Sustaining Minnesota Forest Resources:

Voluntary Site-Level Forest Management Guidelines for Landowners, Loggers and Resource Managers

The Minnesota Forest Resources Council (MFRC) was charged under the Sustainable Forest Resources Act of 1995 with coordinating the development of site-level timber harvesting and forest management guidelines. In response to this mandate, the MFRC convened four multi-disciplinary technical teams to develop guidelines for riparian zone management, wildlife habitat, historic/cultural resources and forest soil productivity. The technical team guidelines were developed through consensus over a two-year period and then integrated to produce a single set of guidelines.

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Minnesota Forest Resources Council
2003 Upper Buford Circle
St. Paul, Minnesota 55108-6146
Phone: (651) 603-0109
Fax: (651) 603-0110
Web: www.frc.state.mn.us

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Editing, design and layout: Schroeder Communications
Illustrations: Drawn By Design
AUTOCAD graphics: William B. Flynn
Visual quality illustrations: Susan B. Davies
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(continued on next page)

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The Minnesota Forest Resources Council
and the members of its Integration Team
would like to thank Mike Phillips
for his tireless commitment, leadership and unfailing humor
throughout the guideline development and integration process.
"So let it be written; so let it be done."

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INTRODUCTION

Sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable forestry is a proactive form of management that provides for the multiple uses of the forest by balancing a diversity of both present and future needs. It is a process of informed decision-making that takes into account resource needs, landowner objectives, site capabilities, existing regulations, economics and the best information available at any given time.

Recognizing the challenges that sustainable forest management represents, this guidebook was developed as a collaborative statewide effort involving a broad spectrum of people who value forested lands in Minnesota. It provides a set of integrated guidelines that address projected impacts on forest resources as identified in the 1994 Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota (GEIS).

These voluntary site-level forest management guidelines provide valuable decision-making tools for landowners, resource managers and loggers throughout Minnesota, who share an ongoing responsibility to make balanced, informed decisions about forest use, forest management and forest sustainability.

A Menu, Not a Mandate

These guidelines are intended to serve more as a menu, not a must-do checklist. They provide a diversity of options for landowners, resource managers and loggers seeking to maintain forest sustainability.

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. 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.

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.

Because the guidebook has been designed for a variety of audiences, some landowners may find it to be more technical than they need, and some resource managers may find it to be more basic than they might prefer. For all readers, though, the individual guidelines—as well as their format—were designed to be as clear, concise and user-friendly as possible:

❐ Part 1 explains the purpose and value of integrated forest management guidelines.

❐ Part 2 describes selected components of a sustainable forest.

❐ **Part 3 represents the hands-on, what-to-do part of the guidebook,** focusing on two related groups of guidelines:

- **General guidelines:** Guidelines common to many forest management activities

- **Activity-specific guidelines:** Guidelines applicable to particular forest management activities

❐ Part 4 includes additional resources: the Resource Directory, the Glossary and the Appendices.

The guidebook recognizes that various users will seek out different kinds of information related to the guidelines. Landowners, resource managers, loggers, contractors and equipment operators will use the guidebook in different ways:

❐ Some users will focus mainly on the guidelines themselves—the "what to do" (Parts 3 and 4)—while others will find the "why do it" (Parts 1 and 2) to be equally as valuable.

❐ Some will read the guidebook cover to cover; others may regularly refer to just a few particular sections.

Here's a quick overview of each of the four parts of the guidebook:

Part 1: The Purpose of Integrated Guidelines

- ❒ The Forest
- ❒ A Framework of Balance and Stewardship
- ❒ A Diversity of Needs
- ❒ The Concept of Integrated Guidelines
- ❒ Who Will Use the Guidelines
- ❒ Factors That May Affect Implementation
- ❒ Recognizing the Need for Flexibility
- ❒ What the Guidelines Are—and What They Are Not

Part 2: Selected Components of a Sustainable Forest

A look at six selected components of a healthy forest ecosystem, describing the value and benefit of the following forest resources to a balanced, sustainable forest community:

- ❒ Cultural resources
- ❒ Forest soil productivity
- ❒ Riparian areas
- ❒ Visual quality
- ❒ Water quality and wetlands
- ❒ Wildlife habitat

Part 3: The Integrated Guidelines

- ❒ The Purpose of Integrated Guidelines
- ❒ How the Guidelines Will Help Sustain Forest Resources
- ❒ General Guidelines Common to Many Forest Management Activities

❐ Activity-Specific Guidelines Applicable to Particular Forest Management Activities:

- Forest road construction and maintenance
- Timber harvesting
- Mechanical site preparation
- Pesticide use
- Reforestation
- Timber stand improvement
- Fire management
- Forest recreation management

Part 4: Additional Resources

❐ Resource Directory: Sources of additional information and assistance

❐ Glossary: Detailed definitions of terms used throughout the guidebook

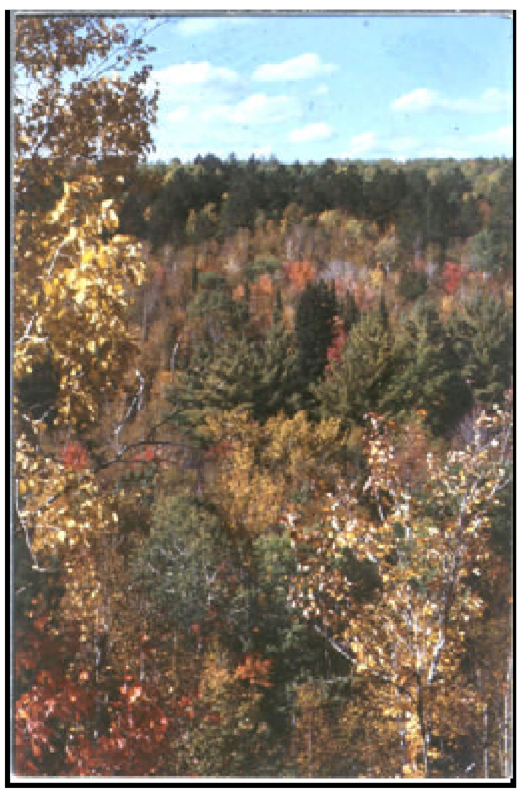
❐ Appendices

PART 1

THE PURPOSE OF INTEGRATED GUIDELINES

The Forest

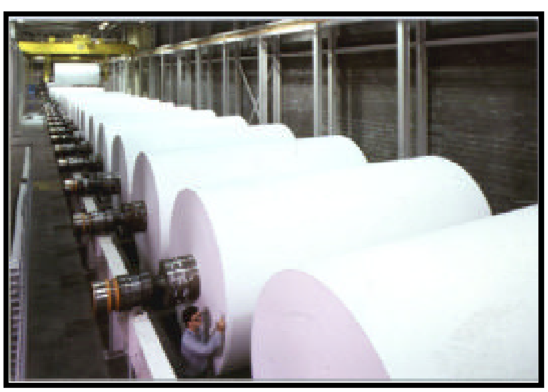
The forest is a diverse and complex community that includes plants, animals, microorganisms and people—along with the surrounding physical environment they inhabit, in which trees are the dominant life form.



The forest is a diverse and complex community, in which trees are the dominant life form. *Photo courtesy of Minnesota DNR*

Sustaining forest resources for future generations depends on balancing a diversity of social, economic and environmental objectives, including:

- ❒ Production of timber for wood and paper products
- ❒ Providing recreational opportunities
- ❒ Protection of cultural resources
- ❒ Enhancement of scenic beauty
- ❒ Improvement of wildlife habitat
- ❒ Conservation of water and soil resources
- ❒ Maintaining the viability of rural communities



Sustaining forest resources for future generations depends on balancing a diversity of social, economic and environmental objectives, including production of timber for wood and paper products. *Photos courtesy of Minnesota DNR (above) and Potlatch Corporation (below)*

Harvesting timber stands can contribute to the long-term health, productivity and sustainability of valuable forest resources. *Photo courtesy of Minnesota DNR*

A Framework of Balance and Stewardship

Forest management can contribute to the long-term sustainability of forested lands in Minnesota. Harvesting timber stands, prescribed burning, the use of pesticides, and the ongoing regeneration of forests contribute to the long-term health, productivity and sustainability of valuable forest resources.

Like many other human activities, from building houses to growing crops to living on a lake, forest management activities also have the potential to adversely affect site-level forest functions and values. As the needs and desires of society impose ever-increasing demands on forest resources, the responsibility to meet those increased demands without compromising the overall sustainability of forest resources becomes more challenging. Within a sound stewardship framework, however, forest management can occur at the site level with no adverse effects on the sustainability of the entire forest ecosystem.

A Diversity of Needs

Sustainability means meeting the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable forestry is a proactive form of management that provides for the multiple uses of the forest by balancing a diversity of both present and future needs. It is a process of informed decision-making that takes into account resource needs, landowner objectives, site capabilities, existing regulations, economics and the best information available at any given time.

Those concerned about forest management have long recognized the challenge of balancing social, economic and environmental objectives and implications. They also recognize the complex relationship between forest management practices and the long-term sustainability of our forests.

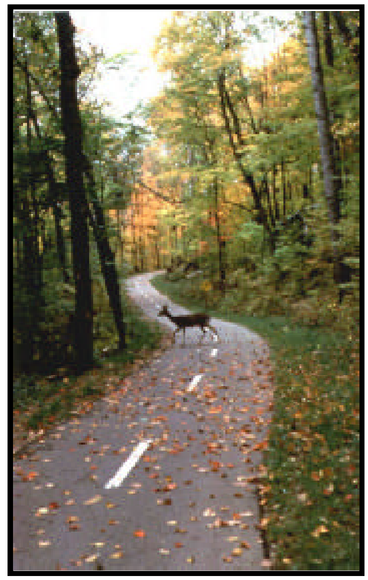
The Concept of Integrated Guidelines

Integrated resource management approaches, comprehensive planning, and recommended practices and guidelines are not new ideas. So what is new? Three things:

- ❒ The concept of one set of integrated guidelines to support the sustainability of many different resources within forest communities
- ❒ The recognition that guidelines should be designed to accommodate a wide range of resource needs, landowner objectives and site conditions
- ❒ The idea of a broad-based, collaborative approach to developing user-friendly guidelines applicable to forests throughout Minnesota

To address the concern that some components of the forest are sensitive to the impacts of increasing uses, the Sustainable Forest Resources Act (SFRA) of 1995 directed the Minnesota Forest Resources Council to coordinate development of an integrated set of voluntary site-level timber harvesting and forest management guidelines.

Integrated guidelines recognize the forest as a community of related resources, rather than a collection of separate resources. *Photo courtesy of Minnesota Department of Tourism*



This concept of integrated guidelines recognizes the forest as **a community of related resources**, rather than **a collection of separate resources.** Integrated guidelines reflect the forest ecosystem that they are designed to help sustain. For information about the guideline development process, see *Appendix A: How the Guidelines Were Developed.*

Who Will Use the Guidelines

These forest management guidelines have been developed for use by forest landowners, resource managers, loggers, contractors and equipment operators, who share a concern for balancing forest management activities and the long-term sustainability of forest resources. Although many individuals may participate in managing a particular site, final decisions regarding guideline implementation lie with the landowner.

These guidelines were designed to help landowners, resource managers and loggers determine **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.

Factors That May Affect Implementation

These guidelines are just that—guidelines. Voluntary implementation of these guidelines may be affected by a number of factors, including:

- ❒ Federal, state and local regulations
- ❒ Economic considerations
- ❒ Site characteristics
- ❒ Landowner objectives
- ❒ Perceived benefits
- ❒ Effectiveness of information/education efforts

Recognizing the Need for Flexibility

Because no single set of guidelines can effectively address the concerns of all situations and all areas, guidelines need to be flexible enough to address site-specific conditions. This flexibility also allows guidelines to be modified to balance resource needs, landowner objectives and site capabilities—as long as modified approaches still achieve the same management goals.

Besides being flexible, these guidelines may evolve and change over time. Guideline revisions may occur in the future to reflect new information, new perspectives or new priorities.

What The Guidelines Are...

❒ **The guidelines are designed to be flexible,** recognizing that both site conditions and landowner objectives vary. Determining the most appropriate guidelines for implementation on a particular site depends on the informed judgment of the landowner, resource manager or logger responsible for that site.

❒ **It may be possible to implement several guidelines simultaneously** in some instances. For example, trees left to protect cultural resources may also satisfy mast guidelines for wildlife, as well as apparent harvest size guidelines for visual quality.

❒ **Implementation of the guidelines is voluntary.**

❒ **The guidelines are designed to help** forest landowners, resource managers and loggers meet two goals:

- Conduct forest management activities while addressing the continued long-term sustainability of diverse forest resources.

- Promote or enhance the functions and values of water and soil resources, riparian areas, wildlife habitat, visual quality and cultural resources.

❒ **The guidelines represent practical and sound practices** based on the best available scientific information.

❒ **The guidelines are designed to assist with site-level forest management.** They are not designed to provide broad-based landscape direction.

...and What They Are *Not*

- **The guidelines are not a substitute for a resource management plan.** They are intended to support implementation of a plan once it is in place.

- **The guidelines are not intended to replace any existing rules or regulations.**

- **The guidelines are not intended as a substitute for obtaining professional assistance** as needed to achieve management objectives or meet appropriate engineering standards. They are guidelines, not construction standards or engineering specifications.

- **The guidelines are not designed to help determine *whether* a particular forest management activity should or should not occur.** They are designed instead to provide guidance in *how* to implement a particular forest management activity.

- **The guidelines are not intended to address *all* forest management activities and *all* forest resources.** They address major forest management activities as they relate to selected components of a healthy forest.

- **The guidelines do not cover all management options related to a particular forest resource.** Wildlife guidelines, for example, provide the essentials to address site-level habitat issues, but they do not list all possible techniques for improving forest habitats or for managing particular species.

PART 2

SELECTED COMPONENTS OF A SUSTAINABLE FOREST:
Rationale and Management Considerations

A forest ecosystem reflects the dynamic interaction between people—landowners, resource managers, loggers, tourists and recreational users—and many different forest resources, including, among others, cultural resources, forest soil productivity, riparian areas, visual quality, water quality and wetlands, and wildlife habitat.

Part 2 introduces and defines these six forest resources, providing the rationale for their role in the overall sustainability of forested lands in Minnesota.

Cultural Resources

Forest Soil Productivity

Riparian Areas

Visual Quality

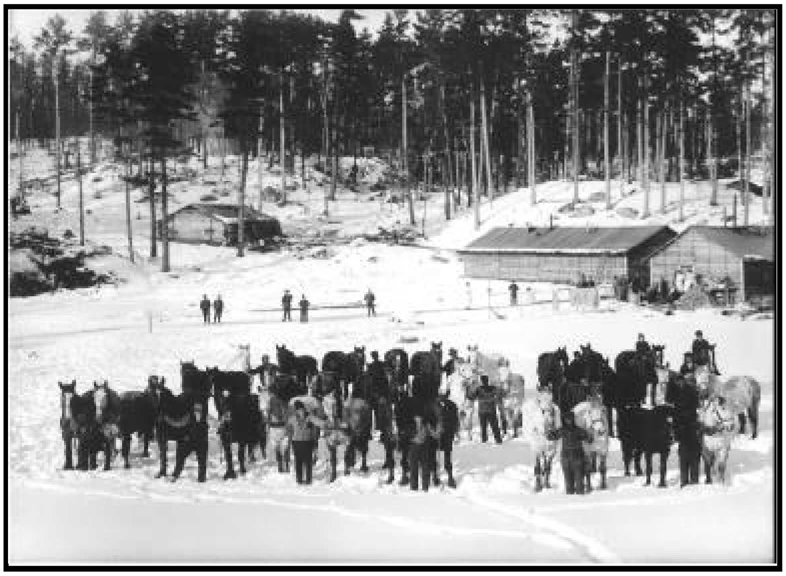
Water Quality and Wetlands

Wildlife Habitat

Cultural Resources

CONTENTS

FIGURE



The location of this historic northern Minnesota logging camp (circa 1915) is today a valuable cultural resource: an archaeological site representing an important chapter in the history of the region. *Photo courtesy of Minnesota Historical Society (William F. Roleff)*

The Value of Cultural Resources

What Cultural Resources Are

In these guidelines, **cultural resource** means any site, building, structure, object or area that has value in American history, archaeology, architecture, engineering or culture. A cultural resource may be the archaeological remains of a 2,000-year-old Indian village, an abandoned logging camp, a portage trail or a pioneer homestead. It may be of value to the nation or state as a whole or important only to the local community. In order to be considered important, generally a cultural resource has to be at least 50 years old.

The people of Minnesota are heirs to a unique legacy of cultural resources, many of which occur within the state's public and private forest lands. Generally, these cultural resources fall into five broad categories: historic structures, archaeological sites, cemeteries, traditional use areas and historic areas.

Burial mounds are a cultural resource that can be found in Minnesota today. This burial mound is located in Houston County. *Photo courtesy of Minnesota DNR Forestry Heritage Resources Program*

The following list provides an overview of the most common types of cultural resources within these categories:

❒ Historic structures

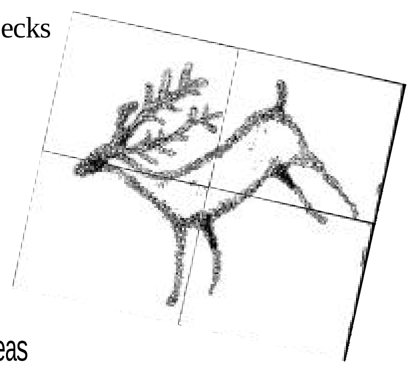
- Houses, barns, outbuildings
- Notable examples of architectural styles or methods of construction
- Buildings reflecting important historical events and trends
- Logging camps and mills
- Sole or rare survivors of important architectural types
- Industrial and engineering structures
- Churches and schools
- Fire lookout towers
- Stores, office buildings, sheds
- Vegetation which is part of a historic site, such as plantations or formal gardens

❐ Cemeteries

- Platted burial grounds
- Burial mounds
- Family cemeteries
- Graves
- Associated vegetation, such as flowers, trees and shrubbery

❐ Archaeological sites

- Sites containing important scientific data
- Sites that shed light on local, regional or state history
- Ruins of historically important buildings
- Villages and camps
- Quarries
- Food-gathering sites, such as ricing camps or sugar bushes
- Middens, cache pits and earthworks
- Petroglyphs (rock carvings) and pictographs (rock paintings)
- Shipwrecks



❐ Historic areas

- Areas shaped by historical land uses (such as agriculture, mining or transportation)
- Roads, trails, highways and portages
- Clusters of buildings and other features
- Parks, gardens and other historic plantings

"Traditional use areas" were the site of a particular activity (such as food-gathering) by a group of people over a period of years. This Ojibwe hut (1920) stored tools and food containers, which the Ojibwe used for food-gathering. *Photo courtesy of Minnesota Historical Society (Frances Densmore)*

❒ Traditional use areas

- Areas traditionally or historically used by one or more groups of people for some type of activity
- Locations associated with traditional beliefs
- Shrines and ceremonial sites

Historical Context

Cultural resources reflect roughly 12,000 years of human occupation in Minnesota, from the earliest appearance of people at the end of the last Ice Age to the 20th century. Cultural resource management professionals commonly divide the state's history into three time periods:

❒ **The Pre-Contact Period** begins approximately 12,000 years ago and covers Minnesota history through about A.D. 1650. Several successive American Indian cultural traditions existed here during this long period of time, as native peoples adapted to a wide range of conditions in all of the state's ecosystems.

Ancient American Indian settlement and subsistence in Minnesota generally reflect the hunting and gathering pattern of the Eastern Woodlands, but there were also societies characterized by agriculture and village life.

❒ **The Contact Period** groups together the events and cultural trends characterized by the interaction of American Indians and Europeans during the period from about 1650, when the first explorers reached Lake Superior, to 1837, the date of the first treaties ceding tribal lands in Minnesota to the United States. Cultural resources from this period are most often linked to the themes of exploration and discovery, the fur trade, acculturation of tribal societies, and initial Euro-American settlement.

❒ **The Post-Contact Period** covers the years between 1837 and the end of the Second World War. Cultural resources from this period are particularly abundant and reflect both broad historical themes and more narrow, localized topics:

- **Broad historical themes** include American Indian reservation communities, logging, agriculture, mining, transportation, industry and urban development.

- **More narrow, localized topics** include ethnic settlements, folk architecture, state parks and pioneer farmsteads.

In special circumstances, cultural resources from the post-1945 era may also be considered significant.

The site of this blacksmith shop at an 1885 lumber camp would today provide important information to help archaeologists (and others) better understand daily life in a logging camp more than 100 years ago. *Photo courtesy of Minnesota Historical Society*

Assumptions and Desired Outcomes

Six primary assumptions provided the foundation for the development of cultural resource guidelines:

- ❒ Cultural resources are scarce and nonrenewable.
- ❒ Voluntary guidelines should enable forest land managers, landowners and cultural resource managers to avoid unnecessary conflicts.
- ❒ Natural environments that have been shaped by historical processes of land use may also have cultural resource value.
- ❒ Long-range planning is the key to successful cultural resource management.
- ❒ Good forest land management is compatible with good cultural resource management practices.
- ❒ Education and partnerships will be the keys to successful guideline implementation.

These guidelines were developed to provide landowners, loggers and resource managers with information about cultural resources and recommendations on how to take them into consideration during forest management activities.

The purpose of the guidelines is to achieve two major outcomes related to all forest management practices:

- ❒ **Increased awareness of cultural resources** among forest landowners, loggers and resource managers
- ❒ **Protection of important cultural resources** during forest management activities

Potential Impacts to Cultural Resources

In general, cultural resources are fragile. Threats range from natural forces (erosion, flooding, weathering and fire) to human action (logging, agriculture, mining, land development and vandalism). Lack of awareness of the existence of a cultural resource is the main cause of damage. Use of these guidelines will encourage implementation of practices that will minimize unintentional damage to cultural resources.

Potential damaging effects to cultural resources resulting from forest land management activities include:

- ❒ Soil disturbance
- ❒ Soil compaction
- ❒ Rutting
- ❒ Changes in public access
- ❒ Changes in vegetation which is part of a cultural resource
- ❒ Damage to above-ground features

Cultural resources are susceptible to the effects of soil erosion, compaction and rutting. These forces can disturb archaeological sites and destabilize historic structures. Traditional use areas may be impacted by timber harvesting, fire management and herbicide use.

While changes in site access created by forest roads make some cultural resources susceptible to looting and vandalism, they may also open up opportunities for on-site education, interpretation and tourism—which may, in turn, lead to new threats to the integrity of the resource.

The Benefits of Cultural Resource Management

The underlying reason for including cultural resource management (CRM) as part of forest management is **the growing recognition that cultural resources have value and should be wisely managed.** Cultural resources represent parts of an inheritance shared by all people. This heritage is of fundamental value to modern-day societies and is truly a gift from the past. Cultural resources are valued in a variety of ways. They often possess spiritual, scientific and other values that are weighed differently by different cultures.

The benefits of CRM are both tangible and intangible. Today CRM is increasingly seen as a necessary component of land stewardship. Forest managers and landowners should use CRM as a tool to minimize conflicts between stewardship and economics, and to treat cultural resources as assets rather than liabilities. Cultural resource management is about people, not things, and its orientation is toward the future, not the past.

While the intangible benefits of cultural resource management cannot always be easily defined, they are nevertheless important:

- ❒ As scarce, nonrenewable parts of the environment, cultural resources by their very nature provide physical links to the past, along with a sense of national, community and personal identity.

- ❒ Historic structures, historic areas, traditional use areas and other above-ground cultural resources provide environmental diversity, while some structures and artifacts have intrinsic value as works of art.

- ❒ Perhaps most importantly, the conservation of cultural resources contributes to an understanding of history, fosters an appreciation for heritage, and stimulates learning at all education levels.

- ❒ Lastly, resources that connect the present with the past fulfill important nostalgic and spiritual instincts shared by large segments of modern society.

The Economics of Cultural Resource Management

Economically, CRM will not usually pay for itself, but some forest landowners will discover that preserved and protected cultural resources can be financial assets that do provide opportunities for development:

❒ Indirectly, cultural resource conservation efforts often contribute to soil, water and wildlife habitat conservation measures.

❒ Some kinds of cultural resources, including archaeological sites and historic structures, have value as heritage tourism sites and may be used to help stimulate outdoor recreational development.

❒ The return on investment in the preservation, rehabilitation and adaptive reuse of above-ground cultural resources is often reflected in increased resale values, and, although "quality of life" benefits are sometimes difficult to accurately measure, CRM may be used as an effective tool for developing a sense of corporate or community identity that increases economic productivity and encourages new investment.

❒ Finally, a growing number of federal and state laws provide financial incentives for preserving and protecting cultural resources. For example, landowners may qualify for a federal income tax deduction, and/or a reduction in estate tax, by donating conservation easements at particularly important cultural resources to non-profit conservancy groups.

Federal investment tax credits are also available for rehabilitating and reusing historically significant buildings and structures. (Unlike some neighboring states, Minnesota does not have property tax abatement for cultural resource properties.) For current information on tax incentives, contact the State Historic Preservation Office. See *Resource Directory.*

Cultural Resource Management and the Law

Although these guidelines are designed to be voluntary, forest managers will need to know something of the non-voluntary, regulatory side of CRM. The legal basis for CRM is deeply rooted in federal and state legislation concerned with natural resource conservation and environmental protection going back to the early 1900s.

The National Historic Preservation Act (NHPA) of 1966, as amended, is the centerpiece of the national historic preservation program and has become an important component of state and local CRM programs in Minnesota. NHPA establishes the National Register of Historic Places and provides for State and Tribal Historic Preservation Officers to implement the national preservation program. Section 106 of NHPA requires that federal agencies consider the effects of their activities on cultural resources.

The State of Minnesota has also adopted laws designed to ensure that both natural and cultural resources are considered in government decision-making. These laws include state environmental policy and environmental rights acts. Virtually all environmental legislation currently on the books applies to CRM issues.

Cultural resource laws in general are intended to ensure that **significant resources will be taken into consideration** when activities are planned that might damage their scientific or cultural values. Both federal and state laws protect cultural resources. In some cases, one or more of these laws might apply on private property as well.

Human burials are given special consideration under both federal and state law. The Minnesota Private Cemeteries Act (MS 307.08) protects all human burials in the state from disturbance, regardless of age, ethnic affiliation or land ownership. Similar protection applies to burials on lands under federal control.

Many graves in pioneer cemeteries do not have markers, making identification and protection more difficult. This headstone, found in a pioneer cemetery in Aitkin County, was on the only one of eight graves with an easily recognizable marker. *Photo courtesy of Minnesota DNR Forestry Heritage Resources Program*

For cultural resources other than cemeteries, how a law applies is determined by three factors:

- ❒ Land ownership
- ❒ The source of funding being used for the activity
- ❒ Any permitting authority that might be involved

Federal law applies whenever activity takes place on federal land **or** will use federal funds **or** will require a permit issued pursuant to federal authority. State law applies whenever the activity is on non-federal public land **or** will use non-federal public funds. If human burials are known or suspected to be present, state law applies regardless of ownership.

Although administration and enforcement of environmental protection laws vary, forest managers would do well to assume that, whenever a government permit or license is required, some kind of CRM review and compliance may also be required.

Federal and state laws, for example, require public land forest managers to consider the effects of their projects on cultural resources. When a cultural resource eligible for inclusion on the National Register must be destroyed or damaged by forest management activities on public land, public funds may be used to recover important historical, archaeological or cultural data that would otherwise be lost.

Burial sites are a special category of cultural resources. Under the Minnesota Private Cemeteries Act, all human burials are afforded the same legal protection as platted cemeteries, regardless of land ownership.

Including Cultural Resource Management in Strategic Planning

For forest landowners with large tracts of ownership, a comprehensive cultural resource management plan may be the most effective way to integrate protection of cultural and historical resources with forest management. Comprehensive planning would assist forest land managers to identify both known cultural resources and areas with potential to contain unrecorded cultural resources. For small landowners and operators, stewardship plans should establish priorities for dealing with cultural resources within the framework of site conservation planning.

Identifying, Assessing and Managing Cultural Resources

Checking Cultural Resource Inventories

Information is available that may help landowners and forest managers in identifying cultural resources. Cultural resource surveys and their resulting inventories form an important basis for forest management decisions that affect cultural resources.

The first step in cultural resource management (CRM) planning is to check existing cultural resource inventories to determine whether any important cultural resources are known to be present within a given area. (See *Appendix B: Cultural Resource Inventory Sources in Minnesota*.) In particular, landowners and forest managers are encouraged to check for recorded burial sites in management areas.

