spans, etc.) may be necessary in the fill road to allow for surface water movement across the site.
- Stabilize exposed soil around permanent or temporary stream and *wetlands* crossings with any one or a combination of the following: seed and mulch, hay bales, rock, *silt fence*, *geotextiles*, and/or *excelsior blankets* (See Section 3.2, pg 15).

3.3.3 Specific BMPs For Bridges

- With *watersheds* of 300 acres or more, use bridges to cross streams if other alternatives are not suitable for containing storm flows.
- Remove temporary bridges and stabilize approaches and stream banks when operations are completed.

3.3.4 Specific BMPs For Fords

- Use fords only for haul roads (not *skid trails*).
- Locate fords where stream banks are low and the bottoms are relatively hard and level.
- Where necessary, establish a smooth, hard-surface, low water crossing. For a permanent ford use gravel or rock filled Geoweb® or concrete pads. For temporary fords use dragline mats or logs to armor (protect) the stream bottom.
- Material should not significantly impound stream flow, impede fish passage or cause erosive currents. Remove temporary crossings from the *channel* when operations are completed.

3.3.5 Specific BMPs For Culverts

- Where fords are not available or recommended, culverts can be used to cross small streams (usually 300 acre or less watershed, depending on physiographic region) including braided streams in broad flats (See map on inside back cover).
- When crossing streams with a *watershed* larger than 300 acres, consult a *qualified professional*.
- Size permanent *culverts* so that the cross-sectional area will accommodate expected 25-year, 24-hour storm flows (See Table 3-C for recommended diameters).
- Size temporary *culverts* so that the cross sectional area will accommodate the 2-year, 24-hour storm flows (See Table 3-C for recommended diameters).

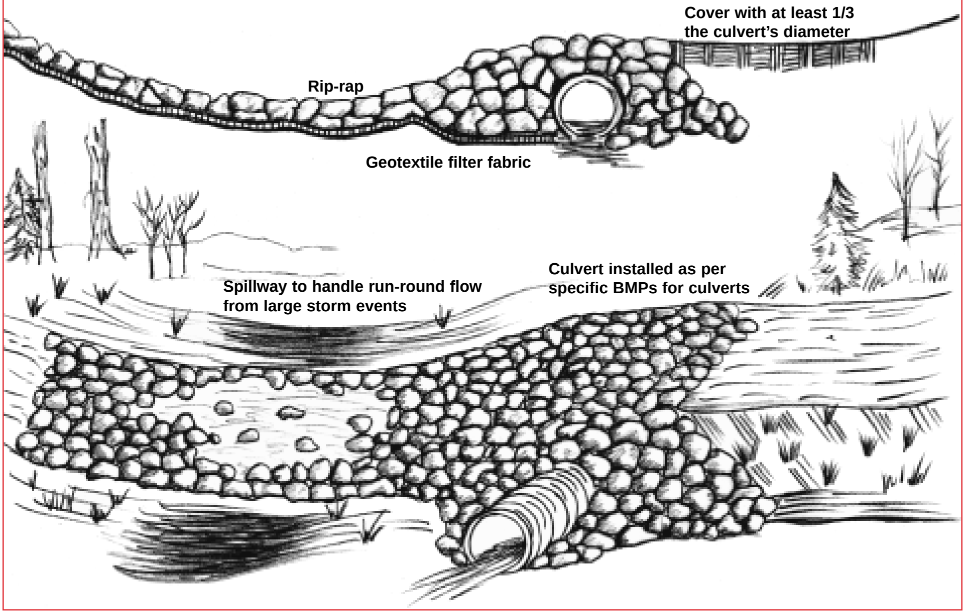
Table 3-C. Recommended Diameters for Permanent/Temporary Culverts

Drainage Area *(acres)*	**Lower Coastal Plain** *(inches)*	**Upper Coastal Plain** *(inches)*	**Piedmont** *(inches)*	**Mountains and Ridge & Valley** *(inches)*
PERMANENT	**(Based on 25-year, 24-hour storm flows)**			
10	24	15	30	24
50	36 or (2-30")	18	48 or (2-36")	48
100	48	24	54 or (2-42")	60 or (2-48")
200	60	36	72 or (2-54")	72
300	2-48"	54	84 or (2-60")	78 or (2-60")

Drainage Area *(acres)*	**Lower Coastal Plain** *(inches)*	**Upper Coastal Plain** *(inches)*	**Piedmont** *(inches)*	**Mountains and Ridge & Valley** *(inches)*
TEMPORARY	**(Based on 2-year, 24-hour storm flows)**			
10	15	15	18	15
50	18	15	30	24
100	24	18	36	30
200	30	24	42 or (2-30")	36
300	48	30	48	42

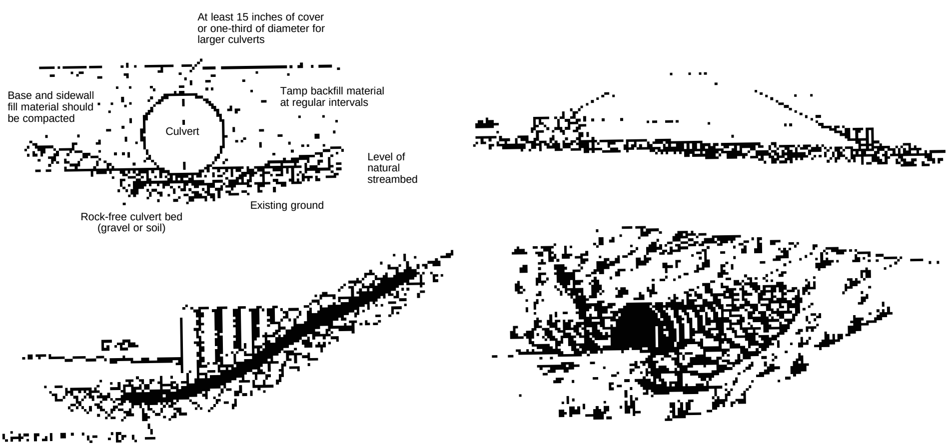
- Under normal conditions, two alternative methods of culverting are acceptable:
    1. Smaller multiple culverts can be substituted to provide for the same cross-sectional area of pipe required as shown in the above table.
    2. A combination of a smaller culvert(s) with rock surfaced road dips constructed in the roadbed to handle the runaround flow from larger storm events (See Figure 3-G).

Figure 3-G. Combination of Smaller Culvert and Rock Surfaced Road Dip



- *Culverts* less than 15 inches in diameter are not recommended.
- Multiple *culverts* should be spaced at a distance of at least one-half the *culvert's* diameter.
- Place the *culvert* in a straight section of the stream and free of obstructions.
- Place the bottom of the *culvert* at the same elevation as the bottom of the stream (See Figure 3-H, for proper *culvert* installation).

Figure 3-H. Stream Culvert Installation with Specifics of Slope, Placement, Fill, etc.



Source: *Bureau of Forestry Wisconsin, Department of Natural Resources*

- Place fill dirt around the lower half of the *culvert* and pack during installation.
- Place at least 15 inches or at least one-third the *culvert's* diameter, whichever is greater, of fill dirt over the top of the *culvert* so that the fill over the *culvert* is the high spot in the stream crossing. This creates an emergency run-around for high flows.
- The *culvert's* ends should be long enough to achieve no more than a 2:1 slope on the fill.
- Stabilize fill at ends of a *culvert* with either *rip-rap*, Geoweb®, *excelsior blankets*, *gabions*, headwalls, grass seed and mulch, hay bales, etc.
- Periodically inspect culverts and remove any debris inside.
- Remove all temporary *culverts* and fill material used in stream or wetland crossings and stabilize streambanks when operations are completed (See Section 3.2 for stabilization recommendations).

3.3.6 Practices To Avoid When Constructing Stream Crossings

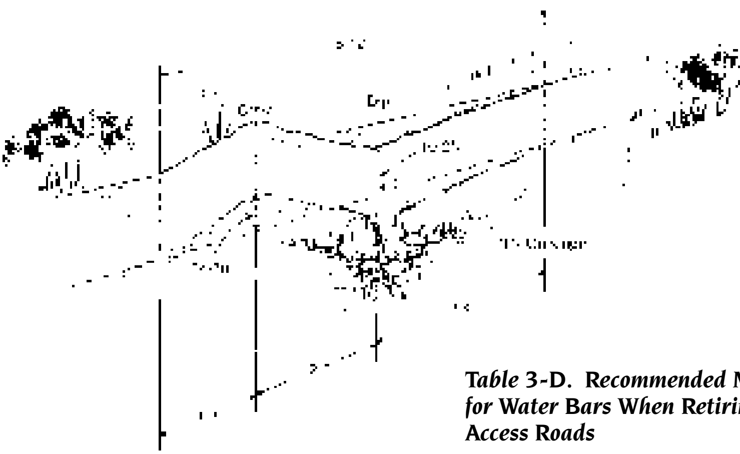
- Using steep approaches (> 3%) into the stream *channel*.
- Crossings at bends in the stream.
- Using fords in streams for *skid trails*.
- Constructing hard surface crossings on streams with mucky, muddy or unstable bottoms.
- Using asphalt materials for low water crossings.
- Anything that impedes the free or expected flow of water.
- Temporary crossings of logs and brush "topped" with soil.
- Using undersized *culverts*.

3.4 BMPS FOR THE MAINTENANCE AND RETIREMENT OF ROADS

- Maintain existing roads in accordance with BMPs.
- Maintain points of ingress from county roads or highways to prevent mud and debris being brought onto these roads.
- Minimize road grading and reshaping on hilly or mountainous terrain unless required to repair damaged road sections.
- Keep outfall of *broad-based dips*, *water bars*, and *water turnouts* open at all times during logging operations. If necessary, install sediment barriers such as rock, hay bales, or silt fence just below outfall.

- Retire temporary *access roads*, *log decks*, *skid trails*, by reshaping and/or constructing *water bars* at recommended intervals. Stabilize as necessary by seeding and *mulching* or scattering *logging debris* over the road surface (See Figure 3-I and Table 3-D for spacing recommendations).
- Periodically inspect retired roads to assure stabilization techniques are still effective and permanent stream crossings are clear and operating properly.

Figure 3-I. Profile of Retired Temporary Access Road Showing Water Bars



***Source*: Cooperative Extension Service Division of Agricultural Sciences and Natural Resources, Oklahoma State University.**

Table 3-D. Recommended Maximum Spacing for Water Bars When Retiring Temporary Access Roads

Road Grade (*percent*)	**Distance Between Water Bars (*feet*)**
2	245
5	125
10	80
15	60
20	50
25	40

3.4.1 Practices To Avoid During Road Maintenance and Retirement

- Excessive traffic on wet roads.

Section 4:
Timber Harvesting

Timber harvesting encompasses several operations. In addition to cutting trees, it typically includes the layout of *access roads*, *log decks*, and *skid trails* and the construction and stabilization of these areas. Timber harvesting can be accomplished while protecting water quality and site productivity and improving the composition and quality of future forests. Evolving timber harvesting technology, equipment, and procedures will provide for better protection of Georgia's waters.

Potential water quality impacts can be avoided or minimized if the harvest plan considers seasonal weather conditions, stand composition, soil type, soil moisture, topography, and type of equipment used. It is important to keep out of streams, to maintain the integrity of their banks, water flow, and stream biology. Specific BMPs for *log decks* and *skid trails* are provided in this section. BMPs for roads are presented in Section 3.

4.1 LOG DECKS

Log decks, also called brows and landings, are areas of concentrated equipment and traffic resulting in a high degree of soil disturbance, soil compaction, and rutting. Storm water runoff and surface *erosion* may increase on these exposed areas and, depending on their locations, could impact water quality. Runoff may contain toxic materials from fuels and lubricants. The following BMPs should be implemented to prevent runoff from reaching nearby watercourses.

4.1.1 BMPs For Log Decks

- Locate *log decks* before planning the road system.
- Minimize the number of *log decks* necessary for the operation.
- Minimize the size of *log decks*.
- Locate *log decks* uphill and *skid* up to them. This results in a cone-shaped pattern of *skid trails*, which disperses water running downhill. If trees must be skidded downhill, *erosion* can be minimized using smaller *log decks* with fewer, shorter and less-traveled *skid trails* leading to any one deck. Install *water bars* with *water turnouts* in *skid trails* prior to final approach to deck to disperse water.
- Locate *log decks* in a stable, well-drained area away from gullies when possible.
- Stabilize as needed when the harvest is completed, using *water bars*, logging

slash, or vegetative cover (See Table 6-A, pg 42 for seeding recommendations).

4.1.2 Practices to Avoid for Log Decks

- Locating *log decks* within the SMZ.
- Allowing *log decks* to concentrate storm runoff onto roads, trails, or direct paths leading to a watercourse.

4.2 SKID TRAILS

Skid trails are for temporary use during the timber harvest. Control and minimize site-damaging effects to soil stability and water quality, such as rutting, puddling, and compaction from harvest equipment. If trails will remain after the harvest for vehicular access, upgrade them to road building standards.

Control and minimize site-damaging effects to soil stability and water quality, such as rutting, puddling and compaction from harvest equipment.

4.2.1 BMPs for Skid Trails

- *Skid* uphill to *log decks* on ridges or hills.
- Have periodic breaks in grade to help disperse surface flow.
- Use temporary closure techniques, such as *water bars* or covering with logging slash, if significant *erosion* may occur before permanent closure techniques are installed.
- Where needed, retire as soon as possible with properly installed *water control structures*. For *water bars* see Figure 3-I, pg 25, and Table 4-A below for proper spacing.
- When grades exceed 15%, use *water bars* with *water turnouts*.

Table 4-A. Spacing of Water Bars on Skid Trails and Firebreaks

Grade of Skid Trail or Firebreak (*percent*)	Distance Between Water Bars (*feet*)
2	250
5	135
10	80
15	60
20	45
30	35
40*	30

** Use grades of 40% and steeper only for short stretches.*

4.2.2 Practices to Avoid With Skid Trails

- Trails over 40% grade except for short stretches.
- Bladed trails unless required on side slopes to create the appropriate grade for safe operations.
- Using stream and drains with defined *channels* as *skid trails*.
- Main *skid trails* within SMZs.

4.3 SKID TRAIL STREAM CROSSING

In certain situations, crossing a stream with a temporary *skid trail* may be preferable to a permanent road crossing. Factors to consider include the value of the timber to be accessed relative to the cost of a permanent crossing, topographic features limiting construction of permanent crossings, and the size of the stream and/or the upstream *watershed*. Regardless of the factors, protect water quality by maintaining the integrity of the stream bank, using water-permeable fill materials that are easy to recover in the restoration process, and minimizing the amount of fill dirt entering the stream.

4.3.1 BMPs For Skid Trail Stream Crossings

- Follow Federal mandates (See Section 3.3.1, pg 19).
- Minimize the number of crossings.
- Cross stream at right angles.
- Maintain stream bank integrity.
- Approach streams at gentle grades of slope, ideally at < 3%.
- Use temporary bridges or spans rather than temporary *culverts*.
- If temporary *culverts* are used, make sure they are properly sized for the *watershed* (See Table 3-C, pg 22).
- Stabilize *culvert* fill during and after construction using any one or a combination of: hay bales; seed and *mulch*; *silt fence*; rock; *excelsior blankets*; *geotextiles*; etc. (See Section 3.2, pg 15).
- Use logs or stems as fill over temporary *culverts* instead of fill dirt whenever possible.
- Remove all temporary fills and restore the *channel* to its original elevation.
- Stabilize approaches during and after construction.

4.3.2 Practices to Avoid For Skid Trail Stream Crossings

- Stream crossings whenever possible.
- Use of fords.
- Blocking stream flow.
- Blocking the migration of aquatic organisms.
- Using *sloughs* as *skid trails*.
- Random crossings with mechanized equipment.
- Leaving logs or stems in stream crossing.

4.4 RUTTING

During harvesting, some soil disturbance and rutting is inevitable, due to the mechanized nature of most harvesting systems. Excessive or inappropriate rutting can impact water quality when it causes *sediment* or silt-laden runoff to enter a stream or when it interrupts or changes the natural flow of water to the stream. Rutting that results in the discharge of *sediment* to a stream may violate Federal and State water-quality laws.

4.4.1 BMPs to Minimize Rutting

- Use low ground pressure equipment, logging mats, or other techniques on saturated soils where practical.
- Minimize the grade of *skid trails*.
- Follow the BMPs for *skid trails* listed in Section 4.2.

Example of soil degredation and water channelization from excessive rutting.

4.4.2 Practices to Avoid For Rutting

- Facilitating the potential movement of *sediment* to a stream or water body.
- Breaking down the integrity of a stream bank.

4.5 EQUIPMENT WASHING AND SERVICING

Improper equipment washing and servicing can introduce hazardous or toxic materials to the harvest site, which can affect water quality.

4.5.1 BMPs for Washing and Servicing Equipment

- Wash and service equipment away from any area that may create a water quality hazard, especially within SMZs and along *ephemeral areas*.
- Dispose of oils, lubrications, their containers and other wastes according to local, State and Federal regulations.
- Remove all used tires, batteries, oil cans, and trash from logging operations before leaving the site.
- Clean up and/or contain fuel and oil spills immediately. Report any chemical spills of twenty-five gallons or more of fuel and oil to soils, and spills of fuels or oils into waterways which produce visible sheens to the GA EPD Emergency Response Program (1-800-241-4113).

4.5.2 Practices to Avoid When Washing and Servicing Equipment

- Washing or servicing equipment where it could affect water quality.

4.6 PROTECTING STREAMSIDE MANAGEMENT ZONES (SMZs) DURING HARVESTING

4.6.1 BMPs for Harvesting Streamside Management Zones

In addition to the BMPs listed in Section 2.1:

- Use techniques that minimize soil disturbance, such as backing trees out with machine, using low ground pressure equipment, using equipment with booms or cable winch.
- Maintain the integrity of stream banks.
- Minimize the exposure of mineral soil by spreading logging slash and using it to drive over.

A well-protected SMZ.

4.6.2 Practices to Avoid When Harvesting Within SMZs

In addition to the avoidance guidelines listed in Section 2.1:

- Using trees or de-limbing gates in the SMZ.
- Leaving tops in stream *channels*.
- Rutting.

4.7 PROTECTING WETLANDS DURING TIMBER HARVESTING

4.7.1 BMPs for Harvesting Forested Wetlands

In addition to the BMPs listed in Section 2.2.11, pg 13:

- Plan the timber harvest for the dry season of the year when possible.
- Use site-specific equipment and methods to minimize water quality impacts, including high-flotation, low-pressure harvesting equipment, shovel logging, or cable yarding.
- Concentrate *skid trails* and use logging slash, mats or other techniques to minimize soil compaction and rutting.
- Use practices conducive to rapid *regeneration*.
- Follow Federally mandated stream and wetland crossings (See Section 3.3.1, pg 19).

Section 5:
Site Preparation and Reforestation

Site preparation facilitates the *regeneration* process and is the first step towards successful *regeneration*. *Site preparation* methods prepare harvested and non-forested areas for desired tree species and stocking. *Site preparation* may be used for both natural and artificial forest regeneration. Methods chosen should reduce logging debris, lessen logging impacts, control competing vegetation, and enhance seedling survival.

The *site preparation* technique used depends on soils, slope, condition of the site, vegetation, crop tree species, cost, location, and landowner goals. Analyze the *erosion* potential of the site prior to any *site preparation*. Topography, soil type, and residual ground cover determine *erosion* potential.

Topography - The steepness and length of the slope are major considerations when determining the treatment intensity. Intensive treatments that are acceptable in areas of little or no slope may be unacceptable in areas of steep slope.

Soil Type - Soil types or mapping units differ in texture, slope, stoniness, erodibility, wetness, or other characteristics that affect the use of the soils by man. Soil surveys describe these limitations as slight, moderate, or severe. Any limitations should receive extra care to prevent soil degradation.

Residual Ground Cover - The amount, species, and size of ground vegetation, logging debris and other organic matter should be a consideration in prescribing the type and intensity of the treatment.

Site preparation techniques can be grouped into three categories: mechanical, chemical, and *controlled burning*. Combinations of these techniques are common.

5.1 MECHANICAL SITE PREPARATION

Mechanical *site preparation* includes *shearing*, *raking*, *subsoiling*, *chopping*, *windrowing*, *piling*, *bedding*, and other physical methods to cut, break apart, or move logging debris, or improve soil conditions following harvest. This category is often described by its impact on the soil. Methods vary from low intensity to high intensity. High intensity methods such as *disking* and *bedding* expose the soil on more than 50% of the site. *Chopping* is a low intensity method. *Erosion* potential usually increases with higher intensity methods, especially in areas with steep slopes. Therefore, high intensity methods are: appropriate for flat and gentle slopes, used with caution on moderate slopes, and avoided on steep slopes. Low intensity methods are preferred on moderate to steep slopes.

5.1.1 BMPs for Mechanical Site Preparation

- Plan the *site preparation* job before starting to ensure that the best treatment is implemented.
- Use the minimum intensity of *site preparation* required.
- On slopes of 6%-10%, intensive mechanical methods should follow the *contour* of the land.
- On slopes of 11%-20%, mechanical methods, other than *chopping*, should follow the *contour* of the land. On soils with moderate to severe erosion potential, strips of untreated areas or windrows should be left to slow water and soil movement down the slope.
- On slopes of 21%-30% with severely erosive soils, use only low intensity mechanical methods that follow the *contour* of the land. Drum chopping should be perpendicular to the slope.
- On slopes greater than 30%, use only hand tools (chainsaw *felling*).
- Where accelerated *erosion* is likely, use methods that leave *logging debris* and other litter scattered evenly over the site.
- When constructing beds on slopes greater than 5%, follow the *contour* of the land.
- Protect forest floor and limit soil disturbance in stabilized gullies that are not eroding.

5.1.2 Practices to Avoid During Mechanical Site Preparation

- Any mechanical methods except drum roller *chopping* or spot cultivation on slopes greater than 30%. Drum chopping should not follow the *contour* of the land.
- Intensive mechanical methods on slopes greater than 20% with severe erosion potential.
- *Windrow* construction that could direct runoff into waterways.
- Mechanically preparing sites when soils are saturated.
- Mechanical methods in SMZs.
- Blocking any drainage with beds, *windrows*, or similar structures.
- *Bedding* that channels surface runoff into waterways and roadbeds.
- Moving soil into *windrows* and piles.
- Re-activating stabilized gullies.

5.2 MECHANICAL SITE PREPARATION IN WETLANDS

Forested *wetlands* offer unique challenges for *site preparation*. The EPA and Army Corps of Engineers have determined that major drainage in jurisdictional wetlands will require a Section 404 permit from the Army Corps of Engineers. Also a Section 404 permit may be required for mechanical *site preparation* for pine establishment in the following forested wetland types, unless they no longer exhibit their unique distinguishing characteristics due to past practices.

1. **Permanently flooded, intermittently exposed and semi-permanently flooded wetlands**: Examples include cypress-gum swamps, muck and peat swamps, and cypress strands/domes.
2. **Riverine bottomland hardwood wetlands**: Seasonally flooded or wetter bottomland hardwood sites within the first or second bottoms where overbank flooding has resulted in alluvial features such as natural levees. Soils are listed in NRCS surveys as poorly or very poorly drained. Bottomland hardwoods do not include sites in which greater than 25% of the canopy is pine.
3. **White cedar swamps**: *Wetlands* greater than one acre in headwaters and greater than five acres elsewhere, underlain by peat of greater than 40 inches, where natural white cedar represents more than 50 % of the *basal area* and where the total *basal area* for all tree species is 60 square feet or greater.
4. **Carolina Bay wetlands**: Oriented, elliptical depressions with a sand rim, either underlain by (a) clay-based soils and vegetated by cypress or (b) peat of greater than 20 inches and typically vegetated with an overstory of red, sweet, and loblolly bays.
5. **Non-riverine forest wetlands**: Rare, high quality (undisturbed) wet forests, with mature vegetation, located on the Southeastern coastal plain, whose *hydrology* is dominated by high water tables. Two forest community types fall into this group:

• **Wet hardwood forests** - interstream flats comprising ten or more contiguous acres typically found on the margins of large peatland areas that are seasonally flooded or saturated by high water tables. Soils are listed as poorly drained mineral soils. Vegetation is dominated (greater than 50% of basal area) by mature swamp chestnut oak, cherrybark oak, or laurel oak alone or in combination.

• **Swamp forests** - flats comprising five or more contiguous acres found on sites that are seasonally to frequently flooded or saturated by high water tables. Soils are listed as very poorly drained. Vegetation is dominated by mature bald cypress, pond cypress, swamp tupelo, water tupelo, or Atlantic white cedar alone or in combination.

Note: Sites dominated by red maple, sweetgum, or loblolly pine alone or in combination are not considered to be of high quality, and therefore do not require a permit.

6. **Low pocossin wetlands**: Central, deepest parts of domed peatlands on poorly drained interstream flats, underlain by peat soils greater than 40 inches, typically vegetated by a dense layer of short shrubs.
7. **Wet Marl forest**: Hardwood forest *wetlands* underlain with poorly drained marl-derived, high pH soils.
8. **Tidal freshwater marshes**: *Wetlands* with dense herbaceous vegetation located on the margins of estuaries or drowned rivers and creeks regularly or irregularly flooded by freshwater.
9. **Maritime grasslands, shrub swamps, and swamp forests**: Barrier island *wetlands* in dune swales and flats, underlain by wet mucky or sandy soils vegetated by wetland herbs, shrubs, and trees.

These forested wetland areas are more precisely described in an EPA and Corps November 1995 memorandum concerning Application of Best Management Practices to Mechanical Silvicultural Site Preparation Activities for the Establishment of Pine Plantations in the Southeast. Consult a *qualified professional* for additional information to determine if one of these wetland types is present on a site.

5.2.1 Other Wetlands

Other jurisdictional forested wetlands do not require a Section 404 permit if mechanical *site preparation* is conducted according to the following six federally mandated minimum BMPs.

5.2.1.1 Federally Mandated BMPs for Mechanical Site Preparation in Wetlands

1. Position shear blades or rakes at or near the soil surface. *Windrow*, pile, and move logs and *logging debris* by methods that reduce dragging or pushing through the soil to minimize soil disturbance associated with *shearing*, *raking* and moving trees, stumps, brush, and other unwanted vegetation.
2. Activities should avoid excessive soil compaction and maintain soil tilth.

3. Arrange *windrows* to limit erosion, overland flow, and runoff.
4. Prevent disposal or storage of logs or *logging debris* in SMZs.
5. Maintain the site's natural *contour* and ensure that activities do not immediately or gradually convert the wetland to a non-wetland.
6. Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.

5.3 CHEMICAL SITE PREPARATION

H*erbicides* are valuable tools in forest management and are used to control competing vegetation in the establishment and management of natural and planted pine stands. H*erbicide* treatments are acceptable site preparation methods on all slopes if conducted properly.

Proper planning and execution are key to safe *herbicide* use. Follow label directions and applicable State and Federal laws in the storage, transportation, handling, and application of all *herbicides*. Apply *restricted-use herbicides* only under the supervision of a certified *pesticide* applicator.

5.3.1 BMPs for Chemical Applications

- Establish appropriate SMZ along *perennial* and *intermittent streams* and flowing bodies of water.
- Consider weather conditions (e.g. temperature, wind speed and *precipitation*), equipment capabilities and *pesticide* formulations to avoid *pesticide* drift into the SMZ.
- Conduct all on-site *pesticide* handling, such as tank mixing, loading and rinsing equipment, away from streams, ponds, wells, and roadside *ditches*.
- Dispose of *pesticide* containers and/or excess *pesticides* according to local, State and Federal regulations and label requirements.
- Clean up and/or contain all *pesticide* spills immediately. Report spills to the GA EPD Emergency Response Program (1-800-241-4113).

5.3.2 Practices to Avoid During Chemical Applications

- Applying a *pesticide* directly to water bodies (streams, lakes, and swamps) unless it is specifically prescribed and labeled for aquatic management.
- Broadcast applications of *pesticides* within SMZs.

5.4 SITE PREPARATION (CONTROLLED) BURNING

Controlled fire is is often used alone or in conjunction with chemical or mechanical *site preparation* to prepare sites for *regeneration*. A properly executed site prep burn only slightly increases the chance for *erosion*. Fires that expose significant mineral soil on moderate and steep slopes, however, may increase *erosion* potential. Other factors also must be taken into consideration. If in doubt about appropriate *site preparation* treatment, consult a *qualified professional*.

5.4.1 BMPs for Site Preparation Burning

- Unless protected by natural barriers, the area to be burned should be protected by *firebreaks* installed following BMP recommendations (See Section 5.5).
- Moisture levels within the soil, forest fuels, and the air should be sufficient to prevent major exposure or damage to the mineral soil, especially on moderate to severely erosive soils.
- Exclude high intensity *site preparation* fires from the SMZ. Cool, low intensity, hazard-reduction fires that do not consume the *duff* layer are allowed.

5.5 PRE-SUPPRESSION FIREBREAKS

Pre-suppression *firebreaks* aid in *site preparation* (controlled) burning, *prescribed burning*, and in controlling wildfires. Proper planning and BMP implementation for pre-suppression *firebreaks* can minimize sediment delivery to surface water. Aerial photographs, topographic maps, or county soil survey maps should be used to locate tract boundaries, streams, *wetlands*, rock outcrops, gullies, and cemeteries, etc. that require extra precautions.

5.5.1 BMPs for Firebreaks

- Where possible, use natural barriers such as roads, streams, and fields as *firebreaks*.
- Install *firebreaks* on the *contour* as much as possible.
- When *firebreaks* cannot be installed on the *contour*, use a gradual grade.
- Use bladed or harrowed *firebreaks* instead of plowed *firebreaks* whenever possible.
- On slopes exceeding 3%, install *water bars* with water turnouts in *firebreaks* according to the BMP recommendations for *skid trail* retirement (See Table 4-A, pg 27).
- Use hand tools or *back blade firebreaks* away from the edge of streams, roads, or *gullies*.
- Install *water bars* and *water turnouts* at approaches to streams, roads, and *gullies* to prevent channeling water from *firebreaks* into these areas.
- Treat active *gullies* the same as streams, using appropriate buffers and plowing practices.

5.5.2 *Practices to Avoid During Firebreak Construction*

- *Firebreaks* that channel surface runoff into streams, roads, or *gullies*.
- Plowing inside the SMZ.

5.6 REFORESTATION

Reforestation can be accomplished artificially or naturally. Natural *regeneration* and hand planting generally pose less of a threat to water quality as opposed to mechanical methods. Complete artificial *regeneration* projects as quickly as practical. A *qualified professional* can provide advice on reforestation choices.

5.6.1 *BMPs For Reforestation*

- Hand plant on >21% slopes with severely erosive soils.
- Machine plant on the *contour* on slopes between 5% and 20%.

Mechanical tree planting

5.6.2 *Practices to Avoid During Mechanical Reforestation*

- Machine planting up and down slopes greater than 5%.
- Machine planting within SMZs.

NOTES:

Section 6:
Management and Protection

6.1 PRESCRIBED BURNING/HAZARD REDUCTION

P*rescribed burning* is used to reduce hazardous accumulations of forest fuels, manage competing plant vegetation, improve wildlife habitat, and perpetuate certain endangered plant and animal ecosystems. When properly planned and conducted, *prescribed burning* has minimal impacts on water quality. These burns should follow federal, state, county and local regulations.

6.1.1 BMPs for Prescribed Burning

- Follow the same BMPs listed in Sections 5.4 and 5.5.

6.2. WILDFIRE SUPPRESSION

Wildfires are suppressed aggressively with the safety of personnel and equipment a primary concern. After suppression, when safety allows, BMPs should be installed during mop up or as soon as possible.

6.2.1 BMPs for Wildfire Suppression Firebreaks

- Locate camps and *staging areas* on upland sites.
- Stabilize areas designated for *water supply points* and dip sites for helicopters to prevent excessive rutting from support equipment.
- Mix and/or handle fire retardants, lubricants, etc. away from streams, ponds, wells, and roadside *ditches*.
- Repair wildfire suppression *firebreaks* as soon as practical after the fire is under control to meet BMPs for pre-suppression plowing.

6.3 FERTILIZATION

Forest fertilization is a valuable *silvicultural* practice that enhances tree survival and growth. The primary nutrients applied are nitrogen and phosphorus. Plan any forest fertilization to prevent direct applications and runoff into water bodies. When conducted properly, forest fertilization poses little threat to water quality. F*ertilizer* applications should not result in violations of State water quality standards for nitrates and phosphorous for lakes. For more information, contact the GA EPD Water Protection Branch (1-404-656-4708) for those water quality standards.

6.3.1 BMPs for Fertilization

- Consider weather conditions (such as temperature, wind speed and precipitation), and equipment capabilities to avoid *fertilizer* drift into the SMZ.
- Conduct all on-site *fertilizer* handling, such as mixing and loading, away from streams, ponds, wells and roadside ditches.
- Clean up and/or contain all *fertilizer* spills immediately. In case of accidental spills, call 1-800-241-4113.
- Dispose of *fertilizer* containers and/or excess *fertilizer* according to local, State and Federal regulations and label requirements.