While other inventories exist (such as those maintained by local units of government and county historical societies), the inventories listed in the Appendix provide the most comprehensive databases, as well as professional staff to provide assistance.

Most of the statewide cultural resource inventories maintain "hard copy" site maps that show specific cultural resource locations, as well as areas that have been surveyed for cultural resources. A formal written request is not necessary. Requests may be made by phone, and requested information is most often available within a few days.

Conducting a Pre-Field Review

If no surveys of a forest management site have been previously completed, landowners and operators may want to conduct their own assessment of the project area's cultural resource potential. This process may entail checking existing maps, air photos and printed historical information, as well as contacting individuals knowledgeable about local history or archaeology.

Documentary information that may be of assistance includes:

- ❐ Township, county, regional or state histories
- ❐ Historical maps, atlases and plats
- ❐ Government land surveyor field notes
- ❐ Information about local Indian communities
- ❐ Industry and business records
- ❐ Air photos
- ❐ Reports of previous cultural resource surveys
- ❐ Interviews with historians, archaeologists and other knowledgeable individuals

These materials are available in libraries and special historical research collections in larger cities; at colleges and universities; and in local public libraries, county courthouses and museums. Public agencies, large private landowners and corporations may have records or histories of their operations.

Assessing Cultural Resource Potential

Some locations are more likely than others to contain cultural resources. The following kinds of features may be expected to have high potential for cultural resources:

- ❐ Current shorelines or "terraces" adjacent to a permanent lake, river or stream

- ❐ Former shorelines, including glacial lakes (such as Agassiz, Upham, Duluth or others), abandoned river channels, solid dry land around large marshes and bogs, and abandoned high-water shorelines on lakes

- ❐ Junctions of water bodies, including stream inlets and outlets to lakes, and river junctions

- ❐ Good places to camp, including areas where people camp now

- ❐ Islands

- ❐ Peninsulas or points of land along a shoreline

❒ Areas adjacent to fish spawning beds, good fishing spots and wild rice beds

❒ Transportation routes, such as old trails, roads, portages and railroads (Many modern roads follow old trails and wagon roads.)

❒ Areas near community centers, such as towns and villages, especially in combination with transportation routes

❒ Depression-era tree plantings (often near old homesteads)

Field Identification of Cultural Resources

A walk-over inspection of the management area may reveal unrecorded cultural resources. Forest managers, landowners and others following these guidelines can undertake a preliminary assessment of a site's cultural resource potential. A walk-over inspection can be done at the same time as other field activities, such as timber inventory or timber sale preparation. Background information gathered during the cultural resource assessment process (see above) may provide some clues as to what kinds of cultural resources might be present and where to look for them.

Here are some things to look for:

❒ High spots offering a panoramic view

❒ Unusual natural features

❒ "Surface" artifacts (anything manmade). Check bare spots, eroded areas, tree tipups and cut banks. Look for broken clay pottery and stone tools ("arrowheads"), as well as manufactured items.

❒ Vegetation that grows in disturbed soils (including poison ivy, ragweed, chenopods, amaranthus and nettles)

❒ Surface features:

- Cellar and well holes
- Cement or asphalt slabs
- Fieldstone foundations and other structures
- Retaining walls
- Miscellaneous building materials (bricks, roofing materials, plaster and stucco)
- Metal pipes (such as well pipes)
- Earthen berms and trenches
- Shallow depressions (such as graves or ricing pits). Note: Such features could indicate possible burial sites. Contact the Office of the State Archaeologist or a cultural resource professional. For sources of information and assistance, see *Resource Directory.*

❒ Milled lumber (such as boards suitable for use in burial crosses, spirit houses or building construction). Note: Burial crosses or spirit houses could indicate possible burial sites. Contact the Office of the State Archaeologist or a cultural resource professional. For sources of information and assistance, see *Resource Directory.*

A traditional Ojibwe burial practice, spirit houses are found throughout forested areas of Minnesota. One example is this spirit house in Cass County, photographed in 1995. *Photo courtesy of Minnesota DNR Forestry Heritage Resources Program*

❒ Domestic or exotic plant species (including lilac bushes, fruit trees and daisies)

❒ Areas with traditional resources, especially where gathering is known to occur or evidence exists that the area is used (for example: wild rice, maple "sugar bush," birch bark, boughs, and such wild foods as berries, mushrooms, roots and herbs)

❒ Fence materials (wood or metal posts, or wire)

❒ Old roads, trails and portages (especially the junction areas where two come together or are associated with a clearing)

❒ Trash dumps containing antique items or jumbo-sized tin cans

❒ Clearings in the woods

❒ Objects in or attached to trees; blazed trees

❒ Standing structures and buildings. Ask these questions:

- How old is it?
- Who owned it? Who designed it? Who built it?
- What condition is it in?
- Is it associated with an important person or event?
- Is it an unusual architectural style?
- How much has it been altered from the original?

Assessing Management Alternatives (see Figure CR-1, page 20)

❒ **Protection by law:** If the pre-field review indicates that the project area contains a site protected by law (such as a burial site), further action will be determined by statute or regulations.

❒ **Identification as a low-sensitivity site:** If no cultural resources have been recorded and the pre-field review and walk-over inspection yielded no indications of important cultural resources, the site would have low sensitivity, which means there are probably no important cultural resources located there. Proceed with the management activity.

❐ **Identification as a high-sensitivity site:** If cultural resources are known to exist, or if the pre-field review and walk-over inspection indicate their presence, or if any of the features listed in the section *Assessing Cultural Resource Potential* are present (see page 15), the site has high sensitivity. In this case, the forest manager has several alternatives to consider, of which the following are recommended:

- Avoid the highly sensitive areas identified within the project area.

- Protect the cultural resource by means of the treatment and mitigation practices described in *General Guidelines: Protecting Cultural Resources* and applicable sections of the activity-specific guidelines.

- Bring in a cultural resource management professional to carry out a survey for archaeological and above-ground cultural resources. Doing so may incur additional costs. For sources of information and assistance, see *Resource Directory.*

When Accidental Discovery Occurs

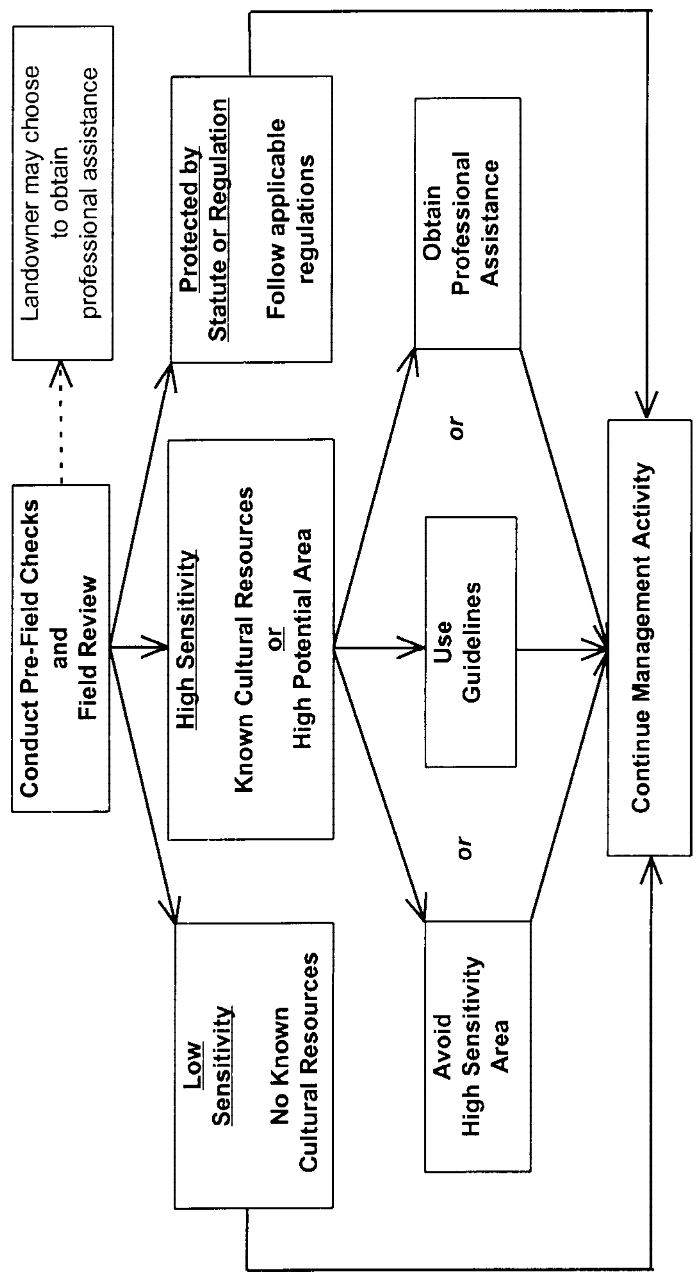
Unrecorded cultural resources may be discovered during operations. Guidelines for proceeding depend upon the nature of the discovery:

❐ In the case of human burials, if such discovery occurs, **temporary suspension of operations in the vicinity of the discovery is required.** If a human burial site is accidentally discovered, contact the Office of the State Archaeologist and the local law enforcement agency. For sources of information and assistance, see *Resource Directory.*

❐ For other types of cultural resources, such as archaeological artifacts, **temporary suspension is not required, but it is recommended.** Suspending operations in the immediate vicinity of the cultural resource will provide time to contact a cultural resource professional or develop plans to apply appropriate guidelines to avoid or mitigate potential effects to the cultural resource.

Figure CR-1

Recommended Procedure for Identifying, Assessing and Managing Cultural Resources



Take the following steps when important cultural resources are discovered during forest management activities:

- ❒ **Safeguard** the condition of the cultural resource by preventing further damage, loss or deterioration.
- ❒ **Investigate and document** the cultural resource in order to determine its significance and conservation potential.
- ❒ **Adjust work schedules** to allow time for data recovery or other mitigation measures, including following appropriate cultural resource guidelines.

Evaluation and Documentation

Evaluation uses the information generated during cultural resource identification to determine whether a particular cultural resource meets defined criteria. The most widely used standard for evaluating the significance of cultural resources is the National Register of Historic Places (NRHP). See *Appendix C: National Register Criteria for Evaluation of Cultural Resources.*

In most cases, the importance (or the cultural resource value) of any one archaeological site, building or area cannot be fully evaluated without comparing it to other cultural resources. As a general rule, CRM professionals (including state or tribal preservation office staff, college and university faculty, or consulting archaeologists and historians) are in the best position to recognize the qualities in a cultural resource that make it worth protecting.

Formal evaluations by cultural resource professionals are usually not necessary within the context of forest management activities. If the landowner thinks the cultural resource is important enough to follow the guidelines, no formal evaluation is necessary.

Documentation of cultural resources discovered during forest management activities is not required. However, landowners and operators are encouraged to make a written record of their discoveries and share that information with the Office of the State Archaeologist (OSA) or the State Historic Preservation Office (SHPO), as well as tribal authorities when appropriate.

The most important fact to document is the location of the cultural resource. See *Resource Directory* for information about cultural resource inventories, documenting cultural resources, and sources of information and assistance.

The Limitations of Mitigation

Cultural resources cannot always be preserved in place, even with the best CRM planning and treatment measures. There will be times when forest management requirements cannot be accommodated by avoidance or protective treatments. Sometimes, steps can be taken to mitigate adverse impacts. For example:

- ❒ Archaeological sites can be subjected to data recovery (salvage excavation) that extracts and preserves useful data that would otherwise be destroyed.
- ❒ Old buildings can be relocated to new sites or salvaged for curation in a museum.
- ❒ Historic structures and cultural features can be documented in the form of maps, photographs and written data, so that their informational value can be preserved.

The Value of Cultural Resource Education and Training

Cultural resource management is about people, not things. These guidelines have been designed to serve as both an information source and a stimulus to increase involvement by forest land managers in the conservation of Minnesota's cultural resources. Therefore, education will be the key to successful guideline implementation.

The use of landowners, foresters, loggers and other forest workers to carry out CRM practices is important because it will help ensure support for forest heritage conservation and reduce costs. Indeed, some of the specific skills applying to CRM that forest workers can demonstrate include first-hand knowledge of local resources, operation of heavy equipment, geographic information systems and photography.

While the amount of CRM training necessary will depend on the aspect of CRM in which those being trained will participate, all landowners and foresters will need at least a brief orientation to the specific challenges and opportunities of CRM, as well as the appropriate CRM terminology, planning methods, treatment and mitigation practices.

Logger education should emphasize the need for consistency in all aspects of CRM, especially cultural resource identification and treatment. Specific training should be made available to operators to enable them to identify and describe cultural resources in the field.

Selected Resources for Additional Information

The American Mosaic: Preserving a Nation's Heritage. 1987. Edited by Robert E. Stipe and Antoinette J. Lee. United States Committee/International Committee on Monuments and Sites (US/ICOMOS). The Preservation Press of the National Trust for Historic Preservation, Washington, D.C. *A one-volume primer on cultural resource management issues, providing an overview of the preservation movement in the United States today. Includes essays on how the national preservation program works, new directions in the preservation movement, private sector cultural resource management, and the place of archaeology in preservation.*

Guidelines for Evaluating and Documenting Rural Historic Landscapes. National Register Bulletin 30. Linda Flint McClelland, J. Timothy Keller, Genevieve P. Keller and Robert Z. Melnick. U.S. Department of the Interior, National Park Service, Interagency Resources Division, Washington, D.C. *This bulletin offers technical guidance for identifying and evaluating cultural resource values embodied in areas shaped by historical processes of land use, such as logging, agriculture, mining and transportation.*

Guidelines for Local Surveys: A Basis for Preservation Planning. 1985. Anne Derry, H. Ward Jandl, Carol D. Shull and Jan Thorman; revised by Patricia L. Parker. Published as National Register Bulletin 24 by the National Park Service. Washington, D.C. *In order to plan for the protection and enhancement of cultural resources, it is necessary to determine what sites and buildings make up that resource. This bulletin provides a wide range of information on identifying, evaluating and protecting cultural resources on both private and public land.*

Nearby History: Exploring the Past Around You. 1982. David E. Kyvig and Myron A. Marty. Published by the American Association for State and Local History. Nashville, Tennessee. *How to search for historic buildings and sites, how to recognize important cultural resources, and how to determine the best strategies for protection.*

The Prehistoric Peoples of Minnesota. Third Edition. 1983. Elden Johnson. Minnesota Historical Society, St. Paul, Minnesota. *This publication provides a general introduction to the first 10,000 years of human history in Minnesota, and explains the methods and goals of modern archaeology.*

Protecting Archeological Sites on Private Lands. 1993. Susan L. Henry, with contributions from Geoffrey M. Gyrisco, Thomas H. Veech, Stephen A. Morris, Patricia L. Parker and Jonathan P. Rak. Published by the National Park Service. Washington, D.C. *A useful handbook for private landowners interested in protecting archaeological sites, providing information on a wide range of techniques for managing archaeological resources. Includes a general overview of regulatory and non-regulatory strategies for land use planning and archaeological site stewardship.*

Unique Historical and Cultural Resources. 1992. Prepared for Minnesota Environmental Quality Board by Jaakko Pöyry Consulting. *This technical paper was prepared as part of the GEIS Study on Timber Harvesting and Forest Management in Minnesota. Defines cultural resources and describes potential impacts to them under various harvesting scenarios.*

Forest Soil Productivity

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FIGURES

TABLE

The Value of Forest Soil Productivity

Sustainable Soil Productivity

Soil productivity is defined as the capacity of soil, in its normal environment, to support plant growth. Soil productivity is reflected in the growth of forest vegetation or the volume of organic matter produced on a site. In forest management, soil productivity is most often measured in volume of trees produced; however, other methods of determining productivity exist, including forest community assessments.

"Minnesota's forest soils are a fundamental resource on which rests the ability of our forests to provide a wide variety of benefits."

Jaakko Pöyry 1992

The goal of these guidelines is to maintain the productive capacity of forest soils in Minnesota. A decrease in soil productivity could affect the level of timber harvesting the forest can sustain, as well as other forest values, such as wildlife habitat and biodiversity. Identifying and reducing impacts to this resource should be an essential part of any strategy to achieve sustainable forest management.

A certain amount of soil impact is inevitable when conducting some forest management activities. Many of the recommended practices are aimed at keeping this impact to a minimum level and affecting only a small percentage of a forest site.

Benefits of Forest Soil Productivity

Soil is the fundamental resource of the forest. Without it or its productive capacity, the other resources of the forest are diminished. Primary benefits of soil productivity include the following:

❒ Maintaining soil productivity is an important consideration in determining the level of timber harvesting the forest can sustain, as well as other forest values, such as wildlife habitat and biodiversity.

❒ Maintaining soil productivity sustains forest soils in a condition that favors regeneration, survival and long-term growth of desired forest vegetation.

❒ Maintaining soil productivity is key to sustainable forest management.

❒ Maintaining forest soil productivity is less costly than correction or mitigation, such as trying to fix damaged soils after the fact.

❒ Soil productivity influences what plants can grow on a site (or in the forest) and how well they grow.

❒ Maintaining the sustainability of forest soils is key to meeting society's need for forest products and other amenities of the forest.

Using Guidelines To Maintain Soil Productivity

Desired Overall Outcomes

These guidelines have been designed to lead to the following outcomes for all forest management activities:

❒ Increasing awareness and understanding of soil impacts caused as a result of forest management activities among forest landowner, resource managers, loggers, equipment operators and others involved in forest management.

❒ Maintaining forest soil conditions to favor regeneration, survival and long-term growth of desired forest vegetation.

❒ Minimizing the forest area occupied by roads, landings and primary skid trails.

❒ Encouraging the use of alternate equipment and operating techniques that avoid or reduce impacts to soils, so that forest management activities can be conducted with little or no reduction in soil productivity.

Soil Productivity and Sustainable Forest Management

Soil plays an important role in forest growth and management. It provides moisture and nutrients for tree growth, serves as a medium for root growth, and physically supports the equipment used in harvesting, yarding and other operations.

Maintaining soil productivity is critical to sustainable forest management. A decrease in soil productivity could affect the level of harvesting the forest can sustain, as well as other forest values, such as wildlife habitat and populations, and biodiversity.

Disturbances initiated by intensive forest management can have diverse impacts on the physical, chemical and biological characteristics of soils, which can, in turn, impact long-term productivity. For example:

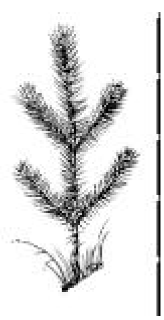
❒ Features such as access roads, landings and primary skid trails result in significant reduction of the productive capacity of the soils directly beneath them.

❒ Severe nutrient depletion reduces soil fertility, directly affecting vegetation growth.

❒ Soil compaction and associated disturbances reduce and disrupt soil porosity, thereby restricting water and air movement into and through the soil. This results in poor soil aeration, which negatively affects root growth and the activity of soil organisms involved in nutrient cycling and other processes.

❒ Compaction also increases soil resistance to root penetration, thus limiting the volume of soil available for root exploitation.

❒ Accelerated soil erosion leads to the removal of surface soil material and increased sedimentation of surface waters.



Some of these impacts (such as the development of roads, landings and skid trails) are an unavoidable consequence of forest access and utilization. These guidelines are intended to minimize negative impacts to soil productivity and ensure the continued sustainability of forest management in Minnesota.

When planning forest management activities, prevention of negative impacts is more desirable than correcting impacts after they have occurred. Mitigation of impacts to the soil after they have occurred can be costly and may not be very effective. It is more effective to prevent impacts from occurring than to resort to such mitigation measures as deep subsoiling, constructing erosion control devices, fertilization or filling in ruts.

Pre-planning and on-site soil investigation are good tools for avoiding negative soil impacts. Soil conditions should be evaluated to determine suitable species, preferred seasons of operations, and preferred site preparation and regeneration techniques.

For example, soils susceptible to severe compaction or rutting under typical climatic conditions should be identified as requiring harvest under frozen ground conditions or with specialized equipment.

Predicting the operability of a site will help protect the site, as well as save operators from the costly process of moving equipment off a site after discovering that negative impacts are occurring. If unique weather conditions occur or specialized equipment is available, these soils may be operable under non-frozen conditions.

Applying Guidelines to Varying Site Conditions

Forests in Minnesota grow on a wide variety of soils and site conditions:

- **Hundreds of different "soil types" have been identified** in the forested portions of Minnesota. These soils include deep organic soils in peatlands; shallow soils over bedrock; dry sandy soils formed in outwash or beach deposits; deep moist loamy and clayey soils formed in rolling glacial till; and poorly drained fine loamy and clayey soils formed in level lake plains.

- **Topography also varies greatly** in Minnesota forest regions, from steep long valley slopes in the southeast to nearly flat lake plains or short steep irregular slopes of the northern forests. Each site presents unique conditions and opportunities.

Because of the great variety of soils and site conditions in Minnesota's forested areas, it is impossible to develop guidelines that cover every situation. These guidelines are intended as a set of general recommendations to be applied to forest management in Minnesota.

Because site conditions vary, it is very important that individuals making forest management decisions evaluate the soil conditions on the site they are considering. Specific soil conditions will allow the manager to develop specific prescriptions for a given site that will ensure that the productive capacity of a site is not reduced due to forest management.

Soil Characteristics and Potential Impacts

Three Related Groups of Soil Characteristics

These guidelines refer to physical, chemical and biological aspects of soils. These three characteristics are closely interrelated, and impacts on one aspect may influence others:

- ❐ The physical properties of soil include such factors as soil texture, structure, porosity, soil density, drainage and surface hydrology.
- ❐ The chemical properties of soil include nutrient status (inputs and outputs) and pH.
- ❐ The biological properties of soil include the multitude of organisms that thrive in soil, such as mycorrhizae, other fungi, bacteria and worms.

Because of the nature of forest management activities in Minnesota, the risk or significance of impacts to soil properties appears to be highest for physical properties, followed by chemical properties, and finally by biological properties.

For example, in Minnesota, forest management sites with reduced growth because of nutrient loss due to timber harvesting are relatively uncommon, while sites that have suffered due to physical impacts are more common. Impacts to physical characteristics also appear to be more long lasting.

In addition, it appears that, if care is taken not to negatively impact the physical and chemical properties of the soil, then the biological aspects take care of themselves. However, if a soil is severely compacted, then forest plants cannot utilize nutrients because of the poor physical rooting environment, and the soil organisms responsible for nutrient cycling are limited as well.

Physical Characteristics of Soil and Potential Impacts

Soil physical properties include soil texture, structure, porosity, soil density, drainage and surface hydrology. These properties are very important in influencing what plants can grow on a site and how well they grow.

The physical soil properties determine the ease of root penetration, the availability of water and the ease of water absorption by plants, the amount of oxygen and other gases in the soil, and the degree to which water moves both laterally and vertically through the soil.

Soil Compaction

According to Jaakko Pöyry (1992), "Soil compaction is one of several types of closely related physical soil disturbances that can occur during timber harvesting and forest management activities. The other types of physical soil disturbance include puddling, rutting and scarification. These disturbances often occur simultaneously and are almost exclusively caused by:

1) Trafficking by heavy equipment during felling, forwarding, skidding and site preparation operations

2) The dragging action of logs as they are moved from the stump to the landing

3) Slash disposal and the creation of planting or seeding sites during site preparation

"It is difficult to distinguish between each type of disturbance in terms of their effect on site properties, and all of these disturbances are often referred to generically as soil compaction.

"Soil compaction is the increase in soil density resulting from loads applied to the soil surface. During the compaction process, soil volume is decreased primarily through the elimination of macropores (pores > 0.002 inches in diameter). Pore volume and pore size are key properties that govern gas and water relations in the soil. Because of their relatively large diameter, macropores are particularly important in regulating the rates of water and gas movement."

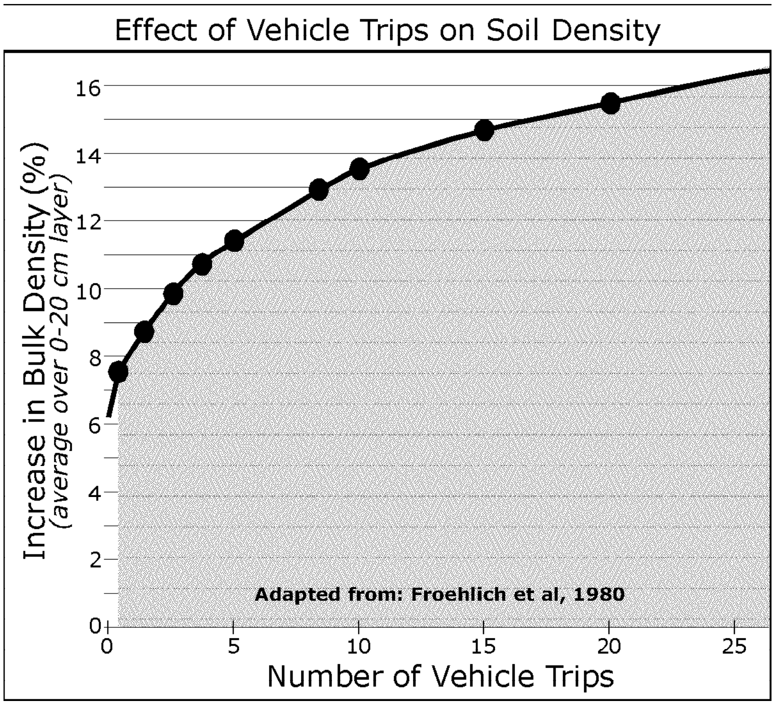


Figure S-1

The first few trips (with heavy equipment) over the soil surface produce the greatest increase in soil density. A large percentage of the increase in soil density occurs during the first six trips on some soils (Froehlich et al 1980). (See Figure S-1.) Machine vibration may also contribute to compaction.

Recovery of compacted soil is variable depending on the severity of the compaction and local conditions. Most studies, however, indicate that recovery from compaction and its effects is long term rather than short term.

Severely compacted soils may require up to 40 years or more to recover naturally, according to Hatchell and Ralston (1971). Froehlich and McNabb (1984) state that "...the effects of soil compaction should be assumed to persist for several decades on forest sites."

Even in cold climates, where the action of freezing and thawing presumably loosens soils quickly, the density of compacted soils decreases slowly (Voorhees 1983 and Corns 1988). In an ongoing study in Minnesota and the Lake States (Stone and Elioff 1998), no reduction in soil density has been measured 5 years after intentional compaction.

"Soil compaction affects site quality and tree growth through its effect on the rooting environment....Reduced aeration significantly decreases the respiratory activity of plant roots and their capacity to supply the plant with adequate moisture and nutrients" (Jaakko Pöyry 1992).

"Compaction also increases soil strength, which reduces root growth by increasing soil resistance to root penetration....The decrease in porosity associated with compaction also reduces soil infiltration capacity or the rate of water movement in the soil....In addition to reducing the amount of soil water available for plant growth, slower infiltration capacities result in increased amounts of over-land flow, which can lead to increased erosion rates" (Jaakko Pöyry 1992).

Rutting

Rutting is the creation of depressions made by the tires of vehicles such as skidders, log trucks and pickup trucks, usually under wet conditions. Rutting occurs when the soil strength is not sufficient to support the applied load from vehicle traffic. A few examples of the effects of rutting:

❒ Rutting affects the surface hydrology of a site as well as the rooting environment. The process of rutting physically severs roots and reduces the aeration and infiltration of the soil in the rut itself, thereby degrading the rooting environment.

❒ Rutting also disrupts natural surface water hydrology by damming surface water flows, creating increased soil saturation up-gradient from ruts, or by diverting and concentrating water flows, creating accelerated erosion.

❒ Soil rutting is also an important indication that other physical soil impacts may be occurring on a site.

Protecting Soil Resources

Timing of forest management activities, development of infrastructure, and selection of equipment and operating techniques are all critical components contributing to the effectiveness of forest management activities, as well as the protection of the soil resource. It is important to avoid operating heavy equipment on a site when adverse soil impacts are likely, and to limit direct trafficking of a site to the smallest area possible.

The susceptibility of soil to compaction and rutting is primarily dependent on soil texture and moisture content. Soils are most susceptible to compaction, puddling and rutting during spring/early summer months, immediately following heavy rains, and in the fall after transpiration has ceased and before freeze-up.

Soils most susceptible to compaction and rutting include fine-textured soils (silty clay, sandy clay and clay) and medium-textured soils (fine sandy loam, very fine sandy loam, loam, silt loam, silt, silty clay loam, clay loam, and sandy clay loam). Poorly and very poorly drained soils of any texture are susceptible to compaction and rutting during most years when not frozen.