6.3.2 Practices to Avoid When Applying Fertilizers

- Applying *fertilizer* directly to water bodies (streams, lakes, and swamps) unless specifically prescribed and approved for aquatic management.
- Applications of *fertilizer* within SMZs.

6.4 REVEGETATION AND STABILIZATION OF SITES

Forest management often creates openings in the form of roads, stream crossings, *log decks*, *skid trails*, and *firebreaks*. Establishing a vegetative cover as soon as possible on these sites reduces erosion and prevents sedimentation. In addition to protecting the soil, vegetative cover can enhance wildlife habitat. Establishing a vegetative cover may include selecting the proper plant species, preparing the site, liming, fertilizing, seeding, and *mulching*. This section provides a variety of seeding mixtures that stabilize sites quickly and also provide benefits to wildlife. Table 6-A provides a quick reference to help with the selection and establishment of seeding mixtures. Selection of plant species, establishment methods, and maintenance procedures should be based on site characteristics, including climate, soils, *aspect*, and land use objectives.

6.4.1 Land Preparation

Site preparation, such as smoothing or reshaping rutted roads and landings, may be necessary before conventional equipment can prepare seedbeds, which are important for vegetation establishment. Disc *harrowing* and dragging will firm and smooth soil and promote good germination. Heavily compacted areas may require *sub-soiling*, ripping, or *disking* to allow water infiltration and to provide a suitable seedbed for root growth.

6.4.1.1 Fertilizer and Lime

A soil test can determine fertility and pH. If a soil test is not available and lime has not been applied in the past three years, apply it at the rate shown in the fol-

Table 6-A. Seeding Mixtures for Erosion Control Plantings

Fall Plantings		**Planting Date**					
Recommended Planting[1]	Seedling[2] Rate (lb/acre)	Coastal	Piedmont	Mountains	Fertilizer (lb/acre)	Wildlife Value	Remarks
Ladino Clover[3] Red Clover Ryegrass Rye Wheat	5 10 15 30 30	September 15 to November 15	September 1 to November 1	August 1 to October 15	500 10-10-10	Excellent	Well drained clayey or loamy soils. Perennial clover can persist for several years. Inoculate clover seed. Maintaining pH above 6.0 is critical.
Crimson Clover Hairy Vetch Wheat	15 15 60	September 15 to November 15	September 1 to November 1	September 1 to October 15	500 10-10-10	Excellent	Well drained clayey or loamy soils. Inoculate clover. Tolerates lower soil pH. Disk lightly in September to encourage reseeding and overseed with wheat.
Arrowleaf Clover or Crimson Clover Ryegrass Wheat	15 15 40	September 15 to November 15	September 1 to November 1	September 1 to October 15	500 10-10-10	Good	Well drained sandy or loamy soils. Inoculate clover. Disk lightly in September to encourage reseeding clover and overseed with wheat and rye.
Wheat or Rye Unhulled Bermuda in sandy soil or Fescue in clayey soil	50 10 25	September to December 15	September 1 to December 1	September 1 to November 15	500 10-10-10	Poor	Cool season annuals provide value for wildlife during fall and winter of first year. Maintain by mowing for weed control and fall fertilization
Spring Plantings		**Planting Date**					
Ryegrass Kobe Lespedeza	20 30	Feb. 15 to April 1	Feb. 15 to April 1	March 1 to April 15	500 10-10-10	Excellent	Low maintenance, reseeding annuals. Inoculate Kobe Lespedeza.
Bahiagrass Brown Top Millet	25 25	March 25 to July 1	April 15 to July 1	NA	500 10-10-10	Good	Include hulled Bermuda at a rate of 10 lb. per acre on sandy sites. Kobe Lespedeza can be added at lb per acre to increase wildlife value.
Bermuda Grass Brown Top Millet	10 25	March 15 to July 1	March 15 to July 1	April 15 to July 1	500 10-10-10	Fair	Does well in dry, sandy sites.

Footnotes for Erosion Control Plantings Table

1) To maximize wildlife value, avoid plantings with Fescue, weeping love grass, Bermuda grass, and sericea Lespedeza.
2) Seeding depths should be 1/4 inch unless otherwise noted.
3) For mixtures including Ladino clover, lime at the rate indicated by soil test or at the rate of 2 tons per acre.

lowing table. Lime and *fertilizer* are most efficient when incorporated into the soil. Spread them uniformly over the site prior to land preparation and mix them completely with the soil. Lime takes several months to react with the soil and become fully effective.

Table 6-B. Rate of Lime to Use When a Soil Test is Unavailable

Soil Texture	Tons/Acre	Pounds/1000 sq. ft.
Sands and loams	2	100
Clayey, acidic	3	150
Clayey, alkaline	0	0

Base additional applications of lime on soil test recommendations.

Forest soils are typically low in phosphorous and/or potassium and usually require lime. Clovers are not productive in acid sites (below pH 6.0) with low fertility unless *fertilizer* and lime are added.

6.4.1.2 Seeding and Mulching

Seeding can be done in a number of ways. The most common method is with a farm tractor and a broadcast seeder. On steep or severely erosive sites, use a hydroseeder. Seed should be covered by pulling a section harrow, cultipacker, or brush.

Mulch should be used on slopes over 5%, on sites where vegetation will establish slowly, or on deep sands or heavy clay soils. Mulch helps prevent *erosion* and allows vegetation to become established. Structural measures such as a diversion, which moves concentrated runoff, usually require mulch. Where there is a danger of mulch being blown or washed off-site, anchor it by running over the mulched area with a disk harrow with the discs set to run straight. On steep slopes, anchor mulch with netting and tack-down staples or spray it with a tackifier.

Section 7:
Additional Management Objectives

The B*est Management Practices* recommendations in this publication are directed at maintaining water quality, which is critical for the conservation of all natural resources. Forest management practices such as timber harvesting, *site preparation*, tree *regeneration*, and forest stand treatments may be conducted in ways that enhance fish and wildlife habitat, *aesthetics*, and recreational opportunities, while accommodating sensitive sites and endangered species. Landowners may have other resource objectives that can be achieved only through the use of practices that vary but are consistent with the protection of water quality. The following comments describe additional management options that landowners may wish to consider.

7.1 WILDLIFE MANAGEMENT

- Compare your current habitat conditions, along with those on adjacent lands, to your wildlife management objectives before making land management decisions.
- Some fish and wildlife species benefit from SMZs wider than the minimum widths specified for water quality BMPs.
- Manage for a diversity of forest types and age classes to enhance wildlife habitat quality.
- Maintain mature mast producing hardwoods in groups or stands.
- Leave corridors of trees connecting mature forest stands to provide food, cover and travel avenues for wildlife while adjacent stands are regenerated.
- Leave snags, dead and down woody debris, brush piles or *windrows* throughout timber harvest areas.
- Use *prescribed fire*, which is one of the most cost effective forest and wildlife management practices.
- Use wildlife friendly plantings for *log decks*, roads and *skid trails* following logging operations.
- For more information on any of the above recommendations, contact the Georgia DNR Wildlife Resources Division (1-706-557-3020).

7.2. PROTECTED SPECIES

The University of Georgia Cooperative Extension Service, the College of Agricultural and Environmental Sciences, or the Georgia Department of Natural

Resources Wildlife Resources Division have publications with listings.

If you suspect the presence of an endangered species, contact the Georgia Department of Natural Resources Wildlife Resources Division or the U.S. Fish and Wildlife Service for verification and management considerations.

7.3. AESTHETICS

- Consider aesthetics during forest management activities and be aware that appearance may influence public opinion.
- Use forest management methods that can minimize visual impacts such as single tree and group selection, *seed tree* and *shelterwood regeneration*, and small patch clearcuts.
- Leave corridors of trees along well-traveled public roads to enhance visual quality.
- Shape harvest areas with natural features of the landscape.
- Reseed bare soil areas promptly.
- Maintain a mixed tree species composition.
- During artificial regeneration, establish tree rows parallel to the road and avoid 90-degree angles.
- Minimize the "skylining" of residual snags and cull trees.
- For more information, see the American Pulpwood Association's *Forestry Aesthetics Guide, Image and Opportunity*.

Aesthetics can influence public perception of forestry.

7.4 SENSITIVE SITES

- Consider protective management prescriptions for unique cultural (Native American sites), ecological (protected species), archeological (Civil War breastworks), geological (rock formations), or historical (old forts and cemeteries) sites. They may need special consideration to manage their values. Contact the DNR Historic Preservation Division (1-404-656-2840).

Section 8:
Appendix

8.1 FEDERAL LAWS AND REGULATIONS AFFECTING FOREST LANDOWNERS

8.1.1 The Federal Clean Water Act, Section 404, 40 CFR Part 232.3

- Exempts normal, established, on-going *silvicultural* operations from permitting.
- Requires *silvicultural* operations to adhere to BMPs and fifteen baseline provisions for forest road construction and maintenance in and across *waters of the* U.S. (lakes, rivers, perennial and *intermittent streams*, *wetlands*, *sloughs* and natural ponds) in order to qualify for the *silvicultural* exemption from the permitting process (See Section 3.3.1, pg 19-20 for the baseline provisions).
- Requires Army Corps of Engineers permit for the conversion of forested *wetlands* to other uses such as agriculture or development.
- A Memorandum of Understanding dated November 28, 1995, between the Army Corps of Engineers and the U.S. Environmental Protection Agency - requires permit for the conversion of specific high-quality bottom land hardwood *wetlands* to pine plantations by mechanical *site preparation* methods and mandates the use of six BMPs in other jurisdictional *wetlands* (See Section 5.2.1.1, pg 35 for the list).
- Provides for civil and criminal penalties up to $125,000 per day.

8.1.2 USDA Programs

Participation by landowners in various loan, price support, agriculture, forestry incentive and assistance programs subject landowners to rules and regulations regarding the Federal Farm Bill (Swampbuster and Sodbuster Provisions).

- Prohibits landowners from converting forested *wetlands* to agricultural uses.
- Provides for penalties including program payments plus interest to be paid back from the time of the conversion, loss of benefits and loss of eligibility in future programs.

8.2 STATE LAWS AND REGULATIONS AFFECTING FOREST LANDOWNERS

8.2.1 The Georgia Water Quality Control Act (O.C.G.A. 12-5-29)

- Makes it unlawful to discharge excessive *pollutants* (*sediment*, nutrients, pesticides, animal waste, etc.) into *waters of the State* in amounts harmful to public health, safety, or welfare, or to animals, birds or aquatic life or the physical destruction of stream habitats (See Section 1 or the Glossary for definition of *waters of the State*).

• Provides for civil and criminal penalties up to $100,000 per day.

8.2.2 Excerpts from Georgia Rules and Regulations for Water Quality Control Chapter 391-3-6-.03 Water Use Classifications and Water Quality Standards (Amended).

General Criteria for All Waters. The following criteria are deemed to be necessary and applicable to all *waters of the State*:

Turbidity. All waters shall be free from *turbidity*, which results in a substantial visual contrast in a water body due to a man-made activity. The upstream appearance of a body of water shall be as observed at a point immediately upstream of a *turbidity*-causing man-made activity. That upstream appearance shall be compared to a point, which is located sufficiently downstream from the activity so as to provide an appropriate mixing zone. For land disturbing activities, proper design, installation, and maintenance of *best management practices* and compliance with issued permits shall constitute compliance.

Temperature: Not to exceed 90˚F. At no time is the temperature of the receiving waters to be increased more than 5˚F above intake temperature except that in estuarine waters the increase will not be more than 1.5˚F. In waters designated as primary *trout streams* by the Wildlife Resources Division, there shall be no elevation of natural stream temperatures. Waters designated as primary *trout streams* are waters supporting a self-sustaining population of rainbow, brown or brook trout. In waters designated as secondary *trout streams*, there shall be no elevation exceeding 2˚F natural stream temperatures. Streams designated as secondary *trout streams* are those with no evidence of natural trout reproduction, but are capable of supporting trout throughout the year.

Following is a listing of *trout streams*. *Trout streams* are classified in accordance with the designations and criteria established by the Georgia Environmental Protection Division. This list may be updated every two years. For the most current list contact the Georgia EPD (404-656-4708).

Designations by County.

BARTOW COUNTY

Primary:
None.

Secondary:
1. Boston Creek and its tributaries upstream from GA. Hwy. 20.
2. Connesena Creek and its tributaries.
3. Dykes Creek and its tributaries.
4. Pine Log Creek and its tributaries.
5. Pyle Creek and its tributaries.
6. Salacoa Creek and its tributaries.
7. Spring Creek and its tributaries.
8. Stamp Creek and its tributaries upstream from County Rd. 269.
9. Toms Creek and its tributaries upstream from County Rd. 82.
10. Two Run Creek and its tributaries.
11. Ward Creek and its tributaries.

CARROLL COUNTY

Primary:
None.

Secondary:
1. Brooks Creek and its tributaries.
2. Mud Creek and its tributaries.
3. Tallapoosa River.

CATOOSA COUNTY

Primary:
None.

Secondary:
1. Hurricane Creek and its tributaries upstream from Peters Branch.
2. Little Chickamauga Creek and its tributaries upstream from County Rd. 387.
3. Tiger Creek and its tributaries upstream from GA. Hwy. 2.
4. Dry Creek and its tributaries upstream from County Rd. 257 (East Chickamauga Creek Watershed).

CHATTOOGA COUNTY

Primary:
None.

Secondary:
1. Allgood Branch and its tributaries upstream from Southern Railroad.
2. Chappel Creek and its tributaries.
3. Chelsea Creek and its tributaries.
4. East Fork Little River and its tributaries.
5. Hinton Creek and its tributaries.
6. Kings Creek and its tributaries.
7. Little Armuchee Creek and its tributaries upstream from County Rd. 326.
8. Middle Fork Little River and its tributaries.
9. Mt. Hope Creek and its tributaries.
10. Perennial Spring and its tributaries.
11. Raccoon Creek and its tributaries upstream from GA. Hwy. 48.
12. Ruff Creek and its tributaries.
13. Storey Mill Creek and its tributaries.
14. Taliaferro Creek and its tributaries.

CHEROKEE COUNTY

Primary:
None.

Secondary:
1. Boston Creek and its tributaries.
2. Pine Log Creek and its tributaries.
3. Salacoa Creek and its tributaries.
4. Stamp Creek and its tributaries.
5. Bluff Creek and its tributaries upstream from County Rd. 114.
6. Murphy Creek and its tributaries.
7. Soap Creek and its tributaries upstream from County Rd. 116.
8. Wiley Creek and its tributaries.

COBB COUNTY

Primary:
None.

Secondary:
1. Chattahoochee River upstream from I-285 West Bridge.

DADE COUNTY

Primary:
None.

Secondary:
1. Allison Creek and its tributaries.
2. East Fork Little River and its tributaries.
3. Lookout Creek and its tributaries upstream from County Rd. 197.
4. Rock Creek and its tributaries.
5. West Fork Little River and its tributaries.

DAWSON COUNTY

Primary:
1. Amicalola Creek and its tributaries upstream from County Rd. 192 (Devil's Elbow Road).
2. Sweetwater Creek and its tributaries.
3. Anderson Creek and its tributaries.
4. Long Swamp Creek and its tributaries.
5. Nimblewill Creek and its tributaries.

Secondary:
1. Amicalola Creek and its tributaries from GA. Hwy. 53 upstream to County Rd. 192 (Devil's Elbow Road).
2. Shoal Creek and its tributaries upstream from the mouth of Burt Creek.

ELBERT COUNTY

Primary:
None.

Secondary:
1. Savannah River for the ten-mile reach downstream from Hartwell Dam.

FANNIN COUNTY

Primary:
1. Conasauga River - Jacks River and its tributaries.
2. Ellijay River and its tributaries.
3. Etowah River and its tributaries.
4. Fightingtown Creek and its tributaries.
5. Owenby Creek and its tributaries.
6. Persimmon Creek and its tributaries.
7. South Fork Rapier Mill Creek and its tributaries.
8. Toccoa River and its tributaries upstream to Blue Ridge Reservoir dam.
9. Toccoa River and its tributaries upstream from the backwater of Blue Ridge Reservoir.
10. Tumbling Creek and its tributaries.
11. Wilscot Creek and its tributaries.

Secondary:
All streams or stream sections not classified as primary in the above list.

FLOYD COUNTY

Primary:
None.

Secondary:
1. Dykes Creek and its tributaries.
2. Johns Creek and its tributaries upstream from County Rd. 212.
3. Kings Creek and its tributaries.
4. Lavender Creek and its tributaries upstream from County Rd. 234.
5. Little Cedar Creek and its tributaries.
6. Mt. Hope Creek and its tributaries.
7. Spring Creek and its tributaries (flows into Etowah River).
8. Spring Creek and its tributaries (flows into State of Alabama).
9. Toms Creek and its tributaries.
10. Silver Creek and its tributaries upstream from GA. Highway 1E.

FORSYTH COUNTY

Primary:
None.

Secondary:
1. Chattahoochee River.

FULTON COUNTY

Primary:
None.

Secondary:
1. Chattahoochee River upstream from I-285 West Bridge.

GILMER COUNTY

Primary:
1. Cartecay River and its tributaries upstream from the mouth of Clear Creek.
2. Clear Creek and its tributaries upstream from County Rd. 92.
3. Conasauga River - Jacks River and its tributaries.
4. Ellijay River and its tributaries upstream from the mouth of Kells Creek.
5. Harris Creek and its tributaries.
6. Johnson Creek and its tributaries.
7. Mountaintown Creek and its tributaries upstream from U.S. Hwy. 76.
8. Tails Creek and its tributaries upstream

from GA. Hwy. 282.
9. Toccoa River - Fightingtown Creek and its tributaries.

Secondary:
1. All streams or sections thereof except the Coosawattee River downstream from GA. Hwy. 5 Bridge, and Talking Rock Creek (not including tributaries) and those classified as primary.
2. Ball Creek and its tributaries.
3. Sevenmile Creek and its tributaries.
4. Town Creek and its tributaries.
5. Wildcat Creek and its tributaries.

GORDON COUNTY

Primary:
None:

Secondary:
1. Johns Creek and its tributaries.
2. Long Branch and its tributaries.
3. Pine Log Creek and its tributaries upstream from GA. Hwy. 53.
4. Pin Hook Creek and its tributaries upstream from Ryo Rd.
5. Rocky Creek and its tributaries upstream from West Union Rd.
6. Salacoa Creek and its tributaries upstream from U.S. Hwy. 411.
7. Snake Creek and its tributaries.

GWINNETT COUNTY

Primary:
None.

Secondary:
1. Chattahoochee River.

HABERSHAM COUNTY

Primary:
1. Chattahoochee River and its tributaries upstream from GA. Hwy. 255 Bridge.
2. Middle Fork Broad River and its tributaries upstream from USFS Rd. 92-B.
3. Panther Creek and its tributaries.
4. Soque River and its tributaries upstream from King's Bridge (bridge on GA. Hwy. 197 just below the mouth of Shoal Creek).

Secondary:
1. Chattahoochee River and its tributaries upstream from GA. Hwy. 115 to the GA. Hwy. 255 Bridge.
2. Davidson Creek and its tributaries.
3. Middle Fork Broad River tributaries entering below USFS Rd. 92-B.
4. Nancytown Creek and its tributaries upstream from Nancytown Lake.
5. North Fork Broad River and its tributaries.
6. Soque River and its tributaries upstream from the mouth of Deep Creek to King's Bridge.
7. Toccoa Creek and its tributaries.

HARALSON COUNTY

Primary:
None.

Secondary:
1. Beach Creek and its tributaries upstream from County Rd. 34.
2. Flatwood Creek and its tributaries.
3. Lassetter Creek and its tributaries.
4. Mann Creek and its tributaries upstream from County Rd. 162.
5. Tallapoosa River and its tributaries upstream from County Rd. 222.
6. Mountain Creek and its tributaries.
7. Tallapoosa Creek and its tributaries.

HART COUNTY

Primary:
None.

Secondary:
1. Savannah River.

LUMPKIN COUNTY

Primary:
1. Amicalola Creek and its tributaries.
2. Camp Creek and its tributaries.
3. Cane Creek and its tributaries upstream from Cane Creek Falls.
4. Cavender Creek and its tributaries.
5. Chestatee River and its tributaries upstream from County Rd. 52-S976.
6. Clay Creek and its tributaries.
7. Etowah River and its tributaries upstream

from the GA. Hwy. 52 Bridge.
8. Hurricane Creek and its tributaries upstream from County Rd. 118.
9. Mooney Branch and its tributaries.
10. Tobacco Pouch Branch and its tributaries.

Secondary:
1. Cane Creek and its tributaries upstream from GA. Hwy. 52 Bridge to Cane Creek Falls.
2. Chestatee River and its tributaries upstream from the mouth of Tesnatee Creek to County Rd. 52-S976.
3. Etowah River and its tributaries upstream from Castleberry Bridge to GA. Hwy. 52 except those classified as primary above.
4. Shoal Creek and its tributaries.
5. Yahoola Creek and its tributaries upstream from GA. Hwy. 52.

MURRAY COUNTY

Primary:
1. Conasauga - Jacks River and its tributaries upstream from Georgia--Tennessee state line.
2. Holly Creek and its tributaries upstream from County Rd. SR826 (USFS line).
3. Rock Creek and its tributaries upstream from County Rd. 4 (Dennis).

Secondary:
1. All tributaries to Carters Reservoir.
2. Holly Creek and its tributaries (including Emory Creek watershed) upstream from Emory Creek to County Rd. SR826 (USFS line).
3. Mill Creek and its tributaries upstream from County Rd. 27.
4. North Prong Sumac Creek and its tributaries.
5. Sugar Creek and its tributaries upstream from County Rd. 4.
6. Sumac Creek and its tributaries upstream from Coffey Lake.
7. Mill Creek and its tributaries.
8. Rock Creek and its tributaries upstream of County Rd. 301.

PAULDING COUNTY

Primary:
None.

Secondary:
1. Possum Creek and its tributaries upstream from County Rd. 64.
2. Powder Creek and its tributaries.
3. Pumpkinvine Creek and its tributaries upstream from County Rd. 231.
4. Pyle Creek and its tributaries.
5. Raccoon Creek and its tributaries upstream from County Rd. SR2299.
6. Tallapoosa River and its tributaries.
7. Ward Creek and its tributaries.
8. Simpson Creek and its tributaries.
9. Thompson Creek and its tributaries.

PICKENS COUNTY

Primary:
1. Cartecay River and its tributaries.
2. Talking Rock Creek and its tributaries upstream from Rt. S1011.

Secondary:
1. Amicalola Creek and its tributaries.
2. East Branch and its tributaries (including Darnell Creek and its tributaries).
3. Fisher Creek and its tributaries (upstream from the confluence of Talona Creek and Fisher Creek).
4. Fourmile Creek and its tributaries.
5. Hobson Creek and its tributaries.
6. Little Scarecorn Creek and its tributaries.
7. Long Branch and its tributaries.
8. Long Swamp Creek and its tributaries upstream from County Rd. 294.
9. Mud Creek and its tributaries.
10. Pin Hook Creek and its tributaries.
11. Polecat Creek and its tributaries.
12. Rock Creek and its tributaries.
13. Salacoa Creek and its tributaries.
14. Scarecorn Creek and its tributaries upstream from GA. Hwy. 53.
15. Ball Creek and its tributaries.
16. Bluff Creek and its tributaries.
17. Sevenmile Creek and its tributaries.
18. Soap Creek and its tributaries.
19. Town Creek and its tributaries.
20. Wildcat Creek and its tributaries.

POLK COUNTY

Primary:
None.

Secondary:
1. Cedar Creek and its tributaries upstream from County Rd. 121.
2. Lassetter Creek and its tributaries.
3. Little Cedar Creek and its tributaries.
4. Pumpkinpile Creek and its tributaries upstream from County Road SR1032.
5. Spring Creek and its tributaries.
6. Swinney Branch and its tributaries.
7. Thomasson Creek and its tributaries.
8. Fish Creek and its tributaries upstream of

Plantation Pipeline.
9. Silver Creek and its tributaries.
10. Simpson Creek and its tributaries upstream of Lake Dorene.
11. Thompson Creek and its tributaries upstream of County Rd. 441.

RABUN COUNTY

Primary:
1. Chattooga River - all tributaries classified as primary.
2. Little Tennessee River - entire stream and tributaries classified as primary except all streams or sections thereof classified as secondary.
3. Tallulah River - entire stream and tributaries classified as primary except the Tallulah River downstream from Lake Rabun Dam to headwaters of Tugaloo Lake.

Secondary:
1. Little Tennessee River downstream from U.S. Hwy. 441 Bridge.
2. Mud Creek downstream from Sky Valley Ski Resort Lake to the Little Tennessee River.

STEPHENS COUNTY

Primary:
1. Middle Fork Broad River and its tributaries upstream from USFS Route 92-B.
2. Panther Creek and its tributaries upstream from the mouth of Davidson Creek.

Secondary:
1. Davidson Creek and its tributaries.
2. Leatherwood Creek and its tributaries upstream from GA. Hwy. 184 Bridge.
3. Little Toccoa Creek and its tributaries.
4. Middle Fork Broad River and its tributaries upstream from NRCS flood control structure #44 to USFS Route 92-B.
5. North Fork Broad River and its tributaries upstream from NRCS flood control structure #1.
6. Panther Creek and its tributaries downstream from the mouth of Davidson Creek.
7. Toccoa Creek upstream from Toccoa Falls.

TOWNS COUNTY

Primary:
1. Brasstown Creek and its tributaries.
2. Chattahoochee River and its tributaries.
3. Gumlog Creek and its tributaries.
4. Hiawassee River and its tributaries - entire stream and all tributaries classified as primary except all streams or sections thereof classified as secondary.
5. Tallulah River and its tributaries.
6. Winchester Creek and its tributaries.

Secondary:
1. Hightower Creek downstream from the mouth of Little Hightower Creek.

UNION COUNTY

Primary:
1. Arkaqua Creek and its tributaries.
2. Brasstown Creek and its tributaries.
3. Chattahoochee River and its tributaries.
4. Conley Creek and its tributaries upstream from County Rd. S2325.
5. Coosa Creek and its tributaries upstream from mouth of Anderson Creek.
6. Dooley Creek and its tributaries.
7. East Fork Wolf Creek and its tributaries upstream from Lake Trahlyta.
8. Gumlog Creek and its tributaries.
9. Ivylog Creek and its tributaries upstream from USFS property line.
10. Nottely River and its tributaries upstream from the mouth of Town Creek.
11. Toccoa River and its tributaries.
12. Town Creek and its tributaries.
13. West Fork Wolf Creek and its tributaries.
14. Youngcane Creek and its tributaries upstream from the mouth of Jones Creek.

Secondary:
1. All streams or sections thereof except the Butternut Creek and its tributaries and the Nottely River downstream of Nottely Dam and those classified as primary.

WALKER COUNTY

Primary:
1. Furnace Creek and its tributaries.
2. Harrisburg Creek and its tributaries (including Dougherty Creek and Allen Creek) upstream from Dougherty Creek.

Secondary:
1. Chappel Creek and its tributaries.
2. Concord Creek and its tributaries.
3. Dry Creek and its tributaries (tributary to East Armuchee Creek).
4. Duck Creek and its tributaries.
5. East Armuchee Creek and its tributaries upstream from GA. Hwy. 136.
6. East Fork Little River and its tributaries (flows into Dade County).
7. East Fork Little River and its tributaries (flows into Chattooga County; includes Gilreath Creek).
8. Gulf Creek and its tributaries.
9. Johns Creek and its tributaries.
10. Left Fork Coulter Branch and its tributaries.
11. Little Chickamauga Creek and its tributaries.
12. Middle Fork Little River and its tributaries (includes Cannon Branch and Hale Branch).
13. Rock Creek and its tributaries (including Sawmill Branch) upstream from Sawmill Branch.
14. Ruff Creek and it tributaries.
15. Snake Creek and its tributaries.
16. West Armuchee Creek and its tributaries.
17. West Chickamauga Creek and its tributaries upstream from County Rd. 107.
18. West Fork Little River and its tributaries.
19. Chattanooga Creek and its tributaries upstream of County Rd. 235.

WHITE COUNTY

Primary:
1. Cathey Creek and its tributaries upstream from the Arrowhead Camp-ground Lake.
2. Chattahoochee River and its tributaries upstream from GA. Hwy. 255 Bridge.
3. Town Creek and its tributaries upstream from the mouth of Jenny Creek.

Secondary:
1. Chattahoochee River and its tributaries upstream from GA. Hwy. 115 to the GA. Hwy. 255 Bridge.
2. Little Tesnatee Creek and its tributaries upstream from the mouth of Turner Creek.
3. Turner Creek and its tributaries except as listed under primary above (Turner Creek nearest to Cleveland City limits).

WHITFIELD COUNTY

Primary:
None.

Secondary:
1. Coahulla Creek and its tributaries upstream from County Rd. 183.
2. East Armuchee Creek an its tributaries.
3. Snake Creek and its tributaries.
4. Spring Creek and its tributaries.
5. Swamp Creek and its tributaries upstream from County Rd. 9.
6. Tiger Creek and its tributaries.
7. Dry Creek and its tributaries.

8.2.3 The Georgia Growth Planning Act (O.C.G.A. 12-2-8)

- Authorized the Georgia Department of Natural Resources to develop minimum planning standards and procedures that local city and county planning and zoning jurisdictions could adopt and enforce pertaining to the protection of *river corridors*, *mountain tops*, *water supply reservoirs/watersheds*, and *wetlands*.
- Requires local governments to use these minimum standards in developing and implementing local comprehensive growth development plans.
- *Silvicultural* practices are exempt from permitting requirements according to the guidelines, but the activity must comply with BMPs within these sensitive areas. The rules for environmental planning for each of these sensitive areas, are as follows:

8.2.3.1 Water Supply Reservoir/Watershed (Chapter 391-3-16-. 01)

- Provides local governments criteria to allow development of a water supply reservoir or watershed without contaminating the water source to a point where it cannot be treated to meet drinking water standards.
- The criteria establishes buffer zones and requirements for land disturbing activities along *perennial streams* and lakes and applies to existing and future *water supply reservoirs* and watersheds.
- Local governments may exempt specific forestry activities from the stream and lake corridor buffers provided the activity complies with *Best Management Practices*.

Figure 8-A. Water Supply Reservoir/Watershed

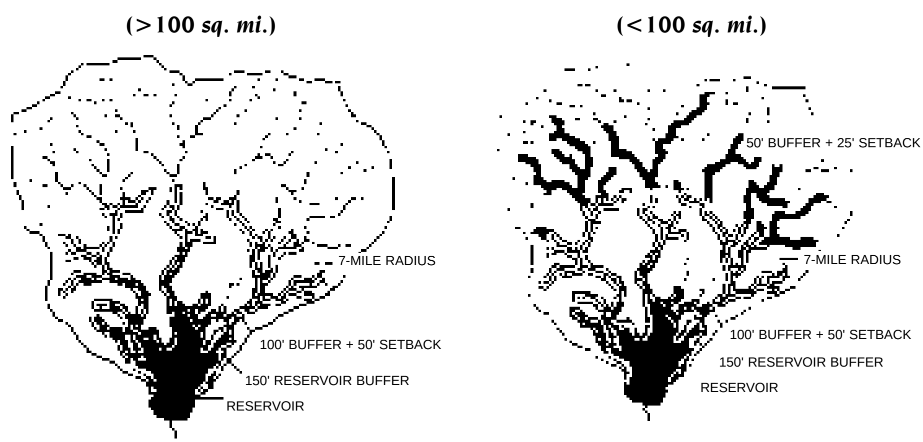
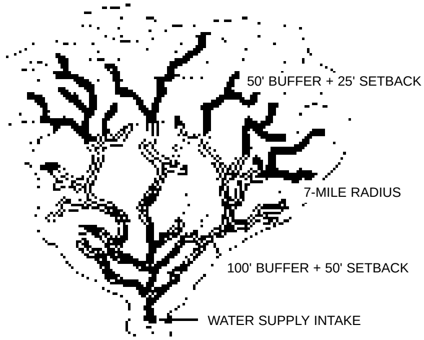


Figure 8-A. Water Supply Intake Watershed (<100 sq. mi.)



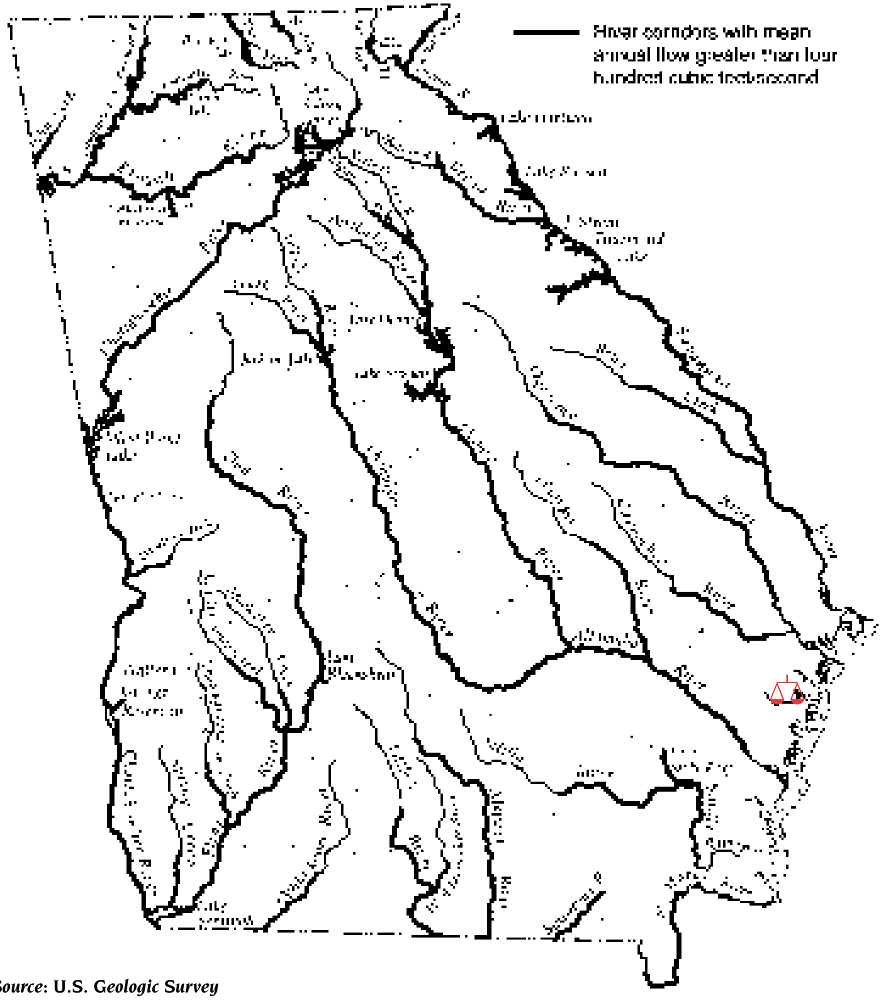
8.2.3.2 Wetlands Protection Act (Chapter 391-3-16-. 03)

- Requires local governments and regional development centers to acknowledge the importance of wetlands for the public good in the land-use planning process.
- Where wetlands exceed five acres, local governments are encouraged to protect them.
- Timber production and harvesting are considered acceptable uses.

8.2.3.3 River Corridor Protection Act (Chapter 391-3-16-. 04)

- Requires local governments and regional development centers to use standards for the protection of river corridors in developing and implementing local comprehensive development plans.
- Applies to any perennial river or watercourse, at that point and below, where the average annual flow is at least 400 cubic feet per second (cfs) as determined by appropriate U.S. Geological Survey documents.
- Protected buffers include all land within 100 feet horizontally on both sides of the river as measured from the riverbanks.
- Plans shall provide for timber production and harvesting provided the activity complies with *Best Management Practices*.
- See map (Figure 8-B).

Figure 8-B. State Designated Protected Rivers: 1992



Source: U.S. Geologic Survey

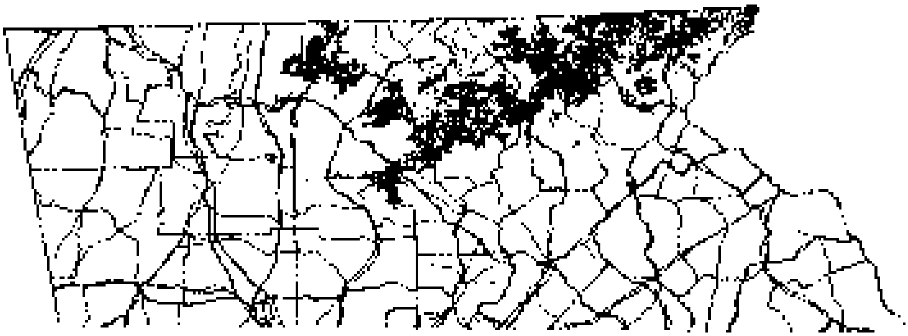
8.2.3.4 Mountain Protection Act (Chapter 391-3-16-. 05)

- Requires local governments and regional development centers to use planning standards for the protection of mountain areas in developing and implementing local comprehensive plans.
- Applies to all land area 2,200 feet or more above mean sea level that has a percentage slope of 25 percent or greater for at least 500 feet horizontally, and

shall include the crests, summits, and ridge tops that lie at elevations higher than any such area.

- Forestry practices are allowed on protected mountains provided the activity complies with *Best Management Practices*.
- See map (Figure 8-C).

Figure 8-C. Generalized Map of Areas Subject to "Mountain Protection"

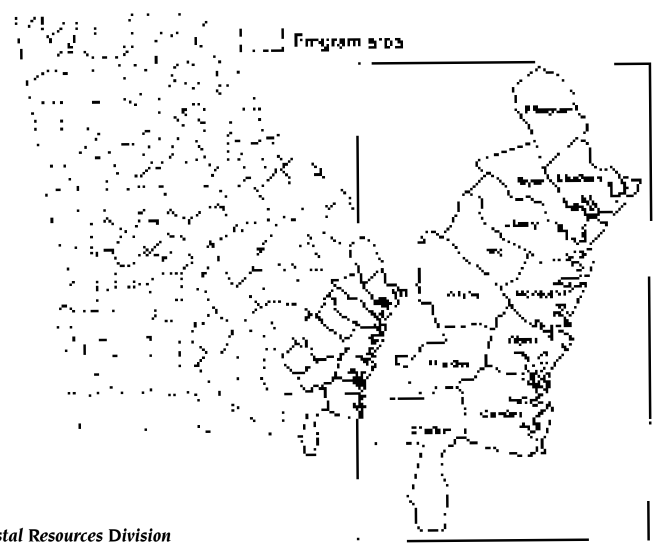


Source: U.S. *Geologic Survey*

8.2.4 Coastal Management Act (O.C.G.A. 12 -5-260)

- Requires existing authorities in the 11-county coastal area to execute the full range of policies and management techniques identified as necessary for coastal management purposes.
- See map (Figure 8-D).

Figure 8-D. Coastal Zone Management Pragram Area



Source: Georgia Coastal Resources Division

8.2.5 Metropolitan River Protection Act (O.C.G.A. 12-5-440)

- Requires the Atlanta Regional Commission (ARC) to adopt a plan that would protect the land and water resources of the Chattahoochee River Corridor from Buford Dam to the southwest edge of Fulton County.
- Establishes a 2,000 foot buffer in which land disturbing activities are regulated.
- Requires a 50 foot buffer of natural vegetation be left in its natural state along the banks of the river and 35 feet along the banks of other tributaries.
- Outside of these buffers and in areas zoned for agriculture, forestry practices are exempt from permitting. However in residential or commercial areas, a plan must be submitted and approved by the ARC when removing healthy trees over two inches in diameter at breast height.
- Establishes civil penalties of $1,000 per acre per day or part thereof on which such violation occurs.

8.2.6 Georgia Forest Fire Protection Act (O.C.G.A. 12-6-90)

- Requires any person, firm, corporation, or association entitled to burn any woods, lands, marshes, or any other flammable vegetation, whether in cultivated or uncultivated areas, shall prior to such burning notify and/or obtain a permit from the county office of the GFC wherein such burning is to be made.
- Any person who makes a burn and fails to give notice and/or obtain required permit shall be guilty of a misdemeanor.

8.2.7 Erosion and Sedimentation Act (O.C.G.A. 12-7-1)

- Provides permitting by local issuing authorities for land disturbing activities.
- Exempts commercial forestry activities, including harvesting, from permitting and minimum requirements of the Act.
- Harvesting inconsistent with BMPs may be interpreted as being in association with land conversion activities and trigger erosion and sedimentation control permits and requirements.

8.2.8 Oil or Hazardous Material Spills or Release Act (O.C.G.A. 12 -14-1)

- Requires producers of hazardous substances including used motor oils or fuels to collect those substances and deliver to registered handlers.
- Requires that in the event of accidental spills that the spill be contained, contaminated soils be collected and delivered to approved waste handling facility, and GA EPD notified(1-800-241-4113).

8.2.9 State Board of Registration for Foresters Standards of Practice (O.C.G.A. 43-1-19) Chapter 220-5.01

- It is the responsibility of each registered forester to practice professional forestry in a manner which protects the public welfare and safety and in a manner which meets generally accepted standards of practice.
- Generally accepted standards of practice shall include, but are not limited to, adherence to B*est* M*anagement* P*ractices* published periodically by the Georgia Forestry Commission and available from the Board office.
- Failure to practice professional forestry in accordance with generally accepted standards of practice shall constitute unprofessional conduct and shall be grounds for disciplinary action as provided for by law.

8.3 LOCAL LAWS, REGULATIONS AND ORDINANCES AFFECTING FOREST LANDOWNERS

Certain counties have adopted local laws and ordinances, which affect forestry activities. These come under the following categories:

8.3.1 Road Protection

May require permits and bonds before harvesting can begin. The Georgia Forestry Association, the Georgia Forestry Commission, and the University of Georgia School of Forest Resources Extension Service maintains current list of those counties.

8.3.2 Zoning

Timber harvesting, in other than agriculture zones, may require permits and specific harvesting requirements.

8.3.3 Timber Tax Collection

Certain counties require permits or notification for timber harvest for the collection of timber tax.

8.3.4 Watershed Protection

Some counties require permits and plans for the removal of timber in floodplains.

8.3.5 Local Land Use Plans

See Comprehensive Growth Planning Act under State laws.

Landowners, forest managers and operators should check with local authorities before undertaking forestry activities.

GLOSSARY

Access Road - A permanent or temporary woods road over which timber is transported from a felling site to a public road. Also known as a haul or system road.

Aesthetics - The study or practices designed to maintain the beauty of forests.

Aspect - The compass direction that the slope of the land faces (north, northwest, south, etc.)

Back Blading - The practice of laying the bulldozer blade on the ground while operating a crawler tractor or other dozer equipment in reverse. This practice is commonly used for smoothing rough soil or for pulling soil or debris away from an area when pushing is not practical.

Basal Area - The area of the cross section of a tree stem near its base, generally at breast height (4 1/2 feet above the ground), inclusive of bark. Expressed in square feet per acre. Stand basal area is generally expressed as the total basal area per unit area.

Bedding - A site preparation technique in which a small ridge of surface soil is formed to provide an elevated planting or seedbed. It is used primarily in wet areas to improve drainage and aeration for seedlings.

Best Management Practices (BMPs) - Methods, measures or practices to prevent or reduce water pollution, including but not limited to, structural and non-structural controls, operation and maintenance procedures, and other requirements, scheduling, and distribution of activities. Usually BMPs are applied as a system of practices rather than a single practice.

Braided Stream - A stream flowing in several dividing and reuniting channels resembling the strands of a braid. The divisions are caused by obstruction from sediment deposited by the stream.

Broad-based Dip - A surface drainage diversion built into the bed of a permanent haul road that consists of a long approach section, a low, out-sloped middle section, and a short terminal section with a reverse grade. They are specifically designed to intercept and divert surface water flow out of a dirt road while allowing vehicles to maintain normal haul speeds. Also called a rolling dip.

Broadcast Burn - A controlled fire within well-defined boundaries to reduce forest fuel hazards.

Brush Barrier - A linear pile of limbs, tops, logs, and other forest debris which is arranged along the lower edge of a road, log deck, or site prepared area to slow, diffuse, or intercept sediment moving off the disturbed site.

Buffer Strip - A transitional area between two different land uses which mitigates the effects of one land use on another. For water quality purposes they are intended to filter surface runoff and trap sediment and associated pollutants before entering water bodies. Some state and local regulations require them.

Canopy Cover - Indices of percent ground surface shaded by a combination of overstory and midstory trees.

Channel - A natural water-bearing trough cut vertically into low areas of the land surface by erosive action of concentrated flowing water.

Chopping - A mechanical treatment in which vegetation is concentrated near the ground and incorporated in the soil. Chopping may be used to facilitate burning.

Clearcutting - A silvicultural system in which all merchantable trees are harvested over a specified area in one operation.

Commercial Forest Land - Forest land bearing or capable of bearing timber of commercial character, currently or prospectively available, and not withdrawn from such use.

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

Controlled Burning (fire) - See prescribed burning

Cross-Drain Culvert - A metal, wooden, plastic or concrete conduit through which ditch flow is directed underneath the road surface to the opposite side of the road.

Culvert - A metal, concrete or plastic pipe, or a constructed box-type conduit through which water is carried under roads or trails.

Ditches and Canals - Manmade water courses.

Dry Wash - A stream bed that carries water only during and immediately following rainstorms. Sometimes referred to as a gully or ephemeral stream.

Duff - Partially decayed organic matter on the forest floor.

Ephemeral Area – Commonly referred to as drains, draws, or dry washes that typically have no well-defined channel and flow only during and for short periods following precipitation. Leaf, straw, and other forest litter is typically present or sporadically displaced in the ephemeral area. Aquatic insects are not present in these areas.

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

Estuary - An inlet or arm of the sea where the tide meets the current at the mouth of a river.

Excelsior Blanket - A machine produced mat of curled wood excelsior bonded with polymer netting.

Fauna - The animals of a specified region or time.

Felling - Cutting down standing trees.

Fertilizers - Any substance or combination of substances used primarily as a source of plant nutrition or soil amendments.

Firebreaks (Fire Lines) - Artificial barriers that contain fires within an area that typically are established by plowing and/or harrowing.

Flora - The plants of a specified region or time.

Forest Chemicals - Chemical substances or formulations that perform important functions in forest management, including fertilizers, herbicides, insecticides, fungicides and repellents.

Gabion - Large, multi-celled, welded wire or rectangular wire mesh boxes, used in stream channel revetments, retaining walls, abutments, check dams, etc. to stabilize steep or highly erosive slopes.

Geotextiles - Fabrics used to improve the load bearing capacity of roads with weak base material.

Geoweb® - A heavy-duty polyethylene cellular confinement system used to improve and stabilize structural fill in roads and embankments.

Gully - A channel, hollow or narrow ravine caused by past land cultivation. Sometimes referred to as a dry wash.

Harrowing (Disking) - A mechanical method of scarifying the soil to reduce competing vegetation and to prepare a site for seeding or planting.

Herbicide - Any chemical or mixture of chemicals intended to prevent the growth of or promote the removal of targeted tress, bushes, and/or herbaceous vegetation.

Humus Layer - The organic layer of the soil formed by the decay of organic matter.

Hydric Soils - Soils exhibiting a considerably wet nature, typically characterized by dark or gray mottled colors and associated with wetlands.

Hydrology - The scientific study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks and in the atmosphere.

Inslope - The feature of a road surface, established during construction or maintenance, that slants the roadbed to the inner or uphill side to facilitate drainage of storm runoff from the road in more concentrated flow into a ditch line.

Integrated Pest Management - The maintenance of destructive agents, including insects, at tolerable levels by the planned use of a variety of preventive, suppressive, or regulatory tactics and strategies that are ecologically and economically effective and socially acceptable.

Intermittent Stream - A watercourse that flows in a well-defined channel during wet seasons of the year but not the entire year. They generally exhibit signs of water velocity sufficient to move soil material, litter and fine debris. Aquatic insects often are difficult to find or not present at all.

Log Deck - A place where logs or tree-length material is assembled for loading and transporting.

Logging Debris - The unused and generally unmarketable accumulation of large limbs, tops, cull logs, and stumps that remain after harvesting.

Mulching - Any loose covering of forest soil with organic residues such as grass, straw or wood fibers that checks erosion and stabilizes exposed soil.

Nonpoint Source (NPS) Pollution - Water pollution that is (1) induced by natural processes including precipitation, seepage, percolation and runoff; (2) not traceable to any discrete or identifiable facility; and (3) better controlled by using BMPs.

Outslope - The feature of a road surface, established during construction or maintenance, that slants the roadbed to the outer or downhill side to facilitate drainage of storm runoff from the road in more diffuse flow than occurs at dips and water bars. Outsloping is a contrasting road design to the crowned roadbed or to an inslope toward a ditch line.

Perennial Stream - A watercourse that flows in a well-defined channel throughout most of the year under normal climatic conditions. Some may dry up during drought periods or due to excessive upstream uses. Aquatic insects are normally present and easily found.

Pesticide - Any chemical substance used to control undesirable insects, diseases, vegetation, animals or other life forms. Herbicides, insecticides, fungicides and nematicides are considered pesticides.

Pollutants - Natural or manmade waste material that contaminates air, soil, or water.

Precipitation - Any form of water that falls to the ground from the atmosphere, including drizzle, rain, snow, snow pellets, ice crystals, etc.

Prescribed Burning (fire) - The use of planned fire that is deliberately set under specific fuel and weather conditions to accomplish any variety of management objectives and is under control until it burns out or is extinguished.

Protected Mountain Top - Mountain tops above 2,200 feet elevation and greater than 25% slope.

Protected River Corridors - One hundred-foot buffers along those rivers at a point and below where the flow is at 400 cubic feet per second (cfs).

Qualified Professional - A person whose training and experience qualifies him/her to make forestry and water quality recommendations. Examples include foresters, hydrologists, soil scientists, forest engineers, fishery and wildlife biologists, or technically trained individuals such as those who have completed the Master Timber Harvesters workshops.

Raking - A mechanical site preparation method to remove trees and shrubs by raking and piling debris. Raking usually moves less soil into windrows than bulldozing.

Regeneration - A young tree crop that replaces older trees removed by harvest or disaster; also the process of replacing old trees with young ones.

Registered Forester - A person who is registered and licensed to engage in professional forestry practices as determined by the Georgia State Board of Registration for Foresters.

Restricted Use Pesticide - A pesticide that is applied only by certified persons for specific uses.

Retirement of Roads - Preparing a road for a long period of non-use by methods including mulching, seeding and installing water bars.

Rip-rap - Rock or other large aggregate that is placed to protect streambanks, bridge abutments or other erodible sites from runoff or wave action.

Rotation Period - The period of time needed to establish, grow and harvest a crop of trees at a specified condition of maturity.

Sediment - Soil particles that have been detached and transported into water during erosion.

Seed Tree Cut - A timber harvesting method that provides for the natural regeneration of a site by leaving single trees, or small groups of seed-bearing trees, evenly distributed throughout the harvest area. Generally results in an even-aged stand.

Seep or Spring - A place where groundwater flows slowly to the surface and often forms a pool; a small spring.

Selection Cut - Removal of select trees in a forest stand based on some economic or physiological criteria. Generally results in an uneven-aged stand.

Shearing - A mechanical site preparation method of removing large numbers of stems too large for disking or drum chopping. Shear blades, mounted on crawler tractors, are angled or V-shaped, have straight or serrated edges and have a "stinger" for splitting larger trees and stumps.

Shelterwood Cut - Removal of mature timber in a forest stand in a series of harvests that extend over a relatively short portion of the rotation. This cut encourages essentially even-aged reproduction under the partial shade of seed trees.

Side Cast - The act of moving excavated material to the side and depositing it.

Silt Fence - A lofty web of mechanically or melt bonded polymer netting, monofilament or fibers that are entangled to form a strong and dimensionally stable matrix to catch storm runoff and soil particles.

Silviculture - The science and art of growing forest crops. More particularly, the principles, theories and practices for protecting and enhancing the regeneration, growth, development and use of forests for multiple benefits.

Sinkhole - A geologic feature that may provide a direct connection between land surface and groundwater.

Site Preparation - A forest activity to remove unwanted vegetation and other material, and to cultivate or prepare soil for reforestation.

Skid - The short-distance moving of logs or felled trees along the surface of the ground from the stump to the point of loading.

Skid Trail - A temporary, non-structural pathway over forest soil for dragging felled trees or logs to a log deck.

Slough - A poorly defined channel in a swamp, bog, marsh, or riverine system, often without a clearly defined inlet or outlet.

Staging Area - An area designated for the concentration of vehicles and equipment for a specific activity.

Streamside Management Zone (SMZ) - A designated area of varying width adjacent to the banks of streams and bodies of water where management practices that might affect water quality, fish, or other aquatic resources are modified.

Sub-soiling - A mechanical site preparation method for ripping apart compact soils or soils with plow pans, hard pans, or fragi-pans under the soil surface.

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

Trout Stream - A perennial stream and its tributaries inhabited by trout. Streams designated as Primary Trout Streams are waters supporting a self-sustaining population of rainbow, brown or brook trout. Streams designated as Secondary Trout Streams are those with no evidence of natural trout reproduction, but are capable of supporting trout throughout the year.

Turbidity - An optical measurement of water clarity.

Water Bar - A hump or small dam-type surface drainage structure used to close abandoned roads, skid trails, and fire lines.

Water Control Structure - Any structure used to regulate surface or subsurface water flows.

Watershed - All land and water within a drainage divide.

Waters of the State - Any and all rivers, streams, creeks, branches, lakes, reservoirs, ponds, drainage systems, springs, wells and other bodies of surface or subsurface water, natural or artificial, lying within or forming part of the boundaries of the state, which are not entirely confined and retained completely upon the property of a single individual, partnership or corporation.

Waters of the U.S. - Includes lakes, rivers, streams (including intermittent streams), mud flats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds.

Water Supply Point - An easily accessible location used to pump water into fire-suppression vehicles.

Water Supply Reservoir/Watersheds - Governmentally owned impoundments of water and the watersheds above such impoundments used primarily to provide water to one or more governmentally owned public drinking-water systems.

Water Turnout - The extension of an access road's drainage ditch or skid trail's or fire line's water bar into a vegetated area to disperse and filter storm water runoff.

Wetlands - Areas inundated or saturated by surface or groundwater 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 possess three essential characteristics: hydrophytic vegetation, hydric soils, and hydrology. Wetlands generally include swamps, marshes, bogs, river floodplains, Carolina bays, cypress domes and stringers, pine hammocks and similar areas.

Windrow - Logging debris and unmerchantable woody vegetation that is piled into rows to decompose or be burned.

Contributors and Sources of Information

PERSONS WHO CONTRIBUTED TO THE DEVELOPMENT OF THIS DOCUMENT:

Joe Allen - Southeastern Wood Producers Association

Glenn Atkinson - International Paper Company

Rich Aubuchon - USDA Forest Service

Lynda Beam - Private landowner

Barry Beers - Prudential Timber Investments

Rex Bonner - The Conservation Fund

Bill Breiner - Bill Breiner Forestry

John Britt - Mead Coated Board, Inc.

Ginger Brown - USDA Forest Service

Dr. Kim Coder - UGA School of Forest Resources

Bonnie Darsie - Nature Conservancy Volunteer

Jeff Durniak - Georgia Wildlife Resources Division

Alan Dozier - Georgia Forestry Commission

Willard Fell - Georgia Forestry Commission

David Ferrell - USDA Natural Resource Conservation Service

John Godbee* - Union Camp Corporation

Micah Goldstein - Georgia-Pacific Corporation

Frank Green* - Georgia Forestry Commission

Dr. Dale Greene - UGA School of Forest Resources

John Greis - USDA Forest Service/ US EPA

Jim Griffith - Georgia Farm Bureau

Greg Guest - Georgia-Pacific Corporation

Tom Harris - UGA School of Forest Resources

Mike Hurst - USDA Forest Service

Bob Izlar – UGA School of Forest Resources

Dr. Ben Jackson - UGA School of Forest Resources

Meg Jones - The Nature Conservancy of Georgia

Frank Jordan – Attorney; Private landowner; Assoc. of Conservation Districts

George Kellogg - International Paper Company

Lynn Klein – Georgia-Pacific Corporation

Bob Lazenby - Georgia Forestry Commission

Drew Marczak – The Timber Company

Dennis Martin - Georgia Forestry Commission

Ted Mikalsen - Georgia Environmental Protection Division

Dr. Karl Miller - UGA School of Forest Resources

Dr. David Moorhead - UGA School of Forest Resources

Dr. Larry Morris - UGA School of Forest Resources

Stuart Moss - F & W Forestry Service

Dr. Wade Nutter - Nutter, Overcash, and Associates

Bill Oettmeier, Jr. - Superior Pine Products

Lee Ogden - UGA School of Forest Resources

Rob Olszewski - Georgia-Pacific Corporation

David Pattison - Stone Container Corporation

Hillrie M. Quin, Jr. - The Conservation Fund; The Georgia Conservancy

Steve Raper – Temple-Inland Forest

Pat Reddish - Newport Timber

Travis Reed – Reed Logging, Inc.

Dick Rightmyer - USDA Forest Service

Mark Roberts - Roberts Timber Company

Scott Robinson - Georgia Wildlife Resources Division

Betty Rothamael – Georgia Wildlife Federation

Andrew Schock - The Nature Conservancy of Georgia

Monte Seehorn - U.S. Forest Service (retired)

Dr. Barry Shiver - UGA School of Forest Resources

Pat Straka – Monsanto

Reggie Thackston - GA Wildlife Resources Division

Steve Tomlin - Union Camp Corporation

Larry Walker - Weyerhaeuser Corporation

Bill White - Georgia Soil and Water Conservation Commission

Carlton Windsor – Rayonier

Mike Zupko - Georgia Forestry Association

**Co-chairs, Georgia Best Management Practices Revision Task Force*

SOURCES OF INFORMATION

For other natural resource information, contact any of the following organizations:

State Agencies:

Georgia Forestry Commission
P.O. Box 819
Macon, Ga. 31202
1-800-GA-TREES
www.gfc.state.ga.us

University of Georgia
School of Forest Resources
Athens, GA. 30602
706-542-2686

University of Georgia
Forest Resources Cooperative
Extension Service
School of Forest Resources
Athens, GA 30602
706-542-3446

Georgia Department of Natural Resources
Environmental Protection Division
NonPoint Source Pollution Program
205 Butler Street, S.E.
East Floyd Towers, Suite 1070
Atlanta, GA. 30334
404-656-4887

Georgia Department of Natural Resources
Wildlife Resources Division
2070 US Highway 278 SE
Social Circle, GA. 30279
770-918-6401

Georgia Soil and Water
Conservation Commission
P.O. Box 8024
Athens, GA 30603
706-542-3065

Federal Agencies:

U.S. Department of Agriculture
Forest Service:
Southern Region
1720 Peachtree St.,NW
Atlanta, GA 30367
404-347-4178
706-546-2272

U.S. Department of Agriculture Forest Service
Chattahoochee-Oconee National Forest
1755 Cleveland Hwy
Gainesville, GA 30501
770-536-0541

U.S. Environmental Protection Agency
Wetlands, Coastal and Water Quality
Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303
404-562-9355

Natural Resources Conservation Service
State Office
Federal Building, Box 13
355 E. Hancock Street
Athens, GA 30601

United States Department of the Interior
Fish and Wildlife Service
Region 4
1875 Century Boulevard
Suite 200
Atlanta, GA 30345

U.S. Army Corps of Engineers
Savannah District
P.O. Box 889
Savannah, GA 31402
912-652-5822

Private Organizations:

The Association of Consulting Foresters
Georgia Chapter
c/o F& W Forestry Services, Inc.
P.O. Box 3610
Albany, GA 31708
912-883-0505

The Atlanta Regional Commission
200 Northcreek, Suite 300
3715 Northside Parkway
Atlanta, GA 30327
404-364-2500

continued . . .

Sources of Information

The Conservation Fund
880 W. Wesley Rd, NW
Atlanta, GA 30327
404-355-7246

The Georgia Farm Bureau
P. O. Box 18002
Macon, GA 31298
912-746-5263

The Georgia Wildlife Federation
1930 Iris Drive
Conyers, GA 30207
770-929-3350

The Society of American Foresters
Georgia Division
912-751-3553

The Georgia Conservancy
1776 Peachtree Street, NW
Suite 400 South
Atlanta, GA 30309
404-876-2900

The Georgia Forestry Association
505 Pinnacle Court
Norcross, GA 30071
770-416-7621

The Nature Conservancy of Georgia
1330 W. Peachtree St, Suite 410
Atlanta, GA 30309
404-873-6946

The Southeastern Wood Producers Assoc.
P. O. Box 9
Hilliard, FL 32046
904-845-7133

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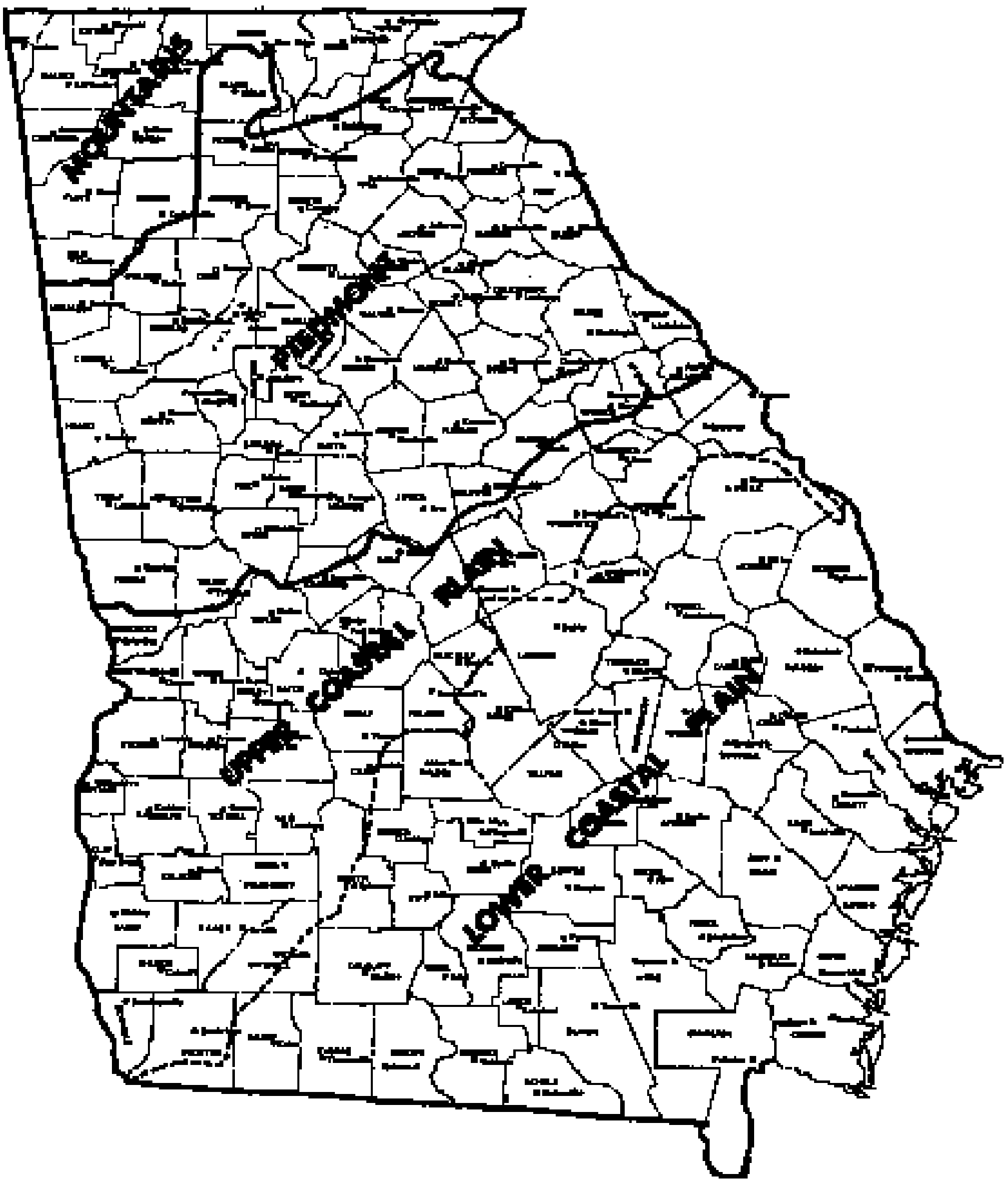
Georgia Forestry Commission
Georgia Wildlife Resources Division
Georgia-Pacific Corporation
The Nature Conservancy of Georgia
Weyerhaeuser Corporation

NOTES:

NOTES:

Physiographic Regions of Georgia



J. Frederick Allen
Director

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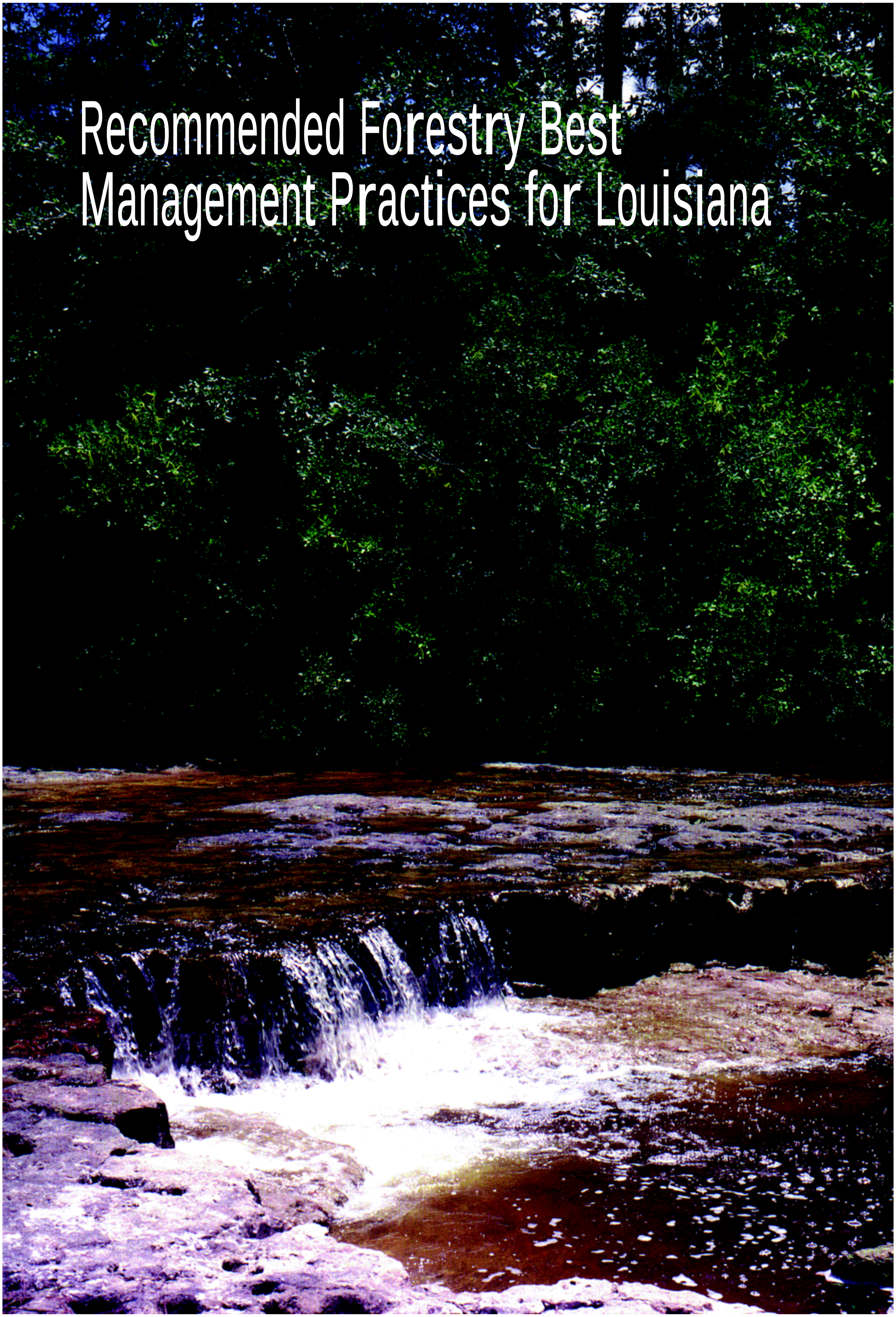
Recommended Forestry Best Management Practices for Louisiana



Recommended Forestry Best Management Practices for Louisiana

CONTENTS

About the Manual

THIS MANUAL IS PART OF A BROAD UNDERTAKING to educate the forestry community in effective management techniques to safeguard our land and waters and to wisely use the resources found in this state.