The preferred operating season for any one site may vary depending on local climatic conditions, equipment being used and operating techniques. The use of low ground pressure (LGP) equipment and such operating techniques as the use of slash mats to drive on can extend operating seasons on low-strength soils. Infrastructure, such as roads, landings and skid trails, directly impacts the soils that it is developed on; therefore any reduction in the area occupied by infrastructure reduces the impact to soil productivity. For more information on how to obtain soil interpretations relating to equipment operation, see *Resource Directory.*

Peatland Timber Harvests

Peatlands are a unique ecosystem producing valuable wood products. These soils pose specific management concerns and harvesting issues, including low soil strength and low nutrient status.

Typically these sites are harvested when soils are frozen. New technologies and equipment allow harvesting on theses sites under non-frozen conditions with minimal impact. LGP equipment, including eight-wheeled tracked forwarders, portable artificial mats, natural slash mats and cable logging systems, are all options for completing harvesting with an impact on soil productivity that is similar to conventional winter harvest methods.

These technologies are especially suitable for shallow organic soils adjacent to high land (likely to a maximum of 500 feet) and on pockets of organic soils within highland soils. Timber harvesting on deep peat soils under non-frozen conditions in large peatlands is not practical because of low soil strength and lack of truck access.

Soil Erosion

Soil erosion is another type of physical soil impact that can occur as a result of soil disturbance during timber harvesting, site preparation and other forest management activities. Soil erosion is the process by which soil particles are detached and transported by water, wind and gravity to some downslope or downstream point. Erosion is a natural process. Increased erosion that occurs due to human activity is considered to be accelerated erosion.

Almost all accelerated erosion on forested lands in Minnesota follows major disturbances that increase the exposure of soil to water (Patric and Brink 1977, as cited in Jaakko Pöyry 1992). Several factors can influence the rate of soil erosion on a site: rainfall intensity and duration, slope steepness and slope length, erodibility of the soil on the site, and soil cover (overstory and surface cover) (Dissmeyer and Foster 1980).

When all other factors are held constant, surface erosion rates increase with increasing rainfall intensity, increasing slope steepness, and increasing slope length (Jaakko Pöyry 1992). Perhaps the greatest factor controlling surface erosion in forests is the amount of vegetative cover and forest litter protecting the soil surface (Megahan 1990, as cited in Jaakko Pöyry 1992).

Soils with the highest inherent erodibility contain high proportions of fine sand and silt, low amounts of soil organic matter, and slow permeability. Table S-1 shows the relative erodibility hazard for different soil textures. Extra care should be taken on silt, silt loam, loam, very fine sandy loam, sandy clay loam, silty clay loam and clay loam soils, as these soils tend to erode easily when disturbed or exposed, especially on long slopes or slopes greater than 10%.

Table S-1

Soil Erosion Susceptibility of Texture Classes

Surface Soil Texture	Susceptibility to Erosion
Silt, silt loam, loam, very fine sandy loam	1 (highest)
Sandy clay loam, silty clay loam, clay loam	2
Clay, silty clay, sandy clay, very fine loamy sand, fine sand loam	3
Sandy loams	4
Loamy sands, sands	5 (lowest)

According to the 1994 Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota (GEIS), the greatest erosion rates in Minnesota were estimated to occur in southeastern Minnesota. The potential for erosion in this part of the state is approximately two to three times the estimated rates of the rest of the state. This landscape has the steepest slopes (averaging 45% in many areas), and the southern portion of the state also has the highest rainfall intensity (Jaakko Pöyry 1994).

Soil erosion impacts the long-term productivity of a soil by removing nutrients and surface soils (which contain a high percentage of nutrients and water-holding capacity of soil). This eroded material (sediment) is then deposited on top of downslope soils, covering up richer surface soils with less productive material. Erosion on skid trails and roads reduces the ability of the soils in the trail or road to revegetate. It also tends to create a poor transportation system that encourages the creation of more trails and roads to replace the eroded ones.

Accelerated erosion is caused by forest management activities that result in the following:

- ❒ Removal of vegetation and litter, or disturbance of surface soil, which exposes mineral soil to rain and water.
- ❒ Soil compaction, which decreases the rate of water infiltration into the soil.
- ❒ Concentration of surface runoff (Jaakko Pöyry 1992). Areas of soil disturbance, such as roads, landings, skid trails, fire lines and site prep areas, can all create soil erosion problems.

For timber harvest areas, the GEIS suggests that mitigation strategies be concentrated around forest roads, skid trails and landings. If the guidelines for reducing compaction and related disturbances are followed, erosion will be reduced. Soil compaction, puddling, rutting and scarification decrease the rate of water movement into the soil, which increases overland flow, channels and concentrated surface runoff, and reduces protective surface cover (Jaakko Pöyry 1992).

One of the most effective means of reducing erosion is to reduce the volume, velocity or distance of travel that water flows down a road, landing or skid trail. This reduction can be accomplished using various water diversion techniques identified in *Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota* (1995).

Implementing practices identified in the BMP guidebook will prevent erosion concerns in most situations. However, erosion control practices as stated in the guidelines should be applied to all sites, not just those sites with direct impact to water quality.

Chemical Characteristics of Soil and Potential Impacts

Soil chemical properties include nutrient status of a soil and soil pH. Soil chemical characteristics are influenced by many things, including soil origin, soil texture and drainage, degree of soil weathering and development, and organic matter type and content. These characteristics vary widely in Minnesota's soils. Forest management affects the nutrient status of a soil/site through 1) removal of nutrients in forest products and 2) disturbance of surface soils through harvesting and site preparation activities.

Nutrient Cycling

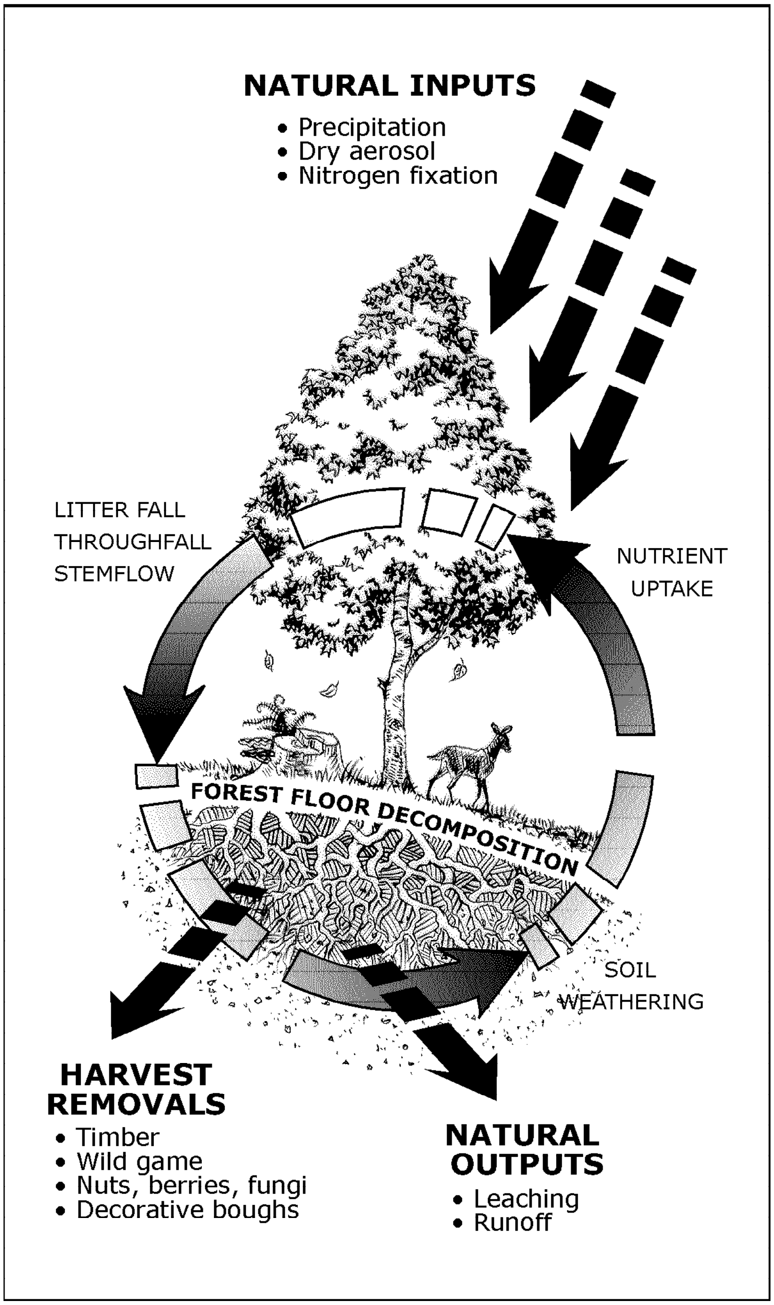
Nutrient cycling is the process by which nutrient elements move into, out of, and within an ecosystem. The forested ecosystem in Minnesota receives natural inputs of nutrients through atmospheric deposition and geologic weathering. See Figure S-2.

Through the life of a stand, these inputs can be significant. Outputs of nutrients occur through timber harvesting or other practices (such as site preparation) and through soil leaching and surface runoff (Jaakko Pöyry 1992).

In Minnesota and adjoining areas, nutrients that are of primary concern for forest growth are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Complete understanding of nutrient use and sustainability requires not only knowledge of the amount of nutrients removed during the harvest (or through poor site preparation techniques), but also knowledge of the nutrient capital of the soil and the rates of natural additions and losses of those nutrients.

Figure S-2

Nutrient Cycling



In contrast to the annual harvests associated with agriculture, forest harvest—and hence nutrient removal—typically occurs only once per rotation or every 40 to 120 years. This not only reduces the rate of removal, but the long-time interval makes natural additions of nutrients by atmospheric deposition and by weathering of soil minerals very important in maintaining nutrient status.

In agriculture, deficiencies of macronutrients have occurred when the rate of nutrient removal via harvest exceeds the reserves in the soil and the annual replenishment through natural processes.

In forest ecosystems, timber harvesting and some site preparation practices remove nutrients and have the potential to create deficiencies if the removal of nutrients through these practices is greater than the replenishment through natural processes during the time between harvests and the amount of nutrients removed from harvest represents a large portion of the soil reserves.

The Balance of Inputs and Outputs

"A long-term view of forest nutrient status of an ecosystem must focus on the balance of inputs and outputs as they affect the nutrient capital. The nutrient capital can be considered to be a resource that can be used by trees, but whose availability depends on the internal dynamics of the system. If inputs of nutrients to a forest ecosystem exceed outputs from that system, then the nutrient capital in the system will increase. Conversely, if outputs exceed inputs, nutrient capital will decrease" (Jaakko Pöyry 1992).

The initial nutrient capital of a site varies widely by soil type. For example, a fine loamy soil formed in lacustrine sediment may contain four times the amount of calcium in the rooting zone than a well-drained sandy soil formed in outwash deposits (Jaakko Pöyry 1992).

Outputs can occur through timber harvesting, removal of slash or surface soil during site preparation, burning, leaching or surface runoff. Most macronutrients that are removed from a site through timber harvest are replaced over the period of the rotation by nutrient inputs through such processes as precipitation, dust deposition and nitrogen fixation. Some notable exceptions are calcium after harvesting aspen stands, and phosphorous and potassium after harvesting on organic soils (Jaakko Pöyry 1992).

Different nutrients are stored in different parts of a tree, and different tree species store the nutrients in different relative abundances throughout the tree. For example, aspen utilizes a relatively high amount of calcium and stores roughly 50% of the calcium in the bole-wood and bark of the tree. Because nutrients that are contained within the harvested portion of a tree are removed from a site, species that store high amounts of nutrients in the bole-wood and bark result in higher amounts of nutrient removed when harvested.

Nutrient removal associated with timber harvest is very dependent on the species being harvested and on the components, or parts of the trees, being removed. For example, a full-tree harvest during the growing season will remove virtually all the nutrients stored in the above-ground part of the trees.

In the case of merchantable bole harvest, with limbing at the stump, the nutrients in the crown and in the upper portion of the woody stem (above the merchantable top diameter) are retained on the site. If trees are skidded to a landing before limbing, then the nutrients in the crown are removed from the actual site of growth as well (Jaakko Pöyry 1992).

Mineral Soils

An analysis of data that were available at the time of the GEIS indicated that, on some sites, some nutrients were being removed by the harvest at a greater rate than the rate of natural additions (defined as *mining* by the GEIS). On mineral soils, the nutrient that was most often of concern was calcium; other nutrients were seldom lost at greater rates than additions.

This caused concern about the relationship of calcium loss to sustainability of forest production. Recent studies have produced additional information indicating that the issue of calcium depletion is less significant than indicated in the 1992 GEIS (Wilson and Grigal 1995).

In summary, the mineral soil sites for which nutrient depletion may become a concern after two or three rotations include aspen (or other hardwoods) on well-drained sandy soils and aspen (or other hardwoods) on shallow (8 inches or less) to bedrock soils.

Aspen grow poorly on these soils, and are often termed "off-site aspen." A rational management strategy for these sites is conversion to pine (red or jack pine) where appropriate. Both pines are more productive on these sites, and they demand much less calcium. On other upland sites, nutrient depletion is usually not an acute problem, but one that can be further studied and dealt with in the future without affecting sustainability.

Other nutrient-retention strategies for these sites include the following:

- ❒ Retaining or redistributing slash on the site
- ❒ Avoiding full-tree harvesting or full-tree skidding that piles slash without redistributing it
- ❒ Addition of nutrients to the site
- ❒ Avoiding shortened rotations

Many modern harvesting systems require full-tree skidding for efficiency of the operation. In these situations, slash can be redistributed out to the site from the landing. Caution should be exercised during non-frozen seasons to avoid trafficking additional areas while redistributing slash. The negative effects of soil compaction due to increased trafficking could outweigh the positive benefits of redistributing slash. It may be advantageous to leave clumps of slash (drags left along skid trails) or leave slash in the skid trails.

Organic Soils

Most deep organic soils in Minnesota (soils with greater than 24 inches of organic surface) contain a relatively low amount of phosphorus (P) and potassium (K) in the rooting zone of the organic soil surface. Deep organic soils do not have a nutrient input of mineral weathering to replenish nutrients; instead, these soils depend solely on atmospheric deposition.

Black spruce is the major species harvested on peatland soils, and many harvesting techniques remove the full tree from the site, including branches and needles. In the case of organic soils, available evidence indicates that this removal of the full tree leads to removal of a large proportion of the potassium and a relatively large proportion of the phosphorus from the site. Rates of replenishment for P and K are low; about 100 years are required to rebuild K reserves to their original level after harvest.

Removal of only the woody bole and associated bark does not lead to these large losses of potassium and phosphorus. Thus, full-tree harvest may be inappropriate without corrective measures such as fertilization. Site preparation techniques that pile or windrow slash result in a similar removal of nutrients from the general area of a site. These practices have an effect similar to full-tree harvesting.

Mechanical Site Preparation

Many mechanical site preparation techniques involve the disturbance, redistribution and possibly the removal of surface soils. The surface horizons of most forest soils are very important to the productivity of the soil. These horizons are rich in organic matter; they contain the bulk of the soil's nutrient and moisture-holding capacity; and they provide a source of mychorrizae. Surface horizons also cushion soil from traffic and buffer extremes in temperature. Severe treatments that remove or displace the surface organic and mineral soil layer may result in nutrient removal and other site degradation, such as soil erosion and compaction.

It is important to remove the surface soil as little as possible from the immediate area of the seedling. Practices that remove surface soil from the general vicinity of a seedling (such as dozing soil into windrows) should be avoided, as these practices remove the many benefits of surface soil from the area utilized by a seedling.

The removal of surface soil is exaggerated with extremes of soil types. In other words, coarse dry soils and wet fine soils, or soil shallow to bedrock, are most likely to be severely impacted from surface soil removal. "Extremely shallow soils have a limited store of nutrients and are sensitive to disturbance, as are coarse-textured, excessively well-drained soils, whose limited nutrient reserves resides principally in the surface organic layer and in logging debris. Any treatment of such sites should retain as much of the organic layer and any logging debris as possible or mix the organic and mineral layers together" (Sutherland and Foreman 1995).

Slash provides shelter that mediates climatic extremes and contributes organic matter (nutrients and water-holding capacity) to forest soils. Although slash may create some hardship when planting a site, windrowing or piling of slash should be avoided, and scattering of slash should be encouraged. This is particularly important on coarse droughty soils.

According to the forest soils technical paper of the GEIS (Jaakko Pöyry 1992): "There is virtually no justification, from the standpoint of nutrient status, for use of any site preparation technique that displaces material. Site preparation techniques that incorporate materials (such as disking) or only displace materials short distances (such as the Brakke scarifier) do not have negative impacts on nutrients."

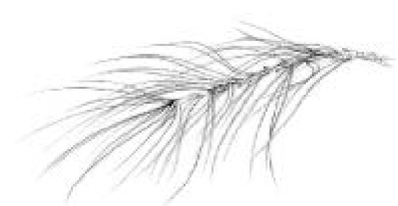
Prescribed fire is used to reduce slash for ease of planting, setting back or killing competing vegetation, or exposing mineral soil for seeding. "Hot" slash burns on dry sandy soils have the potential to reduce soil productivity by consuming the forest floor, which reduces the water-holding capacity of these sites, volatilizes some nutrients, and makes nutrients rapidly available to plant uptake, runoff or leaching.

Biological Characteristics of Soil and Potential Impacts

Biological characteristics of soil include the population of plants and animals that thrive in a particular soil, including microflora (fungi, bacteria, algae) and microfauna (worms, arthropods, protozoa). Forest soils contain a multitude of microorganisms that perform many complex tasks relating to soil formation, slash and litter disposal, nutrient availability and recycling, and tree metabolism and growth. Generally the number of organisms are greatest in the forest floor and the area directly associated with plant roots (Pritchett 1979).

The population of soil organisms (both density and composition) and how well that population thrives is dependent on many soil factors, including moisture, aeration, temperature, organic matter, acidity and nutrient supply (Pritchett 1979).

These physical and chemical soil characteristics are influenced by forest management as previously indicated. Impacts to these soil properties may directly impact the soil biology, thereby impacting the functions of the organisms, many of which are beneficial to plant growth. Implementation of practices that protect the physical and chemical properties of the soil, also protect the "habitat" of the soil organisms and result in sustaining these populations.



Enhancement of Soil Productivity

In addition to guidelines to mitigate against potential negative impacts to soil productivity, opportunities exist to enhance soil productivity. In these guidelines, the term enhancement is defined as improving the current productive potential of a site or fully expressing the productive capacity of a site.

To sustainably meet society's need for forest products and other amenities of the forest, intensive management of a portion of the forest resource may be necessary. The following section describes some of the available options to improve productivity.

Fertilization

Fertilization is often used in agriculture to improve outputs of a particular crop and maintain productivity. In forestry, opportunities exist to increase fiber outputs through fertilization.

Limited research has been done on fertilization of species common in Minnesota. Recommendations for forest fertilization need to be better refined in order to understand situations in which this practice is biologically beneficial and economically effective.

Generally speaking, returns on investment in forestry are greater when made on sites closer to markets, due to transportation costs. Fertilization treatments made later in the rotation have the benefit of reducing carrying costs of money and increasing growth when trees are adding merchantable volume.

Detailed nutrient analysis of the soil and fertilizer should be done before application. Water quality guidelines related to pesticides use should be followed when applying fertilizers.

Genetic Improvement

Capturing a site's potential can often be improved by using improved genetic material. In Minnesota, seed orchards have been developed through concentrated cooperative breeding efforts over the past 20 years. These efforts have been focused on improving growth, tree form and insect and disease resistance.

Seedlings grown from improved seed are available commercially. Currently the most widely-planted species in forested environments are Norway (red) pine, jack pine and white spruce. These species have different opportunities for improved growth. For example, Norway (red) pine has a narrow genetic variability, whereas jack pine has a wide genetic variability.

Shortened Rotation

On those sites where nutrient depletion is not a concern, it may be possible to increase fiber production by reducing rotation age. Given the age distribution of Minnesota's forest resources, capturing production of a portion of these stands may be useful to stabilize the flow of available timber in the future. Feasibility of reducing rotation age will depend on several factors, including end-product, harvesting equipment and nutritional status of the site. Research is needed to better understand the ramifications of reduced rotation on other site factors and to develop guidelines for identifying sites on which reduced rotations could be implemented.

Preventing Flooding

In some cases, increases in tree growth are possible through maintenance of proper drainage. Maintaining proper drainage may include controlling beaver populations to prevent flooding of forested areas and maintaining natural drainage, where consistent with landowner and landscape objectives.

Bedding, mounding and other site preparation methods that modify microsite conditions for tree establishment may also be beneficial for tree growth on saturated soils. These techniques are effective in improving aeration in the root zone immediately after planting, thereby improving early tree growth and survival. It is important on these sites to plant and manage species suitable to the poorly drained conditions.

Competition Control

Controlling competing vegetation has significant positive effects on survival and growth of trees. Various methods, including herbicide use, should be used to control competing vegetation early in the rotation to achieve maximum fiber productivity.

Thinning/Timber Stand Improvement

Commercial and pre-commercial thinning may be useful to capture the productive capacity of a stand. Thinning concentrates growth on fewer stems, thereby increasing the recovery of usable fiber. In addition, thinning can have the effect of shortening rotations by increasing the growth rate of individual trees, thus producing larger trees at an earlier age.

Thinning also allows selection of the most desirable trees in a stand on which to concentrate volume growth. This technique has the effect of increasing the overall value of the stand and presenting the opportunity to provide higher economic returns to landowners by increased product value at an earlier age.

Species/Site Matching

Matching the appropriate species to specific site conditions has the ability to increase forest productivity. For example, aspen growing on coarse-textured soils ("off-site") may decrease the nutrient capital of these sites over time and produce lower yields compared to other species. To increase productivity on these sites, pine species will generally be a more efficient species, both from the perspective of fiber production and nutrient conservation.

Riparian Areas

CONTENTS

FIGURES

The Value of Riparian Areas

A Transition from Aquatic to Terrestrial Ecosystems

A **riparian area** is the area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes and open water wetlands. See Figure RMZ-1.

Riparian areas are among the most important and diverse parts of forest ecosystems. They support high soil moisture and a diversity of associated vegetation and wildlife, and they perform important ecological functions that link aquatic and terrestrial ecosystems:

❒ Riparian areas maintain streambank, channel and shoreline stability, stream temperature and water quality.

❒ Riparian areas provide water storage and conservation, nutrient and food input to the aquatic system, instream structure of coarse woody debris, and a moderated microclimate.

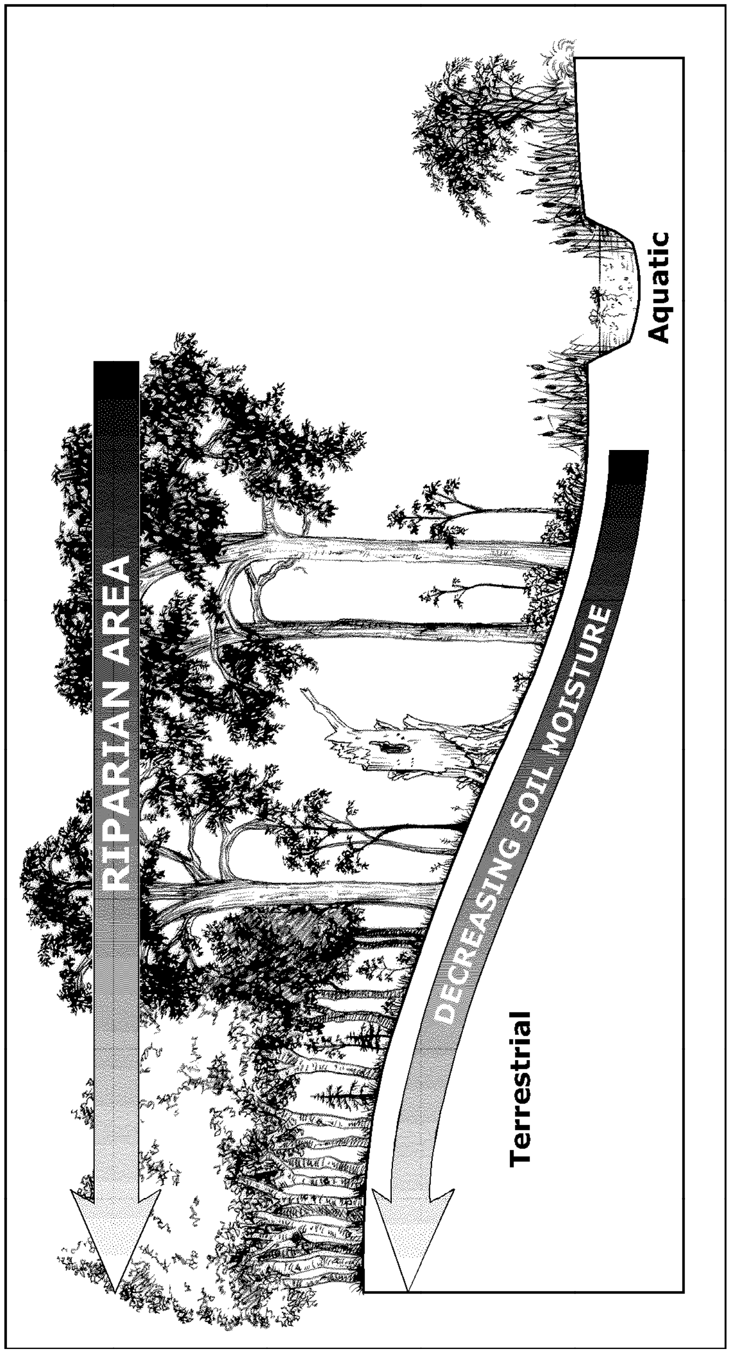
❒ Riparian areas also provide important habitat for many species of fish, mammals, birds, reptiles, amphibians and insects.

❒ Riparian areas are also important for recreation, tourism, forest products, hunting, fishing, biological diversity and other human values they provide.

To protect the functions and values of riparian areas, riparian guidelines recommend specific **riparian management zones (RMZs)** for streams, lakes and open water wetlands. These RMZs are applied in the portion of the riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs.

Figure RMZ-1

Transition from Aquatic to Terrestrial Habitat in a Riparian Area



Protecting Riparian Functions and Values

The purpose of these voluntary guidelines is to protect riparian functions and values by minimizing the potential adverse impacts of forest management. These functions and values include:

- ❒ Timber production
- ❒ Moderation of riparian microclimates caused by canopy shade (including water temperature and soil temperature)
- ❒ Bank, channel and shoreline stability
- ❒ Recruitment of coarse woody debris
- ❒ Habitat diversity
- ❒ Biotic and microhabitat diversity
- ❒ Resiliency to natural catastrophes

Impacts that may occur during forest management activities can affect the functions associated with riparian areas. Some of the issues and concerns associated with conducting forest management activities within forested riparian areas have been summarized (Laursen 1996).

For example, timber removal may increase water and sediment yields, leading to stream channel destabilization and loss of aquatic habitat. It may also decrease woody instream cover, destabilize streambanks, reduce shading, increase water temperatures, reduce inputs of fine litter to the water body, and reduce the diversity of plants and animals in the area. Also, road crossings may add sediment and cause bank failures.

From a landscape perspective, managing a greater proportion of the riparian area for uneven-age mixed stands of longer-lived species suitable to the site can help protect riparian functions and values.

Forested riparian areas perform important ecological functions that link aquatic and terrestrial ecosystems. They are also highly valued by humans because of the wide array of products and services they provide. These beneficial functions and values include the following:

❒ Maintaining soil, channel and streambank stability, stream temperature and water quality

❒ Providing water storage and conservation

❒ Providing nutrient and food input to the aquatic system

❒ Providing instream structure of coarse woody debris

❒ Providing a moderated microclimate

❒ Providing diverse and productive habitat for aquatic and terrestrial wildlife, habitat continuity and travel corridors for wildlife, and support of unique habitats and communities

❒ Providing for recreation, tourism, forest products, hunting, fishing, biological diversity and other human values

The Importance of Riparian Areas

Retaining vegetation, including trees, within riparian areas is key to maintaining functional linkages between the terrestrial and aquatic ecosystems, including the following:

❒ **Retaining nutrients and sediment and maintaining water quality:** Riparian vegetation plays a very important role in retaining nutrients, sediment and organic matter. Intact riparian vegetation also acts as a very effective filter to maintain or improve water quality.

Within the riparian area, the vegetation traps suspended material and slows the water velocity, allowing sediment to settle out. It also slows downslope movement of leaves and branches, providing time for their decomposition and the recapture of nutrients before they reach the water body. Plants that are near the water's edge absorb nutrients directly from the water.

❒ **Wildlife habitat:** Riparian areas have high plant diversity, both horizontally and vertically from the water's edge, which contributes to the high diversity of plants and animals that live in these areas. Frequently the most species-rich habitats to be found in a landscape, riparian areas provide critical corridors linking favored wildlife habitats.