A private-public partnership of the Louisiana Forestry Association (LFA), the Louisiana Department of Environment Quality, and the Louisiana Department of Agriculture and Forestry has formulated this guidebook on the state's non-regulatory Best Management Practices (BMPs). It is hoped that such education will help reduce forest soil movement toward the waters of the state.

This revised manual is only a small part of this campaign. Significant progress has already been made in the protection of Louisiana's water quality through increased use of BMPs. From 1989 to 1997, the use of BMPs has increased eightfold. The latest survey by the Louisiana Office of Forestry found that 83 percent of survey sites in 1997 used BMPs. Our goal is to achieve 90 percent compliance on the year 2000 survey.

The LAF and The Louisiana Logging Council have also implemented a five-step training curriculum that involves loggers, foresters and landowners. A Master Logger designation recognizes loggers completing 30 hours of training in various aspects of forest management, including BMPs. Master Loggers will complete six hours of continuing education annually to retain that title.

Over the last four years, 2,634 people have attended one or more of these classes and 500 loggers have attained Master Logger designation.

These accomplishments have been a great educational undertaking and a great success. We are proud of the progress and look forward to a bright future for Louisiana's forest environment and the forest professionals who provide the resources we grow and use.

Bob Odom
Bob Odom, Commissioner
Louisiana Department of
Agriculture and Forestry

Paul D. Frey
Paul D. Frey
Assistant Commissioner and
State Forester
Louisiana Department of
Agriculture and Forestry

Donald Powell
Don Powell, President
The Louisiana Forestry Association

J. Dale Givens
J. Dale Givens, Secretary
Louisiana Department of
Environmental Quality

Jan Boydstun
Jan Boydstun
Environmental Specialist Coordinator
Louisiana Department of
Environmental Quality

Billy J. Davis
Billy Davis, President
The Louisiana Logging Council

Using the Manual

THIS MANUAL IS WRITTEN TO BE A PRACTICAL FIELD GUIDE for forest landowners, logging contractors and forest industry, to ensure water quality during forestry operations. It sets forth the voluntary guidelines and procedures to be followed for each operation and describes the federally mandated Best Management Practices (BMPs) for forestry operations in wetlands. Each chapter is written as a stand-alone guide. BMPs common to several operations will appear with each.

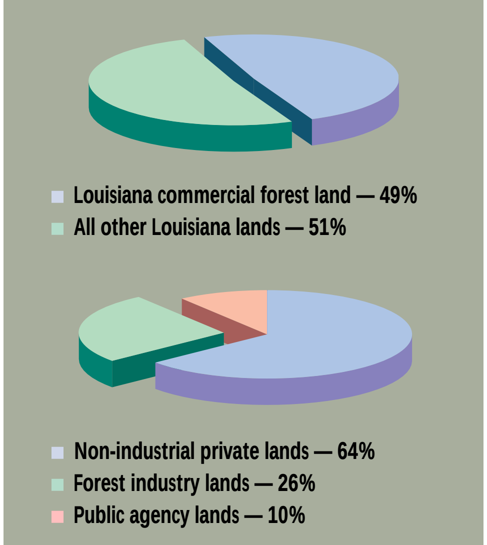
In using this manual the information it provides can be divided into four basic parts:

- **Voluntary guidelines**, *pages 3–29*: Each forestry activity is described and the BMPs associated with that activity are stated.
- **Mandated guidelines**, *pages 30–49*: Discusses the issue of forest wetlands and sets forth the federally mandated BMPs applicable to forest operations in wetlands. Forest operations in the Louisiana Natural and Scenic Rivers System are also discussed.
- **Glossary**, *pages 50–54*: Definition of terms used to describe the activities presented in this manual.
- **Recommended examples & tools**, *pages 55–83*: Detailed examples and tools for implementing the BMPs previously described.

Introduction

COMMERCIAL FORESTS OCCUPY more than 49 percent, or 13.8 million acres, of the land in Louisiana. Forest ownership here is similar to other southern states. At 64 percent, a majority of the forest land is in nonindustrial private ownership; 26 percent owned by forest industry and the remaining 10 percent held by public agencies.

Status of Louisiana Forests & Lands



Forestry annually contributes more than $5 billion to the state's economy. If Louisiana is to thrive economically, our forests' ability to produce goods and services must be sustained.

Forest management programs should incorporate adequate measures to provide for proper soil and water conservation. Most streams originating in or flowing through our timberlands are sources for water supplies, recreation, and other uses.

Section 404 Silvicultural Exemption

In forested wetlands, the Law provides an exemption from permitting under Section 404 for normal ongoing silvicultural operations, provided that the 15 federally mandated best management practices, hereinafter referred to as BMPS, are followed.

The Clean Water Act of 1972 (**Public Law 92-500**) and its amendments mandate water quality sufficient to provide "fishable" and "swimmable" waters. It requires that all ***waters of the United States*** will be protected from degradation. This includes, but is not limited to headwater creeks, rich bottomland hardwoods, and permanently flooded cypress-tupelo areas.

The scope of legal jurisdiction was expanded in 1977 by amendments redefining protection to include the ***waters of the United States*** and their ***adjacent wetlands***. This protection, under Section 404, specifies that anyone engaging in activities impacting waters and wetlands is required to secure a permit before proceeding, unless exempted.

Amendments to the Clean Water Act in 1987 required the Louisiana Department of Environmental Quality to assess the quality of water in the state and report its findings to Congress every two years. Under Section 319 of the amended act, the state was also charged with addressing pollution carried to water bodies by rain-

Private landowners, who own most of Louisiana's forest lands, should recognize that Best Management Practices begin with careful planning.

fall runoff. This type of pollution is called *nonpoint source pollution*. It differs from point source pollution that originates from identifiable locations such as end-of-pipe discharges from an industrial facility or city sewage treatment plant.

Most of the early efforts to clean up water pollution were directed toward point sources. Thus, most of what is left to work on is pollution caused by nonpoint sources. LDEQ's nonpoint section uses a cooperative, non-regulatory approach to address forestry nonpoint pollution statewide; primarily through the use of voluntary foresty practices described in this manual.

With support from the U.S. Environmental Protection Agency, and in partnership with the Louisiana Department of Agriculture & Forestry and the Louisiana Department of Environmental Quality, the Louisiana Forestry Association developed this manual. It is a guide for forest landowners, logging contractors, and forest industry. It sets forth voluntary guidelines and procedures to ensure water quality protection during forestry operations. The goal in meeting state and federal water quality standards is necessary to provide clean water for present and future generations. The forestry community's compliance with this guide is essential for continued freedom and flexibility to practice forestry without further government regulation.

Planning for Forest Operations

PLANNING FOR FOREST operations is complex. It involves several interrelated processes carried out over an extended period of time on areas with varying topography, soil conditions, and other characteristics. Each process may take from days to months to complete. Persons involved in forest operations must comply with numerous laws and regulations. *Best management practices* (BMPs) are recommended operational guidelines to minimize environmental impacts and maintain water quality. Planning is required to incorporate BMPs into a forest operation. The plan should maximize efficiency, minimize traffic, preserve soil integrity, and protect water quality.

There are two stages of planning — preliminary planning and on-the-ground application. A *preliminary plan* is commonly prepared by an appropriate resource professional prior to conducting any operation. This plan includes recommendations for meeting plan objectives with consideration for special areas such as fragile soils on steep slopes that may require special treatment during forest operations.

On-the-ground application can be complex and detailed. It is prepared prior to beginning the operation and should include recommendations on roads, traffic routes, streamside management zones, stream crossings, and the schedule of activities. Finally, each person should be aware of the plan and understand their part in carrying it out.

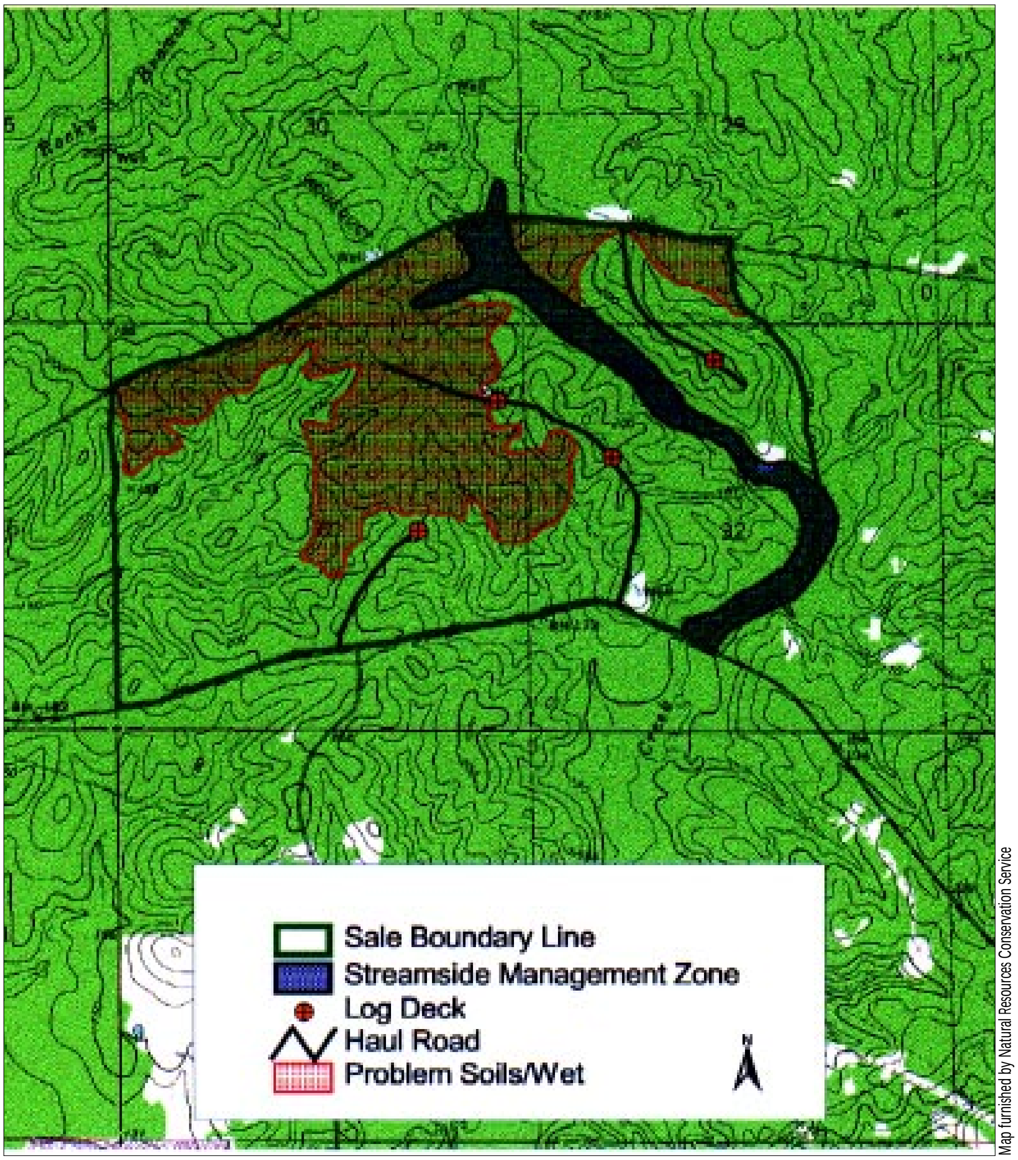
Requirements may differ from tract to tract. For example, does the tract have a stream that requires a streamside management zone? Is there a steep sandy hill on the tract that favors choosing chemical site preparation with hand planting instead of mechanical site preparation followed by machine planting?

Thinking about the following four topics will help select the correct way to accomplish needed forest operations. The planning process should consider these points to protect water quality:

- *The tract topography* — Will topography affect traffic flow for the operation?
- *The tract soil conditions* — Will soil type affect roads and traffic? Will soil type affect equipment decisions and scheduling of activities?
- *The tract hydrology* — How will stream runoff after a major rain affect stream crossing structures?
- *The applicable laws and regulations affecting logging* — How will these laws and regulations affect each part of the forest operation?

Several tools are available to the harvest planner. Some of these are explained in Appendix II.

Forest Hill, Louisiana



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Planning for any forest operation should include a map indicating important features.

Forest Roads

OVERVIEW

A FOREST ROAD SYSTEM is made up of permanent and temporary roads that connect the forest land to existing public roads. They provide forest access for such activities as land management, fire protection, recreation and timber harvesting. Forest roads that are improperly located, poorly constructed and / or not maintained are the largest contributor of nonpoint source pollution from forest activities. Roads on steep slopes, erodible soils or stream crossings hold the greatest potential for degrading water quality. In wetlands, forest roads must comply with 15 mandatory BMPs. See page 36.

PERMANENT ROADS

BMPs for Location & Planning

- Use of tools such as soil surveys, topographic maps, and aerial photographs can help achieve the most practical road construction results.
- Design a permanent road system to meet long-range objectives rather than simply to access individual sites. Numerous separate road projects have more environmental impact than one well-designed road system.
- Stabilize or reconstruct existing roads where significant erosion problems exist. Abandon and retire roads where repair is impractical.
- Safety should always be considered with road design and location of intersections, and access points to public roads.
- Minimize the number of stream crossings.
- Cross streams on straight segments and as close to a right angle as possible (see illustration on page 7).
- Locate roads on the best available sites, avoiding excessive slope.
- All suitable excavated material should be used for the construction of the road, when possible. This may include soil removed from ditches during construction or maintenance.

Note: Additional planning assistance may be obtained from the United States Department of Agriculture, Natural Resources Conservation Service (NRCS).

AVOID

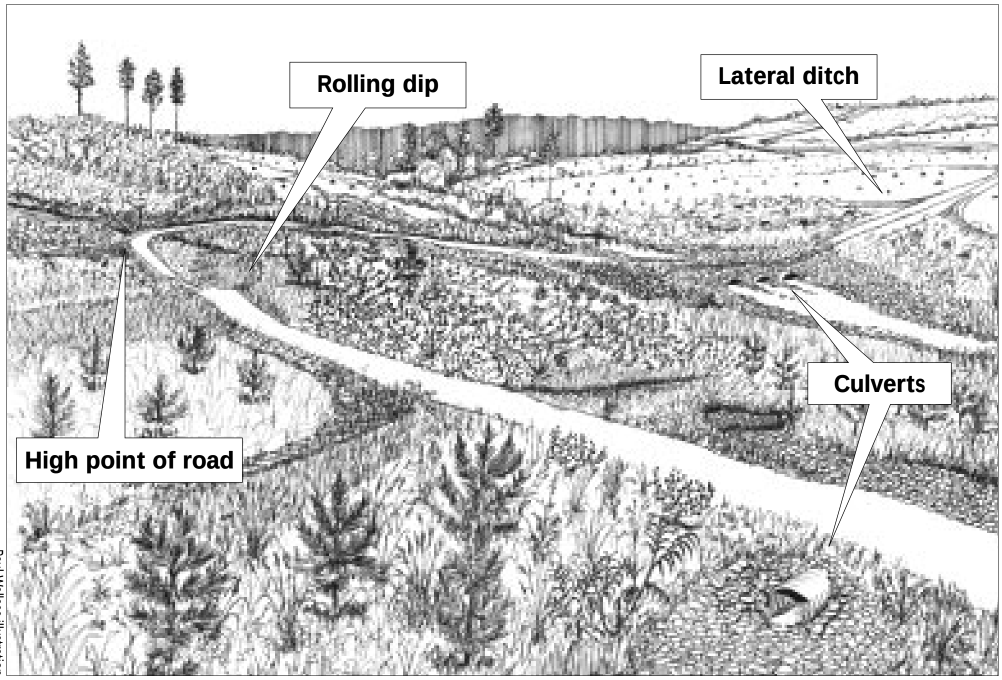
- Using streamside management zone (SMZ) for road locations or traffic areas.
- Locating roads adjacent to SMZs.
- Locating roads where water tends to collect.

BMPs for Construction

- Salvage merchantable timber prior to clearing the right-of-way.
- Stumps, logs, slash and other organic debris should not be covered with fill material and incorporated into road beds unless the corduroy road construction technique is used.
- Minimize the amount of soil on the road banks or roadsides that is exposed to soil erosion. To minimize problems, revegetate or otherwise stabilize these areas as they are created.
- Functional water diversion structures should be installed at the same time roads are constructed. Drainage water should be dispersed onto the undisturbed forest floor when possible. Soil from parallel and lateral ditches may be incorporated as material for the road bed and drainage structure.
- Road bank slopes should be a 2:1 ratio. Seeding, mulching, or other stabilizing means should be used to reduce the potential for erosion.
- Plan for periods of heavy rain during road construction by including temporary waterbars, turnouts, or other structures to slow water runoff.

BMPs for Drainage

- Ditches, culverts, dips, and wing (lateral) ditches should be installed at the time of construction of the roadway. Ditches should be adequately sized and sloped to prevent silting-up and to allow for maintenance equipment access.
- Roads should be designed to drain at all times by using crowning, ditching, culverts, and water bars.
- Ensure that culverts, water turnouts, and broad-based dips empty road runoff onto the undisturbed forest floor.
- All culverts, permanent or temporary, should be of adequate size to carry the water flow anticipated during heavy rains. (**See CULVERT SIZE CHART, Page 61**).



Several types of drainage structures are used in this forest access road.

A permanent culvert of adequate size has been installed on this forest access road.

BMPs for Water Crossings

- Stream crossings should be constructed to minimize the disturbance to stream banks and existing stream channels.
- Use of equipment in the stream bed should be kept to an absolute minimum.
- Crossing streams at fords should take place when stream flow is down and threat of sedimentation is low.
- Fills and earth embankments used as bridge approaches should be stabilized to minimize potential erosion by using headwalls, wing walls, rip-rap, and other suitable material.
- Excess material and woody debris from road construction should be cleared from streams and drainage ways.
- Bridges and culverts should not constrict clearly defined stream channels.

Note: Some of the most common mistakes in road construction and maintenance are shown below.

AVOID

- Improperly sized culverts (too small).
- Poor location (wet spot, loose soil).
- Insufficient number of wing ditches.
- Steep hills (more than 10 percent grade).
- Use of fill material taken from SMZ to cover culvert.
- Improperly maintained road crown.
- Plugged culverts.
- Leaving erodible soils unstabilized.
- Leaving ditches clogged with logging debris.
- Inadequate soil compaction or “set-up” time before heavy use.

Note: Proper maintenance of permanent access roads is of vital importance to logging and land management activities. Road systems should be kept in serviceable condition to minimize erosion by rainfall runoff and vehicle use.

BMPs for Road Maintenance

- The road surface should be crowned or outsloped to dissipate surface runoff and minimize erosion of the roadbed.
- Ditches, wing ditches, and culverts should be kept free of logging debris or other obstructions to allow unrestricted passage of water. Siltation should be removed from ditches and wing ditches through periodic maintenance.
- Exposed soil subject to excessive erosion should be revegetated or otherwise stabilized if natural revegetation will not suffice.
- Trees adjacent to permanent roads should be trimmed or cut back to allow maximum sunlight on the road surface.
- Closed roads should be periodically inspected to ensure their integrity.
- Anticipate weak spots in road bed and repair with support materials. Do not excavate the road surface and create a channel.

Exemption for Roads in Wetlands

Road construction for silvicultural purposes in jurisdictional wetlands does not require a permit because of this silvicultural exemption. However, to qualify for silvicultural exemption, the road construction must comply with 15 mandatory BMPs for forested wetlands, (**from Clean Water Act, Section 404 Program Definition and Permit Exemption, Part 232.3**). **See FOREST WETLANDS, Page 30.**

Forest Roads

TEMPORARY ROADS

Temporary roads often incorporate the same principles as permanent installations, but not the same degree of refinement and permanence. For example, the need exists to disperse water from temporary roads when conditions are wet, just as with permanent roads.

BMPs for Construction

- Roads should be built on the contour and at a sufficient distance to minimize disturbances to streams. Existing ridge lines should be used where possible.
- Crossings should be designed to prevent restrictions of high water flows during harvest operation.
- Temporary roads may include the use of mats, portable bridges, culverts, lateral ditches, etc.
- Temporary roads may require installation of underlayment to operate trucks across soft or unstable areas.
- Cross streams as close to right angles as is practical.
- Temporary roads should be closed and the soil stabilized after use. Stabilize stream banks, ditches, and roads as needed. Remove temporary crossings.
- Maintaining or closing temporary roads as the operation progresses prevents erosion and minimizes downtime.

AVOID

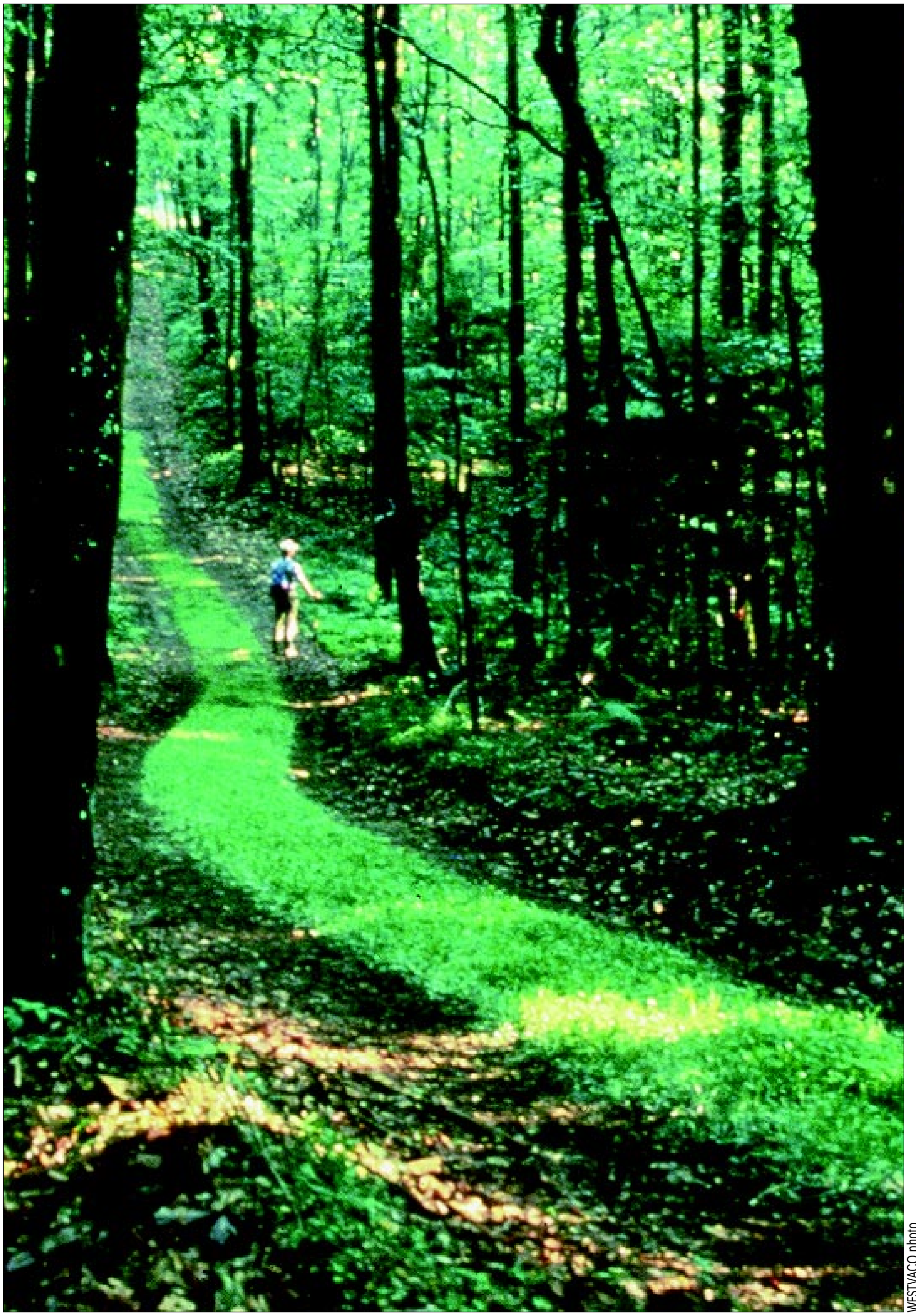
- Roads located directly up or down steep slopes.
- Turning water onto erodible soils unless additional protection from erosion is used.
- Creating channels by cutting deeper and deeper in an attempt to remove soft spots.

Alabama Forestry Commission photo

Installation of one of the types of temporary bridges that can be used.

Alabama Forestry Commission photo

Another type of temporary logging bridge, completed and ready to use.



Temporary roads should be closed and stabilized after use.

Timber Harvesting

PRE-HARVEST PLANNING

HARVESTING OPERATIONS cause a temporary disturbance in the forest. Pre-harvest planning is critical to ensure that operations are conducted in a manner which minimizes impact to water quality.

Note: During harvest design, careful planning and the use of BMPs will minimize soil disturbance and maintain water quality.

BMPs for Planning

- Identification and delineation of sensitive areas such as SMZs, ephemeral streams, bogs, fragile soils, and steep slopes.
- Use of aerial photographs, timber stand maps, topographic maps, and soil surveys to aid in locating log decks or "sets," skid trails, and access roads.
- The timing and type of harvest depends on soil moisture (hydrology), topography, soil type and soil conditions.
- The application of stabilizing or surfacing materials to roads; for example, stone or board run mats applied to potential trouble spots before the operation begins.

Timber Harvesting

STREAMSIDE MANAGEMENT ZONES

A streamside management zone (SMZ) serves as a natural filter of vegetation adjacent to a natural or manmade water body. These zones, also called *riparian* zones, reduce erosion by both slowing the flow of surface water runoff and increasing water filtration. These water bodies may include streams, rivers, bayous, and lakes. To protect water quality, extra precautions may be necessary in carrying out some forest practices.

The key objective of SMZs is to protect and maintain the quality of water on forest lands by the following:

- Maintaining a vegetative filtration strip on ephemeral areas.
- Providing an adequate canopy of forest cover along all perennial streams to maintain normal water and shade conditions.
- Minimizing forest soil erosion by maintaining the appropriate amount of residual ground cover or forest cover under various soil and slope conditions.

When timber is harvested within the SMZ, care should be taken not to compromise the objective of the SMZ.

SMZs should be provided on perennial and intermittent streams and other water bodies. This includes springheads, oxbows, upland flats, and drains bordered by steep or erodible slopes. Any existing drainage structures that over time have come to resemble natural drains are also included.

A *perennial* stream is one that has a well-defined channel and flows year-round except during periods of extreme drought, when they retain pools of water. *Intermittent* streams have seasonal flow and a continuous well-defined channel. *Ephemeral* streams flow during and for a few hours or days after periods of heavy rain and the stream channel is less recognizable than either perennial or intermittent streams.

Streams designated as scenic rivers will be managed in accordance with state law. **See LOUISIANA'S NATURAL AND SCENIC RIVER SYSTEM, page 45.**

SMZ width is dependent on watershed characteristics and the risk of erosion in the SMZ and adjacent area. The risk is increased by sandy soil, steep grade, large watershed size or increasing stream width. Estimated normal flow width is the distance in feet between the water's edge on one side to the water's edge on the other. This width will be estimated at a time when the stream is at its normal (low) flow. Normal flow width will be an average for the stream, taking into consideration the stream will widen as it flows farther from its source.

Note: SMZ widths are measured from the top of each bank and established on each side of the stream. Determination of SMZ width should be site-specific and should be made by foresters or other qualified professionals. Soil type, slope gradient, vegetation cover, volume flow, and stream classification should be taken into consideration when designing each SMZ.

BMPs for Streamside Management

Along perennial streams, timber can be harvested carefully within an SMZ provided that the filtering effects of the SMZ are not compromised.

- Take precautions to protect the remaining timber stands within the SMZ.
- ***Do not remove trees*** from banks, beds or steep slopes if removal will destabilize soil and degrade water.
- Permanent residual tree cover is not required along intermittent and ephemeral streams if vegetation and organic debris are left to protect the forest floor during regeneration.
- Flag or mark SMZs adjacent to all perennial and intermittent streams and lakes before harvesting.
- Plan harvests to minimize stream crossings.
- Locate stream crossings where stream impacts are likely to be minimal.
- Locate roads, skid trails, fire lanes, and logging sets outside the SMZ.
- To minimize damage, limit harvesting on SMZs and sensitive forested wetlands during abnormally wet periods.
- Consider using wide-tire skidders, forwarders, cable skidders, and tracked equipment to minimize soil disturbance in an SMZ.
- Construct stream crossings to minimize stream bank and channel disturbance.
- Cross streams at right angles when practical.
- Consider using portable bridges for temporary stream crossings.
- Promptly remove all temporary crossings and restore the site after harvesting is completed.

AVOID

- Skidding across perennial or large intermittent streams, except over an adequately designed crossing.
- Excessive skidding within an SMZ.

Suggested SMZ Widths

Stream Type	SMZ Width (each side)
Intermittent	35 Feet
Perennial	
less than 20 feet wide	50 feet
more than 20 feet wide	100 feet

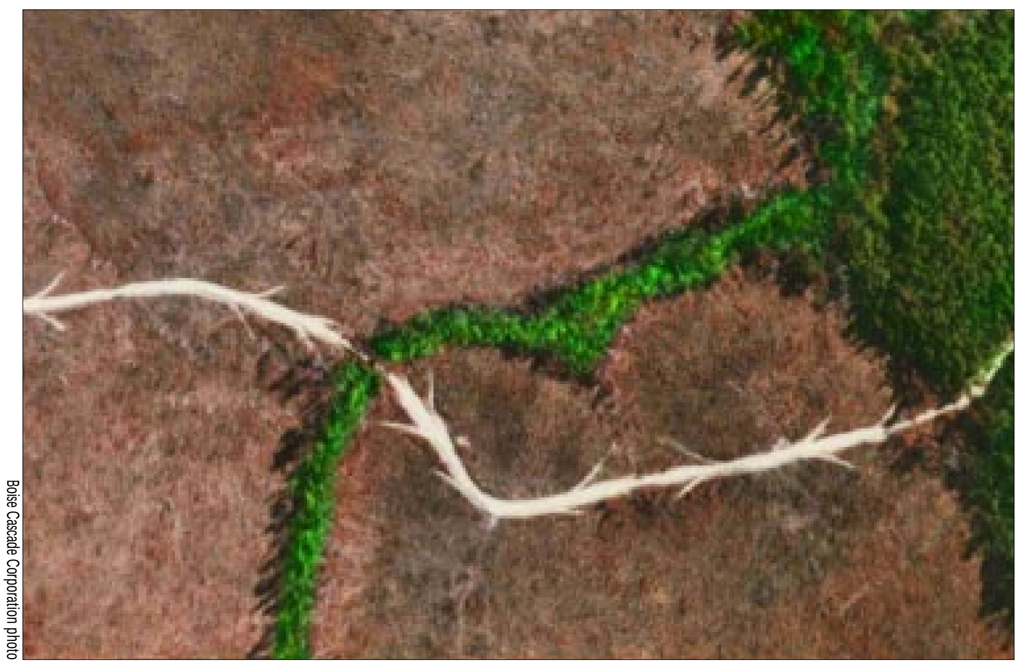
STREAMSIDE MANAGEMENT ZONES

Timber harvesting is allowed in the SMZ, providing the objectives of the SMZ are not compromised.

SMZs provide a water filtration strip of ground cover on ephemeral areas.

WESTVACO photo

An effective SMZ provides adequate canopy of forest cover along all perennial streams to maintain normal water and shade conditions.



Boise Cascade Corporation photo

An effective SMZ minimizes forest soil erosion by maintaining the appropriate amount of residual ground or forest cover under various soil and slope conditions.

Timber Harvesting

Hancock Timber Resources Group photo

Modern harvesting equipment is used to control the direction of felling.

FELLING & SKIDDING TECHNIQUES

BMPs for Skidding

- Use soil surveys, aerial photographs, and topographic maps to help locate skid trails.
- Use the smallest number, width and length of skid trails needed to log the area effectively.
- Use waterbars, wing ditches, or other appropriate practices to slow and disperse water runoff. Construct water bars to divert water rather than block it.
- Keep stream crossings to a minimum.
- Cross streams at right angles and in straight sections of the stream, when practical.
- Skid logs uphill at an angle.
- Scatter logging slash on wetter areas of skid trails to prevent rutting.
- Keep skidder loads light in sensitive areas to reduce rutting and protect drainage integrity.
- Stabilize skid trails to prevent erosion by using waterbars, logging slash, or other appropriate water diversions.
- Establish vegetative cover after smoothing and shaping of bare ground subject to erosion.
- When crossings streams, temporary fills should be removed in their entirety after completion of harvesting operations.
- Restore stream crossings to natural grade and shape.

AVOID

- Sensitive areas and problem soils.
- Skidding straight up or down steep slopes.
- Long, steep skids. Lay out skid trails on slopes at an angle to break up the grade.
- Water draining down skid trails.
- Skidding in a stream channel even when temporarily dry.
- Skidding across perennial streams or large intermittent streams unless it is done with a properly constructed temporary crossing.
- Excessive damage to remaining timber and other vegetation within SMZs.
- Using existing skid trails if further use will cause excessive soil disturbance.

BMPs for Felling

- When possible, trees should be directionally felled away from water bodies.
- Remove only tops and limbs which have fallen into any water body during harvesting.
- Inspect all stream courses to be sure they are free from excessive logging debris.

LANDINGS, LOG DECKS & SETS

Landings, log decks and sets are temporary locations where logs are assembled for temporary storage, loading and transportation.

BMPs for Landings

- Use no more sets than are necessary.
- Make sets no larger than necessary.
- Locate sets on firm, well-drained ground away from streams.
- Locate log sets on a slight slope (less than 5%) for drainage whenever possible.
- Locate sets so skidding will have a minimal impact on the natural drainage pattern.
- Locate sets where skidding will avoid road ditches, sensitive sites, and excessive slopes.
- Reshape disturbed areas to minimize soil erosion.
- Seed and fertilize bare areas that would erode before natural vegetation is re-established.

AVOID

- Locating log decks in SMZs or other sensitive areas.
- Locating log decks where they might result in skidding through sensitive areas.

Timber Harvesting

REVEGETATION

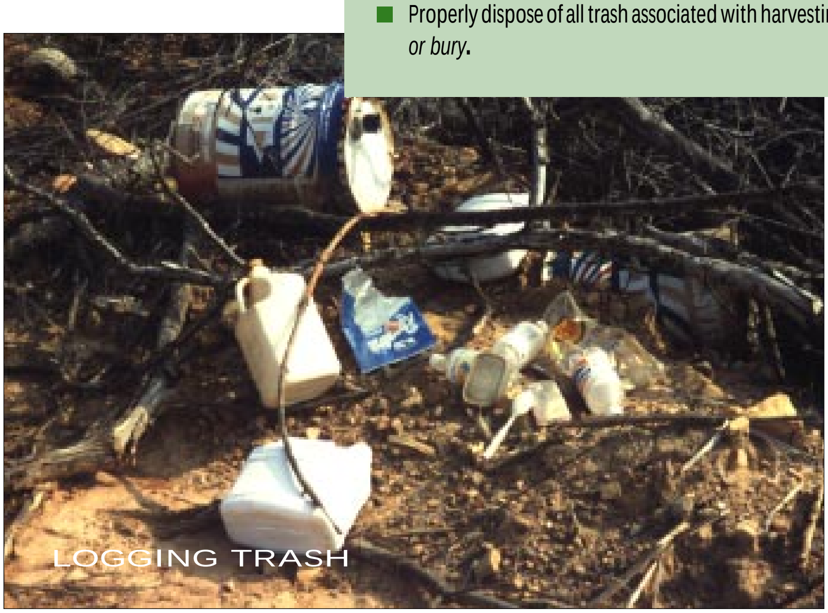
BMPs for Revegetation

- Reestablish vegetation on temporary roads, drainage systems, side slopes, back slopes, skid trails or landings following significant soil disturbances when natural revegetation will not prevent erosion. See Revegetation Of Disturbed Areas in Appendix IV, Page 81.

EQUIPMENT MAINTENANCE & LITTER

BMPs for Equipment Maintenance & Litter

- Perform all maintenance away from riparian areas.
- Capture all coolants, oils, fuels, etc. and dispose of waste properly.
- Repair leaks immediately.
- Properly dispose of all trash associated with harvesting. ***DO NOT*** *burn or bury*.



LOGGING TRASH


SEEDED TEMPORARY ROAD

Site Preparation & Reforestation

GENERAL METHODS

RAPID REGENERATION OF FOREST LAND following final harvest or natural disaster is both economically and environmentally important. Any increase in erosion, water yield, and storm flow coming from a logged site diminishes rapidly as the site revegetates.

Root systems remain in place many years after trees are cut and provide soil stability which reduces the risk of erosion. Trees also intercept water and impede storm water runoff. Many sites require some type of treatment to accomplish quick and effective regeneration of desirable tree species, or to reduce some undesired effects of harvesting.

BMPs for Site Preparation & Reforestation

- Clearly define boundaries of all SMZs before beginning site preparation activities.
- Ripping, shearing, windrowing, and mechanical planting should follow the contours of the land to reduce potential erosion hazard.
- On steep slopes or highly erosive soils avoid intensive site preparation. Use herbicides, hand tools, and / or prescribed fire, but be aware that extremely hot fires may significantly increase erosion potential.
- Hand plant steep, erodable sites as soon as possible after final harvesting and site preparation.
- Where accelerated erosion is likely, use methods which leave logging debris and other natural forest litter scattered over the site.
- Minimize moving soil into windrows and piles.
- 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 should be restored promptly.
- Equipment operators should be trained and appropriate planning done so that soil disturbance, compaction, and displacement is minimized.
- In order to minimize erosion, firebreaks should have water control structures properly installed and maintained.
- Site preparation activities should not enter SMZs and cross stream channels.
- Provide water outlets on bedded or furrowed areas at locations that will minimize movement of soil. Discharge water onto a vegetative surface.

AVOID

- Damage to existing water control devices (i.e. culverts, wing ditches). Site preparation and planting equipment should avoid crossing or turning around in roads, road ditches, and wing ditches. Damages should be repaired immediately.
- Intensive mechanical site preparation on steep slopes or on sites that have high potential for erosion.
- Constructing windrows which will funnel surface runoff into perennial, intermittent, or ephemeral streams.
- Blocking any drainage with beds, windrows, or similar structures.

Two major problems associated with site preparation include soil erosion and potential sedimentation from runoff. Primary factors contributing to accelerated erosion from runoff are percent of the area with exposed soil, type of soil, degree of slope, and ground cover.

Techniques used for site preparation should be based on soils, slope, condition of the site, natural vegetation, crop tree species, and cost. Soils with a shallow surface layer generally have limited capacity to absorb water and are more likely to erode. Steeper slopes provide more rainwater runoff velocity, and thus energy, to erode soils. Ground cover helps hold soil in place and dissipates some of the energy of rainfall.

WESTVACO photo

Ripping, shearing, windrowing and mechanical planting should follow the contours of the land to reduce potential erosion hazard.

Silvicultural Chemicals

FERTILIZATION & PESTICIDES

PESTICIDES, INCLUDING BOTH HERBICIDES AND INSECTICIDES, are valuable tools in maintaining a healthy forest. The use of herbicides, rather than mechanical site preparation methods is recommended on erodable sites to protect water quality. Insecticides can be used to control certain insect infestations where outbreaks are localized provided care is taken to minimize use in SMZs.

Fertilization, may be used to enhance tree growth. Fertilizers can be applied safely with ground and air equipment, provided that care is taken and application is in accordance with label instructions and applicable state and federal laws.

Proper planning, training and conscientious execution of the plan are keys to safe use of silvicultural chemicals.

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

BMPs for Silvicultural Chemicals

- Follow label directions and applicable state and federal laws in the storage, transportation, handling, and application of all chemicals. All worker protection standards should be strictly followed. *All restricted-use pesticides shall be applied under the supervision of a certified pesticide applicator*.

- Know each chemical's characteristics. Know also topography, soils, drainage, weather, and other potential site hazards that might be important for preventing water pollution during application.

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

- Water for mixing with chemicals should be carried to the field in water-only tanks. The danger of getting a chemical into a ground or surface water supply must be avoided. An anti-siphon device is essential in the water intake to prevent back flow. Chemical mixing should only be done at the application site.

- 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 wellheads.

CONTINUED, NEXT PAGE

FERTILIZATION & PESTICIDES

...more Chemical BMPs

- Carefully plan ground and aerial application to avoid direct and indirect entry of chemicals into streams and impoundments. Special care should be taken when chemicals are used in the SMZ. Realize that significant portions of the SMZ will probably be left untreated. Leave well-marked buffer zones between target area and surface water.
- Chemicals must not be applied when stream pollution is likely to occur through aerial drift.
- Use spray equipment that is capable of immediate shut-off.
- Where feasible, utilize injection or stump treatment herbicide methods in areas immediately adjacent to open water.
- If a spill should occur, construct a containment dike around it. Use absorbent material such as kitty litter, sawdust, or soil to soak up fluid. Keep the spill from flowing into streams or bodies of water. *Some spills will require notifying appropriate authorities***.**
- All empty pesticide containers must be triple-rinsed and disposed of in accordance with label requirements.
- *The rinse water should be used in the pesticide mix and sprayed on the treatment area.*
- Clean equipment in a location where chemicals will not enter any stream, lake, pond.

AVOID

- Applying pesticides and fertilizers directly to water bodies such as streams, lakes, or swamps unless specifically prescribed and approved for aquatic management.
- Broadcast application of pesticides within SMZs.
- Applying any herbicide adjacent to the SMZ that would damage trees in the SMZ or enter a stream.
- Aerial chemical application during turns and over open water.
- Exceeding intended or allowable dosages of chemicals.
- Applying chemicals to vegetation protecting eroded slopes, gullies, drainages, and other fragile areas subject to erosion.

Weyerhauser photo

Chemicals should not be applied if water pollution is likely to occur through aerial drift.

Fire Management

PRESCRIBED BURNING

PRESCRIBED FIRE IS AN IMPORTANT AND USEFUL SILVICULTURAL TOOL. It can be used to prepare a site for planting by reducing logging debris or to prepare a seedbed for seed fall. Prescribed fire can also be used in established stands for silvicultural purposes, wildlife habitat improvement, and hazard reduction. A major concern of forest management is the effect of prescribed fire on surface runoff and soil erosion.

Studies have shown that properly planned and conducted prescribed burning has a minimal impact on water quality in the South. Most problems associated with prescribed burning can be eliminated with proper planning, awareness of changing weather conditions, and compliance with Louisiana's Voluntary Smoke Management Guidelines (*copies can be obtained from the Louisiana Office of Forestry*). For most flat, sandy soils there is little danger of soil erosion; however, in steeper topography there is a greater chance for soil movement. When a prescribed fire becomes too hot, the entire surface layer (humus) can be consumed, exposing the underlying mineral soil to erosion and increasing surface runoff.

BMPs for Prescribed Burning

- Site prep burns on steep slopes or highly erodible soils should only be conducted when they are absolutely necessary and should be of low intensity. Time prescribed fires so that the moisture level of the forest floor prevents the entire humus layer from being burned.
- A significant amount of soil movement can occur when preparing for prescribed burns; for example, along firebreaks. Firebreaks should have water control structures in order to minimize erosion. Locate firebreaks on contours as much as possible. Water bars should be constructed in firebreaks at frequent intervals to slow surface runoff in areas subject to accelerated erosion, such as steep grades or highly erodible sloping firebreaks.
- Site prep burning creates the potential for soil movement. All efforts should be made to keep high intensity site prep burns out of SMZs.
- Use hand tools when necessary to connect firebreak lines into stream channels.

AVOID

- Burning when conditions will cause a fire to burn too hot and expose mineral soil to erosion.
- Allowing high intensity fire to enter filter strips or SMZs.
- Burning on severely eroded forest soils where the average litter duff is less than one-half inch.

Fire Management

FIRELINE CONSTRUCTION & MAINTENANCE

Fireline construction and maintenance is an essential part of forest management. It deals with site preparation burning, prescribed burning, and wildfire suppression. 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.

BMPs for Firelines

- 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.
- 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.
- Firelines that approach a drainage should be turned parallel to the stream ***or*** include the construction of a wing ditch or other structure that allows runoff in the line to be dispersed rather than channeled directly into the stream.
- Firelines 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. **See vegetation specifications in Appendix IV , Page 81.**

AVOID

- Disturbing existing gullies where possible.
- Disturbing more soil surface than necessary.
- Connecting firelanes directly into stream channels.
- Plowing against the contour where possible.

Alabama Forestry Commission photo

Fireline construction and maintenance is an essential part of forest management.

Fire Management

WILDFIRE

The first and foremost concern in wildfire control is to prevent damage to people and property. During wildfire suppression, fireline BMPs that slow containment efforts must take a lower priority than fire suppression. Potential problems should be corrected later.

BMPs for Wildfire

- Actively eroding gullies should be stabilized when possible.
- Stabilize and revegetate fire lines on steep grades, areas subject to accelerated erosion, or known sensitive areas.
- Ensure all road surfaces are left stabilized and protected.

Alabama Forestry Commission photo

During wildfire suppression, fireline BMPs that slow containment efforts must take a lower priority than the suppression itself.

Forest Wetlands

BENEFITS AND FUNCTIONS OF 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. 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. **NOTE: The section on wetlands herein is taken from *Handbook on Forested Wetlands*, Forested Wetlands Workshop, August 8, 1996, Alexandria, Louisiana.**

OVERVIEW

Louisiana's bottomland hardwood forests, including wetlands, are productive ecosystems with multiple functions and ecological values that can be managed for commercial timber production without compromising this valuable resource. This section deals with the management of these sites in order that they may continue to provide this ecological value. The reader should keep in mind that many sites classified as bottomlands may be wetland-like, but are not necessarily "wetlands" in the strictest legal or jurisdictional sense. Jurisdictional wetlands are found throughout the state and are not limited to obscure flooded or remote marsh areas.

Maintaining ecological productivity for wetland and wetland-like sites often call for the same management techniques. These wetland BMPs address sustained timber production as one of the landowner's objectives. Timber production is recognized as a land use that is compatible with wetland protection.

Although wetlands are federally regulated, normal forestry operations in wetlands — including but not limited to soil bedding, site preparation, harvesting, and minor drainage (see note on next page) *— are exempt from permit requirements under Section 404 of the Clean Water Act Amendments of 1977,* ***as long as the activity***:

- Qualifies as "normal silviculture."
- Is part of an "established" silvicultural operation.
- Does not support the purpose of converting a water of the United States to a use to which it was not previously subject.
- Follows the 15 mandatory BMPs for road construction (see *Access Systems*), and the six mandatory BMPs for site preparation (see *Site Preparation in Wetlands*).
- 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 (USCOE). If the activity is on a farmed wetland or on agricultural land, the Natural Resources Conservation Service (NRCS) is the appropriate initial contact.

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

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

NORMAL SILVICULTURAL ACTIVITIES

Normal silvicultural activities conducted as part of "established, ongoing" silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Normal activities include but are not limited to road construction, timber harvesting, mechanical or chemical site preparation, reforestation, timber stand improvement and minor drainage. These measures include 15 federal mandatory BMPs for road construction and the six BMPs for silvicultural site preparation activities in forested wetlands. *Recommended Forestry Best Management Practices for Louisiana* are not required for exemption from Section 404 Corps of Engineers permit requirements; but they are ***strongly*** recommended to minimize nonpoint source pollution of waters of the state and / or waters of the United States.

ESTABLISHED SILVICULTURAL OPERATIONS

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

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

- A history of harvesting with either natural or artificial regeneration.
- A history of fire, insect and disease control to protect the maturing timber.
- The presence of stumps, logging roads, landing or other indications of established silvicultural operations that will continue on the site.
- Explicit treatment of the land as commercial timberlands by government agencies under zoning, tax, subsidy, and regulatory programs.
- Certification under the National Tree

Farm System or Stewardship Program

- Ownership and management by a timber company or individual whose purpose is timber production.

While past management may have been relatively non-intensive, intensification of management involving artificial regeneration and other practices can occur as part of a conventional rotation and be considered an established operation.

Although wetland regulations do not require a written forest management plan, it is in a landowner's best interest to document that operations are established, that BMPs are implemented and effective, and that activities are consistent with other Section 404 exemption criteria.

A change in ownership has no bearing on whether a forestry operation is part of an established, ongoing activity. Continuation or strict adherence to a management plan written for the previous owner is not required by Section 404 silvicultural exemptions.

Note: Forestry activities or operations require a 404 permit from the Corps of Engineers under the conditions listed in the adjacent panel.

A 404 Permit is required when:

- The activity results in the immediate or gradual conversion of a wetland to an upland as a consequence of altering the flow and circulation or reducing the reach of waters of the United States.

  Changes in flow, circulation or reach of waters can be affected by permanent major drainage such as channelization or by placement of fill materials. A discharge which changes the bottom elevation of waters of the United States without converting it to dry land, does not reduce the reach of waters but may alter flow or circulation and therefore may be subject to permitting requirements.

  The criteria that are used to determine if a wetland has been converted include a change in hydrology, soils and vegetation to such an extent that the area no longer qualifies as a jurisdictional wetland according to the *Federal Manual for Delineating Jurisdictional Wetlands (1987).*
- A new activity results in a change from the past, historical use of the wetland into a different use to which it was not previously subject where the flow of circulation of waters is impaired or the reach of the waters is reduced. Such a change does not meet the established, ongoing requirement and causes the activity or operation to lose its exemption.

  Examples of this situation are areas where tree harvesting has been the established use and the landowner wishes to convert the site for use as pasture, green tree reservoir, agriculture, real estate or aquaculture. In such cases, the landowner must first obtain a 404 permit before proceeding with the change.
- Roads and stream crossings are constructed in wetlands without following the mandatory federal BMPs.
- The area has lain idle for so long that hydrologic modifications are necessary to resume operations. This does not refer to temporary water management techniques such as minor drainage, plowing, bedding and seeding which are exempt, normal silvicultural activities as long as they don't result in the conversion of wetlands to uplands. However, it does apply to reopening ditches which were once established as permanent wetland drainage structures but have lost their effectiveness for this purpose as they filled in with soil and vegetation.

Note: *Streamside management zones* or SMZs should be established and managed around the perimeter of all major drainages and open bodies of water contained within wetlands; for example, mainstream courses or oxbow lakes.

Forest Wetlands

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."*

Criteria for Delineating Wetlands

Established by the
U.S. Army Corps of Engineers (USCOE)

- **Hydrophytic vegetation** — plants that have the ability to grow, effectively compete, reproduce, and / or persist in anaerobic soil conditions.

- **Hydric soils** — soils that are saturated, flooded, or ponded long enough during the growing season for anaerobic conditions to develop.

- **Wetland hydrology** — inundated by water sufficient to support hydrophitic vegetation and develop hydric soils.

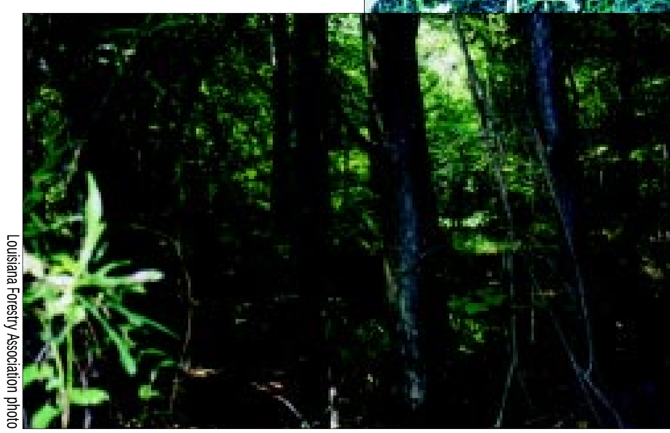
All three must be present under normal circumstances for an area to be identified as a jurisdictional wetland.

Forest Wetlands

PLANNING IN WETLANDS

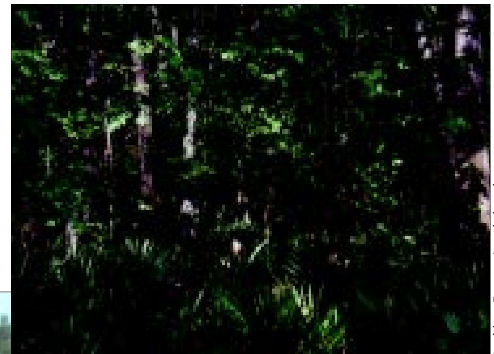
Planning for timber harvesting is an often overlooked step in silvicultural activities. When working in wetlands or wetland-like areas, planning is essential. To facilitate planning, identify and mark the location of waterbodies and other sensitive areas using aerial photographs, topographic maps or soil surveys. (See Appendix II, Page 69).

WESTVACO photo



Louisiana Forestry Association photo

The photos on these two pages illustrate examples of four typical Louisiana wetlands.



Louisiana Forestry Association photo

WESTVACO photo

PLANNING IN WETLANDS

Forest Wetlands

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 will have minimal impact on water quality, hydrology, 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 mandatory Best Management Practices to retain Section 404 exemption status:

15 Federally Mandated BMPs for Roads

1. Permanent roads, temporary access roads, and skid trails in waters of the U.S. shall 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, shall 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 shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows.
4. The fill shall 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 shall 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. shall be kept to a minimum.
7. The design, construction, and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
8. Borrow material shall be taken from upland sources whenever feasible.
9. The discharge shall 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 shall be avoided if practical alternatives exist.
11. The discharge shall not be located in the proximity of a public water supply intake.
12. The discharge shall not occur in areas of concentrated shellfish population.
13. The discharge shall not occur in a component of the National Wild and Scenic River System.
14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts.
15. All temporary fills shall 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.

BMPs for Permanent Roads

- Construct and maintain permanent roads in forested wetlands according to the 15 mandatory BMPs listed opposite.
- 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 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 SMZs and jurisdictional 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, when possible, and should not impede stream flow.
- Minimize sediment production when installing stream crossings.
- Use gates or otherwise restrict unnecessary traffic on wet roads.
- Road ditches should not feed directly into stream channels.

Forest Wetlands

TEMPORARY ROADS AND SKID TRAILS

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

BMPs for Temporary Roads and Skid Trails

- Construct and maintain temporary roads in forested wetlands according to the 15 mandatory BMPs.
- 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.

ROAD MAINTENANCE

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.

BMPs for 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 debris.

Forest Wetlands

HARVEST OPERATIONS IN WETLANDS

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

BMPs for Wetland Harvest Operations

- Harvest during dry periods if possible to minimize rutting.
- Use low pressure / high flotation tires or wide tracks where possible, so that excessive damage to residual stand will not occur.
- Keep skidder loads light when rutting is evident.
- Fell trees away from watercourses if possible.
- During harvesting, remove any obstructions in channels resulting from harvesting operations.
- Limit operations on sensitive sites and in SMZs during periods of wet weather.

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.

Forest Wetlands

SITE PREPARATION IN WETLANDS

Site preparation activities in forested wetlands for the establishment of pine plantations[1] in Louisiana may or may not require a Clean Water Act Section 404 permit.

NO PERMIT REQUIRED

The following are circumstances where mechanical site preparation activities* do not require *a permit:

- Mechanical silvicultural site preparation[2] is a non-permitted activity in wetlands that are:

  Seasonally flooded — Characterized by surface water that is present for extended periods, especially early in growing season and is absent by the end of the season in most years but water table is often near the surface.

  Intermittently flooded — Characterized by substrate that is usually exposed, but where surface water is present for variable periods without detectable season periodicity.

  Temporarily flooded or saturated — Characterized by surface water that is present for brief periods during the growing season, but also by a water table that usually lies well below the soil surface for most of the season.

  Historically 25% or more pine — Conducted in pine plantations and other silvicultural sites that originally or historically contained more than 25% pine in the canopy (except as listed under "permit required," next page — circumstances which *do* require a permit). Examples typical of these wetlands include pine flatwoods, pond pine flatwoods and wet flats, such as certain pine-hardwood forests.

- The site preparation activity is conducted in a manner designed to minimize impacts to the aquatic ecosystem and are conducted according to the six BMPs[3] listed below:

  Minimize soil disturbance — Position shear blades or rakes at or near the soil surface and windrow, pile, and otherwise move logs and logging debris by methods that minimize dragging or pushing through the soil to minimize soil disturbance associated with shearing, raking, and moving trees, stumps, brush, and other unwanted vegetation.

  Avoid soil compaction — Conduct activities in such a manner as to avoid excessive soil compaction and maintain soil tilth.

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1 These guidelines were developed for the establishment of pine plantations and does not apply to, restrict, or require a permit for mechanical site preparation for the establishment of hardwood plantations.

2 Mechanical silvicultural site preparation activities include shearing, raking, ripping, chopping, windrowing, piling and other similar methods used to cut, break apart, or move logging and other debris following harvesting for the establishment of pine plantations.

3 These BMPs firmly establish that forestry site preparation activities including shearing, raking, moving logging slash, windrowing, piling, etc. are part of normal silviculture; therefore, implementation of the mechanical site preparations BMPS does not constitute "land clearing" or other non-exempt activities.

Limit erosion and runoff — Arrange windrows in such a manner as to limit erosion, overland flow, and runoff.

Keep logging debris out of SMZs — Prevent disposal or storage of logs or logging debris in streamside management zones (defined areas adjacent to streams, lakes, and other waterbodies) to protect water quality.

Maintain natural contour and drainage—Maintain the natural contour of the site and ensure that activities do not immediately or gradually convert the wetland to a non-wetland.

Exercise water management — Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.

PERMIT REQUIRED

The following are circumstances where mechanical site preparation activities require a permit:

- A permit will be required in the following areas unless they have been so altered through past practices (including the installation and continuous maintenance of water management structures) as to no longer exhibit the distinguishing characteristics described below (see "circumstances where mechanical silvicultural site preparation activities do not require a permit" above).

Permanantly flooded, intermittently exposed, and semi-permanent flooded wetlands

Permanently flooded wetlands — characterized by water that covers land surface throughout the year in all years.

Intermittently exposed wetlands — characterized by surface water throughout the year except in years of extreme drought.

Semi-permanently flooded wetlands — characterized by surface water throughout the growing season in most years and when absent, the water table is usually at or near the land surface. Examples of these three types include cypress gum swamps, muck and peat swamps and cypress strands / domes.

Riverine bottomland hardwood wetlands

Seasonally flooded floodplains — characterized by seasonally flooded or wetter river floodplain sites where overbank flooding has resulted in alluvial features such as well-defined floodplains, bottom / terraces, natural levees, and backswamps. Surface water present for extended periods, especially early in growing season, but absent by end of the season in most years, but water table often near land surface. Field indicators include water-stained leaves, drift lines and water marks on trees.

Hardwoods dominant — hardwoods dominate the canopy but do not include sites where more than 25% of canopy is pine.

Poorly drained soils — soil characteristics include listed hydric soils that are poorly drained or very poorly drained.

Non-riverine forest wetlands — *Are rare, high-quality, wet forests with mature vegetation; located on the southeastern coastal plains, with hydrology dominated by high water tables representing two forest community types.*

Non-riverine wet hardwood forests — poorly drained mineral soil interstream flats (comprising 10 or more contiguous acres), typically on the margins of larger peatland areas, seasonally flooded or saturated by high water tables, with vegetation dominated (greater than 50% of basal area per acre) by swamp chestnut oak, cherrybark oak, or laurel oak alone or in combination.

Non-riverine swamp forests — very poorly drained flats (comprising 5 or more contiguous acres), with organic soils or mineral soils with high organic content, seasonally to frequently flooded or saturated by high water tables, with vegetation dominated by bald cypress, pond cypress, swamp tupelo, water tupelo, or Atlantic white cedar alone or in combination.

The term "high quality" refers to generally undisturbed forest stands, whose character is not significantly affected by human activities such as forest management. Non-riverine forest wetlands dominated by red maple, sweetgum, or loblolly pine alone or in combination are not considered to be of high quality, and do not require a permit.

Tidal freshwater marshes — *Wetlands regularly or irregularly flooded by freshwater with dense herbaceous vegetation, on the margins of estuaries or drowned rivers or creeks.*

Maritime grasslands, shrub swamps and swamp forests — *Barrier island wetlands in dune swales and flats; underlain by wet, murky or sandy soils, vegetated by wetland herbs, shrubs and trees.*

Four other wetland types in addition to the five above — white cedar swamps, Carolina bay wetlands, low pocosin wetlands and wet marl forests — require a permit for mechanical silvicultural site preparation, but are not normally found in Louisiana.

Note: Pine plantations that have already been established in the nine wetland types are grandfathered and not subject to the above prohibition. Thus, if a pine plantation already exists in the wetland types, no permit will be required for mechanical site preparation in order to continue pine plantation management on that site. Further, it is important to note that the above prohibition against mechanical site preparation in the above wetlands does not preclude pine management all together. Pine management can occur as long as the pine trees can be established consistent with the other clearly exempt activities including, harvesting, minor drainage, seeding, plowing and cultivating.

BMPs for Pine Wetlands

- Site preparation in forested wetlands, as outlined under *Permanently flooded wetlands* above, should be conducted according to the six BMPs listed under Riverine bottomland hardwood wetlands on page 41.

AVOID

- Permanently flooded, intermittently exposed and semi-permanent flooded wetlands.
- Riverine bottomland hardwood wetlands.
- Non-riverine forest wetlands.
- Tidal freshwater marshes.
- Maritime grasslands, shrub swamps and swamp forests.

REFORESTATION IN WETLANDS

Reforestation in wetlands is not much different from regenerating uplands, with regard to water quality; the main factors to consider are the sites' potential for erosion and sedimentation, and for hydrology.

FOREST CHEMICALS IN WETLANDS

Use of chemical treatment should be limited within an SMZ because of their pollution potential. Application of pesticides, including herbicides, should be made by injection or directly. Forest fertilizer should be applied in such a manner (such as rate, time, or frequency of application) to prevent soil or water pollution. If state and federal laws regarding the proper use of silvicultural chemicals are adhered to and manufacturers label directions followed, the judicious use of chemicals should not jeopardize an SMZ or the water it protects. Care should also be taken in areas adjacent to an SMZ to prevent the drift, spill, seepage, or wash of chemicals into the SMZ or watercourse.

BMPs for Chemicals in Wetlands

- Follow all label instructions to the letter. Be aware that some chemicals are labeled for use in wetlands and some are not.
- Conduct applications by skilled and, if required, licensed applicants.
- Identify and establish buffer areas for moving surface waters, especially for aerial applications.

AVOID

- Do not allow spray or rinse water to enter SMZs.


Weyerhauser photo

A variety of plants are found along the upland-bottomland interface.

Louisiana's Natural & Scenic Rivers

OVERVIEW

The Louisiana Natural and Scenic Rivers System is one of the nation's largest, oldest, most diverse and unique state river protection initiatives. It currently includes 52 streams, rivers, bayous, stream complexes and segments thereof, totaling over 1,700 miles in length. Additions or deletions to the Scenic River System are made by the Louisiana Legislature.

The system was proposed in the late 1960s and adopted in the early 1970s with the Louisiana Natural and Scenic River Act, which outlined requirements for a river to be included. It also established a regulatory program and empowered the Secretary of the Louisiana Department of Wildlife and Fisheries (LDWF) to administer the system through regulation and permits.

In 1978, the Legislature created a scenic river task force, mandated to update the Act, set policy and establish regulations for full implementation, and oversee planning for system management by the LDWF.

SENSITIVE ACTIVITIES

The following activities are prohibited, require a permit, or are exempted adjacent to or within 100 feet of the low-water mark of a state scenic stream:

Prohibited activities — Certain activities which drastically alter the natural and scenic qualities of streams in the system are *prohibited* by the State of Louisiana.