The species that are of most concern in riparian areas are "obligate" species, which require both the water and surrounding forests as habitat. In Minnesota, obligate riparian species include 32 reptile/amphibian species, 20 bird species and 15 mammal species. Numerous plant and invertebrate species (such as salamanders) are also strongly associated with these habitats. Those species are found only in these areas or spend critical portions of their life cycle there.

❒ **Inputs of coarse woody debris and fine litter:** Coarse woody debris helps to create and maintain pools, reduces stream velocities, forms eddies where food organisms are concentrated, supplies protection from predators, provides shelter during winter runoff, and traps and stores small debris from the forest. It also traps smaller debris, which then traps fine debris, sediment and organic matter and can lead to natural levee formation.

The fine litter formed by the breakdown of decomposing plants, leaves and animals serves as the energy base for the aquatic food chain. Future sources of decay-resistant coarse woody debris can be maintained by actively managing for large-diameter conifers.

❒ **Maintaining moderate temperatures through shading:** Small increases in air and water temperatures may lead to changes in the composition and growth of fish, aquatic insect and riparian species. Riparian vegetation, particularly the vegetation overhanging or shading the water's surface, regulates water temperature. Shading away from the water's edge helps to minimize the warming of overland surface water flows before they reach the water body.

❒ **Bank, channel and shoreline stabilization:** Roots and rhizomes of riparian vegetation stabilize and reinforce the banks and shorelines of streams, lakes and open water wetlands. Roots proliferate into fresh sediment deposits, helping to stabilize them. In addition, root systems allow the formation of overhanging banks, which provide excellent habitat for aquatic organisms.

Riparian areas were important to society's prehistoric ancestors and are no less so to modern society, if for somewhat different reasons. Because hunting and gathering cultures of the past used riparian areas extensively as places to live and obtain food, cultural resources are often located there.

Today, the water's edge is recognized as an important resource for a variety of reasons, including spiritual values, aesthetics, wood products and recreation.

Variability of Riparian Functions

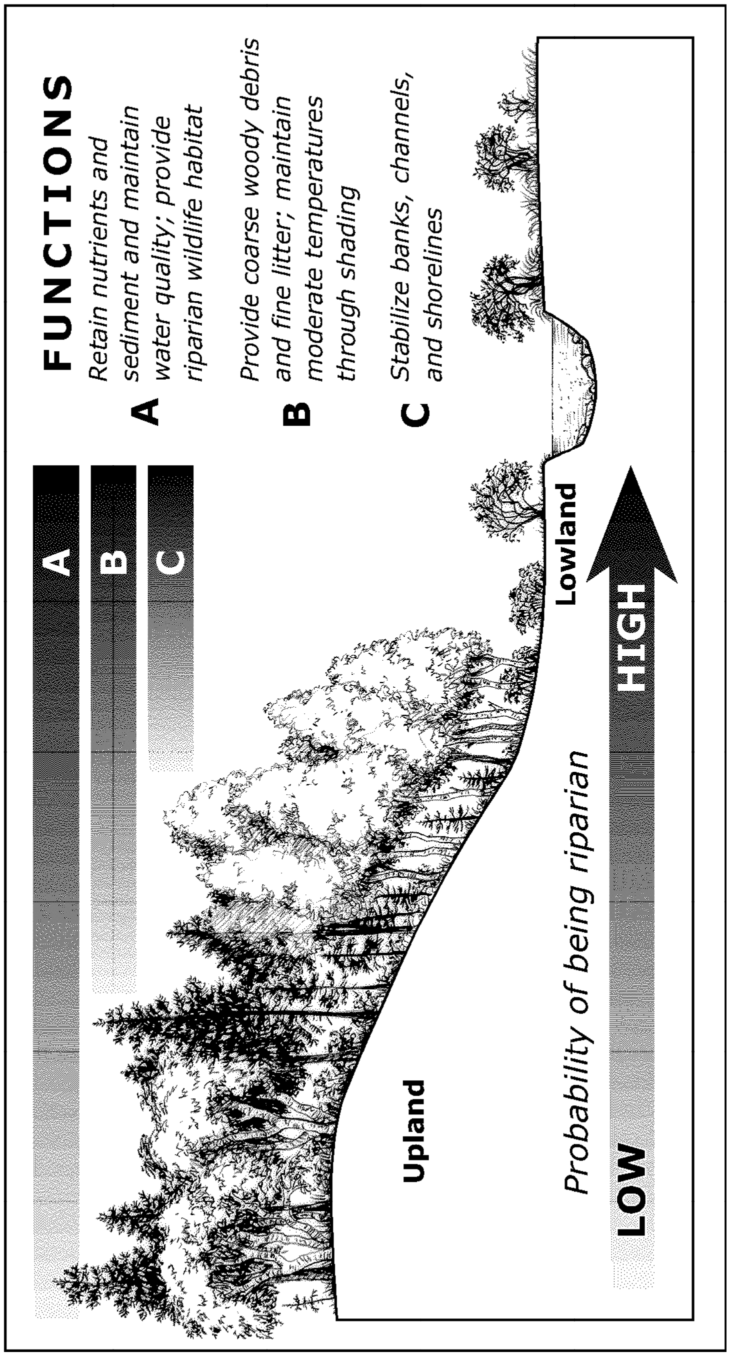
The functional importance of riparian areas varies in type and degree due to their variability in hydrological, topographical and vegetational condition. For example, the riparian area of a lowland black spruce or black ash forest is very different from that of an upland aspen or northern hardwood forest. Similarly, the riparian area associated with a wide swampy floodplain is very different from the riparian area of a stream that has a steep bank adjacent to it.

For this reason, it is difficult to arrive at definitive numerical widths to define the riparian management zone (RMZ), as each riparian area is unique and the management zone chosen will vary in width depending on site conditions and landowner objectives.

It may also be difficult to know where some riparian functional linkages cease to exist, such as the movement of soil in water to a stream or the extent of terrestrial wildlife habitat. Not all riparian functions are equally important at all distances from the water. The probability of a forest serving a riparian function decreases as the distance from the water's edge increases. At some distance from the water's edge, the likelihood of a location having any riparian function at all is very low. See Figure RMZ-2.

Figure RMZ-2

Relationship of Riparian Function and Distance from Water's Edge



The Riparian Management Zone: Minimizing Adverse Impacts on Riparian Areas

Riparian management zones (RMZs) are areas of special concern along streams, lakes and open water wetlands. They are intended to retain relatively continuous forest cover for the protection and maintenance of aquatic and wildlife habitat, aesthetics, recreation and forest products. Within the RMZ, management activities should be modified through RMZ guidelines to minimize potential adverse impacts.

For example, it is important to keep slash out of intermittent streams where flash flooding will move the excess debris downstream. Additionally, an RMZ should be designed to minimize blowdown of residual trees. This requires consideration of site characteristics (such as exposure to wind, species and soil moisture) as well as the width and residual basal area.

The leave tree recommendation for even-age management—"Following harvest, concentrate leave trees adjacent to the RMZ in clumps, strips or islands, varying in size with a minimum size of 1/4 acre per clump and occupying a minimum of 5% of the area adjacent to the RMZ"— is a strategy to address blowdown of residual trees within RMZs. Refer to Table GG-5 and Figure GG-15 in *General Guidelines: Managing Riparian Areas* for more information on relationships between varying residual basal area in the RMZ and landowner objectives and RMZ functions.

The recommended minimum RMZ widths in *General Guidelines* Tables GG-2 through GG-6 provide general guidance for most water quality, aquatic and wildlife habitat protection, and aesthetic objectives.

Landowner interest in increasing the functional effectiveness of riparian areas or considering larger landscape implications of their management actions may result in wider RMZs than those recommended in the guidelines. Consultation with a natural resource professional may help in making these decisions.

The Need for Monitoring and Research

There is a need to intensively monitor and to carry out research to determine the effectiveness of riparian management zone guidelines and their ability to accomplish their intended objectives.

While the guidelines are based on the best available scientific information and compromise, most of the research studies that form the basis for discussion were conducted in other regions of the country. Considerable research in Minnesota is needed on riparian areas due to the lack of data specific to landforms, water bodies and forest cover types found within the state.

The types of site-specific research that would be beneficial for Minnesota's conditions include assessments of the following:

❐ How leaving varying amounts of residual basal area after timber harvesting within riparian forests may affect such factors as the composition, growth and productivity of the residual forest and biological diversity.

❐ How leaving large dead trees on the ground after timber harvesting within riparian forests may affect such factors as the composition, growth and productivity of the residual forest and biological diversity.

❐ How varying levels of riparian forest reserves (including residual basal area, crown closure and width of the riparian management zone) may, over time, affect such factors as bank stability; reduction in overland flow of sediment; ability to remove chemicals (including nitrogen and phosphorus) from overland flow; maintenance of moderate water temperatures through shading; provision of coarse woody debris; and the production of fine litter.

Other Considerations

❒ Guidelines for skid trails established as part of water quality and wetland guidelines are appropriate for use when operating within the RMZ. See *Timber Harvesting: Skidding and Skid Trails,* and *Timber Harvesting: Water Quality and Wetlands.*

❒ The term "shade strip" (as referenced in *Protecting Water Quality and Wetlands in Forest Management*) is not used in this integrated guidebook. Instead, the term "riparian management zone (RMZ)" should address all of the functions and values (including water temperature) that were formerly associated with shade strips.

❒ Leaving some super-canopy trees and other long-lived species in the RMZ should be a consideration. If possible, choose trees from the "Excellent" category of Table GG-7: Leave Tree Preferences for Longevity, Windfirmness and Cavity Potential in *General Guidelines: Retaining Leave Trees.*

This approach will provide habitat for riparian species that require large super-canopy trees (trees above the existing mature canopy) for hunting perches and nesting sites. (The "excellent" species recommended are white pine, oaks, elms, ashes, sugar maple, yellow birch and basswood.)

Selected Resources for Additional Information

At the Water's Edge: The Science of Riparian Forestry. Conference Proceedings. 1996. S. B. Laursen (ed.). Minnesota Extension Service, St. Paul, Minnesota. 160 pages.

Biodiversity: A Background Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. 1992. Jaakko Pöyry Consulting, Inc., Tarrytown, New York. 109 pages.

Final Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota. 1994. Jaakko Pöyry Consulting, Inc., Tarrytown, New York.

Forest Wildlife: A Background Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. 1992. Jaakko Pöyry Consulting, Inc., Tarrytown, New York. 283 pages.

Maintaining Productivity and Forest Resources Base: A Background Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. 1992. Jaakko Pöyry Consulting, Inc., Tarrytown, New York. 302 pages.

Northeast Region Plan; Forest, Fish and Wildlife Management Program Appendix: Biodiversity Guidelines. 1994. Minnesota Department of Natural Resources, Division of Forestry, St. Paul, Minnesota. 40 pages.

Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota. 1995. St. Paul, Minnesota. 140 pages.

Riparian Vegetation Effectiveness. National Council of the Paper Industry for Air and Stream Improvement, Inc., Research Triangle Park, North Carolina. 26 pages. (Unpublished)

Visual Quality Best Management Practices for Forest Management in Minnesota. 1994. St. Paul, Minnesota. 78 pages.

Visual Quality

CONTENTS

Scenic quality is one of the primary reasons people choose to spend their recreation time in or near forested areas. *Photo courtesy of Dorian Grilley*

The Value of Visual Quality

A Concern for Aesthetic Quality

Minnesotans are concerned about the aesthetic quality of forested lands throughout the state, which are a great source of pride for Minnesota citizens. Scenic beauty—or “visual quality”—is one of the primary reasons people choose to spend their recreation and vacation time in or near forested areas.

They are also attracted by the peace and quiet of the outdoors, the serenity, the solitude, and a host of other emotional, spiritual and sensory responses that make up the richly aesthetic and deeply personal experience that is so closely tied to time spent in or near our forests.

Minnesota forests are particularly vital to the health of two industries: tourism and forest products. *Photos courtesy of Minnesota Department of Tourism (left) and Minnesota Timber Producers Association (right)*

Minnesota forests are particularly vital to the health of two industries: tourism and forest products. While many of the demands on the forests from these two industries are compatible and even complementary, concern about the specific impacts of various forest management practices on visual aesthetics has led to the development of a guidebook titled *Visual Quality Best Management Practices for Forest Management in Minnesota.*

Published in 1994, this guidebook provides the source of the visual quality guidelines that have been integrated into this larger guidebook.

To obtain a copy of *Visual Quality BMPs for Forest Management,* contact:

Cultural and Aesthetics Program Coordinator
Minnesota DNR Forestry
413 S.E. 13th Street
Grand Rapids, MN 55744
(218) 327-4449
Fax: (218) 327-4517

Benefits of Visual Quality Management

Visual quality is one important aspect of the broad, multi-faceted concept of integrated forest resource management. Visual quality management can:

❒ Enhance visual quality of forested lands for recreational users, resulting in a healthy tourism economy.

❒ Reduce conflicts with and negative perceptions of the timber industry, therefore helping to sustain a healthy timber economy.

❒ Minimize visual and audible impacts of forest management activities on tourists and recreational users.

❒ Minimize visibility of harvest areas by limiting apparent size of harvest.

❒ Minimize visual impact of slash.

❒ Minimize the impact of landing operations on recreational viewers and users.

❒ Minimize visual contrast created by snags and broken or leaning trees.

Minnesotans are concerned about the aesthetic quality of their forest areas, which are a source of pride for citizens of the state. *Photo courtesy of Minnesota DNR*

❒ Reduce visual impacts associated with the design and use of forest access roads.

❒ Reduce the visual impact of site preparation practices and reduce the time that the effects of these practices are visible.

❒ Promote more natural-appearing stands.

❒ Enhance the aesthetics of visual management areas by minimizing visual impacts of TSI activities.

❒ Reduce visual impacts of treated vegetation.

❒ Reduce noise and unsightliness related to gravel pits.

Visual Sensitivity Classifications

Recognizing Different Levels of Visual Sensitivity

In 16 of the most heavily forested counties in Minnesota, county visual quality committees have classified all roads, designated recreation trails, and lakes and rivers into one of three visual sensitivity categories.

Three factors were used in determining classifications:

- ❒ The perceived degree of sensitivity of users of that travel route or recreation area concerning landscape aesthetics
- ❒ The volume and type of use the travel route or recreation area receives
- ❒ The speed of travel within the route or area

Large unbroken clearcuts are generally perceived by the public as unsightly, at least until the newly established regeneration begins to restore the natural beauty of the site. *Photo courtesy of Itasca County Land Department*

Visual Sensitivity Categories

Three visual sensitivity classifications reflect different levels of concern on the part of typical users:

❐ Most Sensitive

Applies to travel routes and areas where significant public use occurs and where visual quality is of high concern to typical users. Examples of such routes may include public highways, local roads, recreational lakes and rivers, and designated recreational trails and areas that provide a high level of scenic quality.

❐ Moderately Sensitive

Applies to travel routes or recreation areas, not identified as "most sensitive," where visual quality is of moderate concern to typical users. Examples of these routes and areas may include public highways and local roads, recreational lakes and rivers, and designated recreational trails that provide moderate to high scenic quality but less significant public use.

❐ Less Sensitive

Applies to travel routes or recreation areas, not identified as "most sensitive" or "moderately sensitive," where visual quality is of less concern to typical users. Examples of these routes may include public highways and low-volume local forest roads, non-designated trails, and non-recreational lakes and rivers.

The Value of Visual Sensitivity Classifications

Visual sensitivity classifications help the landowner, resource manager and logger choose visual quality guidelines that help fulfill the expectations of the county visual quality committees. Visual quality guidelines used in an area classified as "most sensitive" would be different than guidelines used in an area classified as "less sensitive."

An example: In areas classified as "most sensitive," landings should be avoided within view of travel routes or recreation areas. However, in areas classified as "less sensitive," landings may be visible, but placing landings in the travel route right-of-way should be avoided.

The "most sensitive" classification applies to those travel routes or areas where significant public use occurs and where the visual quality is of high concern to typical users. *Photo courtesy of Minnesota Department of Tourism*

Determining Classifications for a Particular Site

The 16 counties where visual sensitivity classifications have been completed include Aitkin, Becker, Beltrami, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Lake of the Woods, Mille Lacs, Pine and St. Louis counties.

County visual sensitivity classification maps may be viewed by contacting county land departments or local DNR Forestry offices within the counties. See *Resource Directory*.

In counties where there are no formal visual sensitivity classifications, landowners, resource managers and loggers should use their knowledge and experience to classify the visual sensitivity of the area where they are working. Based on their determinations of the area's visual sensitivity, they should follow the appropriate guidelines for that sensitivity classification.

Water Quality and Wetlands

CONTENTS

The Value of Water Quality, the Threat of Nonpoint Source Pollution

An Abundance of Clean Water

An abundance of clean water is one of Minnesota's greatest resources. Much of this water originates in forested watersheds. In addition to water, these forested areas provide many other valuable resources and support a variety of human activities.

Landowners, resource managers, loggers and contractors attempt to balance a variety of objectives when planning and conducting forest management activities. These activities include the production of timber, the support of recreational uses, the enhancement of scenic beauty, the improvement of wildlife habitat, and the protection of forest ecosystems. When carrying out any forest management activity, care is needed to prevent or minimize nonpoint source pollution impacts on water quality and wetlands, as well as impacts on normal water flow in wetlands.

Potential Impacts of Nonpoint Source Pollution

Nonpoint source (NPS) pollution is diffuse pollution that originates from over the landscape. While the amount from any one particular location may seem insignificant, the combined effects of NPS pollution from throughout a watershed can impact water quality and wetlands.

NPS pollution reaches streams, lakes, wetlands and ground water through leaching, surface runoff and erosion. While some NPS pollution does occur naturally, such as when soil is carried in runoff to surface water, human activity can dramatically increase the potential for NPS pollution. Many forest activities have the potential to contribute NPS pollution to streams, lakes, wetlands and ground water.

Types of water pollutants that can be generated from forest activities include:

❒ Sediment
❒ Nutrients
❒ Pesticides
❒ Fuels and lubricants
❒ Organic matter
❒ Thermal impacts

NPS pollution from forest activities is not severe in most areas of Minnesota, due to the state's topography, soils and forest locations. Forest management activities with the greatest potential for creating NPS pollution include:

❒ Forest road development
❒ Timber harvesting activities
❒ Mechanical site preparation
❒ Pesticide application
❒ Prescribed burning and fireline clearing

Of these activities, the building and maintenance of forest roads is generally considered to have the greatest potential to impact water quality and wetlands. This impact is due to the concentration of activity, the extent of area affected, the amount of disturbed and exposed soil, and the relative permanence of a forest road. These effects are of particular concern when activities are close to water.

Benefits of Guidelines

Guidelines for water quality and wetlands provide a number of important benefits. These guidelines:

❒ Prevent or minimize nonpoint source pollution from forest management activities.

❒ Prevent or minimize erosion and subsequent sedimentation of water bodies.

❒ Prevent or minimize the movement of pesticides, fuel, lubricants and other chemicals to surface water, wetlands and ground water.

❒ Maintain water temperatures within their normal range.

❒ Maintain normal hydrologic flows in wetlands.

How Guidelines Can Protect Water Quality and Wetlands

NPS pollution cannot be eliminated entirely, but guidelines for water quality and wetlands can prevent or minimize the impact of forest management activities on streams, lakes, wetlands and ground water. Recommended guidelines (implemented individually or in combination) provide landowners, resource managers, loggers and contractors with the tools to either prevent NPS pollution or ensure that the amount of NPS pollution is kept to a level compatible with state water quality and wetland protection goals.

In addition to protecting water quality, guidelines for wetlands provide the tools to maintain the functions and values of wetlands by protecting normal water flow in wetlands.

Guidelines for water quality and wetlands can prevent or minimize the impact of forest management activities on streams, lakes, wetlands and ground water. *Photo courtesy of Minnesota DNR*

Water Quality and Wetland Protection in Minnesota

A Regulatory Umbrella

Statutes and regulations currently exist for federal, state and local agencies to control water pollution and protect wetlands on both public and private forest lands:

❒ **At the local level**, this "regulatory umbrella" includes comprehensive local water plans, local zoning ordinances and shoreland management regulations.

❒ **At the state level**, regulatory involvement includes the Minnesota Groundwater Protection Act, the Minnesota Wetland Conservation Act, the Minnesota Pollution Control Agency Water Quality Standard Rules (Minn. Rule 7050), and the Minnesota Department of Natural Resources Protected Waters Permit Program.

❒ **At the federal level**, regulations include the National Environmental Policy Act, the National Forest Management Act, the Federal Clean Water Act, the Coastal Zone Management Act, and the Food, Agriculture, Conservation and Trade Act.

Providing Exemptions and Flexibility

Wetlands are highly productive sites for a variety of ecologic functions, as well as for the enhancement of water quality. All management operations in or adjacent to wetlands should be planned and conducted in a manner that protects these functions.

State and federal wetland regulations provide an exemption for silvicultural activities in wetlands. To qualify for an exemption for silvicultural activities in a wetland under the Minnesota Wetland Conservation Act, an individual or organization:

- ❐ Must use appropriate erosion control measures to prevent sedimentation of water.

- ❐ Must not block fish activity in a watercourse.

- ❐ Must comply with all other applicable federal, state and local requirements, including Best Management Practices and water resource protection requirements.

The wetland guidelines were developed to meet the intent of federal regulations (33 Code of Federal Regulations [CFR], Section 323.4, and 7 CFR, Part 12). These sections were 1) modified to allow flexibility of implementation where appropriate, and 2) broadened to cover the activities listed in the Wetland Conservation Act. The federal criteria that served as the standard for much of the original BMP development are listed in *Appendix G: Baseline Standards for Development of Best Management Practices To Provide Wetland Protection.*

Because one single set of practices cannot effectively address the concerns of all situations and all areas, guidelines need to be flexible enough to address site-specific conditions.

This flexibility also allows individual guidelines to be modified to balance water quality and wetland protection with other forest values and management considerations, such as promoting biodiversity and enhancing wildlife and aquatic habitat. Modified approaches may be used as long as the alternate practices achieve the same level of protection for water quality and wetlands.

A Cooperative Response to Water Quality Concerns

Effective protection of water quality and wetlands depends in great part on the attitude toward—and acceptance of—water quality and wetland protection measures by individual landowners, resource managers, loggers and contractors.

Broad-based recognition of the need for guidelines to protect water quality and wetlands led to a gathering of a diverse working group of individuals representing many public and private organizations.

This group developed a guidebook titled *Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota*. Published in 1989 and updated in 1995, this stand-alone publication serves as the source document when Best Management Practices for water quality protection (BMPs) are referenced in statute.

The goal of these guidelines (termed BMPs in the guidebook) was to accomplish the following:

- ❐ **Heighten awareness** of nonpoint source pollution.
- ❐ **Provide tools** to landowners, resource managers, loggers and contractors for protecting water quality and wetlands in forested watersheds in a manner consistent with the intent of federal and state water quality and wetland protection mandates.
- ❐ **Provide sufficient information and guidance** to assist these individuals in making informed and appropriate management decisions on a site-by-site basis.

Protecting Water Quality and Wetlands in Forest Management provided the source of the guidelines for water quality and wetlands that have been integrated into this larger guidebook. Copies of *Protecting Water Quality and Wetlands in Forest Management* are available from local DNR Division of Forestry offices, or call (651) 297-7298.

Wildlife Habitat

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TABLES

FIGURE

Developing Wildlife Habitat Guidelines

Parameters and Considerations

Wildlife defined: For purposes of these guidelines, wildlife is defined as all forms of life that are wild (including plants, animals and microorganisms). These guidelines consider only forest-dependent terrestrial and amphibious forms of wildlife in its recommendations.

Ten wildlife-related topics were considered in these guidelines:

- ❒ Leave trees and snags
- ❒ Coarse woody debris and slash
- ❒ Conifer retention and regeneration
- ❒ Mast
- ❒ Patterns of cutting
- ❒ Endangered, threatened and special concern (ETS) species
- ❒ Sensitive communities and sites, and tree species at the edge of their range
- ❒ Wetland inclusions and seasonal ponds
- ❒ Riparian wildlife habitat
- ❒ Additional consideration: Legacy patches

Other interrelated issues were considered during guideline development, including:

- ❒ Vertical structure of vegetation
- ❒ Variation of silvicultural systems
- ❒ Mimicking natural disturbance
- ❒ Old forest characteristics
- ❒ Lowland conifer communities
- ❒ Exotics and hybrids
- ❒ Forest type conversion

The original scoping process focused on mitigating wildlife impacts projected in the 1994 Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota (GEIS). Additional issues beyond those covered in the GEIS were also considered. The intention is to provide practical, science-based (to the extent possible) voluntary guidelines to address significant issues and projected impacts, at least minimally, and to mitigate these impacts or prevent them from occurring.

Integration of wildlife guidelines with other guidelines addressing cultural resources, forest soils, riparian areas, visual quality, and water quality and wetlands helped resolve any differences in applicability among them. Other dimensions of forest management, such as forest health or recreation, were given less consideration during the development of wildlife habitat guidelines.

Limitations and Assumptions

"Essential" guidelines, rather than comprehensive: Certainly, much more can be done to enhance wildlife habitat or individual species than what is recommended within these guidelines. Furthermore, each management practice, including the option to do nothing on a site, will at once favor some species and disfavor other species. As a result, it is not practical to provide a comprehensive set of guidelines covering all possibilities for improving habitat in Minnesota forests. Instead, these guidelines cover the essentials for addressing site-level issues while deferring to other existing guidelines, publications or professional managers to provide direction to those whose objectives focus on wildlife management.

Guidelines and "additional considerations": Some of the recommendations are based on less clear or emerging issues that may change with time. Such recommendations are included as "additional considerations," such as legacy patches, which provide direction to landowners wishing to improve wildlife habitat. Thus, two classes of recommendations are provided: "guidelines" and "additional considerations." Although both are voluntary in nature, the guidelines have higher priority and will also be more important to monitor over time.

Site-level guidelines with "landscape implications": Wildlife habitat guidelines were drafted assuming that a practice has been selected for a particular site and that the guidelines should provide direction for someone applying that practice. Throughout the process, however, it was difficult to separate landscape-level and site-level issues. While many issues clearly fit into one level or the other, some fall into a gray area.

For wildlife, more than for other forest resources, what occurs on a site influences the surrounding landscape, and vice versa. While the guidelines focused on the site level as much as possible, some of the more important overlaps have been included as "landscape implications." Landscape-level wildlife needs should be addressed through professional planning for individual properties and through cooperation among landowners and agencies within a landscape.

Overlapping benefits: Many of the wildlife habitat guidelines can be applied simultaneously. For example, leave tree clumps in clearcuts might also serve as rare species buffers or legacy patches, or they may provide mast production. These overlapping benefits may extend to other forest resources as well, such as for cultural resource protection.

Recognizing practicality issues: In implementing the wildlife habitat guidelines, users should be mindful of the practicality of guidelines, recognizing the additional cost and effort needed to implement them. For example:

- ❒ Application of guidelines may result in increased time for design, administration or execution of forest management activities.

- ❒ Trees may be withdrawn from harvest availability for the short or long term, decreasing potential revenue.

- ❒ Retention of various structural habitat components (such as snags and down logs) may reduce expected tree regeneration or lead to increased mortality or pest damage in some cases.

Guidelines and additional considerations have been developed for 10 topics, which have been integrated into the overall forest management activity guidelines in Part 3. The benefits and rationale for these guidelines follow for each of the 10 wildlife-related topics.

Benefits of Wildlife Habitat Guidelines

Benefits apply mainly to the wildlife habitat on a site, but improved habitat may indirectly lead to a better-functioning ecosystem and therefore improved overall productivity of the site in the long run. Implementation of guidelines for wildlife habitat:

❐ **Provides for wildlife requiring perches,** tree cavities and bark-foraging sites through retention of suitable leave trees and snags on a site during forest harvesting and timber stand improvement.

❐ **Provides cover, food or growing sites** for certain amphibians, reptiles, mammals, birds, invertebrates, fungi and green plants through retention or creation of coarse woody debris and slash during forest management.

❐ **Ensures diversity of wildlife habitat** through the retention and regeneration of conifers for food, nesting and cover in mixed deciduous/coniferous stands.

❐ **Provides for adequate mast production** from trees and shrubs as food for wildlife.

❐ **Provides site-level wildlife habitat requirements** by using a variety of sizes and shapes of harvest areas.

❐ **Increases awareness of endangered, threatened and special concern species** and manages forests to maintain or enhance existing populations of these species.

❐ **Increases awareness of sensitive communities and sites** and maintains or enhances them where they are found.

❐ **Provides for perpetuation of most of the genetic diversity within tree species,** as well as maximization of the potential for tree species to shift their geographic ranges in response to possible rapid climatic changes.

❐ **Provides site-level wildlife habitat features** for terrestrial species associated with wetland inclusions and seasonal ponds within forests.

❐ **Provides site-level wildlife habitat features** for riparian obligate terrestrial species.

❐ **Maintains the biological continuity** of a harvested site.

Rationale for Guidelines in Each Topic Area

Leave Trees and Snags

Purpose: To provide for wildlife requiring perches, tree cavities and bark-foraging sites through retention of suitable leave trees and snags on a site during forest harvesting and timber stand improvement.

Rationale, Background and Benefits

In Minnesota, some 40 birds, 29 mammals, and several reptiles and amphibians use snags. The major issue for cavity-dependent wildlife and timber harvesting is whether some suitable trees and nest cavities remain for these species following logging or timber stand improvement.

Retention of leave trees and snags during timber harvesting provides habitat for wildlife requiring perches, tree cavities and bark-foraging sites as the surrounding forest regenerates, by mimicking natural disturbances to some degree. Leave trees and snags may also provide unique niches and microsites for a variety of plants, especially within retained clumps or as individuals fall over with time and begin to decay. Soil conditions will also benefit.

The fundamental idea is to retain some structure for snag- and cavity-dependent species on a site or maintain the potential to produce such structure as a stand grows and develops.

Ecoregion Applicability

One issue indirectly tied to ecoregions is openland/brushland management. Such habitats may require felling of all stems to reproduce open conditions.

Both snags (standing dead trees) and leave trees (live trees retained on a site) provide for wildlife requiring perches, tree cavities and bark-foraging sites. *Photo courtesy of Potlatch Corporation*

Another issue in agriculture/forest interfaces is nest parasitism by cowbirds. Timber harvests in forests adjacent to agricultural areas may require clear-felling of all stems along edges.

Regarding a preferred mitigation strategy to retain more trees with cavities, the GEIS states: "This mitigation should be applied over all Minnesota ecoregions, but for mammals it may be especially critical within the range of the gray squirrel, projected to be heavily impacted under all harvest scenarios."

Landscape Implications

Although these guidelines address site-level recommendations for snags and leave trees, the contribution of an individual site should be considered in the context of the surrounding landscape. Many of the cavity-dependent species being addressed have home ranges larger than the typical harvest unit, so planning for their needs requires a broader look, both spatially and temporally, at the larger forest community.

If suitable habitat exists surrounding a given harvest site to maintain populations of these species, then leave trees may not be as critical on that site. However, if harvests are likely in the adjacent habitats, then the trees left on the initially harvested sites become more important as the surrounding forest regenerates. Consideration must be given to the time it takes for a regenerating stand to produce trees of adequate size and degree of decay to provide suitable structure.

Consider reducing leave tree and snag requirements on harvest sites adjacent to agricultural lands (especially pastures) to reduce nest parasitism by cowbirds and nest predation. Note also that not all forest communities naturally provide snags; therefore, across a given landscape, not all sites must be managed for leave trees and snags.

Coordination among neighboring landowners may result in varying numbers of leave trees on a site if adjacent lands exceed or fall short of the recommendations. Managers of larger landholdings may be able to plan for sufficient cavity-dependent wildlife habitat on portions of their property (such as riparian reserves) and reduce leave tree/snag requirements on other portions.

Leave trees provide sites for nesting, such as this goshawk nest. *Photo courtesy of Potlatch Corporation*

Coarse woody debris provides cover, food, habitat structure and growing sites for many different animals and plants. *Photo courtesy of Potlatch Corporation*

Coarse Woody Debris and Slash

Purpose: To provide cover, food or growing sites for certain amphibians, reptiles, mammals, birds, invertebrates, fungi and green plants through retention or creation of coarse woody debris and slash during forest management.

Rationale, Background and Benefits

Salamanders, snakes, small mammals and birds will benefit most from coarse woody debris and slash. Small mammals dependent on slash and coarse woody debris in turn provide food for mammalian carnivores and forest raptors (such as the pine marten and the northern goshawk).

A variety of invertebrates, soil microorganisms and plants will also benefit from the niches created by down logs. Regeneration of yellow birch, white cedar and eastern hemlock will be enhanced. Many sites already provide the number of down logs (or more) called for in the guidelines. Coarse woody debris may need to be created in some plantations.

Ecoregion Applicability

When choosing leave logs, note that species at the edge of the range will differ depending on ecoregion. (See *Sensitive Communities and Sites, and Tree Species at the Edge of Their Range,* page 26). Coarse woody debris decays more rapidly in the southeast, where consideration should be given to making leave logs with as large a diameter as possible.

Landscape Implications

Although the guidelines focus on the managed site itself, coarse woody debris left on that site may be benefiting reptiles and amphibians living there but breeding elsewhere. Thus, coarse woody debris placement might be influenced by off-site features. Therefore, consider proximity to wetland inclusions and seasonal ponds off the site.

Conifer Retention and Regeneration

Purpose: To ensure diversity of wildlife habitat through the retention and regeneration of conifers for food, nesting and cover in mixed deciduous/coniferous stands. Conifers should continue to be a significant structural component in appropriate habitats and landscapes.

Rationale, Background and Benefits

One of the greatest concerns for wildlife in northern Minnesota is extensive conversion of mixed aspen/birch-conifer forests to early successional aspen-birch. Retaining young conifers, including isolated trees and scattered clumps, can provide habitat and food needed for many different wildlife species and can increase the probability that conifers will later regenerate on harvested areas.

Various animal species, including the great gray owl, bald eagle, pine warbler, white-tailed deer, moose, pine marten, lynx, snowshoe hare and red-backed vole, depend on coniferous stands for structural attributes. Others—including spruce grouse, red-breasted nuthatch, red squirrel, porcupine and moose—depend on food that coniferous stands provide. Conifers provide thermal cover from both heat and cold. Reduced snow depth and surface crusting benefit both deer and moose. Some conifer-associated species of birds will only remain in clearcut areas if conifer patches of sufficient size are left.

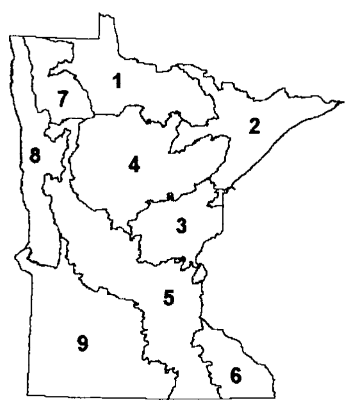
Encouragement of coniferous regeneration in mixed deciduous-coniferous forests in the northeast will help lessen the impact on those reptiles and amphibians associated with mixed forests, such as the wood turtle, ringneck snake and red-backed salamander. Retaining clumps of conifers will also protect soil characteristics and associated ground flora.

Conifers should be left for the many important habitat characteristics that these trees provide to a large portion of Minnesota's vertebrate fauna. Conifer stands, inclusions of conifers within mixed-species stands, and conifer understories in mature aspen and birch stands are all important components of wildlife habitats in Minnesota.

When retaining conifers, clumps are preferable to scattered trees. Clumped conifers are more windfirm; are better potential seed sources because of improved pollination; can withstand snow and ice loads more successfully; and can provide better cover. See Table WH-1.

Ecoregion Applicability

These guidelines are applicable to Ecoregions 2, 3 and 4 and possibly Ecoregions 1, 5 and 6.



Landscape Implications

Application of these guidelines may have implications where landscape connectivity or riparian corridors are a concern.

Table WH-1

Conifer Species and Examples of Use by Wildlife

Conifer Species	Examples of Use by Wildlife
Red pine	Mature trees may be used by raptors for perches or nest trees. Seeds are important mast for winter songbirds and red squirrels.
White pine*	When young, provides good escape and severe weather cover for many species. High calorie, large seeds eaten by many small mammals and winter songbirds. Mature trees are important for cavity-dependent wildlife, preferred bald eagle nest trees, and escape trees from bears. Roosting trees for wild turkeys.
Jack pine	Very good cover when trees are young. Used as browse. Buds and needles are important spruce grouse food. Seeds eaten by red squirrels. Persistent cones provide a year-round food source.
Balsam fir	Important winter and summer cover for deer, moose and many species of birds. Birds eat seeds and use trees for nesting. Winter browse for moose.
Black spruce	Important escape and severe winter cover. Birds eat seeds and use trees for nesting. Buds and needles are important spruce grouse food.
Tamarack	Mature stands provide excellent habitat for owls. Snags are useds as hunting/singing perches.
White cedar	Mast is important food source for winter songbirds. Very important winter cover for deer. Important for browse during severe winters. Provides cover and cooling effect near water.
White spruce	Important seed source for winter finches. Summer nest cover for songbirds. Black-backed woodpeckers forage under bark for insects.
E. red cedar	Important winter cover. Berries used by birds for food.
Hemlock	Mature trees provide important owl roosting sites. Very limited range in Minnesota: special concern species.

*See also *Minnesota's White Pine: Now and for the Future.* 1996. White Pine Regeneration Strategies Group, Minnesota DNR, St. Paul, Minnesota.

Mast

Purpose: To provide for adequate mast production from trees and shrubs as food for wildlife.

Rationale, Background and Benefits

High levels of fat, protein and carbohydrates in mast contribute to energy stores critical for migration or hibernation, and for survival of newly independent young. Some birds and mammals depend heavily on mast during peak production periods in late summer and early fall. During winter, some sources remain available on trees and shrubs, under snow or stored in caches.

Mast production is generally favored by increased crown exposure to light, crown size, maturity of trees or shrubs, increased soil nutrients, tempered microclimates (especially during flowering) and adequate soil moisture. Production on a site tends to vary considerably from year to year.

Other considerations:

- ❒ Mast-producing species often depend on animals for their dispersal and reproduction.
- ❒ Riparian edges often contain a higher concentration and richness of mast-producing species.
- ❒ Most shrub species will regenerate well and produce mast after cutting, burning or soil disturbance.

Although the GEIS points out concerns for oak and other dominant tree species, especially in relation to game species (such as deer or gray squirrels), trends in other mast species were not modeled.

As a result, recommendations for oak and other dominant tree species are presented as “guidelines,” while recommendations for other mast-producing species are presented as “additional considerations.” See Table WH-2.

Table WH-2

Examples of Mast-Producing Plants That Benefit Wildlife in Minnesota

Mast Species	**Examples of Use by Wildlife**
Oaks (acorns) and hazel nuts	Deer, bear, wild turkey, woodpeckers, blue jay, wood duck, squirrels
Maple and ash seeds	Small mammals, evening and pine grosbeaks
Aspen, birch and hazel buds	Ruffed grouse
Yellow and white birch seeds	Common redpoll, pine siskin, American goldfinch
Conifer cones and seeds (such as white cedar, balsam fir, black spruce, white pine, common juniper, red cedar, Canada yew)	Red squirrels, white-winged and red crossbills, pine siskins, red-breasted nuthatch, pine grosbeak
Late summer soft mast (such as juneberries, blueberries, cherries, dogwoods and elderberries)	Important to a wide diversity of birds and mammals as they prepare for migration and winter
Soft mast retained in fall and through winter (such as mountain ash, highbush cranberry and nannyberry, winterberry)	Waxwings, pine grosbeaks, and other diverse bird and mammal species
Vines (such as wild grape)	Diversity of birds and mammals

Ecoregion Applicability

Retention of mast and other key food-producing tree types should be prioritized in accordance with the local abundance of each tree species. In areas of least abundance, greatest attention should be applied to retention. For oaks, the northern range limit is most critical in assuring that the range of producing trees is not diminished. Mountain ash berries are an important food source for birds during harsh winters. This species occurs commonly in three northeastern counties (Cook, Lake and St. Louis).

Landscape Implications

Land managers in regions with low mast availability have opportunities to enhance wildlife habitat characteristics by careful management of mast species on their land. Some wildlife species may travel significant distances to obtain mast. The black bear, for example, may travel 10 miles to obtain mast.

Patterns of Cutting

Purpose: To provide site-level wildlife habitat requirements by using a variety of sizes and shapes of harvest areas.

Rationale, Background and Benefits

Because there is such a great variety in the home range territory of various organisms, it is important that forests be managed at a variety of scales. This management objective will involve making silvicultural decisions on a landscape basis. Ideally the management regime should range from the very fine-scale management represented by selection cutting to the coarse-scale management affected by sizable clearcuts. Size of clearcuts should be determined by considering issues such as size of the management unit, the home range requirements of large animals, aesthetics and natural disturbance regimes.

Size and shape of both cut and uncut areas should meet habitat needs of wildlife. To benefit wildlife in managed forests of Minnesota, a variety of cut sizes—from as small as one acre to larger than 100 acres—is recommended. Larger patch sizes have historically occurred under natural disturbance regimes on even-aged, fire-dependent types, such as jack pine. Smaller patches are appropriate in more heterogeneous forest types, such as deciduous forests on moraines.

Ecoregion Applicability

More diverse (larger) patch sizes are possible in northeast Minnesota than in the forest fragments of southeast Minnesota.

Landscape Implications

In areas dominated by agricultural land use practices (in southcentral and southeast regions), where riparian forests represent the majority of the forest in the area, consider only uneven-age management.

On large clearcuts, consider harvesting in segments over several years. This will provide both early successional diversity and, over the long term, a large mature forest patch. Coordinate with adjacent landowners when natural patch boundaries cross property lines.

Endangered, Threatened and Special Concern Species

Purpose: To increase awareness of endangered, threatened and special concern species (ETS species) and manage forests to maintain or enhance existing populations of these species. See Table WH-3 (beginning on page 21).

Rationale, Background and Benefits

Minnesota is home to more than 2,500 plant species, several hundred vertebrate species, and numerous invertebrates. The Minnesota Department of Natural Resources (DNR) has designated 439 of these plants and animals as endangered, threatened, or species of special concern, with nearly 30%—128 species—further identified as species that may be affected by forest management activities. Eleven of these are also federally listed as threatened or endangered.

All species are part of the natural forest ecosystem and contribute to its healthy functioning. Additional values of diversity include the following:

- ❒ Conservation of genetic strains of plants or animals that are adapted to local climate and site conditions
- ❒ Conservation of local populations with natural resistance to disease
- ❒ Conservation of species that may produce new economically valuable products
- ❒ Conservation of rare species that may play critical but unknown roles in ecosystem function
- ❒ Conservation of aesthetic and recreational values
- ❒ Usefulness for scientific and educational purposes

Knowledge of the occurrence of rare plants and animals in Minnesota is incomplete. The best information on occurrences of rare species is being gathered by the Minnesota County Biological Survey, initially in the more critical prairie, metropolitan and southeastern counties. As of January 1998, surveys have been completed in 33 counties, and surveys are under way in an additional 18 counties. As each county is surveyed, a more complete basis for identifying sensitive species and areas will be available. Even when this project is complete, however, many occurrences of rare species will remain unknown, especially in forest areas of northern Minnesota.

Relatively little is known about the impacts of timber harvesting or other forest management activities in Minnesota on rare species or their habitat. Several recent studies in other parts of the country suggest that long-lived, slowly dispersing understory plants, especially those in late-successional forests, are negatively affected by timber harvest. If biologists and forest landowners work together, informed decisions can be made to protect rare plants and animals.

Endangered and threatened species are protected in Minnesota by one or both of the following laws: the Federal Endangered Species Act of 1973 (Public Law 100-478) and "Protection of Threatened and Endangered Species" (Minnesota Statute 84.0895). Species of special concern are not protected by either state or federal laws.

Native birds and certain wildflowers (lady's slippers, other orchids, trilliums, gentians, arbutus and lotus) are protected by other state and federal laws, including the Conservation of Certain Wildflowers statute, the Migratory Bird Treaty Act, and the Bald Eagle Protection Act.

Other laws, both state and federal, may apply to the protection of plants and animals in the state. For specific information on ETS species occurrences, the laws protecting them, and recommended management practices (including buffers), contact either the Minnesota Natural Heritage and Nongame Research Program or a DNR regional nongame specialist. See *Resource Directory*.

Field Survey Consultants and Other Resources

Consult with DNR wildlife managers, nongame specialists or Minnesota Natural Heritage and Nongame Research staff. See *Resource Directory*.

Other survey consultants and sources of information include:

- ❒ Local wildlife biologists, foresters, park managers or naturalists

- ❒ Nature centers, environmental learning centers, colleges, universities and University of Minnesota Extension offices

- ❒ Ecologists, botanists, natural resource consultants or forest stewardship plan preparers

- ❒ ETS source books, including:

Coffin B. and L. Pfannmuller. 1988. *Minnesota's Endangered Flora and Fauna*. 473 pp. University of Minnesota Press. *Illustrated book covering some 300 species, ranging from mosses and lichens to vascular plants, birds, mammals, reptiles, amphibians, fish, butterflies, mollusks and tiger beetles. Individual species accounts, state distribution maps, illustrations and habitat. (Note that the status of many species has changed since this book was published).*

Chippewa National Forest, Minnesota Department of Natural Resources, Leech Lake Reservation. 1996. *Rare Plants Field Guide: Chippewa National Forest and Cass County*. Unpaginated. *Loose-leaf in ring binder. 36 species. Color photo, description and habitat information for each species, line drawings for some species.*

Shubat, Deborah, and Gary Walton. 1997. *Rare Plants of Minnesota's Arrowhead*. Olga Lakela Herbarium, University of Minnesota, Duluth. *Pocket-size field guide to 56 species of non-grasslike plants from the 1996 Minnesota DNR ETS list that have records in Carlton, Cook, Lake or St. Louis counties. Color photo, distribution map, description and habitat information for each species.*

Ecoregion Applicability

Applies to all ecoregions.

Landscape Implications

Some area-sensitive ETS species will benefit most from large, unfragmented habitat blocks.

Table WH-3

Minnesota ETS Species To Be Concerned About When Conducting Forest Management Activities

Table WH-3 (cont'd)

Table WH-3 (cont'd)

Table WH-3 (cont'd)

Table WH-3 (cont'd)

Source: Natural Heritage and Nongame Wildlife Research Program, Minnesota DNR. Based on Minnesota's List of Endangered, Threatened and Special Concern Species, July 1996.

Sensitive Communities and Sites, and Tree Species at the Edge of Their Range

Purpose: To increase awareness of sensitive communities and sites and maintain or enhance these where they are found; and to provide for perpetuation of most of the genetic diversity within tree species, as well as maximization of the potential for tree species to shift their geographic ranges in response to possible rapid climatic changes. See Figure WH-1, beginning on page 29.

Rationale, Background and Benefits

Sensitive communities and sites represent only a very small portion of the total forested area of the state. Even where they do occur, they often occupy only a limited part of a managed parcel of land. Adjoining properties may share these features in some cases.

The best information on occurrences of sensitive sites and communities is being gathered by the Minnesota County Biological Survey, initially in the more critical prairie, metropolitan and southeastern counties. As of January 1998, surveys have been completed in 33 counties, and surveys are under way in an additional 18 counties. As each county is surveyed, a more complete basis for identifying sensitive areas will be available. Even when this project is complete, however, many sensitive communities and sites will remain unknown, especially in forest areas of northern Minnesota.

Identifying sensitive sites and communities in the field can be challenging and may require expert evaluation.

Some sensitive sites and communities are best managed by avoidance, while other sites can either be maintained or enhanced by the use of appropriate silvicultural or harvesting procedures.

For the most part, sensitive communities and sites are not protected by statutes. One exception is calcareous fens, a particular kind of treeless wetland community, which is protected by Minnesota Statute 103G.223.

Most tree species in Minnesota reach the limit of their geographic range somewhere within the boundaries of the forested portion of the state. There is a need to perpetuate genetic diversity within tree species and maximize the potential for tree species to shift their geographic ranges in response to possible rapid climatic changes.

Species and Communities Affected

The following natural communities (native plant communities) may possibly be affected. This list of communities is based on the current version (1.5) of *Minnesota's Native Vegetation: A Key to Natural Communities. (*These are specifically described plant communities in specific parts of the state. Thus, "jack pine woodland" is not just any jack pine stand, but a particular assemblage of plants in a certain part of Minnesota):

- ❒ Mesic oak savanna
- ❒ Dry oak savanna
- ❒ Jack pine woodland
- ❒ Jack pine barrens
- ❒ Oak forest (big woods section) mesic subtype
- ❒ Oak forest (central section) mesic subtype
- ❒ Maple-basswood forest (big woods section)
- ❒ White pine forest (southeast section)
- ❒ White pine-hardwood forest (southeast section)
- ❒ Upland white-cedar forest (southeast section)
- ❒ Northern hardwood-conifer forest (southeast section)
- ❒ Northern hardwood conifer forest (northern section) (yellow birch-white cedar subtype)
- ❒ White cedar swamp (seepage subtype)
- ❒ Black ash swamp (seepage subtype)
- ❒ Lowland hardwood forest (bur oak, basswood-black ash subtype)
- ❒ Algific talus slope

Field Survey Consultants and Other Resources

The following resources can assist in a field survey to identify sensitive sites or communities:

❒ DNR wildlife managers, nongame specialists or Minnesota Natural Heritage and Nongame Research staff. For information and assistance, see *Resource Directory.*

❒ Local wildlife biologists, foresters, park managers or naturalists.

❒ Source publications, including:

- *Minnesota's Native Vegetation: A Key to Natural Communities*
- *Natural Vegetation of Minnesota at the Time of the Public Land Survey*
- *Minnesota's St. Croix River Valley and Anoka Sandplain: A Guide to Native Habitats*
- *Minnesota's Natural Heritage: An Ecological Perspective*

Ecoregion Applicability

Applies to all ecoregions.

Landscape Implications

Forest prairie transition zones typically will have different management options than forest zones. Cooperative management with neighbors is possible when sensitive sites or communities extend over several ownerships.

Figure WH-1: Tree Range Maps

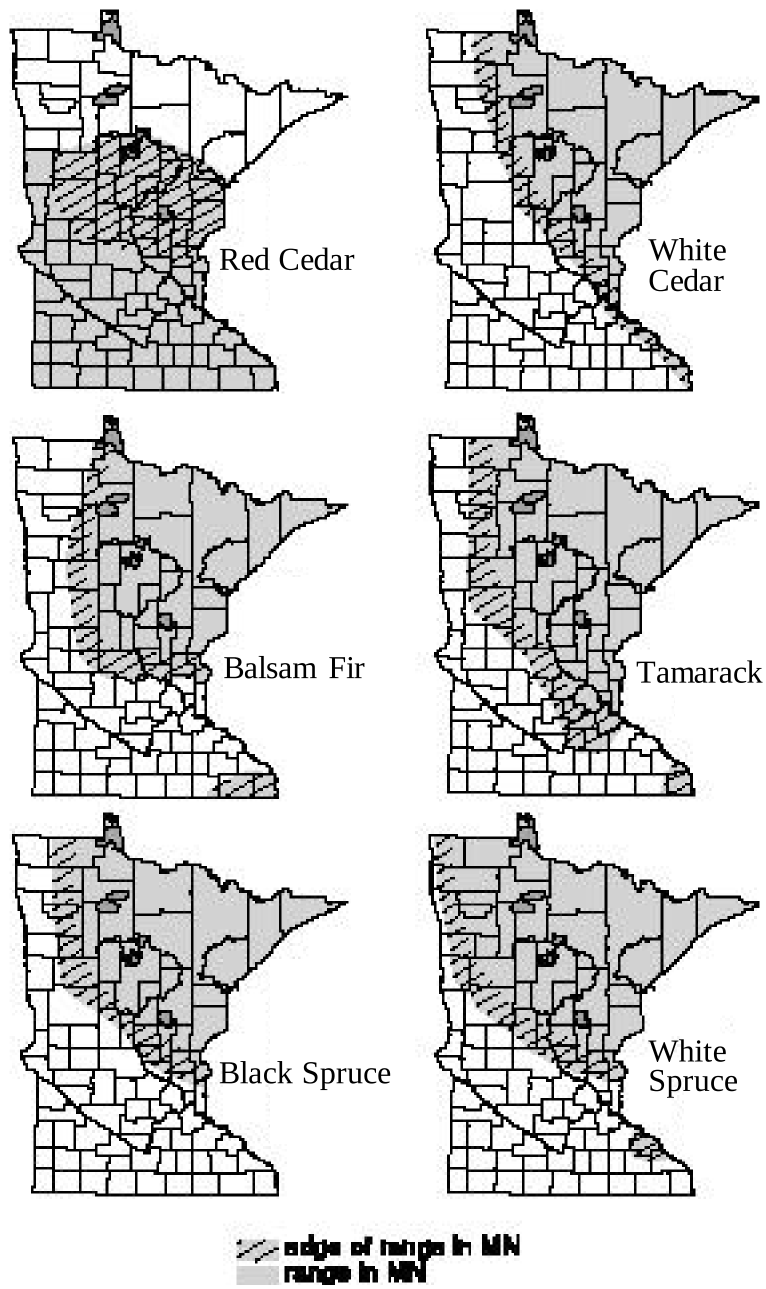


Figure WH-1: Tree Range Maps (cont'd)

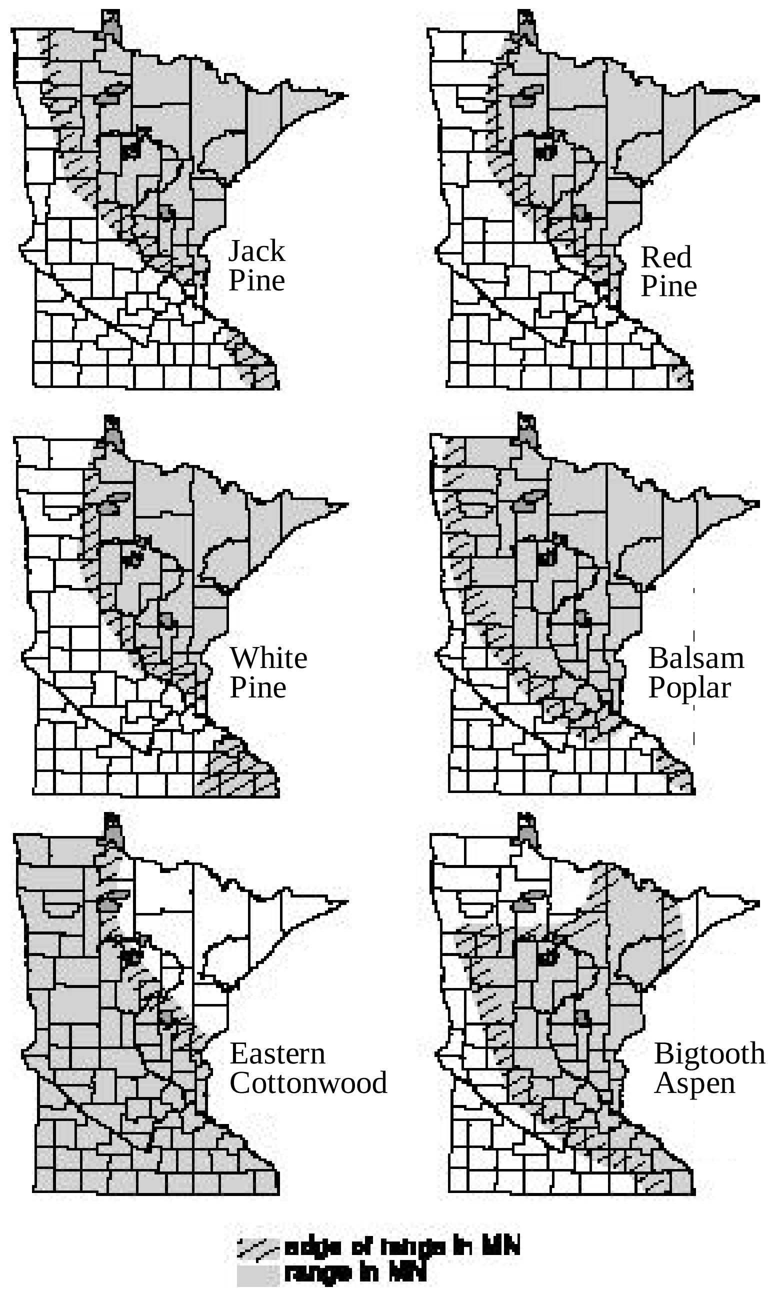


Figure WH-1: Tree Range Maps (cont d)