- Channelization
- Channel realignment
- Clearing and snagging
- Impoundments
- Commercial clearcutting within 100 feet of the low-water mark

Scenic River Permit Requirements

Activities requiring permit — Any other activity that may have a direct, significant ecological impact on the river must be permitted by the Louisiana Department of Wildlife and Fisheries. In addition, four other agencies — the Department of Environmental Quality, Department of Agriculture and Forestry, Department of Culture, Recreation and Tourism, and the Office of State Planning — review permit applications. **Activities which must be permitted**, for example, include, but are not limited to:

- Bridge, pipeline and powerline crossings
- Bulkheads, piers, docks and ramps
- Waste water discharges
- Land development adjacent to the river
- Aerial application of pesticides and fertilizers to fields adjacent to scenic streams.
- Water withdrawals

Contact the Louisiana Department of Wildlife & Fisheries for permitting information under the Louisiana Natural & Scenic Rivers System.

Activities exempted from regulation by the act — While clearcutting of trees for commercial purposes within 100 feet of the low water mark is prohibited, removal of a portion of the trees is allowed as follows:

- *Selective harvesting* — The selective harvesting of trees for commercial purposes is exempt under the following definition: the removal of trees, either as single scattered individuals or in small groups at relatively short intervals, resulting in openings generally less in width than twice the height of the dominant trees. Repeated indefinitely, selective harvesting ensures the continuous establishment of reproduction, and an uneven aged stand adequate to encourage and maintain stream shading and stream bank integrity."

- The cutting of trees for the control of disease or insects
- The harvesting of timber for personal use by the person who owns or leases the property

Permits are not required for harvesting trees adjacent to natural and scenic rivers, as outlined above, provided that *prior notification* is given to the Louisiana Office of Forestry.

Disposal of trees or tree tops into a Scenic River is a violation of both the State Water Pollution Control Act and the Scenic Rivers Act. The riparian landowner is liable for a violation of this nature regardless of who actually placed the trees or tops into the stream.

BMPs for Natural & Scenic Rivers

ACTIVITIES REQUIRING PERMIT

- Bridge, pipeline and powerline crossings
- Bulkheads, piers, docks and ramps
- Waste water discharges
- Land development adjacent to the river
- Aerial application of pesticides and fertilizers to fields adjacent to scenic streams.

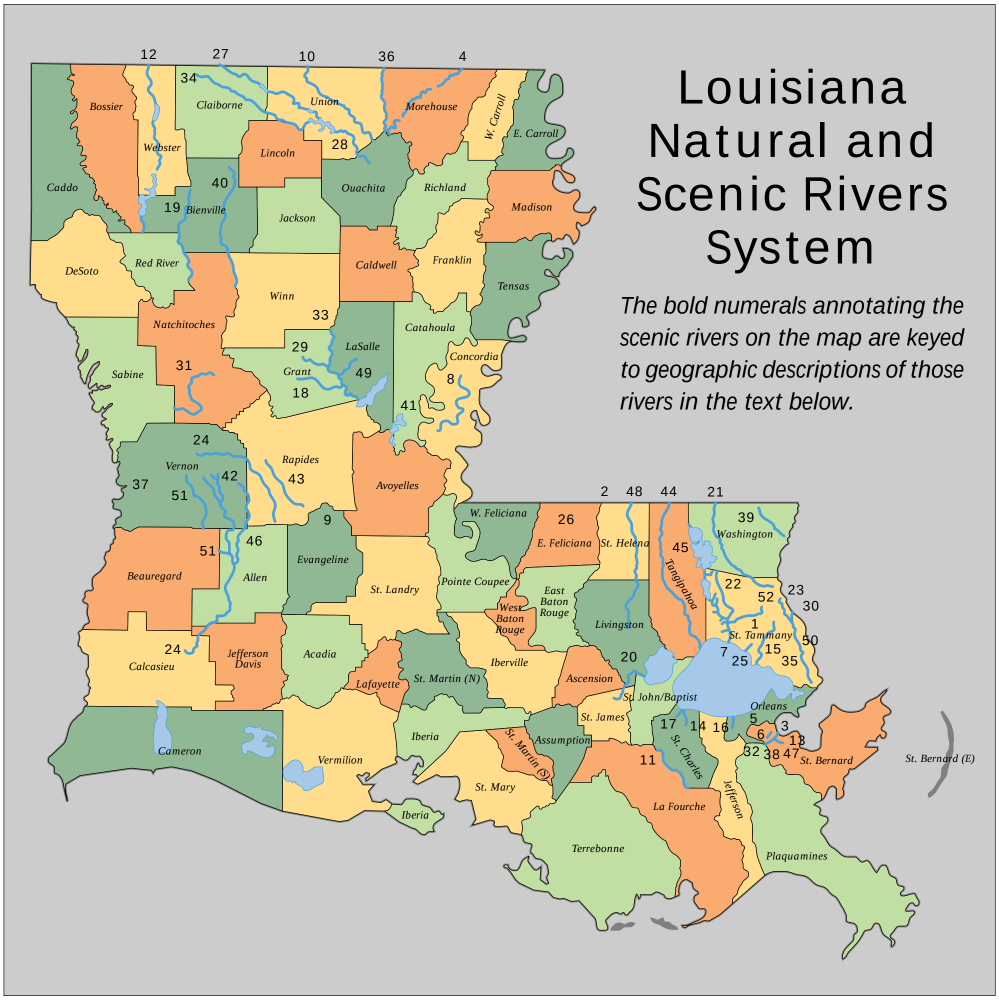
ACTIVITIES REQUIRING NOTIFICATION OF THE LOUISIANA OFFICE OF FORESTRY

- Selective harvest in 100 foot buffer
- Cutting trees for insect and / or disease control
- Harvesting trees for personal use

AVOID

PROHIBITED BY THE STATE OF LOUISIANA

- Channelization
- Channel realignment
- Clearing and snagging
- Impoundments
- Commercial clearcutting of timber within 100 feet of the low-water mark



Louisiana Natural and Scenic Rivers System

The bold numerals annotating the scenic rivers on the map are keyed to geographic descriptions of those rivers in the text below.

1. **Abita River,** *St. Tammany* — From its headwaters to its entrance into the Bogue Falaya River.
2. **Amite River,** *East Feliciana* — From the Mississippi state line to Louisiana Highway 37.
3. **Bashman Bayou,** *St. Bernard* — From its origin to Bayou Dupre.
4. **Bayou Bartholomew,** *Morehouse* — From the Louisiana-Arkansas state line to Dead Bayou.
5. **Bayou Bienvenue,** *St. Bernard* — From Bayou Villere to Lake Borgne.
6. **Bayou Chaperon,** *St. Bernard* — From its point of origin to its end.
7. **Bayou Chinchuba,** *St. Tammany* — From the West Causeway approach south to Lake Pontchartrain.
8. **Bayou Cocodrie,** *Concordia* — From Wild Cow Bayou to Little Cross Bayou.
9. **Bayou Cocodrie,** *Rapides, Evangeline* — From U.S. Highway 167 to the Bayou Boeuf-Cocodrie Diversion Canal.
10. **Bayou D' Loutre,** *Ouachita, Union* — From the Louisiana-Arkansas state line to its entrance into the Ouachita River.
11. **Bayou Des Allemands,** *LaFourche, St. Charles* — From Lac Des Allemands to Lake Salvador.
12. **Bayou Dorcheat,** *Webster* — From the Arkansas state line to its entrance into Lake Bistineau.
13. **Bayou Dupre,** *St. Bernard* — From the Lake Borgne Canal to Terre Beau Bayou.
14. **Bayou La Branche,** *St. Charles* — From its source to where it drains into Lake Pontchartrain.
15. **Bayou La Combe,** *St. Tammany* — From its headwaters to Lake Pontchartrain.
16. **Bayou St. John,** *Orleans* — From its point of origin to its entrance into Lake Pontchartrain.
17. **Bayou Trepagnier,** *St. Charles* — From Norco to where it joins Bayou La Branche.
18. **Big Creek ,** *Grant* — From Highway 167 in Grant Parish to its entrance into Little River.

OVERVIEW

19. **Black Lake Bayou,** *Red River, Winn, Bienville* — From the Webster-Bienville Parish line to Black Lake in Natchitoches Parish.
20. **Blind River,** *St. James, Ascension, Livingston, St. John* — From its origin in St. James Parish to its entrance into Lake Maurepas.
21. **Bogue Chitto River,** *Washington, St. Tammany* — From the Louisiana-Mississippi state line to its entrance into the Pearl River Navigation Canal.
22. **Bogue Falaya River,** *St. Tammany* — The river from its headwaters to Louisiana Highway 437 in St. Tammany Parish.
23. **Bradley Slough (Bayou),** *St. Tammany* — all of that portion of the slough lying within the boundaries of St. Tammany Parish.
24. **Calcasieu River,** *Vernon, Rapides* — From Louisiana Highway 8 east through Vernon Parish and all of that portion of said river lying within the boundaries of Rapides Parish. *Allen, Jefferson Davis, Calcasieu* — From the mouth of the Whiskey Chitto River in Allen Parish, south through Jefferson Davis Parish, and to its intersection with the Ward Eight Park in Calcasieu Parish.
25. **Cane Bayou,** *St. Tammany* — From its headwaters to Lake Pontchartrain.
26. **Comite River,** *East Feliciana, East Baton Rouge* — From the Wilson-Clinton Highway in East Feliciana Parish to the entrance of White Bayou in East Baton Rouge Parish.
27. **Corney Bayou,** *Claiborne, Union* — From the Louisiana-Arkansas state line to Corney Lake and Corney Lake Dam to Lake D'Arbonne.
28. **D'Arbonne Bayou,** *Union, Ouachita* — From the Lake D'Arbonne Dam to its entrance into the Ouachita River.
29. **Fish Creek,** *Grant* — From its origin near Williana to its entrance into Little River.
30. **Holmes Bayou,** *St. Tammany* — All of that portion of the bayou lying within the boundaries of of St. Tammany Parish.
31. **Kisatchie Bayou,** *Natchitoches* — From its entrance into Kisatchie National Forest to its entrance into Old River.
32. **Lake Borgne Canal (Violet Canal),** *St. Bernard* — From the Forty Arpent Canal to Bayou Dupre.
33. **Little River,** *Rapides, Grant, Catahoula, LaSalle* — From the juncture of Dugdemona and Castor Creek to its entrance into Catahoula Lake.
34. **Middle Fork of Bayou D'Arbonne,** *Claiborne, Union* — From its origin near Louisiana Highway 2 Alternate to Lake D'Arbonne.
35. **Morgan River,** *St. Tammany* — From its juncture with the Porters River to its re-entry into the West Pearl River.
36. **Ouachita River,** *Morehouse, Union* — From the north bank of Bayou Bartholomew at its intersection with the Ouachita River to the Arkansas state line.
37. **Pearl Creek,** *Vernon* — From Louisiana Highway 111 to its entrance into Sabine River.
38. **Pirogue Bayou,** *St. Bernard* — From Bayou Dupre to New Canal.
39. **Pushepatapa Creek,** *Washington* — From East Fork and West Fork join near state line to where it breaks up prior to its entrance into the Pearl River.
40. **Saline Bayou,** *Bienville, Winn, Natchitoches* — From its origin near Arcadia Louisiana to Highway 156 in Winn Parish.
41. **Saline Bayou,** *Catahoula, LaSalle* — From Saline Lake to Larto Lake.
42. **Six Mile Creek,** *Allen, Vernon* — Includes the East & West Forks and beginning at the boundary of Fort Polk Military Reservation (Lookout Road) and extending south through Vernon and Allen Parishes to its entrance into Whiskey Chitto Creek.
43. **Spring Creek,** *Rapides* — From Otis to Cocodrie Lake in Rapides Parish.
44. **Tangipahoa River,** *Tangipahoa* — From the Mississippi-Louisiana state line to the I-12 crossing.
45. **Tchefuncte River and its Tributaries,** *Washington, Tangipahoa, St. Tammany* — From origin in Tangipahoa Parish to its juncture with the Bogue Falaya River, and from the Bogue Falaya River to Louisiana Highway 22, excluding any tributaries thereto from the Bogue Falaya south to Louisiana Highway 22.
46. **Ten Mile Creek,** *Rapides, Allen, Vernon* — From the boundary of Fort Polk Military Reservation (Lookout Road) through Vernon Parish and all of that portion of said creek lying within the boundaries of Rapides and Allen Parishes.
47. **Terre Beau Bayou,** *St. Bernard* — From Bayou Dupre to the New Canal.
48. **Tickfaw River,** *St. Helena* — From the Louisiana-Mississippi state line to Louisiana Highway 42.
49. **Trout Creek,** *LaSalle* — From its origin near Highway 8 to its entrance into Little River.
50. **West Pearl River,** *St. Tammany* — From the confluence of Wilson and Bradley Sloughs to its entrance into Lake Borgne.
51. **Whiskey Chitto Creek,** *Vernon* — From the boundary of Fort Polk Military Reservation (Lookout Road) to the Vernon-Beauregard Parish line. *Allen* — From the Beauregard Parish line to its entrance into the Calcasieu River.
52. **Wilson Slough (Bayou),** *St. Tammany* — All of that portion of the slough lying within the boundaries of St. Tammany Parish.

NOTIFICATION OF COMMERCIAL HARVESTING

LOUISIANA OFFICE OF FORESTRY (LOF)
NOTIFICATION OF COMMERCIAL HARVESTING
ADJACENT TO NATURAL AND SCENIC RIVERS

A. Date LOF notified ____________________

B. Name of designated natural or scenic river ____________________

C. Landowner ____________________

D. Location:

Parish ____________ Section ____________

Township ____________ Range ____________

E. Estimated date operation will begin ____________________

F. Estimated date operation will end ____________________

G. Person notifying LOF: 1. Name ____________________

2. Phone No. ____________________

H. LOF person receiving notice ____________________

I. Inspecting forester ____________________

J. Date inspected ____________________

K. Retain this form in district office files and send copy to:

Scenic River Coordinator
Department of Wildlife & Fisheries
P. O. Box 98000
Baton Rouge, LA 70898-9000

Chief, Forest Management
LA Office of Forestry
P. O. Box 1628
Baton Rouge, LA 70821-1628

Glossary

TERMS OF FOREST MANAGEMENT

Access road — A temporary or permanent access route for vehicular traffic.

Barriers — An obstruction, intended to restrict pedestrian, horse, or vehicular traffic to a specific location.

Bedding — A site preparation technique, usually in wet areas, whereby a small ridge of soil is formed as an elevated planting or seedbed.

Best management practices (BMPS) — Forest management practices, developed to minimize or prevent non-point source water pollution.

BMPs, 15 Mandatory — See page 36.

Borrow pit — An area that has been excavated for earthen material.

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

Buffer strip — A relatively undisturbed section of forest adjacent to an area requiring special attention or protection such as a stream or lake.

Channel — A natural stream which conveys surface runoff water within well-defined banks.

Chemical site preparation — The use of herbicides to control plant competition to prepare an area for the establishment of a future forest either by artificial or natural means.

Chopping — The flattening of vegetation remaining after harvest in order to concentrate it near the ground.

Clearcutting — The total removal of a merchantable tree crop from an area.

Contour — An imaginary line on the surface of the earth connecting points of the same elevation.

Contour line — A line drawn on a map connecting points of the same elevation.

Corduroy — Placing small poles side by side, perpendicular to the roadway, usually over a mat of woody vegetation.

Culvert — Pipe made of metal, plastic, or other suitable material; installed under roads to transmit water from the roadway or side ditches, storm runoff, seeps and drains.

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

Disking — Tilling soil to enhance site preparation.

Diversion ditch — A drainage depression or ditch built across a slope to divert surface water from that slope.

Ephemeral stream — A water course generally without a well-defined channel that flows only in response to rainfall. These streams flow less than 20% of the year during normal rainfall conditions.

Erosion — The detachment and transportation of soil particles.

Filter strip — A vegetated area of land separating a water body from forest management activities.

Firebreak (fire lane) — Naturally occurring or man-made barriers to the spread of fire.

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

Ford — A natural or paved stream crossing suitable for shallow streams with stable bottoms.

Forest practices — An activity related to the growing, protecting, harvesting, and processing of forest tree species.

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.

Grade — The slope of a road, usually expressed as a percent.

Gully — An eroded channel at least 12 inches deep.

Harvesting — The removal of merchantable tree crops from an area.

Herbicide — Any chemical or mixture of chemicals intended to prevent the growth of or promote the removal of targeted trees, bushes, and/or herbaceous vegetation.

High-flotation equipment — Machinery that exerts low ground pressure.

Humus layer — The top layer of the soil formed by the decay of organic matter.

Intermittent stream — A watercourse that flows in a well-defined channel for 20–90% of the year during normal rainfall conditions.

Jurisdictional wetlands — Areas subject to the regulations of the Clean Water Act of 1987; generally, concave or low-lying topographic forms that collect, store, or flow water frequently enough to favor a majority of plants that are adapted to saturated soil conditions.

Lateral ditch — A water turnout to move water from the roadway or road side ditches. It is the same as a wing ditch or diversion ditch.

Log deck — A place where logs are assembled for temporary storage, loading and transportation.

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

Logging debris — The unutilized and generally unmarketable accumulation of woody material, such as limbs, tops, and stumps, that remains after timber removal.

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 — The layer of earth composed of sand, silt, and clay, in varying amounts, with less than 20% organic matter in the surface layer.

Mulching — Covering an area loosely with some material to hold soil in place and facilitate revegetation. Straw, bark, hay, or wood fibers are common mulches.

Natural channel — A water course created by the erosive forces of water moving over land.

Natural regeneration — The planned regeneration of a forest that either uses existing trees as a source of seed or encourages sprouting from stumps or roots.

Non-point source pollution — Pollution which is 1) induced by natural processes, including precipitation, seepage, percolation, and runoff; 2) not traceable to any discrete or identifiable facility; 3) controllable through the utilization of best management practices.

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

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 road — A road along a hill constructed so that the water will flow across the road toward its downhill side.

Perennial stream — A watercourse that flows continuously (at least 90% of the year) in a well-defined channel.

Pesticides — Any chemical substance that is used to control undesirable insects, diseases, vegetation, animals, or other forms of life.

Point source pollution — Sources of water pollution which can be traced to a specific place or location.

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 — The controlled application of fire to wild land 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.).

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

Parallel ditch — A drainage ditch alongside and parallel to a road.

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.

Riparian — The land adjacent to and pertaining to the banks of streams, rivers, or other water bodies.

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

Rutting — Tracks in the soil resulting from the passage of heavy vehicles.

Rolling dip — Cross between a water bar and a broad-based dip; it has a reverse grade, but is shorter than a broad-based dip.

Salvage cut — 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.

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

Secondary road — A road constructed for a particular use or single operation and normally abandoned upon completion of the operation.

Sediment — Soil material suspended in air or water which is being transported or moved from its original site; the material which is deposited.

Seedbed — The soil prepared by natural or artificial means to promote the germination of seed and the growth of seedlings. (also see log deck)

Set — A place where logs are assembled for temporary storage, loading, and subsequent transportation.

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 from the soil surface by water runoff.

Side ditch — A drainage ditch alongside and parallel to a road.

Silvicultural activities — All forest management activities, including intermediate cutting, harvest, log transportation, and forest road construction (**EPA interpretation**).

Silviculture — Generally, the science and art of cultivating (growing and managing) 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. (**Society of American Foresters**)

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

Skid trail — A route over which logs are moved from the location where the trees were felled to a landing or road.

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

Slope — Steepness of the land expressed as the amount (in percent) of vertical fall per 100 ft. of horizontal distance.

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.

Stream — A well-defined natural channel that has a flow anywhere below its headwaters greater than 5 cubic feet per second at least 50% of the time (**EPA—US Army Corps of Engineers**). A permanently or intermittently flowing body of water that follows a defined course.

Ephemeral stream flows during precipitation events and for a short period thereafter along a course that may or may not have a well-defined channel.

Intermittent stream flows only during wet periods (20–90% of the year), in a continuous, well-defined channel.

Perennial stream flows most of the time (more than 90% of the year) and flows in a well-defined channel.

Streambanks — The boundaries of a stream which contain normal flows.

Streamside management zone (SMZ) — Also known as riparian zones, these are sensitive areas adjacent to lakes, streams, and water courses where extra precautions in carrying out forest practices are necessary to protect water quality.

Temporary road — A minimal road of short-term use, which links timberland parcels to a permanent road.

Turnout — Drainage ditch which drains water away from roads. (see wing ditch)

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

Water body — An area of standing water with relatively little or slow movement (pond, lake, bay, slough).

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.

Watershed area — All land and water within the confines of a drainage divide.

Wetlands — Geographic area characteristically supporting hydrophytes, hydric soils, and some saturation or flooding during the growing season.

Windrow — Slash, residue, and debris pushed and / or raked into 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. It is the same as a lateral or diversion ditch.

Appendix I: Road Specifications

RECOMMENDATIONS FOR FOREST ROADS

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

- 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. By breaking or changing grade frequently fewer erosion problems will result than by using long, straight, continuous grades.

- 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.

- 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, page 66; and size chart, page 62).

- Install water turnouts prior to a stream crossing to direct road runoff water into undisturbed areas of the streamside management zone (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 or identifiable stream. Distance is measured from the bank to the edge of soil disturbance, or in case of fills, from the bottom of the fill slope.

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

- 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 beginning of the incline.

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

- At culverts and dips, install rip-rap or other devices at the outlets to absorb and spread water, if needed.

- Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.

- Control the flow of water on road surfaces by keeping drainage systems open and intact during logging operations.

- Inspect roads at regular intervals to detect and correct potential maintenance problems.

Appendix I: Road Specifications

WING DITCHES

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

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

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

Recommended Wing Ditch Spacing

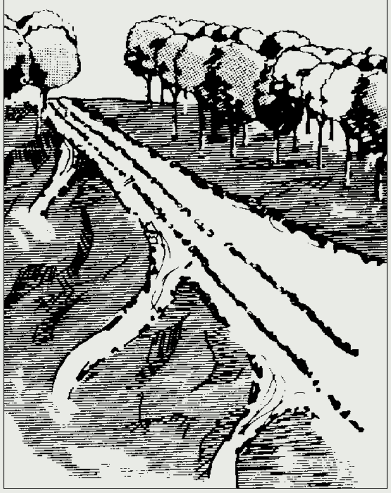
Slope Range		Maximum Distance Between Wing Ditches/ Turnouts (Feet)
Flat	2%	250
	3%	220
	4%	190
	5%	160
Moderate	6%	144
	7%	128
	8%	112
	9%	96
Steep	10%	80
	11%	60

RECOMMENDED SPECIFICATIONS

- The wing ditch should intersect the roadside ditch line at the same depth and be outsloped to a maximum grade of 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 downsloped less than 2% of the natural contour.
- Wing ditches may often be needed to provide stable outlets for other water control devices such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect. The spacing of wing ditches will be determined by the topography and relief of the area. Soil texture should also be considered for wing ditch spacing. On highly erodible or sandy soils wing ditches / turnouts should be spaced closer together than on clay soils.
- Wing ditches should not feed directly into adjacent drainages, gullies or channels.
- Wing ditches should be installed or cut solidly into the soil and wide enough to allow maintenance with logging equipment, such as skidders.

Basic Specifications for Water Turnout Installation

Typical Wing Ditch Bar



Water Dispersal Area
Turns Downslope

Purposes—To safely divert water from a side ditch and disperse it onto a stable outlet.

Construction guidelines—Constructing wing ditches or water turnouts with as flat a bottom as possible:

- Begin the ditch with its bottom at the same depth as the road ditch
- Angle the turnout away from the road to direct all the water from the road ditch
- The curve the wind ditch across the hill to flatten out the grade in the ditch — however, be careful not to turn it back uphill
- Blend or feather the end onto a stable outlet to spread the water as much as possible
- avoid building turnouts that release water directly into streams

Distance guidelines—Water turnouts or wing ditches may often be needed to provide stable outlets for other water control devices such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect.

WING DITCHES

Appendix I: Road Specifications

STREAM CROSSINGS

Definition: Culverts, bridges, or rock fords that allow 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 with minimal increase in stream sedimentation.

Conditions where practice applies: Used for ongoing operations where streams or drainages must be crossed by logging, site preparation, road maintenance, and fire suppression equipment.

RECOMMENDED SPECIFICATIONS

General

- Aggregate or other suitable material should be laid on approaches to fords, bridges, and culvert crossings to ensure a stable roadbed approach and minimize sediment in the stream.
- When necessary, stabilize road surfaces and cut and fill slopes using effective erosion control and water control methods (seeding, commercial erosion control material, rip-rap, etc.)
- 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.
- Remove culverts and bridges from temporary stream crossings upon completion of operations and return the crossing as closely as possible to its original condition.

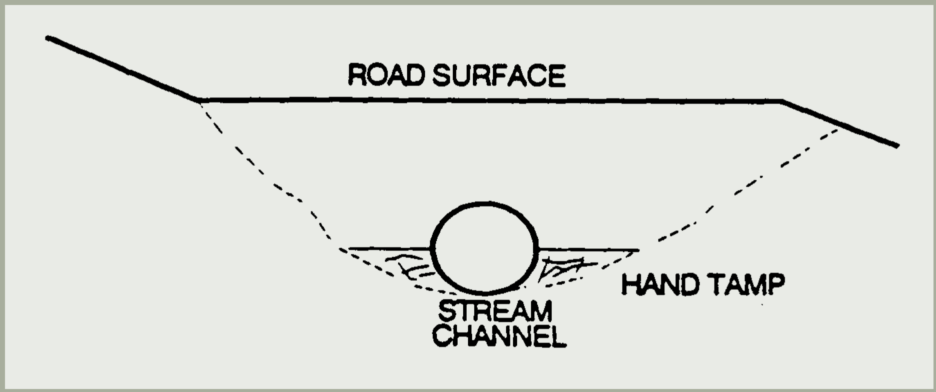
Bridges

- Bridges should be constructed with minimum disturbance to the stream bank, channel and adjacent SMZ.
- When it is necessary to protect approaches and roadbed fills near bridges, adequate erosion protection should be provided by head walls, wing walls, rip rap, etc.
- 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.

Fords

- Rock fords may be used if no practical alternative exists. Approaches, stream banks, and stream bottoms must be hard enough or sufficiently stabilized to minimize stream bottom and bank disturbance.

Basic Specifications for Culvert Design and Installation



Definitions

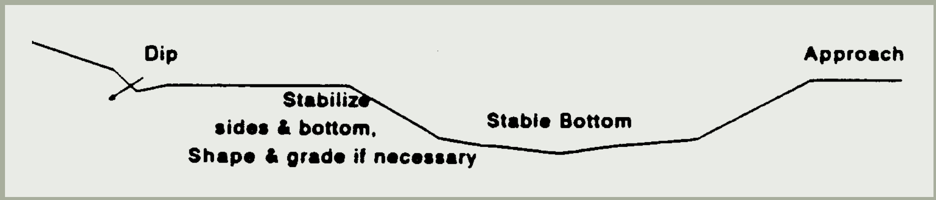
Peak runoff is the accumulated amount, in cubic feet per second, of a storm's runoff from an entire drainage area. Factors that affect runoff include vegetative cover, slopes and soils. The design guidelines included in this section are calculated on a 5-inch, 24-hour storm occurrence.

Head is the vertical column of water that is temporarily stacked over the culvert's entrance. Head provides the energy needed to force water through the culvert. The greater the head, the more water that can be forced through the pipe.

Construction guidelines

- Culverts should be placed in straight sections of stream channels
- The stream should have as straight an entrance and outlet as possible
- The inlet should be placed on the stream bed, not above it
- The approach to the stream crossing should be at right angles to the stream
- Seat the culvert on firm ground, not fill, and compact the earth at least halfway up the side of the culvert
- 18" of compacted fill over culverts is recommended

Basic Specifications for Installation of Fords



If fords (low-water crossings) are used

- Look for stream crossings that have low banks and solid stream beds
- Look for stream sections that can accommodate approaches of about 50 feet on both sides, and that are reasonably level
- Stabilize immediately, and if necessary use heavy applications of gravel
- Make crossings at right angles to the stream and only in straight sections, never in bends
- Install wing ditches, waterbars or dips before the crossing; this will drain water off the side of the road rather than into the stream
- Use other stream crossing methods such as culverts or bridges if water quality is important for domestic use, livestock water, fishponds, etc.
- Never use during high water periods

Appendix I: Road Specifications

CULVERTS FOR ROADS

Definition: Pipe made of metal, plastic, 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 installation should be periodically inspected for obstructions.

RECOMMENDED SPECIFICATIONS

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

- The culvert should be placed 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.

- The culvert should be angled 30 to 45 degrees to the direction of water flow.

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

- Culverts should be firmly seated and earth compacted at least halfway up the side of the pipe. Cover, equal to a minimum of half the culvert diameter (preferably 1 foot 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 application should be a minimum of half the pipe diameter.

Culvert Size Chart									
Acres Drained	Light Soils (SANDS)			Medium Soils (LOAMS)			Heavy Soils (CLAYS)		
	Flat (%) 0–5	Mod (%) 5–15	Steep (%) 15+	Flat (%) 0–5	Mod (%) 5–15	Steep (%) 15+	Flat (%) 0–5	Mod (%) 5–15	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						

Appendix I: Road Specifications

BROAD-BASED DIPS

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

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

Conditions where practice applies: Used on truck haul roads and heavily used skid trails having a gradient of 8% or less. Should not be used for stream crossings.

Recommended Broad-based Dip Spacing

Slope (%)		Distance Between Broad-based Dips (Feet)
Flat	2%	300
	3%	233
	4%	200
	5%	180
Moderate	6%	166
	7%	157
	8%	150

RECOMMENDED SPECIFICATIONS

- Installation should take place following basic clearing and grading for roadbed construction.
- A 20-foot long, 3% reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location.
- The cross drain outslope will be 2% to 3% maximum.
- An energy absorber such as rip rap and, in some cases, a level area where the water can spread, should be installed at the outfall of the dip to reduce water velocity thus minimizing erosion.
- On some soils the dip and reverse grade section may require bedding with three inches of crushed stone to avoid rutting the road surface.
- Broad-based dips are very effective in gathering surface water and directing it safely off the road. Dips should be placed across the road in the direction of water flow.
- Approximate recommended spacing table for broad-based dips.

Appendix I: Road Specifications

ROLLING DIPS

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

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

Recommended Rolling Dip Spacing

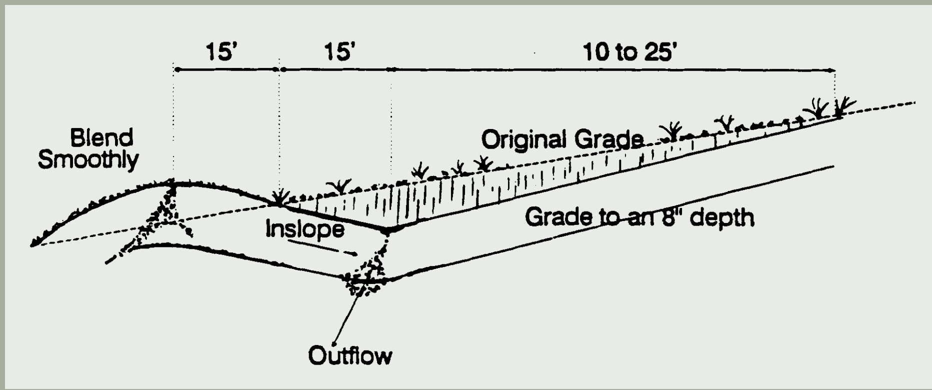
Slope (%)		Distance Between Broad-based Dips (Feet)
Flat	2%	300
	3%	233
	4%	200
	5%	180
Moderate	6%	167
	8%	150
Steep	9%	144
	11%	136
	13%	131
	15%	127

Conditions where practice applies: Used on truck haul roads and heavily used skid trails having a gradient of 15% or less. Should not be used for crossing streams, springs, and seeps.

RECOMMENDED SPECIFICATIONS

- Installation following basic clearing and grading for roadbed construction or on skid trails after logging is completed.
- 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.
- 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.
- Spacing rolling dips can be determined from the adjacent table.

Basic Specifications for Rolling Dip Installation



Definition — Rolling dips are a cross between water bars and broad-based dips. Like broad-based dips, they have a grade (a shorter one) and they direct water from the roadway. Like water bars, they may also rely on a mound of soil at the down-hill side.

Purposes

- To gather water and direct it safely off the roadway
- To provide cross-drainage of inside ditches

Where suitable

- Not for handling live (constantly running) water
- On roads that will be used
- Can be employed on steeper grades than broad-based dips

Construction guidelines

- Place across the road in the direction of flow
- Outslope the dip only, not the road
- Mound excavated material from the dip on the down-hill side
- Blend the mound to as gentle a slope as possible, to make traveling over it easier

ROLLING DIPS

Appendix I: Road Specifications

WATERBARS

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

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

Conditions where practice applies: This is a practice that can be utilized on limited use roads, trails and firebreaks and abandoned or retired roads and trails where surface water runoff may cause erosion of exposed soil.

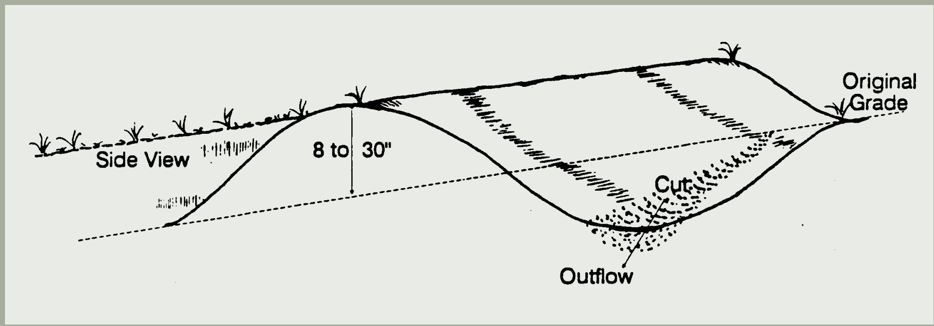
Recommended Waterbar Spacing

Grade of Road		Distance Between Waterbars (Feet)
Flat	2%	250
	3%	220
	4%	190
	5%	160
Moderate	6%	144
	7%	128
	8%	112
	9%	96
Steep	10%	80
	11%	60

RECOMMENDED SPECIFICATIONS

- Waterbars should be placed at an angle of 30 to 45 degrees to the road, firebreak or trail. Waterbars are not dams. Waterbars intercept and / or divert surface water runoff.
- Recommended proper spacing between waterbars can be determined from the table, below left.
- 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 should fall no more than 2%.
- Specifications for waterbar construction on forest roads, trails and firebreaks must be site specific and should be adapted to existing soil and slope conditions.

Basic Specifications for Waterbar Installation



Purposes

- To gather and shed surface water off a road, trail, firebreak, etc.
- To divert water from an inside ditch
- To prevent excessive erosion until revegetation can be established

Where suitable

- Roads and trails that will have no or very limited traffic
- Abandoned or retired roads and trails
- Firebreaks

Construction guidelines

- Angle across the road in the down-grade direction
- Tie the upper end into the inside ditch's bank, when present
- Empty onto stable outlets
- Can be constructed mechanically or by hand

Note: *See the waterbar spacing guidelines displayed in the small table on the opposite page. In addition to distance between waterbars, consider taking advantage of factors such as slope changes, curves and presence of stable outlets.*

WATERBARS

Smurfit-Stone Container Corp. photo

Tree farmers practice sustainable forestry. That means they share a unique commitment to produce wood for America's needs while protecting our soil, water, and wildlife resources and providing recreation from our woodlands.

Appendix II: Planning Tools

EVALUATING SLOPE

Definition: Slope is the steepness of the land expressed as the amount (in percent) of vertical fall per 100 feet of horizontal distance. For example, a 3% slope means a three foot change in elevation per 100 feet of horizontal distance.

Importance of slope: Slope along with soil texture (sand, loam, clay) and ground cover determines how fast water will drain from an area. Water drains quickly from steep slopes, however erosion may be a problem. Flat surfaces may result in saturated soils. Slope can be managed during road design and layout.

Estimating slope: Slope can be divided into three broad categories: *flat*, *moderate*, and *steep*. Standing downhill, and facing uphill, try to look level back into the hill. To help keep your line of sight level, face uphill with your arm stretched out in front of you with a pencil (or a rolled up dollar bill) pointing up out of your fist. Looking over the tip of the pencil will keep your sight level. Estimate the horizontal, level distance between you and where your line of sight hits the ground. Divide the height distance by horizontal distance to determine the percent of slope. Instruments can be obtained to increase accuracy: an Abney level for $100+, a clinometer for $100, or a slope gauge for $40.

Other sources of slope information:

- USGS topographic maps
- Soil surveys
- Soils maps

Appendix II: Planning Tools

EVALUATION OF AERIAL PHOTOS

Definition: Aerial photographs or "maps" are high altitude photos taken in a very concise and systematic manner. Although maps can be made in color and even infrared, the most commonly used aerial photos are black and white. The top of the map is usually north.

Information provided:

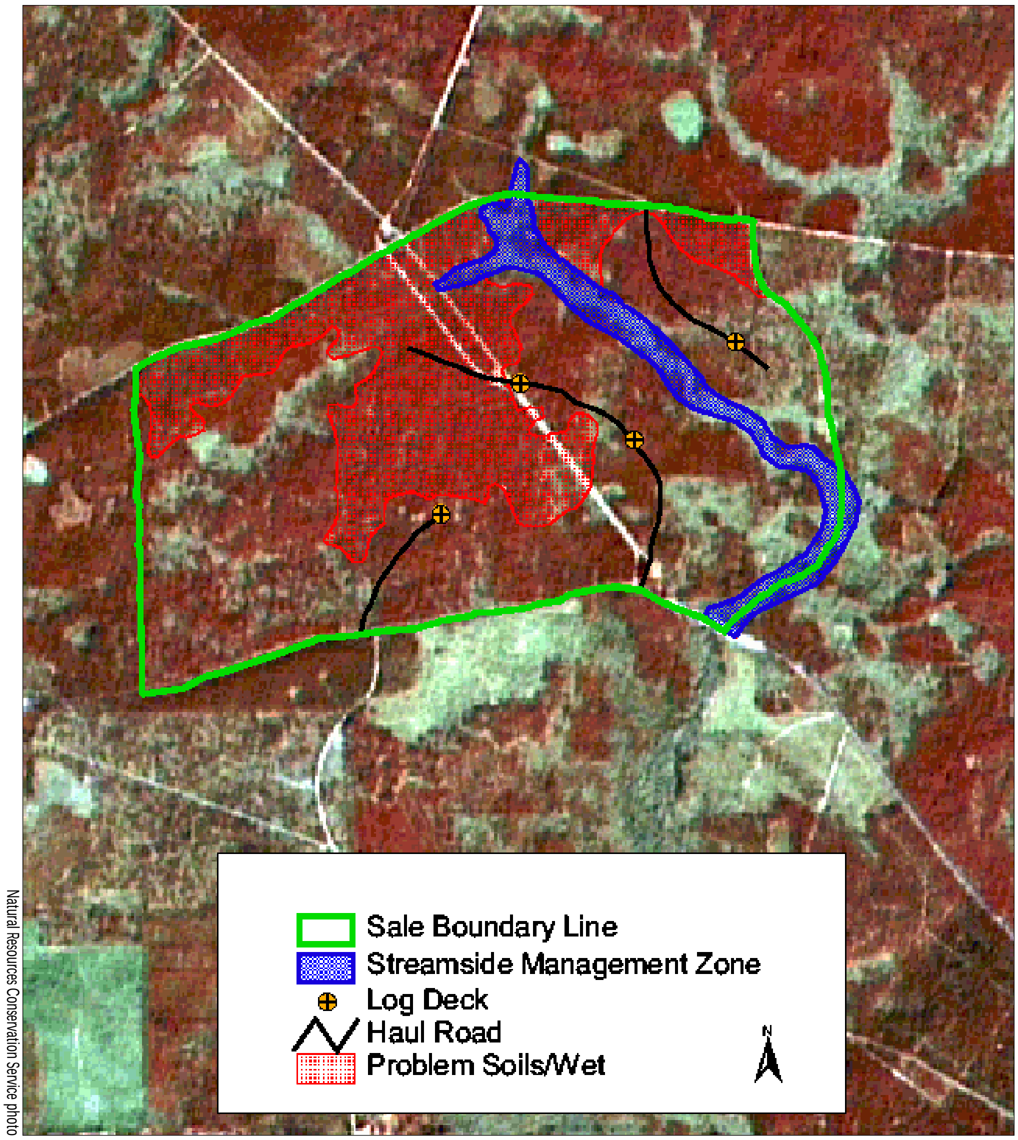
- Boundaries and timber types (for example, on aerial photos, pines appear darker than hardwoods)
- Drainage patterns
- Roads, buildings, etc.

Scale: Aerial photos come in many scales such as 1" = 660', 1320', etc. It is important to know the photo scale before using.

Sources for aerial photo information:

- Natural Resources Conservation Service
- Farm Services Agency
- Louisiana Department of Agriculture and Forestry
- Private vendors

Forest Hill, Louisiana



Natural Resources Conservation Service photo

1:24,000

Aerial photographs are valuable planning tools.

Appendix II: Planning Tools

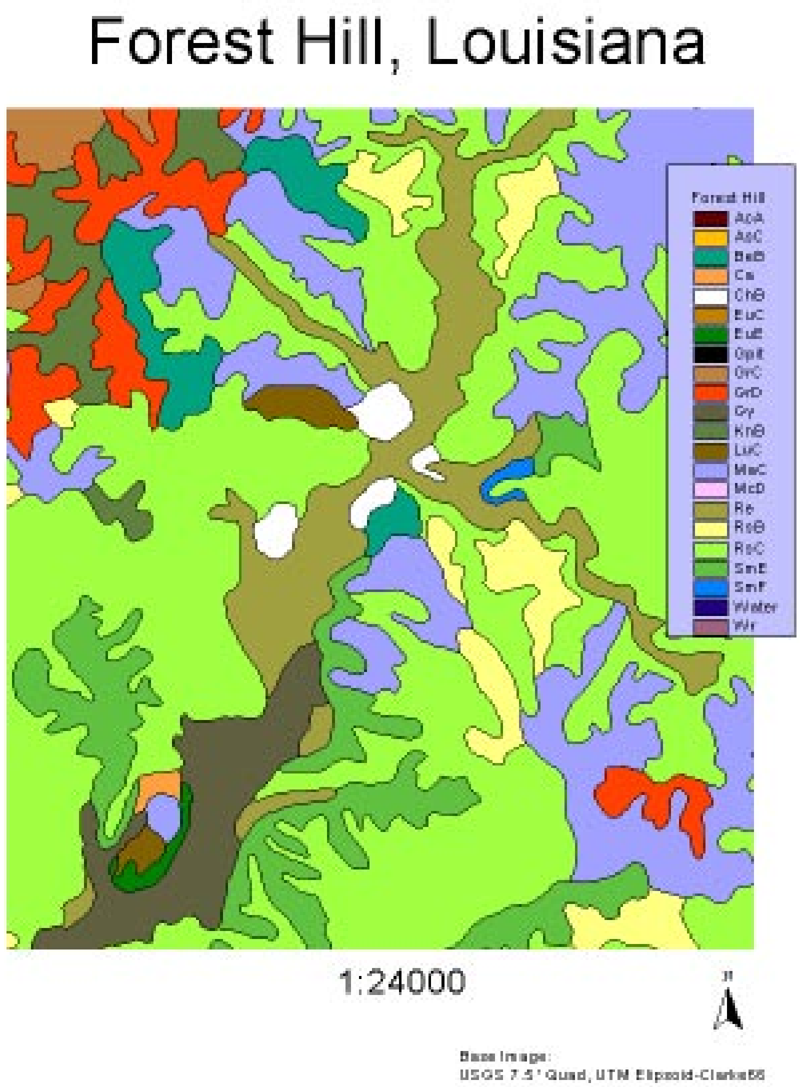
EVALUATION OF SOIL MAPS

Definition: Soils maps are aerial photographs on which the types are delineated. Soils are classified, mapped, and published by the Natural Resources Conservation Service into a book called a Soil Survey. A Soil Survey can be obtained at your local NRCS office.

Use for soil maps:

- Plan routes
- Avoid problem areas such as wet areas
- Plan where and how to cross streams
- Estimate slopes that may be encountered
- Determine drainage patterns

Soil surveys and soils maps are important planning tools, but an on-site check of the exact soil type and slope is essential.



Natural Resources Conservation Service map

Soil maps are available in each Louisiana parish. They are available to the public at the local (USDA) Natural Resources Conservation office.

Appendix II: Planning Tools

EVALUATION OF TOPOGRAPHIC MAPS

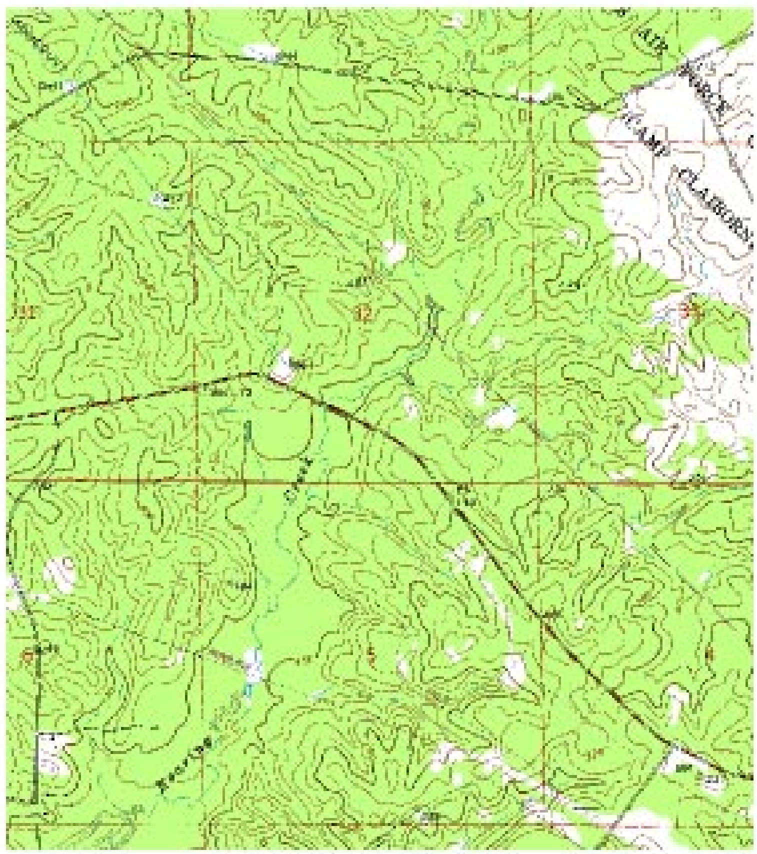
Definition: Topographic maps or “quad sheets” are printed maps that portray the relief of the landscape. In addition, they also display physical features such as roads, buildings, rivers, and creeks.

Scale: The most common used topographic map is the 7.5 minute map which has a scale of 1:24,000 or 1 inch = 2,000 feet. In any case, scale is displayed at the bottom of the map.

Relief: Changes in elevation are shown by a series of contour interval lines. These lines represent a point’s elevation above sea level. Any point along a line is the same elevation as any other point on the same line. The closer the contour lines are to each other, the steeper the slope. The elevation distance between the lines is usually 5 or 10 feet. This information is given at the bottom center of the map. The elevation is frequently printed along several of the contour lines.

Determining slope: Determine the elevation change between two points from the contour lines, being sure to use the proper contour interval. Divide this change by the distance between the two points, using the scale at the bottom of the map. Multiply by 100 to get the percent slope.

Forest Hill, Louisiana



1:24000

Contour Interval 10 Feet

Base Image:
USGS 7.5' Quad, UTM Elipsoid-Clarke66

Natural Resources Conservation Service map

Topographic maps are available from most forestry and engineering suppliers.

Appendix II: Planning Tools

EVALUATION OF DRAINAGE AREA

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

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

- On hilltops, contour lines will form a small, roughly circular shape.
- On contour lines with fingerlike projections, the fingers point uphill.

The watershed can be defined by drawing arrows in the direction of drainage to the common point.

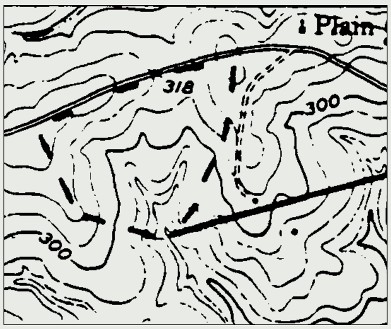
Determining areas: After the watershed is drawn, the number of acres in the area can be estimated. For a topographic map with a scale of 1:24,000 (a 7.5 minute map) the table below can be used as a quick guide.

Guide for Area Estimation on 7.5-Minute Topographic Maps

Facsimile / Shape	Acres
Head of pencil eraser	5
Dime	40
Nickel	50
Quarter	70
1” X 1” square	90

Estimating Storm Runoff for Culvert Sizing

Sample Topographic Map

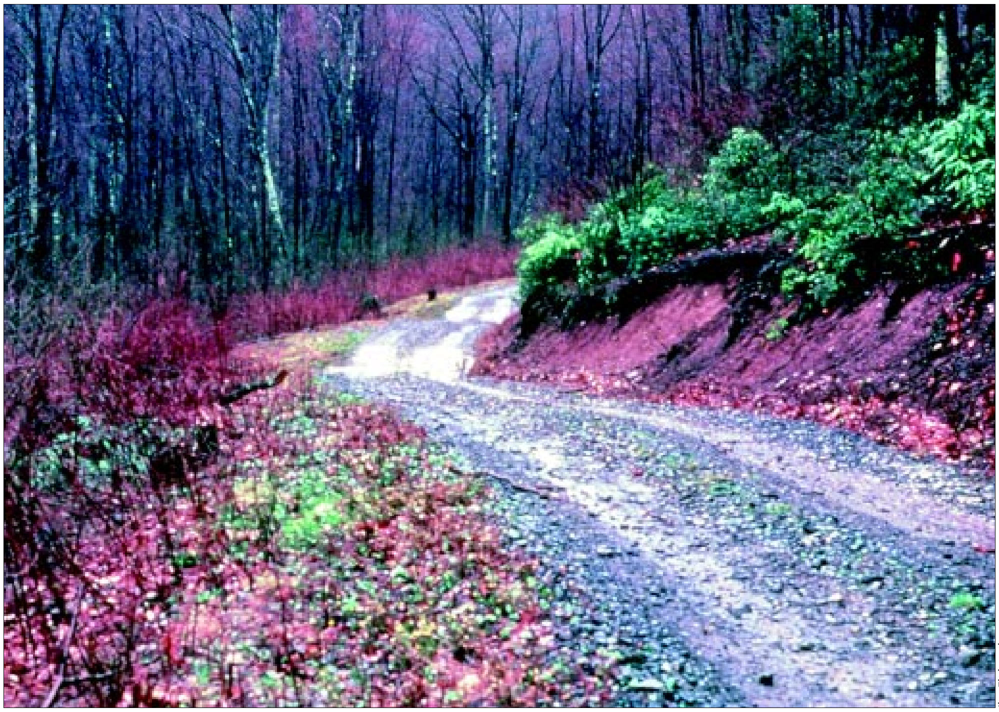


Estimation guidelines

- Using appropriate maps (like topo map, left), estimate the drainage area for the stream crossing site.
- Using either a soils map or testing the texture by feel, determine if the drainage is predominantly sandy, loamy or clayey.
- Determine the average slope class (flat, moderate or steep) of the drainage area. Although most drainage areas will be either flat or moderate, do not consider the crossing site only, but the whole drainage area.
- Using the table below, determine the runoff for a 5-inch, 24-hour storm for the appropriate drainage area, soil type and slope class.

Peak Runoff from A 5-Inch Storm, in Cubic Feet per Second

Acres	Flat Slopes			Moderate Slopes			Steep Slopes		
	Sand	Loam	Clay	Sand	Loam	Clay	Sand	Loam	Clay
5	4	9	15	6	12	19	8	14	20
10	7	14	24	11	21	35	15	27	40
15	9	19	32	14	29	47	21	39	57
20	11	23	40	17	35	60	26	50	75
25	12	26	47	20	42	70	30	60	92
30	14	30	52	23	47	80	35	70	110
35	15	32	60	25	52	90	40	77	125
40	17	35	65	27	57	100	43	85	140
45	18	37	70	30	62	120	47	95	150
50	19	40	75	32	67	140	50	100	165
75	25	52	100	42	87	160	67	130	230
100	30	65	120	50	110	190	80	170	290



Jim Finley photo

An example of rolling dips on a permanent road.

Appendix III: Road Surface Area

DETERMINING ROAD SURFACE AREA

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

- Determine the road acreage for each segment of the road system from the Road Surface Area table given below.
- Combine the acreage of each road segment to determine the total acreage of the entire road system.
- Multiply the total acreage of the road system by the recommended application/acre of the appropriate revegetating material (e.g., fertilizer, seed mix, mulch, etc.) to determine the total amount of materials needed.

Guide for Determining Road Surface Area

Road Length (FEET)	Road Width (FEET)						
	8	10	12	14	16	18	20
	ACRES						
50	0.010	0.010	0.010	0.020	0.020	0.020	0.020
100	0.022	0.020	0.030	0.030	0.040	0.040	0.050
250	0.050	0.060	0.070	0.080	0.090	0.100	0.110
500	0.090	0.120	0.140	0.160	0.180	0.210	0.230
750	0.144	0.170	0.210	0.240	0.270	0.310	0.340
1,000	0.180	0.240	0.280	0.320	0.370	0.410	0.460
1,500	0.280	0.340	0.410	0.480	0.550	0.620	0.690
2,000	0.360	0.480	0.560	0.640	0.730	0.830	0.920
5,000	0.920	1.150	1.380	1.610	1.800	2.070	2.300
5,280	0.970	1.210	1.450	1.700	1.940	2.180	2.430

Wider road widths can be calculated by using multiples from the above table

Appendix III: Road Surface Area

DETERMINING ROAD SURFACE MATERIAL

The following is intended as an aid to determining the surface area of other disturbed forest sites.

- Determine the acreage of each disturbed forest site using the following formula:

average length X average width = total square feet

total square feet / 43,560 = acreage

- Combine the acreage of each site to determine the total acreage of all disturbed sites.
- Multiply the total acreage of the disturbed sites by the recommended application / acre of the appropriate revegetating material, such as fertilizer, seed mix, and mulch, to determine the total amount of materials needed.

Surface Material Determination for Roads

CUBIC YARDS OF SURFACING MATERIAL PER 100 FEET OF ROAD LENGTH

Road Width, *feet*	Surfacing Material Thickness, *inches*		
	2	**4**	**6**
8	5	10	15
10	6	12	19
12	7	15	22
14	9	17	26
16	10	20	30
18	11	22	33
20	12	25	37
22	14	27	41
24	15	30	44

Appendix IV: Revegetation

REVEGETATING DISTURBED AREAS

Definition: The establishment of 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.

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 & Seedbed Preparations

- All disturbed areas with a grade of 5 percent 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 a high erosion potential (such as sets, skid trails, and haul roads) should be identified as soon as the operation is completed. See the tables on the following pages.

- 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

- 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 (0.5–1 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.

- 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.

- Adapted plants — See the table, on the following pages, *Seed for Revegetation in Louisiana*, for a list of plants and their adaptation by soil types.

- Planting rates and dates — See the table on the following pages, *Revegetation – Planting Information*.

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

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

Seed for Revegetation in Louisiana

Revegetation 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[1]	X	X
	Elbon rye	X	X	X
	Wheat	X[1]	X	X
Perennial				
Grasses	Bahia[2]		X	X
	Bermuda			
	Alecia	X	X	X
	Coastal	X	X	X
	Selection 3	X	X	X
	Sheffield	X	X	X
	Common[2]		X	X
	NK-37		X	X
	Tall fescue[2]		X	X
	Lovegrass[2]			
	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

[1] Not adapted to very deep sands. [2] Most shade tolerant. [3] Used as a temporary cover, in mixes, or for wildlife.

Revegetation — Planting Information

Revegetation Type and Season	Species Name	Season of Growth	Planting Dates	Planting Rate / Acre
Annual				
Grass / crops	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.
Perennial				
Grasses	Bahia[2]	warm	year-round[2]	30 lbs.[1]
	Bermuda			
	Alecia	warm	1/15–6/1	48 bu.
	Coastal	warm	1/15–6/1	48 bu.
	Selection 3	warm	1/15–6/1	48 bu.
	Sheffield	warm	1/15–6/1	48 bu.
	Common[2]	warm	3/15–5/15	4 lbs.[1]
	NK-37	warm	3/15–5/15	4 lbs.[1]
	Tall fescue[2]	cool	9/15–11/15	20 lbs.[1]
	Lovegrass[2]			
	Weeping	warm	3/15–5/1	4 lbs.[1]
	Wilman	warm	3/15–5/1	4 lbs.[1]
	Alamo switchgrass	warm	3/15–5/1	7 lbs.[1]
Legumes[3]	Singletary peas	cool	9/15–11/30	70 lbs.[1]
	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.

[1] Pure live seed (% germination x % purity = pure live seed. [2] Bahia can be planted year-round if planted with an approriate cover.
[3] Innoculate legumes before planting. Note: Sowing rates are double normal rates to ensure maximum cover.

Mississippi's

BMPs

Best Management Practices for Forestry in Mississippi

The *Best Management Practices Handbook* was developed by individuals representing a cross section of the forestry community, working through the Environmental Affairs and Wildlife Committee of the Mississippi Forestry Association.

MISSISSIPPI
FORESTRY COMMISSION

Mississippi's Best Management Practices

Third Edition
(Internet Version)
March 2000

MFC Publication # 107

FOREWORD

The Water Quality Act of 1987 established as a national policy "that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of the Act to be met through the control of both point and nonpoint sources of pollution." Section 319 of the Water Quality Act focuses on nonpoint sources of water pollution.

Nonpoint source pollution is any pollution in which the specific point of generation and exact point of entry into a watercourse cannot be defined. Origins of nonpoint source pollution include percolation, seepage and surface runoff from agricultural and silvicultural lands, and from construction, mining, and urban areas.

This handbook presents recommended standards, methods and specifications for the forest resource manager and forest landowner to follow in order to carry out silvicultural and forestry-related activities in compliance with Section 319 of the Water Quality Act. The term "best management practice" refers to a practice, or combination of practices, that is determined to be the most effective, practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.

The best management practices discussed in this handbook address these categories:

Streamside Management Zones

Woodland Trails and Roads

Forest Harvesting

Site Preparation

Tree Planting

Revegetation of Disturbed Forest Sites

(Note: Words shown in *italics* are defined in the glossary.)

CONTENTS

INTRODUCTION

Return to Contents

Mississippi has 18.6 million acres of forestland. It is estimated that some type of forest activity occurs on nearly 750,000 acres annually in the state. This represents approximately four percent of the state's forestland. Most streams originate or course through these forests and are sources for water supplies, prime recreation, and other water uses. Because of the importance of water resources, *silvicultural* practices should incorporate adequate measures to protect water quality from deteriorating. Anyone causing the pollution of or degradation to the state's waters is in violation of state law (Statute 49-17-29, Miss. Code, 1972). The most practical approach for reducing the *nonpoint source pollution* from forestland activities is the use of best management practices, commonly referred to as BMPs.

Best management practices are non-regulated guidelines for silvicultural practices which, when properly applied, will control water pollution from nonpoint source pollutants and maintain *site productivity*. The BMPs presented in this handbook are best suited for Mississippi's climate, soils, and topography.

While most best management practices have a direct cost involved with implementation, many also have indirect economic returns beyond the water quality improvement goals for which they are primarily developed. Management decisions which include the use of BMPs often promote long-term benefits to the logger and landowner. For example, proper road and trail construction and drainage, in addition to fostering stream pollution abatement, extends the logging season by allowing an earlier passage of vehicles following periods of wet weather, thereby providing an economic benefit. In addition, vehicle maintenance costs associated with cleaning equipment are reduced as a direct result of properly locating roads and trails and providing adequate drainage. Many BMPs have similar tangible benefits which may not be readily seen.

From a forest production standpoint, the loss of one inch of topsoil due to faulty *site preparation* techniques has been estimated to reduce the site index by 5 to 10 feet, resulting in a decrease of volume production.

It is recommended that forest resource managers and others responsible for applying forestry practices use the "non-regulatory" best management practices discussed in this handbook. It will be necessary to monitor how well best management practices are being followed and the effectiveness of these practices in maintaining water quality. Presently, the Mississippi Forestry Commission monitors the compliance and use of best management practices and reports its findings to the Department of Environmental Quality.

Principles of Nonpoint Source Pollution Control Methods

Return to Contents

Nonpoint source pollution is defined in Section 319 of the Water Quality Act of 1987 as "pollution caused by diffuse sources that are not regulated as point sources and normally associated with agricultural, *silvicultural* [emphasis added] and urban runoff, runoff from construction activities, etc. Such pollution results in human-made or human-induced alteration of the chemical, physical, biological and radiological integrity of the water."

The control of pollutants resulting from all forestry activities can be accomplished through adherence to six basic principles:

1. Do not allow surface water runoff from any type of soil disturbance to run directly into a watercourse.

2. Maintain the integrity of all streambeds and banks. When it is necessary to alter a stream's course for any reason, return the streambed and banks, as near as possible, to their original condition.

3. Do not leave debris of any type (logging or inorganic) in streambeds.

4. Do not spray chemicals directly into water or allow chemicals, *herbicides*, fertilizers or petroleum products to degrade surface or groundwater.

5. Leave *streamside management zones* along watercourses both to filter *sediment* from overland flow and to maintain the inherent, normal temperature of water in all streams and other bodies of water.

6. Provide for rapid revegetation of all denuded areas through natural processes supplemented by artificial revegetation where necessary.

It is the responsibility of the landowner and/or timber owner to ensure that pollution of state waters does not occur from forestry operations. The professional resource manager and the equipment operator working for a landowner also have an ethical responsibility to ensure that practices preformed do not cause pollution under the Water Quality Act and state law. It is in the best interest of all parties involved with managing the forest resource to ensure compliance with water quality standards so as to maintain site quality and prohibit mandatory *silvicultural* practices.

WATER QUALITY/FOREST MANAGEMENT PLANS

Good preharvest planning is recommended for water quality control. Soil *erosion* and *sedimentation* are forms of *nonpoint source pollution* that can be minimized by careful planning of road locations, logging and *harvesting* practices, *regeneration* operations, and timber stand improvement activities. A forest management plan, complete with water quality objectives, provides the foresight needed to apply environmentally responsible forestry practices. State and federal agencies, consultants and private organizations offer assistance in developing forest management plans which meet the objective of protecting water quality.

To best implement best management practice guidelines prior to harvest, *site preparation*, and other forestry activities, it is suggested that a forest management plan include the following information:

1. Name: Provide the name and address of the owner and, if applicable, the natural resource manager.

2. Location: Identify the property by legal description, city, town, highway numbers, name of *watershed*, receiving streams and major river basins. This information can be obtained from highway maps, topographic maps and aerial photographs.

3. Type of ownership: Describe the type of ownership (e.g., private, corporate; private, non-corporate; private, group, club or institution; or public).

4. Prepared by: The name and address of the person who prepared the plan.

5. Map: Include the total land area in the tract (e.g., open, cropland, woodland) and receiving waters.

6. Description of property: The total acreage of open land, cropland, and woodland and a general description of land use should be given. This information may be obtained from farm plans, property deeds and aerial photographs.
   Detailed woodlands information should include:
   - General soil type and erodibility (obtain from local Natural Resources Conservation Service).
   - Range of percent slope (obtain from local Natural Resources Conservation Service).
   - Timber quality and age class (provided by a *registered forester* by on-site inspection).
   - Landowner's objectives (provided by the landowner).
   - Forestry practice recommendations (provided by a *registered forester*).

7. Existing pollution problems: Conduct an on-site inspection of all streams and other bodies of water to determine if any pollution problems exist, noting such evidence as excessive *sedimentation*, algae growth and fish kills.

8. Best management practices: Describe practices recommended for the tract. Include schedule of implementing recommended practices. Recommendations should be based on practices discussed in this handbook.

STREAMSIDE MANAGEMENT ZONES

Return to Contents

Harvesting and *site preparation* activities may result in several types of *non-point source pollution* (NPSP), such as excessive *sediments*, *organic* debris, chemicals, nutrients, and an increase in average water temperature. *Streamside management zones* (SMZs) are vegetated areas adjacent to streams and watercourses that help protect them from these pollutants. This residual vegetation acts as a filter to trap sediments, chemicals, and nutrients before they reach the water. Some of this vegetation along *perennial* streams also provides the shade necessary to avoid adverse changes in water temperature. The proper use of SMZs depends upon stream type.

In Mississippi, streams are classified into two types: *perennial* and *intermittent. Drains* are considered separately. *Perennial* and *intermittent* streams need the use of SMZs, while drains do not.

Perennial
A *perennial stream* is a watercourse that has a well-defined *channel* with a continuous presence of water for more than 9 months of the year under normal climatic conditions. This includes pools of water along the watercourse during the drier months.

Intermittent
An *intermittent stream* is a watercourse with a well-defined *channel* that maintains seasonal water flow, under normal climatic conditions, 3 to 9 months of the year.

Drainage
A *drain* (also known as a drainage or ephemeral stream) may or may not have a well-defined *channel* and only has water in response to the stormflow.

The stream type will dictate the amount of harvest allowed within the SMZ as well as the types of forestry activities. The assistance of professional foresters or loggers familiar with the area will be beneficial in determining stream type. If there is a question about the type, treat it as a *perennial stream*. Regardless of whether it is a perennial or intermittent stream, or a drain, several limitations must be adhered to:

General SMZ Guidelines

- Never use a stream or drain *channel* as a *skid trail* or road.
- Remove all *logging debris* from the stream.
- Minimize the number of stream or drain crossing points.
- Cross streams and drains only at a right angle.
- Never block the flow of water through a stream or drain *channel*.
- Avoid *rutting* through streams or drains.
- Avoid *prescribed burning*.
- Harvest of any stems on the edge of a stream *channel* must be accomplished in such a manner as to minimize impact to the stream bank.