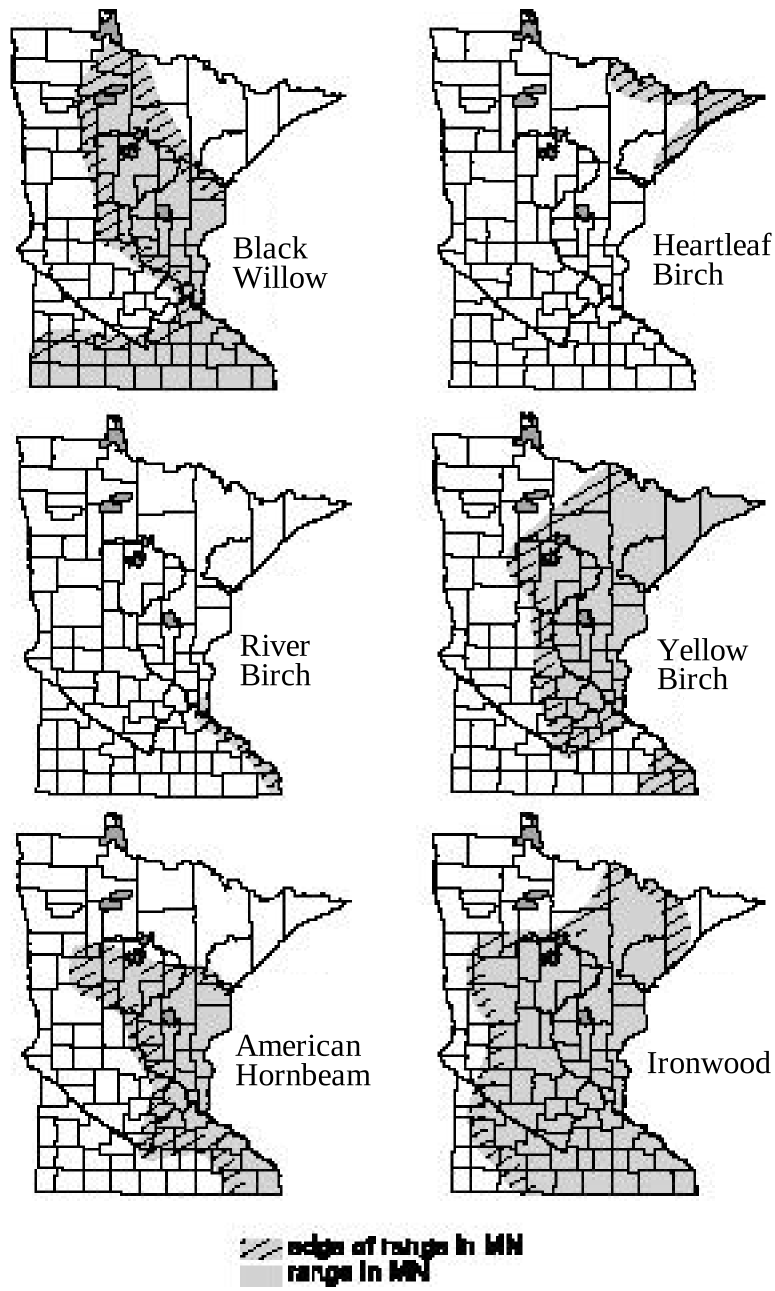


Figure WH-1: Tree Range Maps (cont d)

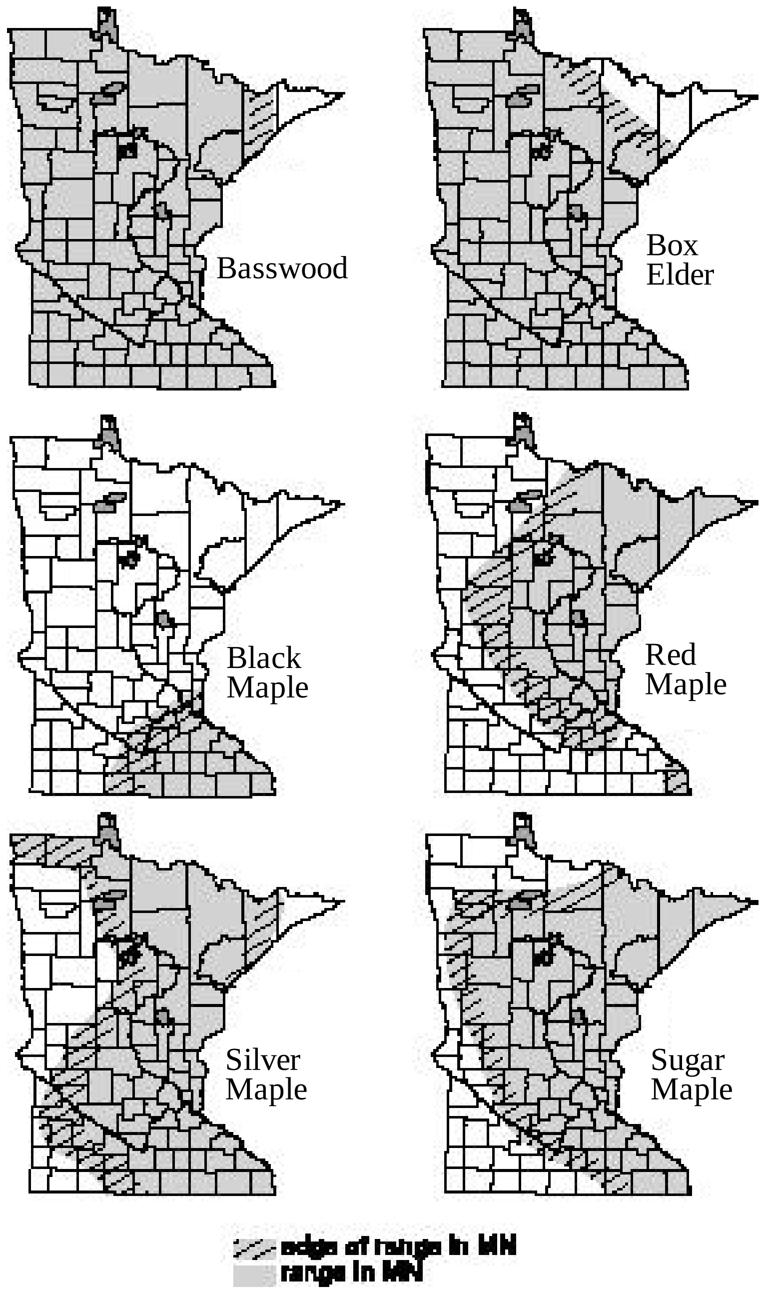


Figure WH-1: Tree Range Maps (cont'd)

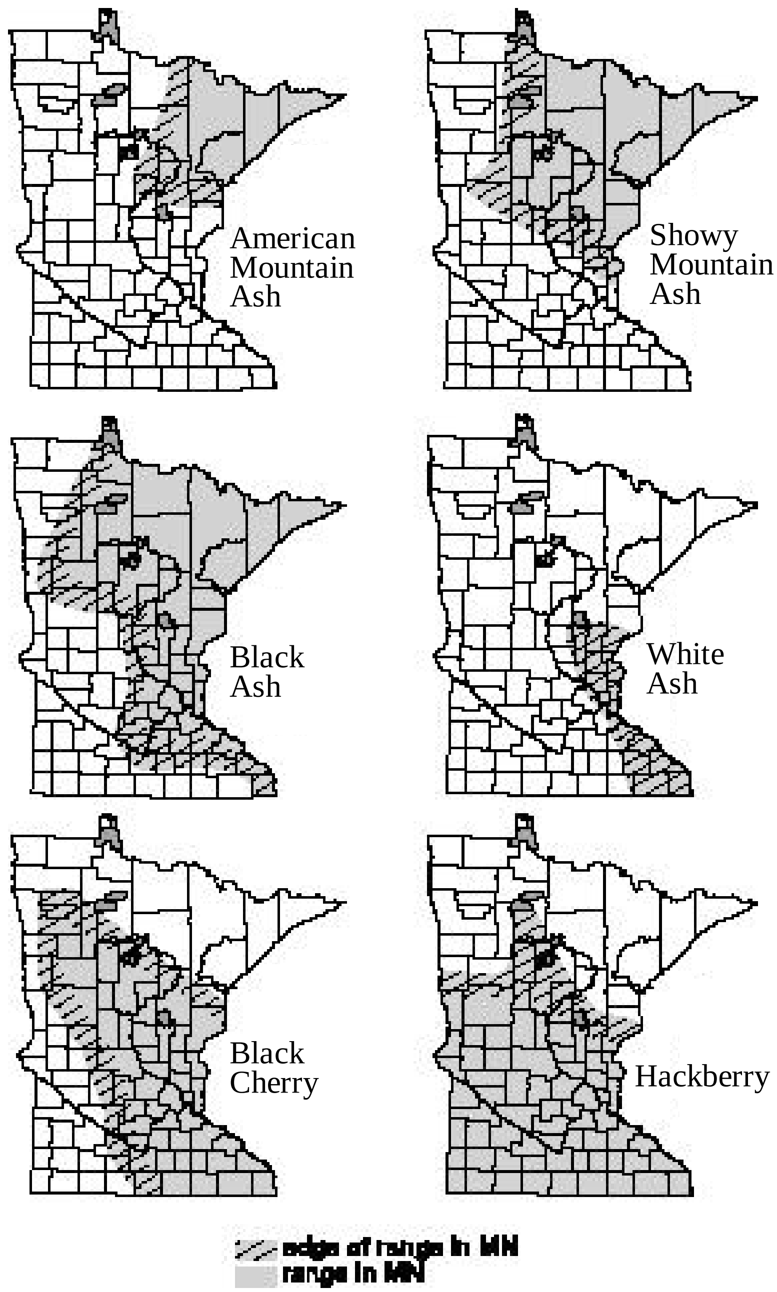


Figure WH-1: Tree Range Maps (cont'd)

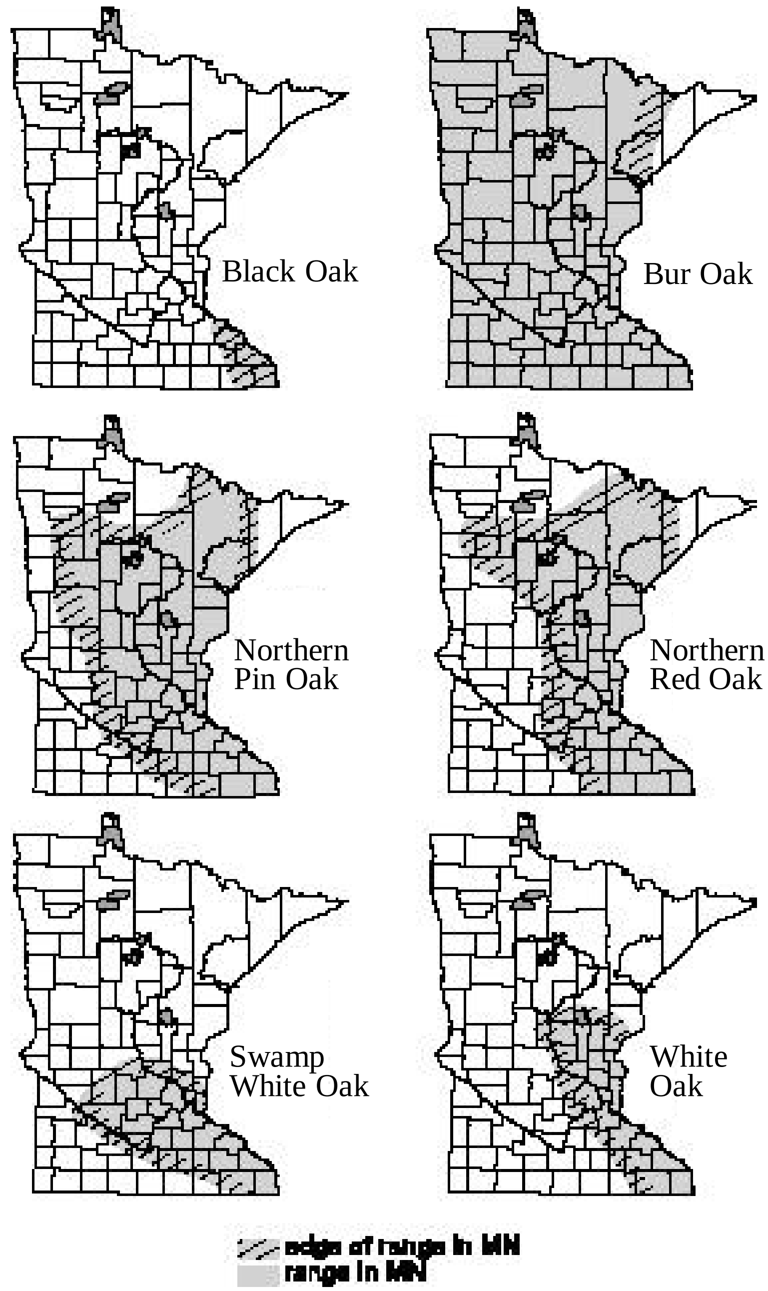
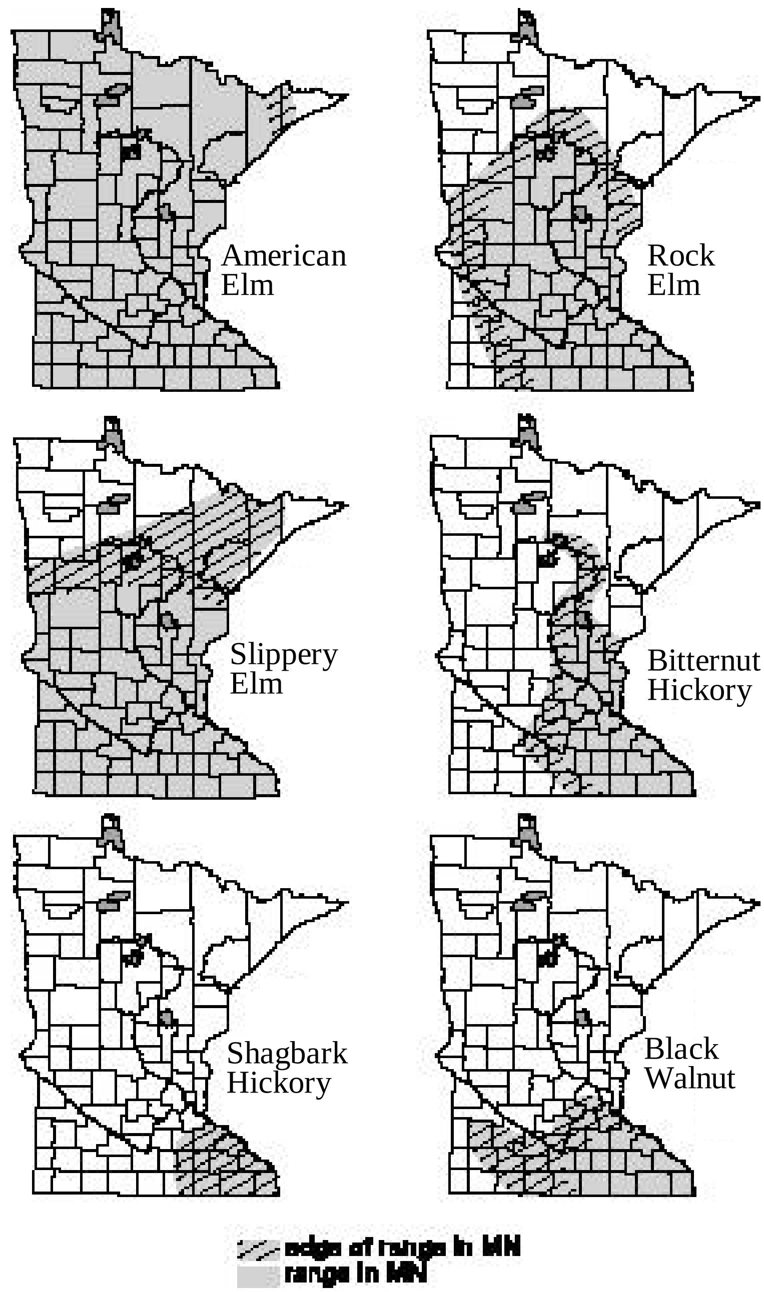


Figure WH-1: Tree Range Maps (cont'd)



Wetland Inclusions and Seasonal Ponds

❒ **Wetland inclusions** are wetland basins within an upland site.

❒ **Seasonal ponds:** Sometimes called *vernal pools*, seasonal ponds are depressions in the soil surface where water pools during wet periods of the year, typically in spring and fall.

- A seasonal pond will have an identifiable edge caused by annual flooding and local topography.
- The edge is best identified during the spring or fall, but it may be identified during dry periods by the lack of forest litter in the depression. Such depressions typically are fishless and retain water for longer periods than puddles.

Note: The leaf litter is replenished annually but is consumed during inundated periods and noticeably depleted thereafter. Deciduous litter will likely be consumed faster and more thoroughly than conifer litter.

Wetland Inclusions and Seasonal Ponds

Purpose: To provide site-level wildlife habitat features for terrestrial species associated with wetland inclusions and seasonal ponds within forests.

Rationale, Background and Benefits

Minnesota has a variety and abundance of wetland inclusions and seasonal ponds. The mixture of land and water features across the landscape provides an important dimension to the habitats of many wildlife species.

Wetland inclusions and seasonal ponds are different from puddles. Wetland inclusions and seasonal ponds retain water for longer periods and support populations of invertebrates that consume forest litter that falls into the depressions. These invertebrates provide food for birds and other species. With a lack of fish and other predators, these waters can be prime breeding habitat for amphibians. Seasonal ponds are also important spring food sources for breeding waterfowl.

Seasonal ponds are best identified in spring when full of water. Frog calling in spring, vegetation type or topography might provide additional clues to their location.

Amphibians and reptiles will benefit the most from application of wetland-related guidelines. The GEIS projected no significant negative impacts to species or communities. However, there were four species of reptiles and amphibians not modeled in the GEIS because of a lack of ecological data. Of these four, two are especially linked to wetland inclusions: the gray tree frog and the blue-spotted salamander:

- ❒ The gray tree frog requires ponds within forests surrounded by abundant riparian vegetation. The extent to which wetland protection guidelines will maintain shading, litter depth, water quality and plant cover around wetland inclusions and seasonal ponds in forests will closely parallel the degree to which these frogs are protected from impacts.

- ❒ The blue-spotted salamander requires semi-permanent ponds surrounded by hardwood forests, preferably maple-basswood, that have abundant woody debris on the ground. This species will be impacted by short rotations where there is a loss of debris and by the degradation of seasonal ponds.

Applying guidelines for water quality, leave trees and snags, coarse woody debris and slash during forest management activities can retain and create key habitat features (including woody debris, litter depth and plant cover) in these areas, while preventing siltation, excessive warming or premature drying-up of wetland inclusions and seasonal ponds.

The Need for Research and Monitoring

Even though the ecological importance of wetland inclusions and seasonal ponds is recognized, the total number and location of all such water bodies in Minnesota forests is unknown.

Existing inventories, such as the National Wetland Inventory, are incomplete with regard to wetland inclusions. Furthermore, seasonal ponds are sometimes difficult to recognize in the field.

Uncertainty regarding the abundance and location of wetland inclusions and seasonal ponds indicates the need to document their occurrence and further research their role in forest ecology in Minnesota.

For more information regarding wetland inclusions and seasonal ponds, see *Technical Literature on Wetland Inclusions and Seasonal Ponds*, page 50.

Riparian Wildlife Habitat

Purpose: To provide site-level wildlife habitat features for terrestrial riparian-obligate species.

Rationale, Background and Benefits

Riparian areas are among the most important parts of forest ecosystems. These areas have high plant diversity, both horizontally and vertically from the water's edge, which contributes to the high diversity of animals that live in these areas.

Up to 134 vertebrate species occur in riparian forests in this region, but many of these species will also use non-riparian forest habitat.

The species that are of most concern in riparian areas are "obligate" species, which require both the water and surrounding forests as habitat. In Minnesota, 32 reptile/amphibian, 20 bird and 15 mammal species are considered obligate riparian species. Numerous plant and invertebrate species are also strongly associated with these habitats.

Different animals are associated with different stream sizes. In general, larger animals are associated with larger streams and smaller species with smaller streams. A reverse pattern is found in some salamanders.

Although some degree of mature forest cover is desirable along many riparian areas, all habitat conditions are valid, given long-term disturbance regimes. The greatest concern for riparian habitats is in those areas of the state where uplands have been converted to agriculture, resulting in little additional forest of any kind in the region. This situation occurs more in the southeastern and western portions of the state rather than in the north, which affords more flexibility in age classes, structures and cover type.

Forest streams come in many sizes, growing from spring-fed trickles to large rivers as they move downhill and converge with one another to drain larger and larger watersheds. Along this gradient, the ecological characteristics of a riparian area change in a gradual continuum. Because of these characteristics, management guidelines for riparian areas in general should be considered on a landscape level.

Landscape issues are not addressed in these guidelines. Application of some wildlife-related site-level guidelines may differ within and outside the riparian management zone (RMZ), as described in Table WH-4.

It is important to keep in mind the following wildlife-related concerns for riparian habitats:

Leave trees and snags:

❒ Many riparian species are cavity dependent.

❒ Some riparian species require large super-canopy trees (trees above the existing canopy) for hunting perches and nesting sites.

❒ Shade is essential for maintaining microhabitat conditions for some riparian animals.

Coarse woody debris and slash:

❒ Several riparian animal species require downed logs for cover.

Mast:

❐ Riparian edges often contain a higher concentration and richness of unique mast species, especially shrubs, than adjacent upland areas.

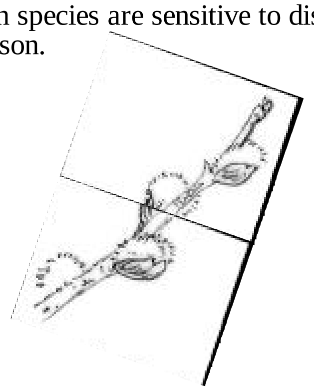
ETS species:

❐ Some ETS species occur in riparian areas.

Sensitive communities and sites:

❐ Some sensitive communities occur in riparian situations.

❐ Many riparian species are sensitive to disturbance during the breeding season.



Ecoregion Applicability

These guidelines are applicable to all forested ecoregions. In the southeast, consider limitations of harvest on adjacent slopes and the requirement of wider no-harvest strips adjacent to streams and rivers.

Landscape Implications

In areas dominated by agricultural land use practices (in south-central and southeast regions), where riparian forests represent the majority of the forests in the area, consider only uneven-age management.

Table WH-4

Differences in Application of Guidelines Within and Outside the Riparian Management Zone (RMZ)

Wildlife-Related Topic	Applying Guidelines Within the RMZ	Applying Guidelines Outside the RMZ
Leave trees and snags	❒ See RMZ recommendations for numbers and distribution of leave trees. ❒ Emphasize leave trees from "excellent" category when possible. See *General Guidelines: Retaining Leave Trees.* ❒ Leave some bigger conifers and other long-lived tree species.	❒ Leave trees in 1/4-acre-plus clumps over 5% or more of clearcuts, and/or 0-15 scattered leave trees per acre. ❒ OK to choose all species. ❒ Leave trees scattered throughout the site. ❒ Leave a variety of tree sizes.
Coarse woody debris and slash	❒ Leave or create at least 4 bark-on downed logs per acre (overall site average, including non-RMZ, may still be a minimum of 2 per acre). ❒ Avoid disturbing down logs and uprooted stumps in the RMZ.	❒ Leave or create at least 2 bark-on downed logs per acre.
Conifer retention and regeneration	❒ Leave undisturbed as many immature and mature conifer trees in the RMZ as possible.	❒ Protect conifer regeneration as possible throughout the site.
Mast	❒ Leave undisturbed as many mast-producing trees and shrubs in the RMZ as possible. ❒ Plan management activities to avoid removing or trampling mast-producing trees and shrubs.	❒ Scatter mast trees and shrubs throughout the site.

Table WH-4 (cont'd)

Wildlife-Related Topic	Applying Guidelines Within the RMZ	Applying Guidelines Outside the RMZ
Patterns of cutting	❒ In harvests > 100 acres with an RMZ, consider leaving a forested travel corridor for animals along the RMZ. ❒ Consider alternative management (other than clearcuts with leave trees) in stands currently comprised of mainly shade-tolerant species.	❒ No specific guidelines
ETS species	❒ It is important to gather information and contact individuals or agencies with ETS knowledge while planning management in stands that have RMZs.	❒ Consider contacting experts if ETS species are suspected to occur on site.
Sensitive communities and sites	❒ It is important to gather information and contact individuals or agencies with knowledge of sensitive communities and sites while planning management in stands with RMZs. ❒ Timber harvest activities should be scheduled or designed to avoid disturbing breeding ETS or sensitive species.	❒ Consider contacting experts if sensitive communities are suspected to occur on site.
Legacy patches	❒ In a stand that has an RMZ whose vegetation is similar to the surrounding upland, and for which a legacy patch is needed or desired, place the legacy patch in the RMZ.	❒ Place legacy patch in representative habitats throughout the site.

Additional Consideration: Legacy Patches

Purpose: To maintain the biological continuity of a harvested site having less than 30 ft^2 /acre residual basal area.

Rationale, Background and Benefits

Biological continuity of a harvest site is the perpetuation of the full complement of organisms (including fungi, soil invertebrates, ground layer plants, reptiles, amphibians and small mammals) that have been successful in occupying the area in recent generations.

By avoiding soil compaction of the entire harvest site, removal of the natural litter layer and alteration of the hydrology of a reserve patch, additional source areas may be provided for recolonization, gene pool maintenance and establishment of microhabitats for organisms that can persist in small patches of mature forest.

Site sensitivity, and therefore the need for legacy patches, is dependent upon soil compressibility, soil drainage and time of year of harvest. In practice, a legacy patch is similar to a leave tree clump or island (see *General Guidelines: Retaining Leave Trees*), except that a legacy patch:

- ❒ Is not disturbed with regard to soil compaction, litter removal and alteration of hydrology
- ❒ Does not need to be considered on all sites
- ❒ Is representative of the site

Assessing the Need for Legacy Patches

Consider whether a legacy patch is necessary by consulting Table WH-5. Even if the table indicates a need, however, a legacy patch may not be needed if the desired results can be achieved through normal operating procedures that provide the same benefits as a legacy patch (such as a 1/4-acre leave tree island left on frozen ground, or the use of low-impact harvesting equipment that minimizes disturbance on a site).

In harvests where less than 30 ft^2/acre basal area remains and Table WH-5 indicates a need, the following characteristics are preferred:

❒ A patch should be undisturbed in terms of soil compaction, natural litter layer and hydrology.

❒ Patches should vary in size, with a minimum of 1/4 acre per patch.

❒ For harvest units at least 15 acres in size, leave a minimum of 5% of the unit undisturbed.

❒ Randomly locate the patch (or patches) within a harvest unit to represent well the community type being harvested, including, if possible, some high quality trees.

❒ The duration of a legacy patch is through one rotation. Location of the patch may vary during subsequent rotations. If a legacy patch is left in an intensively managed area (such as a plantation), it would be most beneficial to keep the patch in the same location over several rotations.

Table WH-5 (footnotes on next page)

Decision Matrix for Legacy Patches on Mineral Soil Uplands with Less Than 6 Inches of Peat

Drainage [1]	Texture [2]	Depth to Restricting Layer [3]	5% Legacy Patch Requirement		
			Growing Season	Dormant Season	
			Any Soil	Unfrozen Soil	Frozen Soil [4]
Excessive & Somewhat Excessive	Coarse	>2 ft.	No	No	No
		<2 ft.	No	Yes	No
Well & Moderately Well	Coarse	>2 ft.	No	No	No
		<2 ft.	No	Yes	No
	Medium	>4 ft.	No	Yes	No
		<4 ft.	Yes	Yes	No
	Fine	>3 ft.	No	Yes	No
		<3 ft.	Yes	Yes	No
Somewhat Poor	Coarse	>3 ft.	No	Yes	No
		<3 ft.	Yes	Yes	No
	Medium & Fine	not applicable	Yes	Yes	No
Poor	All	not applicable	Yes	Yes	No

Footnotes to Table WH-5 (page 45):

1. Soil Drainage Classes

❒ **Excessively and somewhat excessively drained:** Water drains very rapidly. Soils are commonly shallow, very porous, steep, or a combination of these conditions. No gray mottles occur within 60 inches of the surface.

❒ **Well-drained and moderately well-drained:** Water drains quickly enough in the upper 20 to 40 inches to prevent the formation of gray mottles. Gray mottles may form within 20 to 40 inches (moderately well) of the surface if downward water movement is retarded by a clay layer or if a regional water table is present for part of the growing season.

❒ **Somewhat poorly drained:** Water drains slowly. Saturation occurs long enough to form gray colors (mottles or dominant matrix) within 10 to 20 inches of the surface. Soils generally have a layer that retards downward water movement or a high water table for part of the growing season.

❒ **Poorly drained:** Water drains very slowly. Saturation occurs long enough to form gray colors (mottles or dominant matrix) within 10 inches of the surface. Soils generally have a layer for part of the growing season.

2. Soil textures are groups of standard classes as defined by the Natural Resources Conservation Service, 1975. Soil Taxonomy. USDA Agric. Handbook 436. pp. 469-472.

❒ **Coarse:** sand, loamy sand, sandy loam

❒ **Medium:** fine sandy loam, very fine sandy loam, loam, silt loam, silt, silty clay loam, clay loam, sandy clay loam

❒ **Fine:** silty clay, sandy clay, clay

3. Any feature that retards downward water movement, such as hardpans, soil horizons greater than 6 inches thick with silty clay loam, clay loam, sandy clay loam, silty clay, sandy clay, or clay textures; bedrock; or frost, during spring breakup.

4. Soil should be sufficiently frozen to avoid disturbing the surface layer. Determining when soil is frozen may vary depending on location. One rule of thumb: “If there is 14 inches of snow by the third week of December, there will be no frost in the soil. Likewise, following winter, if there are three consecutive nights above freezing, the frost will be gone.”

Note: Drainage, texture and depth to restricting layer may be obtained from site visits or a county soils atlas map (available from local NRCS offices). See *Resource Directory*.

Species and Communities Affected

Late successional species and those that do poorly on disturbed soils will benefit the most. Many soil microorganisms helpful in plant regeneration and other important processes will help in the regeneration of the harvested site.

Ecoregion Applicability

This guideline is applicable to all ecoregions where soil conditions indicate a need, harvests are initiated on unfrozen ground, and routine harvesting practices do not meet the guideline recommendations.

Landscape Implications

Larger designated reserve areas, such as those found in state parks and Scientific and Natural Areas, can fill a role on the landscape level similar to that provided by legacy patches on the site level.

Selected Resources for Additional Information

Amphibians and Reptiles of Minnesota. 1994. B. Oldfield and J. J. Moriarty. University of Minnesota Press, Minneapolis, Minnesota. 237 pages. *This volume describes each of Minnesota's reptiles and amphibians, noting distribution, habitat and life history of each species.*

Biodiversity: A Technical Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. 1992. Jaakko Pöyry Consulting, Inc. Raleigh, North Carolina 111 pages. *This technical paper provides background on GEIS modeling results for biodiversity, including information on projected impacts of increased timber harvest, suggested mitigations and detailed information on plants and plant communities. This paper was a primary source for development of site-level wildlife habitat guidelines.*

Birds and Forests: A Management and Conservation Guide. 1995. J. C. Green. Minnesota Department of Natural Resources, St. Paul, Minnesota. 182 pages. *This book provides a wealth of information on habitat needs of and management recommendations for Minnesota's diverse bird populations. Both stand-level and landscape-level recommendations are included.*

County Biological Survey of Minnesota. Minnesota Department of Natural Resources, St. Paul, Minnesota. *This program began in 1987 as a systematic survey of rare biological features. The goal of the survey is to identify significant natural areas and to collect and interpret data on the distribution and ecology of rare plants, rare animals and natural communities. Published maps display the results for 17 of 33 counties surveyed through January 1998. Surveys are under way for 18 additional counties.*

Creating a Forestry for the 21st Century: The Science of Ecosystem Management. 1997. K. A. Kohm and J. F. Franklin (eds.) Island Press, Washington, D.C. 475 pages. *This compilation of papers looks at various aspects of forest ecosystem management, including a summary of various wildlife topics, including economic concerns.*

Final Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota. 1994. Jaakko Pöyry Consulting, Inc. Tarrytown, New York. 496 pages plus an executive summary and appendix. *This GEIS study was the main impetus for the development of forest management guidelines by the Minnesota Forest Resource Council's technical teams. This paper was a primary source for development of site-level wildlife habitat guidelines. It includes projections of significant impacts to various forest resources based on three projected levels of timber harvest in the state.*

Forest Wildlife: A Technical Paper for a Generic Environmental Impact Statement on Timber Harvesting and Forest Management in Minnesota. 1992. Jaakko Pöyry Consulting, Inc. Raleigh, North Carolina. 283 pages plus an appendix. *This technical paper provides background on GEIS modeling results for wildlife, including a host of information on projected impacts of increased timber harvest, suggested mitigations and individual species life histories. This paper was a primary source for development of site-level wildlife habitat guidelines.*

The Mammals of Minnesota. 1982. E. B. Hazard. University of Minnesota Press, Minneapolis, Minnesota. 280 pages. *This book is an excellent source for ranges, habitats and natural histories of Minnesota's mammals.*

Minnesota's Endangered Flora and Fauna. 1988. B. Coffin and L. Pfannmuller (eds.) University of Minnesota Press, Minneapolis, Minnesota. 473 pages. *Although slightly dated because of the changing status of individual species, this book remains a key information source on the status, habitat and identification of endangered, threatened and special concern species in the state.*

Minnesota's Native Vegetation: A Key to Natural Communities (v. 1.5). 1993. Natural Heritage Program, Minnesota Department of Natural Resources, St. Paul, Minnesota. 110 pages. *Descriptions and keys to identification of natural communities are included in this technical manual. Characteristic plant species are listed for each community. Future updates may include successional pathways and clearer ties to the Ecological Classification System and commonly recognized cover types.*

Report on the Scientific Roundtable on Biological Diversity Convened by the Chequamegon and Nicolet National Forests. 1994. T. R. Crow, A. Haney and D. M. Waller. North Central Forest Experiment Station, USDA Forest Service, St. Paul, Minnesota. General Technical Report #NC-166. 55 pages. *This report gives consensus-based alternative management strategies for Great Lakes forests by this group of natural resource professionals.*

Saving Nature's Legacy: Protecting and Restoring Biodiversity. 1994. R. F. Noss and A. Y. Cooperrider. Island Press, Washington, D.C. 416 pages.

Vascular Plants of Minnesota: A Checklist and Atlas. 1991. G. B. Ownbey and T. Morley. University of Minnesota Press, Minneapolis, Minnesota. 307 pages. *More than 2,000 vascular plants found in Minnesota are listed in this reference book. Maps of collected specimens of each species depict their ranges within the state. This book was a key resource for developing maps of tree species at the edge of their range in Minnesota.*

Wildlife, Forests, and Forestry: Principles of Managing Forests for Biological Diversity. 1990. M. L. Hunter, Jr. Prentice Hall, Inc,. Englewood Cliffs, New Jersey. 370 pages. *This text reviews the many facets of wildlife in the managed forest, providing a balanced approach to modern forest wildlife management.*

Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington. 1979. J. W. Thomas (ed.). USDA. Forest Service Agricultural Handbook No. 553. US Government Printing Office, Washington, D.C. 512 pages. *Although this handbook focuses on western wildlife species and their habitats, much of the background information and principles are applicable throughout the forests of the United States and represent accepted management practices of many wildlife management agencies.*

Woodland Stewardship Plan Manual. 1991 (periodically updated). Division of Forestry, Minnesota Department of Natural Resources, St. Paul. *Tabbed three-ring binder including numerous brochures, fact sheets and individual management plans for non-industrial private forest (NIPF) landowners. This document is a primary source for NIPF landowners enrolled in the Forest Stewardship program. The information in the stewardship manual should complement and expand on the site-level wildlife habitat guidelines in this document, providing comprehensive planning information for a specific parcel of land.*

Technical Literature on Wetland Inclusions and Seasonal Ponds

Ash, A.N., and R. C. Bruce. 1994. Impacts of timber harvesting on salamanders. *Conserv. Biol.* 8:300-301.

Blaustein, A. J., and D. B. Wake. 1995. The puzzle of declining amphibian populations. *Scientific American.* Vol. 272. no. 4, pp. 52-57.

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Cox, R. R., and M. A. Hanson, C. R. Roy, N. E. Euliss, Jr., D. H. Johnson and M. G. Butler. 1998. Mallard duckling growth and survival in relation to aquatic invertebrates. *Journal of Wildlife Management* 62:124-133.

de Maynadier, P. G., and M. L. Hunter. 1995. Relationships between forest management and amphibians. *Environmental Review-Dossiers Environment* 3:233-261.

Kenney, L. P. 1995. Wicked big puddles: a guide to the study and certification of vernal pools. U. S. Government Printing Office.

Lannoo, M. J. (ed.) 1998. *Status and Conservation of Midwestern Amphibians.* University of Iowa Press, Iowa City, Iowa.

Lugo, Areil E., Sandra Brown and Mark Brinson. *Ecosystems of the World: Forested Wetlands.* Vol. 15. Elsevier Science Publishers B. V. New York, New York.

Mitsch, W. J., and J. G. Gosselink. 1993. *Wetlands.* Van Nostrand Reinhold. New York, New York. 722 pages.

Murkin, H. R., and D. J. Batt. 1987. The interactions of vertebrates and vertebrates in peatlands and marshes. *Memoirs of the Entomological Society of Canada* 140:15-30.

Pierce, Gary. (1997, Aug. 30) New wetland loss numbers and forested wetlands (Citing internet sources) <froghome@eznet.net>

Roble, S. M., and D. B. Kittredge, Jr. 1991. Protection of vernal pools during timber harvesting. *The Northern Logger and Timber Processor*. May: 6-7.

Thorpe, J. H., and A. P. Covich. 1991. *Ecology and Classification of North American Freshwater Invertebrates.* Academic Press, Inc. San Diego, California. 911 pages.

Trettin, C. C. (ed.) et al. 1997. *Northern Forested Wetlands: Ecology and Management.* Lewis Publishers, New York, New York.

Welsch, D. J., D. L. Smart, J. N. Boyer, P. Minkin, H. C. Smith and T.L. McCandless. 1995. Forested wetlands: functions, benefits and the use of best management practices. Northeastern Area, USDA Forest Service, Radnor, Pennsylvania. 62 pages.

Wiggins, G. B., R. J. Mackay and I. M. Smith. 1980. Evolutionary and ecological strategies of animals in annual temporary pools. *Archiv für Hydrobiologie Supplement* 58:97-206.

PART 3

INTEGRATED GUIDELINES

The Purpose of Integrated Guidelines

The purpose of integrated forest management guidelines is to provide consistent, coordinated guidance in sustaining many of the functions and values of our forest resources, including (as outlined in Part 2) cultural resources, forest soil productivity, riparian areas, visual quality, water quality and wetlands, and wildlife habitat.

Forest management includes a broad diversity of activities related to using, maintaining and sustaining Minnesota forests. Major forest management activities, which these integrated guidelines address, include:

- ❒ Forest road construction and maintenance
- ❒ Timber harvesting
- ❒ Site preparation
- ❒ Pesticide use
- ❒ Reforestation
- ❒ Timber stand improvement
- ❒ Fire management
- ❒ Forest recreation management

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.

How the Guidelines Will Help Sustain Forest Resources

The following outcomes identify the overall benefits of these integrated forest management guidelines. Addressing six forest resources (cultural resources, forest soil productivity, riparian areas, visual quality, water quality and wetlands, and wildlife habitat), the guidelines for forest management activities provide substantial benefits to the sustainability of forest ecosystems by:

- ❒ **Increasing awareness of cultural resources** among forest landowners, resource managers and loggers, and protecting important cultural resources.

- ❒ **Maintaining the productive capacity of forest soils,** to favor the regeneration, survival and long-term growth of desired forest vegetation.

- ❒ **Maintaining and enhancing vegetation within riparian areas** for the benefit of water quality, fish and wildlife, timber products, recreation and aesthetics.

- ❒ **Maintaining and enhancing scenic quality in forested areas** for the enjoyment of tourists, recreational users and local travelers.

- ❒ **Maintaining water quality and protecting wetlands.**

- ❒ **Encouraging stewardship of wildlife habitat and forest communities,** including all organisms that depend on forests for all or part of their needs.

Two Types of Guidelines: General and Activity-Specific

The guidelines that provide these benefits to forest resource sustainability are divided into two groups: general guidelines, which are common to many forest management activities; and activity-specific guidelines, which apply to specific forest management activities.

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

GENERAL GUIDELINES

Common to Many Forest Management Activities

These forest management guidelines are designed to help sustain the following forest resources: cultural resources, forest soil productivity, riparian areas, visual quality, water quality and wetlands, and wildlife habitat. These guidelines are applicable to many forest management activities, including forest road construction and maintenance, timber harvesting, mechanical site preparation, pesticide use, reforestation, timber stand improvement, fire management and forest recreation management.

While many guidelines address only one or two particular forest management activities, a number of the guidelines are applicable to many activities. For example, guidelines for managing fuel and lubricants or maintaining coarse woody debris are not specific to any one forest management activity; they apply to all activities, as do guidelines for goal-setting and conducting a preliminary site inventory.

These general guidelines represent a basic framework for sustaining forest ecosystems, providing a common foundation of "how-to's" that apply to many different management activities.

ACTIVITY-SPECIFIC GUIDELINES

Applicable to Particular Forest Management Activities

Beyond the general guidelines, which share a common application to many—if not all—forest management activities, many guidelines apply to particular forest management activities. These activity-specific guidelines are unique to a particular activity. They are designed to work together with the general guidelines to provide a coordinated framework for helping ensure the sustainability of the functions and values of our forest resources.

Within activity-specific guidelines, frequent references 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.

GENERAL GUIDELINES
Common to Many Forest Management Activities

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Managing Riparian Areas (cont d)

FIGURES

FIGURES (cont'd)

TABLES

GENERAL GUIDELINES

Common to Many Forest Management Activities

General guidelines are divided into two sections: *Planning* and *Operational Activities*. These two sections suggest that a commitment to sustainability of forest resources is both a planning commitment and an operational commitment:

❒ The *Planning* section recognizes that many planning considerations related to resource protection and forest sustainability are common to most forest management activities, and that the commitment to sustainability begins in the early planning stages—long before the actual management activity begins.

❒ The *Operational Activities* section focuses on general on-site guidelines that carry out the commitment to sustainability that was begun during the planning phase.

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.

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.

PLANNING

Identifying Goals and Objectives

Getting started requires identifying land ownership goals and objectives. This first step may require the assistance of professionals. A few considerations related to identifying goals and objectives include the following:

❒ **Planning for the long term is critical** to managing a forest. Why? Because whatever a landowner does (or doesn't do) will have long-term effects.

❒ **Developing a management plan** will assist the landowner in determining objectives, managing efficiently, avoiding costly errors, making knowledgeable decisions and evaluating progress.

❒ **Identifying ownership goals** and objectives for the property is the first step in planning how to manage a forest. Begin by identifying the following:

- What resources are most important: trees? soil? water? recreation? wildlife? fish?

- What kind of inventory will have to be taken?

- Are stated goals and objectives for the site in question really possible?

Ask these three questions:

- **What** does the landowner want from the forest?
- **How much** does the landowner want?
- **When** does the landowner want it?

❒ **Making objectives specific** will make management choices more clear. Professionals may be able to help clarify objectives and make them specific.

❐ **Establishing priorities is an essential step** whenever multiple objectives exist.

❐ **Once goals and objectives are identified,** the next step for a landowner is to determine whether to move forward without professional assistance, or whether the assistance of professionals would be beneficial. For sources of professional assistance, see *Resource Directory*.

Conducting a Site Inventory

Conducting a site survey involves gathering information, surveying the site firsthand, and then considering a number of factors related to resource needs, landowner objectives and site capabilities. The following planning and design considerations are not all inclusive, but they do identify some of the key factors in making informed forest management decisions.

Gathering Information

❐ **Secure aerial photographs, topographic maps, soil surveys, visual sensitivity classification maps** and other tools available to provide assistance in evaluating properties and developing plans for forest management activities. Sources of this information include local Soil and Water Conservation District (SWCD) offices, local USDA Natural Resource Conservation Services (NRCS) offices, local Department of Natural Resources (DNR) offices, and county land departments. Many counties have completed soil surveys, and a number of them have also developed visual sensitivity classification maps.

For sources of these information tools, and for a list of counties that have developed visual sensitivity classification maps, see *Resource Directory*.

U Find out whether any special management considerations exist on adjacent properties. For sources of information and assistance, see *Resource Directory.*

U Check existing cultural resource inventories to determine whether any cultural resources are known to be present within the management area. For sources of cultural resource inventories, see *Resource Directory.*

U Consult a Minnesota DNR wildlife manager, forester or nongame specialist, or Minnesota Natural Heritage staff for information about the occurrence of endangered, threatened or special concern species (ETS species), sensitive communities, or sensitive sites on or near the management area prior to beginning management activities. For additional contact information, see *Resource Directory.*

U Determine whether permits are required from the DNR for crossing of intermittent or perennial streams and open water wetlands. See *Appendix H: Work Activities That Do Not Require a DNR Protected Waters Permit.*

Additional Consideration

K Consider doing additional research on the history of the project area, especially if existing cultural resource inventories contain no information about the area. Such research efforts may include checking existing maps, air photos and printed historical information, as well as contacting individuals knowledgeable about local history or archaeology. For additional information, see *Part 2: Cultural Resources* and *Resource Directory.*

The preliminary site survey evaluates many resources, features and site conditions, including soil characteristics, such as soil texture, which may be determined by hand. *Photo courtesy of Minnesota DNR*

Surveying the Site Firsthand

U Conduct an on-the-ground evaluation of all land being considered for the forest management activity. It is important to have this firsthand knowledge of the area being considered. Familiarity with soils, terrain and vegetation in the area will assist landowners and resource managers in:

- Making decisions related to operating periods, harvest methods and equipment, tree species suitability, or reforestation strategies
- Choosing appropriate methods of operation
- Affirming (or modifying) forest management objectives

U Evaluate soil conditions to determine tree species, preferred seasons of operation, site preparation and regeneration techniques, and other information related to forest management decisions.

U Identify resources, features and site conditions that may require special attention, such as:

• Perennial and intermittent streams, lakes, wetlands and seasonal ponds

• Steep slopes, rock outcrops, unstable or poorly drained soils, sinkholes, seeps and springs (See Figure GG-1.)

• Snags and nesting sites

• Soil or site conditions that may dictate specific operational timing or methods and equipment to be used, or that may lead to weather-related or seasonal closure of the operations

• Special soil conditions and topographic features that make some areas of the state more sensitive than others to accelerated erosion due to soil disturbance

U Assess cultural resource potential. Identification of cultural resources is fundamental for protection of those resources. See *Part 2, Cultural Resources: Identifying, Assessing and Managing Cultural Resources* and *Resource Directory.*

Figure GG-1

Seep in a Forested Area

Additional Consideration

K Consider conducting additional field survey work prior to forest management activities to determine whether endangered, threatened or special concern species (ETS species), rare tree species, or sensitive communities or sites are present. See *Part 2, Wildlife Habitat*: *Endangered, Threatened and Special Concern Species* and *Sensitive Communities and Sites, and Tree Species at the Edge of Their Range.*

Factors To Consider in Site Evaluation

After identifying the physical characteristics of the site during an on-the-ground evaluation (as detailed in the previous section), it is also important to identify how these characteristics may affect the planning and design of a particular forest management activity. Some of these considerations include:

❒ Soil capabilities and limitations (For information on how to obtain soil interpretations relating to equipment operations, see *Resource Directory.)*

❒ Location and width of filter strips and riparian management zones (RMZs)

❒ Stream crossings

❒ Visual sensitivity areas

❐ Evaluating the most efficient use of existing and planned infrastructure (the network of access roads, approaches, trails and landings used to move equipment onto and around a forest management site). Infrastructure considerations include the following:

- Roads, trails, landings and approaches needed to meet objectives
- Adequacy of any roads, trails and landings already in existence
- Assessment of additional roads, trails, landings and approaches needed

Communicating Information

❐ **Create a site map or conduct an on-site review** with the operator to indicate the location of any special concern areas identified during the site survey. Be sure that maps are large enough to adequately depict sensitive areas. See Figure GG-2.

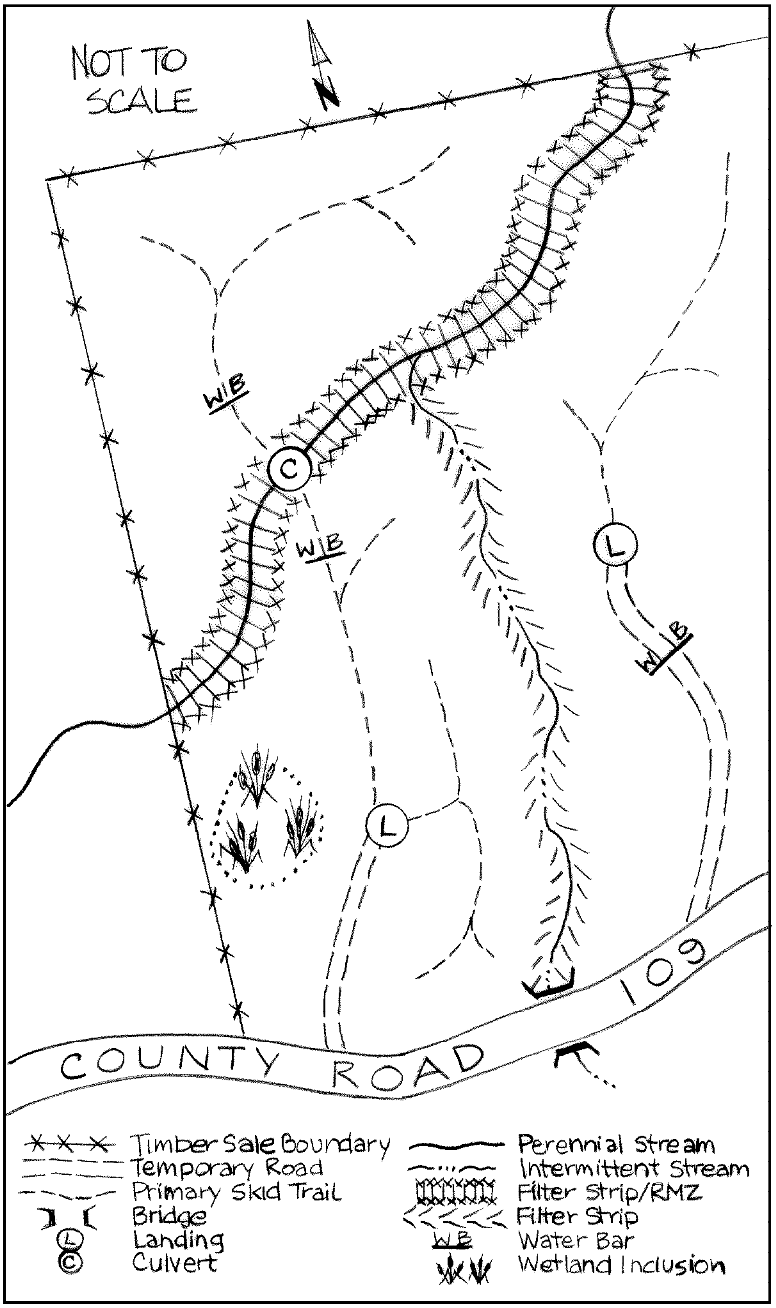
❐ **Share any information gained** by those conducting the preliminary evaluation among involved landowners, resource managers, loggers and operators. Sharing information helps to assure a common understanding of landowner objectives, existing regulations and site conditions.

Incorporating Sustainability into Forest Management Plans

Forest management activities should follow a well-thought-out plan that defines such factors as the extent and duration of the activity, the most appropriate season and method of operation for the activity, appropriate forest management guidelines to limit site disturbance, and other management objectives related to forest resource sustainability.

Figure GG-2

Harvest Site Map



The timing of forest management activities or recreational activities can be constrained by pre-existing or seasonal conditions, regulations and limitations, such as seasonal road load limits, seasonal forest access limitations, forest fire hazard conditions, and appropriate times for such activities as herbicide treatments, tree planting and road construction.

Timing and Coordination of Activities

U Conduct forest management activities when soil conditions are firm enough to support the type of equipment being used, in order to protect soil productivity and minimize damage to any cultural resources that may be present.

U Plan to conduct forest management activities in wetlands when frozen or when firm enough to support equipment being used. Evaluate the site based on weather conditions to ensure adequate support for equipment to prevent or minimize rutting. Examples of weather conditions that could be cause for concern include heavy rain, flooding, significant snow before frost, and three consecutive nights above freezing after frost has been established.

U Plan for removal of equipment and cut material from wetland areas prior to thawing at the end of the winter season, or leave it until the next winter.

U Plan to conduct activities during the preferred operating periods for site and soil conditions. Preferred operating periods for a site may vary due to local and seasonal climatic conditions, equipment being used and operating techniques.

U Combine and integrate forest management activities where appropriate to reduce or eliminate the need for multiple entries by heavy equipment. For example, full-tree skidding may be used for preparation of jack pine seed beds, eliminating the need for additional site preparation.

U Protect reserve areas and structural habitat components retained in previous stand treatments.

Timing and Coordination of Activities To Reduce Noise and Visual Impacts

*In areas classified as most sensitive:**

- **Avoid management operations during periods of peak recreational use** whenever possible.
- **Reduce noise** in early morning, late evening and other appropriate times whenever possible.
- **Selectively restrict use of recreational facilities** to avoid conflict with management activities.
- **Temporarily relocate recreation trails** away from management activity areas.
- **Inform and educate recreational users** regarding management issues, limitations and timing prior to, during and after management activities.

*In areas classified as moderately sensitive:**

- **Selectively restrict use of recreational facilities** to avoid conflict with management activities.
- **Time management activity** with consideration for public use patterns.
- **Minimize direct conflict with forest recreational users** during peak use and special event periods.
- **Temporarily relocate recreation trails** away from management activity areas.
- **Inform and educate recreational users** regarding management issues, limitations and timing prior to, during and after management activities.

*In areas classified as less sensitive:**

- **Limit time constraints** to special events or site-specific concerns.

*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.

Winter harvesting is one example of timing forest management activities to protect soil and cultural resources, as well as to avoid periods of peak summer recreational use. *Photo courtesy of Minnesota Timber Producers Association*

Designing Operations To Fit Site Conditions

U Determine the preferred operating season for a specific site to help avoid unwanted impacts to the site, as well as the costly process of moving equipment from a site or shutting down operations if negative impacts are occurring.

U Take into account that the preferred operating season may vary for any one site depending on soil characteristics, local climatic conditions, equipment being used, and operating techniques. The use of low ground pressure (LGP) equipment and such operating techniques as using slash mats to drive on can extend operating seasons on low-strength soils.

U Use caution when operating heavy equipment on sites whenever adverse soil impacts are likely. Soil susceptibility to compaction and rutting is primarily dependent on soil texture and moisture content. Soils are most susceptible to compaction, rutting and puddling at the following times:

- During spring and early summer months
- Immediately following heavy rains
- During the period between when transpiration ceases in the fall and before freeze-up occurs

Managing and Minimizing Infrastructure

In the context of forest management activities, infrastructure is defined as the network of access roads, approaches, trails and landings used to move equipment onto and around a forest management site.

Any reduction in the total amount of area occupied by such infrastructure reduces the impact on soil productivity, as well as potential impacts to cultural resources, riparian areas and wildlife habitat. For more information on how to obtain soil interpretations relating to equipment operation, see *Resource Directory*.

U **Consider future management activities that may use common infrastructure** for management of adjacent stands or ownerships. Develop or plan infrastructure accordingly.

U **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.

U **Where appropriate, limit direct trafficking** of a site to the smallest area necessary when planning such management activities as harvesting and site preparation.

Equipment, Fuel and Lubricants

Forest management activities often require the use of a variety of equipment during field operations, as well as the associated use of fuels and lubricants. These operations typically occur at remote locations, with maintenance activities taking place on-site.

Precautions are needed to prevent soil, water and wetland contamination when using fuels, lubricants and other materials associated with heavy equipment operations. Proper planning will help prevent or minimize spills of fuels, lubricants or other materials.

Contamination of soil, water and wetlands can be prevented with proper planning, such as this remote storage tank for waste oil. *Photo courtesy of Minnesota DNR*

U Eliminate or reduce potential contamination arising from spills. Routine maintenance of equipment, including regular checks of hoses and fittings for leaks or wear, is essential to protecting streams, lakes, wetlands, seasonal ponds, ground water and soils from the impacts of fuel and lubricant spills and leaks.

U Place fueling and maintenance areas, wherever practical, outside of filter strips or the riparian management zone, whichever is wider.

Water Quality and Wetlands

U Plan forest management activities to avoid operations in wetlands, including building landings, skid trails and roads. Where avoidance is not practical, minimize impacts by limiting the extent of wetland activities.

U State and federal wetland regulations provide an exemption for roads constructed for the primary purpose of providing access for conducting forest management activities.