All SMZs will extend from both stream banks to a distance determined by the *slope* of the land. The intent is to maintain sufficient overstory and understory cover to provide shade, maintain bank stability, and protect water quality. Additional benefits include enhancing wildlife habitat, creating wildlife corridors, and providing habitat diversity in harvested areas.

SMZ Guidelines for Perennial Streams

Allowed	Not Allowed
! Select Harvest: Must leave 50 square feet of *basal area* per acre within the SMZ in the absence of an understory.	! Roads (except perpendicular stream crossings) ! *Excessive rutting* ! Damage to stream bank ! Any chemical application ! Any fertilizer application ! *Prescribed burning* ! *Mechanical site preparation* ! *Log decks* or landings

Perennial Stream SMZ Width by Slope

The *perennial stream* SMZ will have a minimum width of 30 feet extending from both sides of the stream measured from the banks. As the slope of the land increases, the SMZ width will increase.

Percent Slope	SMZ Width
0%-5%	30 feet
6%-20%	40 feet
21%-40%	50 feet
Over 40%	60 feet

SMZ Guidelines for Intermittent Streams

Intermittent streams will have an SMZ with a minimum width of 30 feet on both sides of stream bank. Experience and judgement will dictate whether this width should be increased under certain conditions.

Allowed	Not Allowed
! Regeneration Harvest: Provided other vegetation and/or *ground cover* remains to protect the forest floor and the stream bank in a manner that will maintain water quality. ! Individual stem treatment with *herbicides* to release desirable *regeneration*.	! Roads (except perpendicular stream crossings) ! *Log decks* or landings ! *Excessive rutting* ! Damage to stream bank ! *Prescribed burning* ! *Mechanical site preparation* ! Aerial broadcast of *herbicide* treatments

Guidelines for Drains

Drains do not require SMZs. However, there are several limitations that must be adhered to:

- ! Never use a drain as a *skid trail* or road.
- ! Never leave *logging debris* in drain *channel*.
- ! Cross drains only at right angle.
- ! Minimize the number of crossing points.
- ! Avoid *rutting*.
- ! Avoid blocking the flow of water.

WOODLAND TRAILS AND ROADS

Return to Contents

A woodland trail or road is a *skid trail* or *haul road*, temporary or permanent, constructed to provide access into forested lands. Temporary trails and roads are planned for short-term use (i.e., during a single operation or activity of normally up to 12 months duration). Permanent roads are constructed for longer periods of service. Specific guidelines for constructing *erosion* control structures are provided in Erosion Control Methods.

SKID TRAILS

Skid trails are used for moving harvested materials from stump to landing. To avoid excessive and unnecessary soil *erosion*, provisions should be made for the adequate drainage of skid trails. A skid trail system, combined with properly located *log decks* and main *haul roads*, will aid in preventing soil erosion and stream *sedimentation*.

Construction

- Locate trails to serve the intended purpose while facilitating adequate control of surface water and *sedimentation*. Aerial photographs and maps are helpful in designing road and trail networks. Locate landings first and design *skid trail* approach with low *grade*.
- Keep *skid trail* grades (steepness) below 15%, if possible.
- Break the grade occasionally and avoid long, steep grades.
- A cross-drain is needed immediately above extra steep pitches in the road and immediately before bank seepage spots.
- Install *water turnouts* at same spacing as on *haul roads*.
- Cross streams at right angles and use simple *culverts* or bridges.
- Construct small bridges or install *culverts* at live stream crossings.
- Locate trails where side drainage can be attained.
- Avoid potentially sensitive areas and problem soils.
- Avoid streambeds, rocky places and steep slopes.

Maintenance

Maintenance of *skid trails* during logging consists chiefly of maintaining an effective drainage system. On completion of the logging operation, follow these steps:

- To protect trails after they are retired, proper water diversion structures are recommended.
- Discourage unnecessary traffic.
- Scatter brush and/or slash on *skid trails* to slow water movement and reduce *erosion*.
- At stream crossings, the streambed should be cleared of all slash and restored to natural shape and *grade*.

HAUL ROADS

The following guidelines are suggested as simple, effective means of controlling *sedimentation* from areas of soil disturbance. More elaborate stabilization techniques are offered in technical guides prepared by the Natural Resources Conservation Service. These guides should be used when costs are warranted and additional uses for access roads are envisioned.

Construction

Locate roads to serve the intended purpose while facilitating adequate control of surface water and *sedimentation*. Aerial photographs and maps are helpful in designing road and trail networks.

- Avoid potentially hazardous areas and problem soils, if possible.
- Locate roads where side drainage can be achieved.
- Topsoil, trees, stumps, roots, brush, weeds, and other objectionable material should be removed from the area required for the roadway, including shoulders, ditches, side road approaches. Dispose of this material above the ordinary highwater mark.
- Use all suitable excavated material for the construction of the road when possible.
- Construct roads during drier periods of weather when possible.
- Allow road surface to settle before using.
- Avoid flat, no-grade roads. *Grade* should be limited to between 2% and 10%, if possible. Grades above 10% can be used for short distances. Avoid long steep grades to reduce the total number of *drainage structures* needed.
- Roads should be wide enough to enhance surface drying and minimize soil compaction during wet periods.
- Cuts and fills should have side slopes that are stable for the soil material.
- Unditched *haul roads* are sometimes used for short distances when only one or a few loads of timber must be hauled from an area. Locate these roads on solid ground using *water bars* or other drainage devices to remove standing water from the road.
- Establish bank stabilization in all stream crossing designs.

Maintenance

- Maintain road surfaces as needed to limit the development of ruts.
- Discourage unnecessary traffic during periods of excessive moisture.
- Clean all *drainage structures* and ditches as needed.
- When a road is to be retired, *culverts* may be removed and replaced with water bars, dips, or ditches.
- To protect roads and ditches from erosion after roads are retired, revegetation is recommended. Road closure by barriers, gates and other structures is advised.

EROSION CONTROL METHODS FOR TRAILS AND ROADS

The siltation load in surface water runoff from roads and trails is a major contributor to *sedimentation* from logging activities. Several types of water control structures are suggested as effective means to reduce sedimentation arising from the transportation network. The specific type or mix of types most appropriate are dependent upon the soils, topography, equipment and objectives inherent to a particular operation.

Streamside Management Zones

A *streamside management zone* (SMZ) is a *buffer strip* of natural vegetation between a disturbed site and a watercourse. This zone slows the flow of water runoff and catches *sediment* before it enters the watercourse. (See Streamside Management Zones.)

! Roads, trails and landings located above a watercourse should have a SMZ between the disturbed site and the stream. Runoff from these areas should not be channeled directly into the SMZ but, instead, allowed to run diffusely across it.

! While areas suitable for SMZs will typically occur alongside a watercourse, in some instances the terrain may provide or favor a SMZ immediately downslope of the road or trail. In such cases, maximum advantage should be taken of this circumstance. In general, the closer to the disturbed site the SMZ is located, the more effective it will be in protecting the watercourse from *sediment*-laden runoff.

! Material from a grubbing or cleaning operation can be used to construct brush barriers or dams as an alternative means of filtering and slowing runoff from a disturbed site. This alternative should only be used when a natural SMZ is infeasible or unavailable.

Broad-based Drainage Ditch

A *broad-based drainage ditch* is a carefully constructed outslope section of the road which serves as both a water catchment and drainage *channel*. This erosion control method requires an outslope of approximately 3% and a minimum width of 20 feet.

The distance from one drainage ditch to the next is determined by the formula:

$$\text{Distance (feet)} = \frac{400}{\%\ slope} + 100$$

Fords

A *ford* is crossing over a shallow part of a body of water.

! Use fords only if streambeds are solid and if the installation of bridges and *culverts* will accelerate soil movement.

! Enforce both approaches to a ford with gravel.

! Do not use fords in sensitive water areas.

Bridges

Bridges should be used over larger streams where heavy or long-term traffic is expected. This handbook does not attempt to make recommendations on bridge construction.

Water Turnouts

A *water turnout* is the extension of a drainage ditch into a vegetated area, providing for the dispersion and filtration of storm water runoff. Turnouts should be installed on any section of road or trail where water could accumulate.

In general, water turnouts should be spaced at intervals no greater than:

- 200 feet apart on 2% to 5% grades,
- 100 feet apart on 6% to 9% grades, and
- 75 feet apart on 10% grades.

Water Bars

A *water bar* is a mound of soil designed to divert runoff water away from the road.

Water bars should cross roads at a 30 degree angle.

- Shallow water bars may be constructed prior to and during logging use and should be considered a temporary structure.
- Deep water bars are utilized when use of the road is finished and are considered a permanent structure.
- Water bars may be constructed by hand or by bulldozer.

Water Bar Spacing	
Grade of Road *(percent)*	Approximate Distance *(feet)*
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

Outslopes

- Design outslopes to effectively move water away from the center of a road.
- Outslope the entire width of the road to reduce the number of *drainage structures* needed.
- A recommended slope is 1/4" per foot of road width.
- Outsloping is not recommended for highly erodible soils.

Culverts

A *culvert* is a metal or plastic pipe used to control the flow of surface water runoff and to allow for unobstructed flow of stream water. Place culverts in such a manner as to adequately drain the roadway while preventing soil erosion.

The culvert sizes in the following table are appropriate for both permanent and temporary crossings. In the majority of situations, the minimum culvert diameter recommended is 18 inches. However, a smaller diameter culvert may be used when minor drainage exists on flat topography.

Recommended Minimum Diameters for Culvert Crossings	
Drainage Area *(acres)*	Culvert Diameter *(inches)*
50 (and less)	18
100	24
200	36
500	60

General Guidelines for Culverts

- ! When using combinations of culverts to carry equivalent water flow, use culverts that are 3/4 the diameter of the recommended diameter. For example:
  Two 48" culverts may substitute for one 60" culvert;
  Two 54" culverts may substitute for one 72" culvert.
- ! At road crossings of permanent streams, all structures should be placed to allow fish passage.
- ! All culverts should be installed at the proper level and of sufficient size to carry anticipated water flow.
- ! Keep culverts clear of debris to allow unrestricted flow.
- ! Hollow log *culverts* are not recommended for permanent roads, but are acceptable on temporary roads if removed when the road is retired.
- ! The lumber used in box culverts should be a minimum of 2 inches thick for both permanent and temporary roads.
- ! Culverts should be covered with a minimum of 12 inches of earth fill or ½ the culvert diameter, which ever is greater.
- ! The length of *culvert* should extend the full width of the roadbed, including side slopes. Or, if the culverts do not extend to the base of the side slopes, they should be protected with adequate headwalls or headers.
- *!* *Riprap* and sediment traps should be installed as needed at culverts to prevent washing out.
- ! To avoid ponding at the culvert inlet, the outlet end of the culvert should drop at the rate of 1/4" per foot of culvert length.

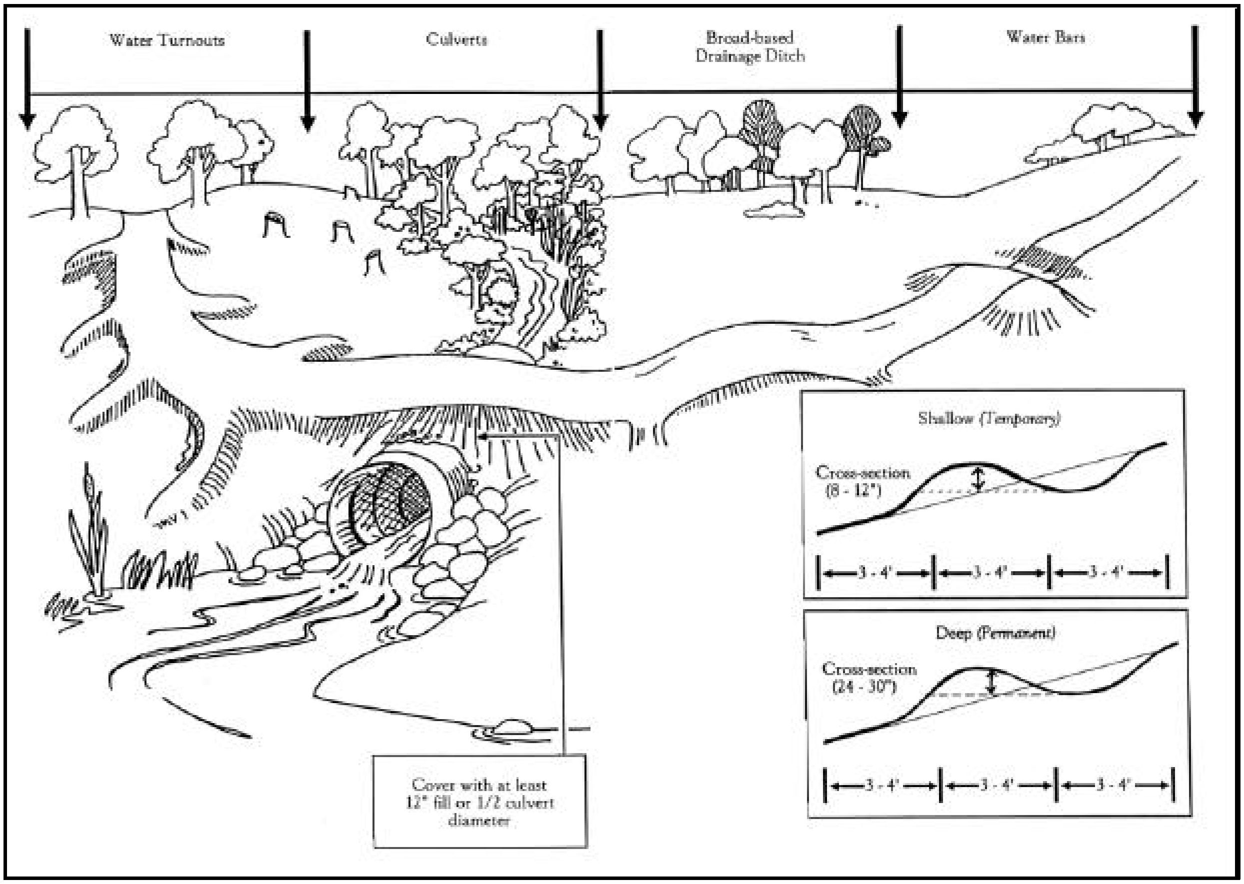


Illustration: placement of several erosion control methods.

Temporary Stream Crossing

The crossing of streams by roads, skid trails, or firebreaks should be avoided. If stream crossings are unavoidable, minimize the number of crossings, cross the stream by the least disruptine manner possible, and control sediment. Protect water quality by maintaining the integrity of the stream bank, using fill materials that are easy to remove in the restoration process, and minimizing the amount of fill dirt entering the stream.

Temporary crossings should be constructed using the following recommendations:

- Cross streams at right angles.
- Approach streams at gentle slopes.
- If possible, use temporary bridges or portable logging mats (wood or steel dragline mats) rather than culverts.
- If temporary culverts are used and will be in place for more than 10 days, the fill should be stabilized using seed and mulch.
- Whenever possible, use logs or stems as fill over temporary culverts instead of fill dirt.
- Stabilize approaches during and after construction.
- When logging is complete, remove all temporary fill material and restore the channel to its original elevation.

FOREST HARVESTING

Return to Contents

Forest *harvesting* is the cutting and removal of forest products from forestlands. Harvesting is conducted in order to obtain forest products, enhance the growth potential of trees left standing, or establish new individual trees and stands by removing woody vegetation. Activities involving the road and trail system, combined with other harvesting-related operations, can create water quality problems unless precautions are taken.

Preplanning the harvesting operation is essential in order to effectively minimize site degradation from erosion and water quality problems. The resource manager and equipment operator can sharply reduce the pollutant load resulting from forest harvesting activities by understanding each of the elements involved and applying common-sense, preventive measures.

Access Trails and Roads

! Follow the guidelines for access trails and roads. (See Woodland Trails and Roads.)

! Use procedures which will promote the quickest healing of *skid trails*.

! Conduct skidder logging on the *contour* as much as possible.

! Skid uphill when skidding must be done against the *contour*.

! Hold the number of trips on the same *skid trail* to a minimum.

Streamside Management Zones

! Maintain SMZ between heavily cut areas and watercourses. (See SMZs.)

Logging Debris

! Avoid introducing *organic* debris into streams, which can alter the natural temperature and oxygen content of the water. Debris can also alter the natural flow, or movement, of the stream, which may lead to increased *sedimentation* in the stream.

! Remove tree tops and other *logging debris* from streams.

Equipment Maintenance

! Avoid spillage or discharge of petroleum products, antifreeze, and other maintenance materials, especially near streams and other bodies of water.

! Drain equipment fluids into containers and dispose of according to label directions.

! Dispose all empty containers in the same manner.

Landings and Concentration Yards

- Locate a landing or concentration yard on a site which will not present an erosion and subsequent siltation problem.
- Leave an adequate SMZ between landings and watercourses.
- Landings and yards should have a slight slope to allow drainage.
- Provide for adequate drainage on approach roads so that road drainage water does not enter the landing area, causing muddy, wet conditions.
- Provide for stabilization of landings immediately following the completion of operations. (See Revegetation of Disturbed Forest Sites.)

Portable Sawmills and Sawdust

- Locate portable sawmills on reasonably level sites.
- Deposit sawdust on level ground.
- Divert runoff water around a sawdust pile by ditching.
- Locate sawdust piles at least 300 feet from streams.

Return to Contents

SITE PREPARATION

Site preparation is the treatment of an area to encourage natural seeding of desirable trees or to facilitate *artificial regeneration* of forest trees by planting or direct seeding. On areas recently harvested or areas growing undesirable vegetation, site preparation may be necessary prior to establishing a new stand of trees. A site can be prepared for regeneration through the use of *prescribed burning*, heavy equipment, chemicals, or a combination of these or other acceptable methods.

Establishment or re-establishment of a stand of trees on cleared land will reduce erosion and protect or enhance water quality. Further protection can be achieved by the manner in which the site is prepared for such revegetation. Prompt revegetation following *site preparation* is desirable to effectively control erosion, *sedimentation* and nutrient leaching.

General Guidelines for Site Preparation

- Avoid excessive soil compaction.
- Keep soil disturbance to a minimum.
- Minimize disturbance on slopes.
- Follow the *contour* as close as possible when conducting *mechanical site preparation* (excluding *chopping*).
- Discharge water from site-prepared areas onto vegetated surfaces, wherever possible.
- Consider chemical site prep over mechanical site prep on highly erosive sites.
- Never broadcast chemicals in watercourses and *streamside management zones*.
- Never wash chemical containers or clean equipment in streams.
- Keep chemicals away from surface water when mixing.
- Always choose the site prep method that creates the least soil disturbance, remains effective and safe, and accomplishes *regeneration* goals.

PRESCRIBED BURNING

The use of fire before planting or seeding will reduce logging residues, undesirable trees and competing vegetation. Most soil erosion problems arising from *prescribed burning* come from the plowed firelines installed with heavy equipment. However, firelines will cause very few water quality problems when properly installed. (Note: Firelines should not be confused with firebreaks, which are wide, grass-seeded lanes used to break up fuel loading and to provide access into and around wooded areas. Firebreaks should be managed as Skid Trails .)

- *Prescribed burning, including fireline construction, should be kept out of SMZs.*
- Eliminate extremely hot prescribed burns. These may start active erosion since most of the organic cover is consumed by the fire. An extremely hot burn can also alter the soil's physical properties in a manner which decreases water infiltration, resulting in an increase of surface water runoff.

Fireline Construction

- Avoid constructing firelines at right angles to *contours*.
- Construct firelines around slopes at a *grade* of less than 10%, if possible.
- Install *water turnouts* and/or *water bars* when the fireline is being constructed. The distance between water bars is identical to those needed on logging roads. (See Water Turnouts/Water Bars.)
- Avoid installing *diversion ditches* at the head of a drain.
- Do not construct a fireline down the slope of a shallow, natural *gully* since this eliminates all possibility of leading water away from the line.
- Leave a *streamside management zone* between the fireline and stream.
- Firelines should not run directly into an SMZ. When anchoring a fireline to a SMZ, turn the line at the edge of the SMZ so that the plowed line parallels the zone.

MECHANICAL

Bulldozing, *shear-blading*, drum *chopping* and *disking* cause varying degrees of soil disturbance. A combination of treatments may be used on some sites. These treatments should be conducted in such a manner as to minimize soil displacement or compaction, minimize soil erosion on slopes and *sediment* movement into water, and to prevent accumulation of debris in creek bottoms, ponds, streams or rivers.

Sheet erosion and subsequent *sedimentation* may be caused where the topsoil is removed by a straight-blade bulldozer. This practice does not create a major erosion problem on relatively level land, but erosion problems may develop on rolling or steep terrain.

- Avoid *mechanical site preparation* on steep slopes with extremely erodible soils.
- Do not push debris into a *natural drainage*.
- The practices of light dozing, root raking and *shear-blading* usually produce better results with fewer problems than straight-blading because less topsoil is disturbed.
- Construct *windrows* along the *contour*, keeping them short with numerous breaks.
- Drum choppers cause even fewer erosion problems because the topsoil and *litter* are less disturbed.
- Provide water outlets on furrowed areas at locations that will minimize movement of *sediment*.
- Where possible, discharge water onto vegetated surfaces.
- *Bedding* is used on poorly drained sites located on flat or nearly flat land. Soils must be of sufficient depth to provide a satisfactory root zone after bedding. On flat sites, the beds should run across the *contour* in a manner which will provide maximum surface drainage. (Note: Bedding may be used on slopes and terraces for topsoil consolidation and competition control. In these situations, beds should run along the *contour*.)
- One of the most effective measures for keeping *sediment* from site-prepared areas out of streams is the use of an SMZ. (See Streamside Management Zones.)

CHEMICAL

Chemical site preparation is an important alternative to *mechanical site preparation*. It may be used in conjunction with *prescribed burning* and, to some extent, with other site prep methods. Very little, if any, water quality problems arise when *herbicides* are used properly.

The use of herbicides should be carefully planned to prevent the contamination of streams and lakes, which may damage fish and other aquatic life.

- Choose a herbicide registered for intended uses and suitable for use on target species.
- Herbicides should also be suitable and safe for use with available methods of application.
- Always use herbicides in accordance with label instructions.
- Store herbicides where there is no danger of being spilled or released into the environment.
- Do not mix chemicals near springs, streams and lakes.
- Since wind and high temperatures increase the chance of herbicide drift, volatilization and pollution of water and atmosphere, make sure that atmospheric conditions are such that a maximum amount of chemical reaches target species, especially during aerial or spray applications.
- Never apply herbicides directly to water (except when the chemical is approved for application over water).
- Clean chemical application equipment away from streams and other water sources.
- Dispose of excess herbicides and containers in accordance with label instructions.

TREE PLANTING

Return to Contents

Tree planting is the planting of forest tree seedlings, either by hand or machine. Tree planting may be undertaken solely to protect a *watershed*, or it may be conducted to establish a stand of trees for timber production, conserve soil and moisture, beautify an area, improve wildlife habitat, or for a combination of objectives.

Planting sites include open fields, harvested timber areas, understocked woodlands, areas where less desirable tree species are to be replaced with desirable tree species, and sites where erosion problems exist.

- Tree planting by hand causes little, if any, erosion.
- Tree planting by machine may temporarily cause erosion. The plow point and coulter blade on the planting machine creates a planting slit in which a seedling is placed. The slit is closed around the seedling by the planter's packing wheels, which may create a depression on each side of the slit. The depressions may *channel* surface water runoff, thus creating an erosion problem. To avoid ditch formation, machine planting should follow the *contour* of the site.

REVEGETATION OF DISTURBED FOREST SITES

For the purpose of this handbook, revegetation is defined as the process of re-establishing a vegetative cover on an erodible, disturbed forest site in order to stabilize the soil, thereby reducing erosion and runoff of *sediment* to watercourses. Revegetation recommendations should be developed by a natural resource professional.

Effective long-term erosion control is obtained with the establishment of a permanent vegetative cover. However, at times it may not be possible to establish a permanent vegetative cover due to limiting circumstances (e.g., time of year, availability of plant materials, etc.). In this case, the resource manager should establish a vegetative cover to provide temporary erosion protection to the disturbed site, with a permanent vegetative cover being established as soon as possible.

The following guidelines should be followed when establishing a vegetative cover.

SITE PREPARATION FOR VEGETATIVE COVER

! Road surfaces and landings should be smoothed and shaped to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and maintenance.
! *Culverts* should be maintained or replaced with *water bars* or ditches adequate to carry the runoff.

SEEDBED PREPARATION

! The top layer of soil should be loosened by raking, *disking* or other acceptable means before seeding.
! Chisel or loosen compacted areas.
! Spread available topsoil over unfavorable soil conditions.
! When conventional seeding is to be done, no preparation is required providing the soil material is loose (i.e., on a fresh *skid trail*) and has not been sealed by rainfall.
! On smooth, cut slopes or compacted trails the surface will require pitting, trenching, or scarifying to provide a place for seed to lodge and germinate.
! Incorporate lime and/or fertilizer into the top 3 to 4 inches of soil as a part of seedbed preparation when practical.

SEEDING

! Inoculate legume seed with proper inoculant before planting.
! Apply seed uniformly by broadcasting with a cyclone seeder or close drilling.
! Normal depth for covering seed ranges from 1/4 inch for ryegrass to 1 inch for small grain.
! When seed is applied with a hydraulic applicator, firming the soil is not necessary.

LIME AND FERTILIZER

! For the establishment of vegetation such as grasses and/or legumes, apply lime and fertilizer as needed for the species to be planted.

Selection of Species

Selecting the proper plant species suitable to the soil and seasonal conditions is vital to establishing an effective vegetative cover. Recommended plant species are offered in the following tables.

Recommended Species for Temporary Cover		
Species	Preferred Planting Dates	Seeding Rate
Browntop Millet	May-July 15	25 lb.of seed/acre
Sorghum/Sudangrass	April-July	35 lb. of seed/acre
Ryegrass (Gulf or Marshall)	Sept.-Oct.	30 lb. of seed/acre
Oats (Florida 501 Bob)	Sept.-Oct.	4 bushels/acre
Wheat	Sept.-Oct.	2 bushels/acre
Rye (Vitagraze)	Sept.-Oct.	2 bushels/acre

Recommended Species for Permanent Cover		
Species	Preferred Planting Dates	Seeding Rate
Lespedeza (Sericea)	March-April	30 lb. seed/acre
Fescue (Ky-31)	Sept.-Nov.	20 lb. seed/acre
Bahiagrass	Feb.-June or Sept.-Nov.	30 lb. seed/acre
Bermudagrass (hulled)	March-June	8 lb. seed/acre

Wildlife Planting Recommendations		
Some landowners may wish to establish vegetation which will provide both ground cover and benefit to wildlife species. The following table lists those plants which may serve both purposes.		
Species	Preferred Planting Dates	Seeding Rate
Browntop Millet	May-July 15	20 lb. seed/acre
Oats	Sept.-Oct.	4 bushels/acre
Wheat	Sept.-Oct.	20 lb. seed/acre
Winter Peas	Sept.-Oct.	30 lb. seed/acre
Red Clover (Redland, Atlas)	Sept.-Oct. 15	8 lb. seed/acre
White Clover (Regal, Osceola)	Sept.-Oct.	3 lb. seed/acre

Artificial regeneration - The establishment of a forest by planting seedlings or by seeding an area.

Basal area - A measure of the cross-sectional area taken up by trees at 4.5 feet above ground level.

Bedding - A site preparation technique, usually in wet areas, whereby a small ridge of soil is formed
as an elevated planting or seedbed.

Best management practices (BMPs) - Forest management practices, developed pursuant to federal water quality legislation, to minimize or prevent nonpoint source water pollution. Often in more general usage referring to any good forest stewardship practices.

Broad-based dip - A surface drainage structure designed to convey surface runoff off of a road while allowing vehicles to maintain normal speeds.

Buffer strip - A relatively undisturbed section of forest adjacent to an area requiring special attention or protection such as a stream, lake, or road.

Channel - A natural stream which conveys surface runoff water within well-defined banks.

Chemical site preparation - The use of herbicides to control plant competition to prepare an area for the establishment of a future forest either by artificial or natural means.

Chopping - The flattening of vegetation remaining after harvest in order to concentrate it near the ground.

Contour - An imaginary line on the land surface that is at a constant elevation.

Culvert - A metal, concrete or plastic pipe through which water is carried.

Disking - Tilling soil to reduce competing vegetation.

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

Drainage structure - A man-made structure that facilitates the movement of water off an area.

Erosion - The detachment and transportation of soil particles.

Excessive rutting - The determination of excessive rutting is highly subjective and must be made by a *registered forester* or other qualified professional experienced in local logging operations, soil types, and site conditions (see definition of *registered forester*). The determination must consider rutting extent and depth, soil type, slope, position on slope, management prescription, and any other pertinent factors.

Ford - a natural or paved stream crossing suitable for shallow streams with stable bottoms.

Grade - The slope of a road, usually expressed as a percent.

Ground cover - Any living or nonliving organic material which may provide stabilization of the forest floor.

Gully - An eroded channel (generally at least 12 inches deep) which has deepened to the point that it cannot be removed by tillage.

Harvesting - The removal of merchantable tree crops from an area.

Haul road - primary road used for transporting harvested timber from a site.

Herbicide - Any chemical or mixture of chemicals intended to prevent the growth of or promote the removal of targeted trees, bushes, and/or herbaceous vegetation.

Intermittent stream - A watercourse that flows in a well-defined channel for 3 to 9 months of the year during normal rainfall conditions.

Litter - The uppermost, slightly decayed layer of organic matter on the forest floor.

Log deck - A place where logs or tree-length material is processed for loading and transporting.

Logging debris - The unutilized and generally unmarketable accumulation of woody material, such as limbs, tops and stumps, that remains after timber removal.

Mechanical site preparation - The cutting of all standing material with blades or choppers to prepare an area for the establishment of a future forest either by artificial or natural means. Associated mechanical practices include *disking* and *bedding*.

Mulching - Covering an area loosely with some material to hold soil in place and facilitate revegetation. Straw and bark are common mulches.

Natural drainage - A naturally occurring conduit for the flow of water.

Nonpoint source (NPS) pollution - Pollution which is (1) induced by natural processes, including precipitation, seepage, percolation and runoff; (2) not traceable to any discrete or identifiable facility; and (3) controllable through the utilization of wise management practices.

Outslope - To slope the road surface to cause drainage to flow toward the downhill side.

Organics - Particles of vegetation or biological material which can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Perennial stream - A watercourse that flows continuously (9 months of the year) in a well-defined channel.

Prescribed burning - The controlled use of fire to reduce or eliminate the unincorporated organic matter of the forest floor, or low, undesirable vegetation.

Regeneration - Renewal of a forest by either natural or artificial means.

Registered forester - A person who is registered and qualified to engage in professional forestry practices as determined by the Mississippi State Board of Registration for Foresters.

Riprap - A layer of rock used for stabilizing soil that is subject to erosion.

Rutting - Tracks in the soil resulting from the passage of heavy equipment.

Sediment and sedimentation - Eroded soil particles that are deposited downhill or downstream by surface runoff.

Shear-blading - The cutting of merchantable residual trees and stumps close to the ground after harvest.

Silviculture - The science and art of cultivating forests based on the knowledge of the life history and general characteristics of forest trees; the principles, theories, and practices for protecting and enhancing the establishment, growth, development, and utilization of forests for multiple benefits.

Site productivity - An expression of an area's natural fertility or capacity to grow vegetation, especially trees.

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

Skid trail - A temporary, non-structural pathway over forest soil for dragging (skidding) felled trees or logs to a landing for processing.

Streamside management zone (SMZ)- An area adjacent to the bank of a stream or body of open water where extra precaution is necessary to carry out forest practices in order to protect bank edges and water quality.

Water bar - A mound or ridge of soil formed across a road or trail for the purpose of deflecting water onto the adjacent area, usually into the forest *litter*.

Water turnout - The extension of an access road's drainage ditch into a vegetated area to provide dispersion and filtration of stormwater runoff.

Watershed - All land and water within the confines of a drainage basin.

Windrow - *Logging debris* and unmerchantable woody vegetation that has been piled in rows.

FORESTRY BEST MANAGEMENT PRACTICE GUIDELINES FOR WATER QUALITY MANAGEMENT IN OKLAHOMA

Oklahoma Department of Agriculture
Forestry Services
Oklahoma City, Oklahoma

Initial BMP Guidelines -- 1976
EPA 208 Task 152 -- 1982
EPA 319 Management Plan -- 1991

TABLE OF CONTENTS

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 all of these needs be met.

Oklahoma Dept. of Agriculture – Forestry Services
2800 North Lincoln Boulevard
P. O. Box 528804
Oklahoma City, OK 73152
405-522-6158

FORESTRY BEST MANAGEMENT PRACTICE GUIDELINES FOR WATER QUALITY MANAGEMENT IN OKLAHOMA

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

<u>Basis for BMPs</u>

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. Disposal of Debris and Litter

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

Major Water Quality Influences

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.

Sediment: 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. 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 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 ($NH4^+$) 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.

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