Under the Minnesota Wetland Conservation Act (Minnesota Rules Chapter 8420.0122 Subp. 7), a replacement plan for wetlands is not required for 1) temporary or permanent crossings, or for 2) entering a wetland to perform silvicultural activities, including timber harvesting as part of a forest management activity, so long as the activity:

- Limits the impact on the hydrologic and biologic characteristics of the wetland.
- Does not result in the construction of dikes, drainage ditches, tile lines or buildings.
- Does not result in the drainage of the wetland or public waters.
- Avoids filling whenever possible.

To qualify for an exemption under the Minnesota Wetland Conservation Act (Minnesota Rules Chapter 8420.0115), an individual or organization:

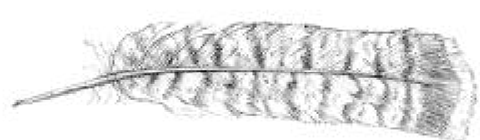
- Must use appropriate erosion control measures to prevent sedimentation of water.
- Must not block fish activity in a watercourse.
- Must comply with all other applicable federal, state and local requirements, including water resource protection requirements and water quality Best Management Practices (BMPs), as presented in *Protecting Water Quality and Wetlands in Forest Management: Best Management Practices in Minnesota* (1995).

When planning to conduct an exempt activity, contact the appropriate local governmental unit for advice on minimizing wetland impacts.

Rare or Sensitive Species

U **Modify management activities** to maintain, promote or enhance ETS species (endangered, threatened or of special concern) on the site.

U **Avoid forest management activities that isolate or eliminate populations of tree species** at the edge of their range. Favor these species via regeneration, as leave trees, or through other suitable methods to perpetuate them on site. See *Part 2, Wildlife Habitat: Sensitive Communities and Sites, and Tree Species at the Edge of Their Range.*



Additional Consideration

K **Consider consulting with the DNR or other forest management experts** on ways to maintain or enhance sensitive communities and sites while conducting forest management activities on or near them. For a specific listing of sensitive communities, see *Part 2, Wildlife Habitat: Sensitive Communities and Sites, and Tree Species at the Edge of Their Range*.

Maintaining Filter Strips

Managing land to control nonpoint source pollution near surface water and wetlands is important. Timber harvesting activities, mechanical site preparation, prescribed burning and road construction increase the potential for sedimentation due to mineral soil exposure.

Planning Considerations

❒ **Maintaining a filter strip** between the water body and the forest disturbance can protect surface water. Filter strips are areas adjacent to perennial and intermittent streams, lakes, open water wetlands, wetland inclusions, seasonal ponds, seeps and springs that help minimize the runoff of sediment, debris, nutrients and pesticides into these water bodies.

Filter strips provide a zone of infiltration that protects surface water by 1) allowing remaining vegetation to remain essentially undisturbed, and 2) allowing the forest floor to trap sediment from adjacent land areas.

❒ **Forest management activities may be conducted in filter strips** as long as the integrity of the filter strip is maintained. These activities should produce minimal exposure of mineral soil.

Defining Filter Strips

U **Apply the following filter strip guidelines** to all perennial and intermittent streams, lakes, open water wetlands, wetland inclusions, seasonal ponds, seeps and springs. Filter strips should border and parallel the edge of all water bodies.

Apply them independently of the width of the riparian management zone, and adhere to them except when the recommended 5% maximum level of mineral soil exposure is unacceptable for the regeneration of certain desired species:

- Limit mineral soil exposure to less than 5%, well distributed throughout the filter strip.

• Avoid concentrating disturbance in the filter strip, to prevent concentration of flows across the filter strip.

• Establish filter strip widths based on percent and length of slope. See Table GG-1, Figure GG-3 and Figure GG-4.

Filter Strip Width Guide

Slope of land between activity and water body	Recommended width of filter strip (slope distance)*
0-10%	50 feet
11-20%	51-70 feet
21-40%	71-110 feet
41-70%	111-150 feet

**For roads, distance is measured from the edge of soil disturbance. For fills, distance is measured from the bottom of the fill slope.*

Table GG-1

U Consider additional stabilization measures when necessary, such as the use of slash, straw bale barriers, mulch and silt fences, including instances when:

• An area of soil is exposed within the filter strip and sedimentation is likely to result.

• Management objectives preclude the use of a filter strip and sedimentation is likely to occur.

Figure GG-3

RMZ for Non-Trout Perennial Streams < 3 Feet Wide of Varying Slopes in High Bank and Upland Forests:
Even-Age and Uneven-Age Management

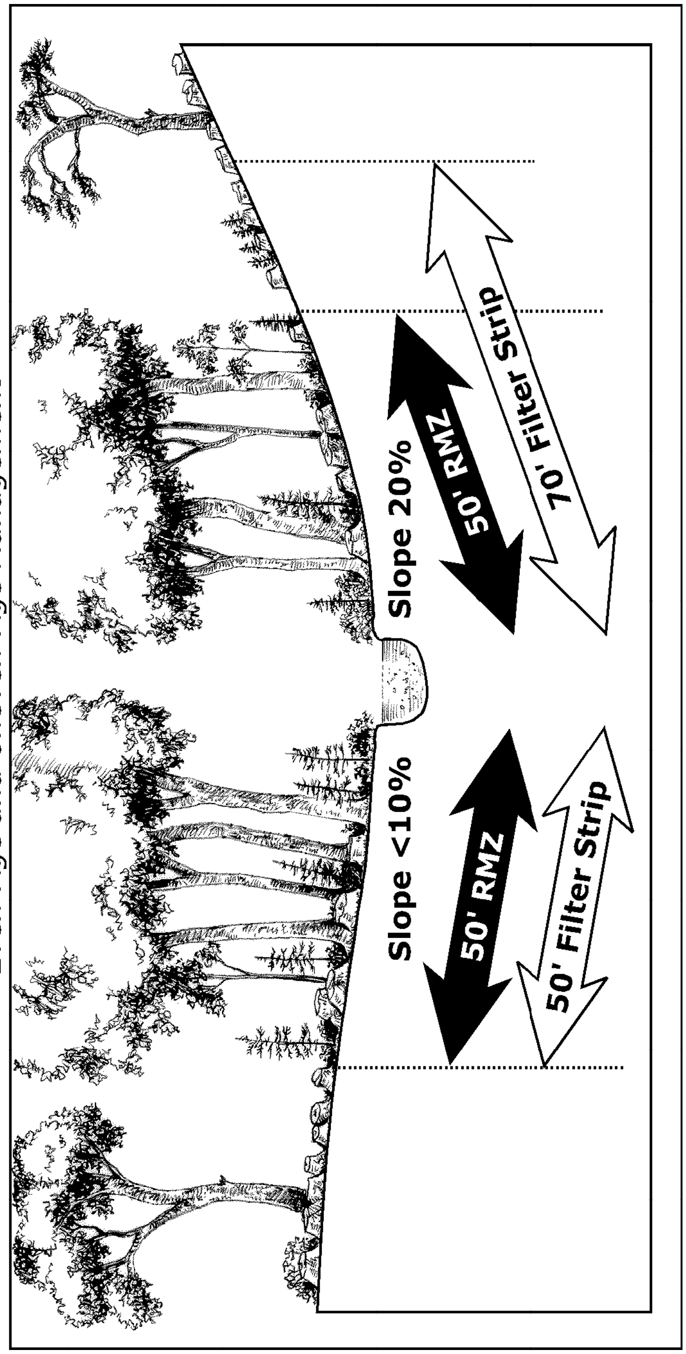
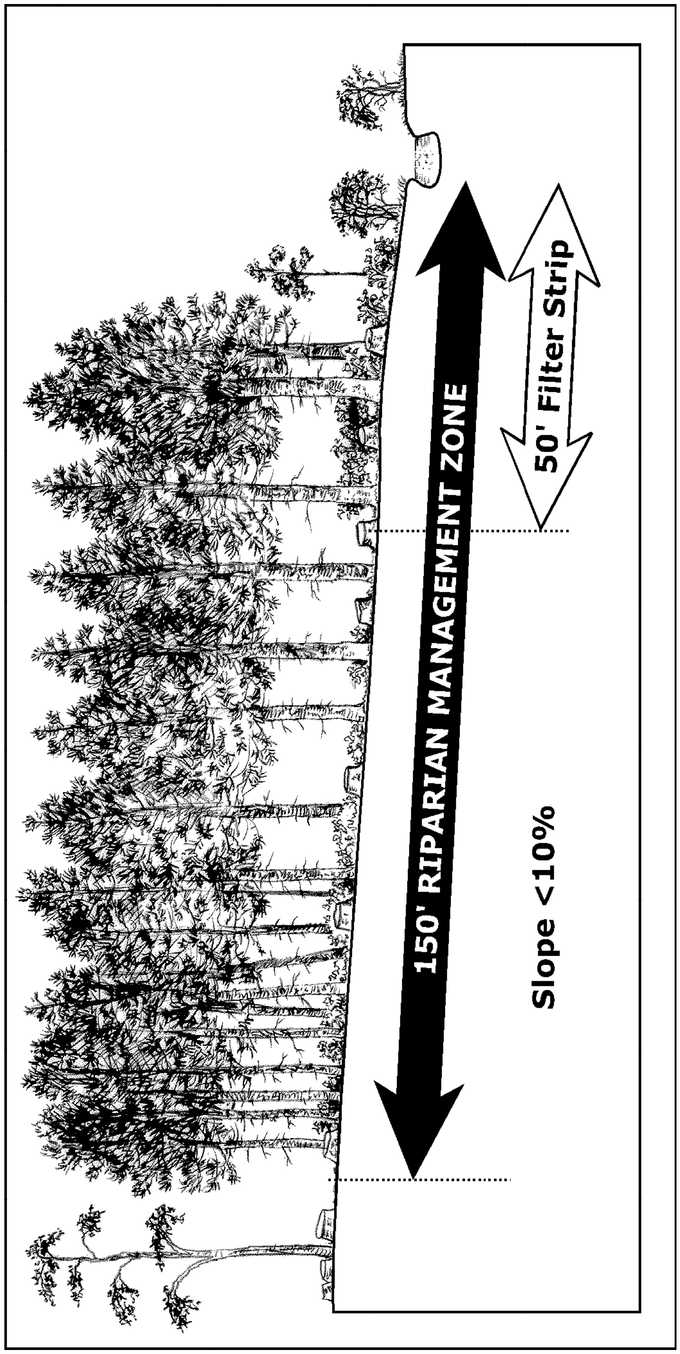


Figure GG-4

Filter Strips and RMZ for Designated Trout Streams Where Slope Is < 10%:
Even-Age Management



Managing Riparian Areas

Riparian management zone (RMZ) guidelines should be determined during the on-the-ground evaluation of the site. They are based on the topography, hydrology and vegetation within the riparian area.

Width, residual basal area and other recommendations are provided based on different types of water bodies, site conditions within the riparian area, and management objectives (even-age or uneven-age management).

The recommended width and basal area guidelines and the flexibility considerations apply within the RMZ. **Outside of the RMZ, normal operations apply,** unless other guidelines further modify those operations.

Forest management activities may be conducted within the riparian management zone.

Components of RMZ Guidelines

Riparian management zone guidelines include width and residual basal area recommendations:

- ❐ **Recommended widths** are measured along the slope distance from the edge of the water body. Where the edge of the water body is not a straight line, the RMZ width may either parallel that edge or be a straight line (see Figure GG-5). In either case, the width that is applied on the ground represents the average distance from the water's edge.

- ❐ **Basal area** is the cross-sectional area of a live tree 4.5 feet above ground (based on its diameter at breast height, or DBH). Basal area describes the extent to which an area is occupied by trees (a relative index of the density of trees in an area). It is expressed in square feet per tree (ft^2/tree) or per acre (ft^2/acre). See *Appendix F: Determining Basal Area.*

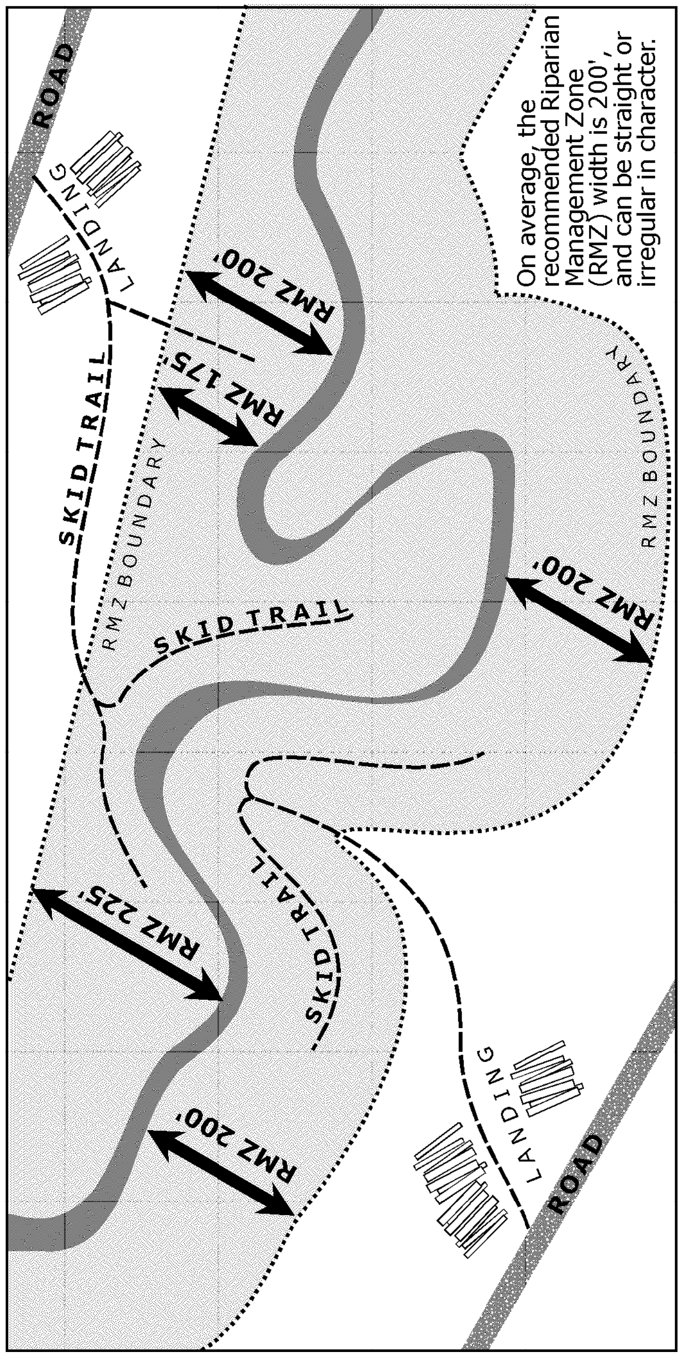
Basal area is the cross-sectional area of a live tree 4.5 feet above ground (based on its diameter at breast height, or DBH). *Photo courtesy of Potlatch Corporation*

Crown closure (the degree to which the forest floor is shaded by tree crowns when the sun is immediately overhead) can also provide an approximation of the extent to which an area is occupied by trees. See *Appendix F: Determining Basal Area.*

In addition to width and basal area recommendations, there are other riparian guidelines which address other issues within the RMZ. See *Incorporating Riparian Guidelines into Plan Design* (page 35).

Figure GG-5

Sample Location of Harvest Activity in Relation to RMZ Boundaries
(Uneven-Age Management Adjacent to a Designated Trout Stream)



Flexibility Considerations

The variability of site conditions and landowner objectives points to the need for flexibility and professional judgment in making forest management decisions within RMZs. The following flexibility considerations, which are applicable to streams, lakes and open water wetlands, can help landowners, resource managers and loggers make appropriate forest management decisions.

❒ **The width and residual basal area guidelines represent recommendations** designed to protect and maintain riparian functions and values. Landowners, resource managers, loggers and contractors should consider the silvicultural needs of the species to be managed, as well as the protection and maintenance of riparian functions and values. Forest management plans within RMZs should consider stream characteristics, as well as goals related to forest regeneration, fisheries and recreation.

❒ **It is acceptable to vary above or below recommended width and residual basal area guidelines,** including those situations in which the management objective is to mimic natural processes. Landowner management objectives and management recommendations for the RMZ should be documented during the planning process.

❒ **The slope aspect (direction that the slope faces) should not determine** whether the RMZ guidelines should be altered around a water body, since shade is not the sole function of an RMZ.

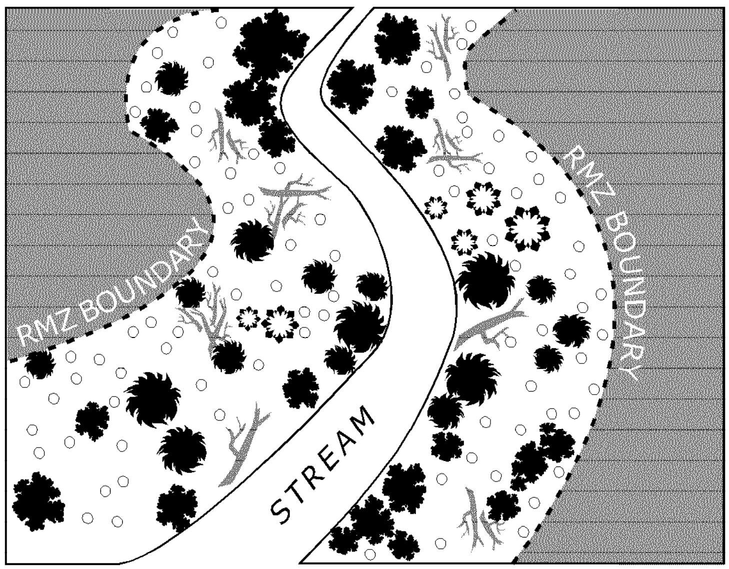
❒ **The residual basal area within the RMZ** should be relatively evenly distributed throughout the RMZ. Gap and clump regeneration patterns may be used. See Figure GG-6.

❒ **Cleared areas within the RMZ** should be kept to the minimum size required to meet forest management objectives, while also considering the protection and maintenance of riparian functions and values.

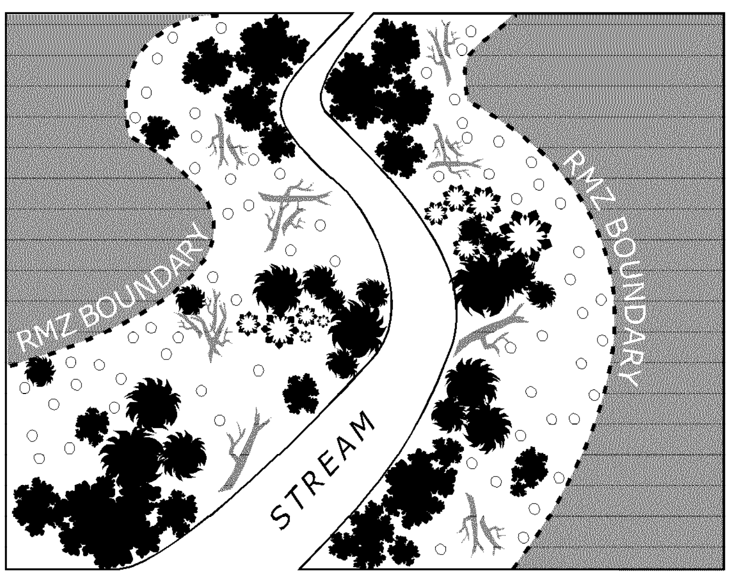
❒ **Consider that many riparian functions and values are best maintained** at higher residual basal areas, which will not provide the best regeneration of species managed using even-age management approaches. See *Recognizing Tradeoffs,* page 32.

Figure GG-6

Residual Distribution Options Within the RMZ

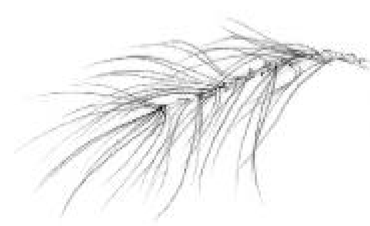


The same RMZ shown with relatively even distribution of residuals (above), and gap and clump distribution of residuals (below).



❒ **Best professional judgment should be used** to determine the species and distribution of residual trees within the RMZ. Consider:

- Site conditions (such as steep slopes or highly erodible soils)
- Species
- Wildlife habitat needs, especially for cavity-nesting riparian species
- Bunching or clumping of residuals, which helps to reduce windthrow
- Favoring tree retention near the bank edge
- Other management objectives



❒ **Decisions regarding residual species,** as well as individual trees to be retained, should be based on the following considerations:

- Distribution within the RMZ
- Regeneration requirements (such as shade tolerance and amount of scarification needed)
- Crown size (for example, maples generally have a larger crown than aspens)
- Windfirmness (including rooting pattern and pre-harvest exposure to wind). See *General Guidelines: Retaining Leave Trees.*

❒ **Application of some wildlife-related guidelines may differ** within and outside of the RMZ. For more detail, see *Part 2, Wildlife Habitat: Riparian Wildlife Habitat.*

Recognizing Tradeoffs

As with many forest management activities and decisions, riparian guidelines may present tradeoffs that need to be considered.

, **One example of such tradeoffs** is the density of residual trees, as measured by residual basal area, when considering even-age management guidelines.

According to management guidelines for aspen (a species commonly managed using even-age management approaches):*

> "For best aspen sucker regeneration...the parent stand must have a minimum aspen density of 50 trees or 20 square feet basal area per acre. To stimulate suckering, allow heat and light to reach the forest floor by **removing as much of the overstory as possible,** preferably all trees 2 inches or more DBH (diameter at breast height). As little as 10 to 15 square feet basal area of residual overstory will slow sucker growth by 35 to 40 percent." (Perala 1979).

In contrast, however:

> The protection and maintenance of riparian functions and values (such as inputs of coarse woody debris and fine litter, bank and shoreline stability, shading of the water body, and aesthetics) is enhanced by **leaving more residual overstory than is normally recommended** to promote the best regeneration of shade-intolerant species such as aspen.

A tradeoff exists. In this case, riparian functions and values are best maintained at residual basal areas that will not provide the best regeneration of shade-intolerant species such as aspen.

, Another example of these tradeoffs is the issue of the width of the riparian management zone. Not all riparian functions and values are equally important at all distances from the water's edge.

While the area closest to the water body is most important for protecting riparian functions and values, that importance decreases and can become very low at a location some distance from the water's edge.

, Tradeoffs can also interact with each other. As an example, regeneration of shade-intolerant species may be sufficient when more residual overstory is retained if the slope, aspect or width of the RMZ allows heat and light from the side to reach the forest floor.

In recognition of these and other tradeoffs, the RMZ guidelines include several recommendations that are intended to provide flexibility for accommodating a range of landowner objectives and site conditions, including forest diversity. Exercise professional judgment when making riparian recommendations. Landowner management objectives and management recommendations for the riparian management zone should be documented during the planning process.

*To obtain management recommendations for other species, contact a forestry professional for assistance. See *Resource Directory*.

Defining the Riparian Management Zone

The riparian management zone (RMZ) is the area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs. It is the area where riparian guidelines apply. Outside of the RMZ, normal operations apply, unless other guidelines further modify those operations.

Forest management activities may be conducted within the RMZ.

Management of riparian areas focuses on differentiating between various types of water bodies and associated site conditions within the riparian area. Riparian area site conditions include topography, hydrology and vegetation.

Width and basal area recommendations are based on the following:

- ❒ Type of water body
- ❒ Riparian area site condition
- ❒ Management objective (even-age or uneven-age management).

The recommendations are divided into two primary groups:

- ❒ Designated trout streams (and their designated tributaries) and designated trout lakes
- ❒ All other water bodies, including non-trout streams, non-trout lakes, and open water wetlands

Recommended guidelines for the second group ("all other water bodies") vary depending upon the forest type adjacent to the water body.

Incorporating Riparian Guidelines into Plan Design

In addition to width and basal area recommendations for riparian zone management, the following guidelines address additional issues within the RMZ:

U Review Flexibility Considerations (pages 29-31) and incorporate into forest management activities as appropriate.

U Manage lands adjacent to water bodies according to forest type and site conditions, including the option of varying from riparian guidelines where the management objective is to mimic natural processes.

U Maintain a forested condition of varying ages adjacent to water bodies, generally to the top of the adjacent terrace slope when a terrace slope exists.

U Manage for longer-lived, uneven-age, mixed-species stands within the RMZ to provide:

- Shade and moderated microclimate
- Coarse woody debris
- Microhabitat diversity
- Resiliency to natural catastrophes
- Bank stability
- Nutrient cycling and carbon and nutrient input

U Manage for long-lived conifers in northern Minnesota as an option where beaver are to be discouraged near water bodies.

U Consider extended rotation forestry within the RMZ around all streams, lakes and open water wetlands.

U Leave some super-canopy trees and other long-lived species in the riparian management zone. If possible, choose trees from the "Excellent" category list. This decision will provide habitat for riparian species that require large super-canopy trees (trees above the existing mature canopy) for hunting perches and nesting sites. See Table GG-7: Leave Tree Preferences for Longevity, Windfirmness and Cavity Potential, page 73.

U When a timber stand is in a deteriorating or declining condition, apply appropriate forest management activities to rejuvenate it.

U Use flagging or paint to clearly delineate the edge of the RMZ so that operators can identify its location on the ground.

U Distribute the residual basal area within the RMZ relatively evenly throughout the RMZ, but allow for gap and clump regeneration patterns. Avoid creating large cleared areas within the RMZ.

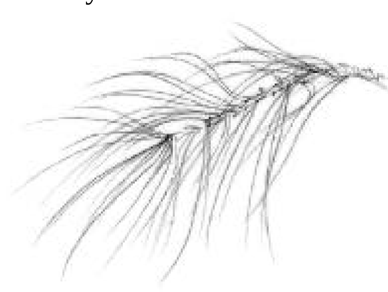
U Create or retain at least four leave logs per acre within the RMZ. Use sound forest management where insect and disease concerns exist. See *General Guidelines: Providing Coarse Woody Debris.*

U Adhere to filter strip guidelines except when the recommended 5% maximum level of mineral soil exposure is unacceptable for the regeneration of certain desired species. See *General Guidelines: Maintaining Filter Strips.*

U Minimize disturbance to other vegetation (such as brush or grass) within the RMZ where such vegetation provides primary shading, bank stability and energy input.

U Wherever practical, place fueling and maintenance areas, landings and roads (except those roads that are needed to cross a stream, lake or open water wetland) outside of filter strips or the RMZ, whichever is wider. See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

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



Overview of RMZ Width and Residual Basal Area Recommendations

Designated Trout Streams (and Their Designated Tributaries) and Designated Trout Lakes

(even-age and uneven-age management)

Table GG-2 only — Fig. GG-7 (even-age)
Fig. GG-8 (uneven-age)

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes, Open Water Wetlands)

Sedge, Grass, Shrubs and Swamp Forests
(even-age and uneven-age management)

Table GG-3 only — (no figure)

High Bank and Upland Forests
(even-age management)

Table GG-3
(general recommendations)

Table GG-4
(specific recommendations)

Table GG-5 and Fig. GG-15
(management considerations)

Fig. GG-13 (streams)
Fig. GG-14 (lakes, open water wetlands)

High Bank and Upland Forests
(uneven-age management)

Table GG-3
(general recommendations)

Table GG-6
(specific recommendations)

Fig. GG-16 (streams)
Fig. GG-17 (lakes, open water wetlands)

(see next page for locator listing)

Locator Listing for RMZ Tables and Figures

Designated Trout Streams (and Their Designated Tributaries) and Designated Trout Lakes

RMZ WIDTH AND RESIDUAL BASAL AREA RECOMMENDATIONS

Certain water bodies are designated through rule-making as trout streams (and their designated tributaries) or trout lakes. If forest management activities occur adjacent to these designated water bodies, refer to the following table and figures for RMZ width and residual basal area recommendations that apply:

- ❐ Table GG-2 (even-age and uneven-age management)
- ❐ Fig. GG-7 (even-age management)
- ❐ Fig. GG-8 (uneven-age management)

Important Considerations

Four important considerations relate to these guidelines:

❐ **Stream width is estimated at the bankfull elevation** at the narrowest portion of a straight channel segment within the management area.

❐ **RMZ width is measured as slope distance** (the linear distance along the ground), not horizontal distance, **except** when the ground is level, in which case slope distance and horizontal distance are the same.

❐ **Residual basal area recommendations represent the density of residual trees**, measured in ft^2/acre, immediately following any forest management activities that remove trees.

❐ **No minimum tree diameter is established** when measuring for basal area reserves.

Table GG-2

Designated Trout Streams (and Their Designated Tributaries) and Designated Trout Lakes: RMZ Width and Residual Basal Area Recommendations[1,2,3]

Management Objective	**Recommended Minimum RMZ Width** (slope distance) (in feet)	**Recommended Minimum Residual Basal Area** (ft^2/acre)
Even-Age Management (see Fig. GG-7)	150	60
Uneven-Age Management (see Fig. GG-8)	200	80

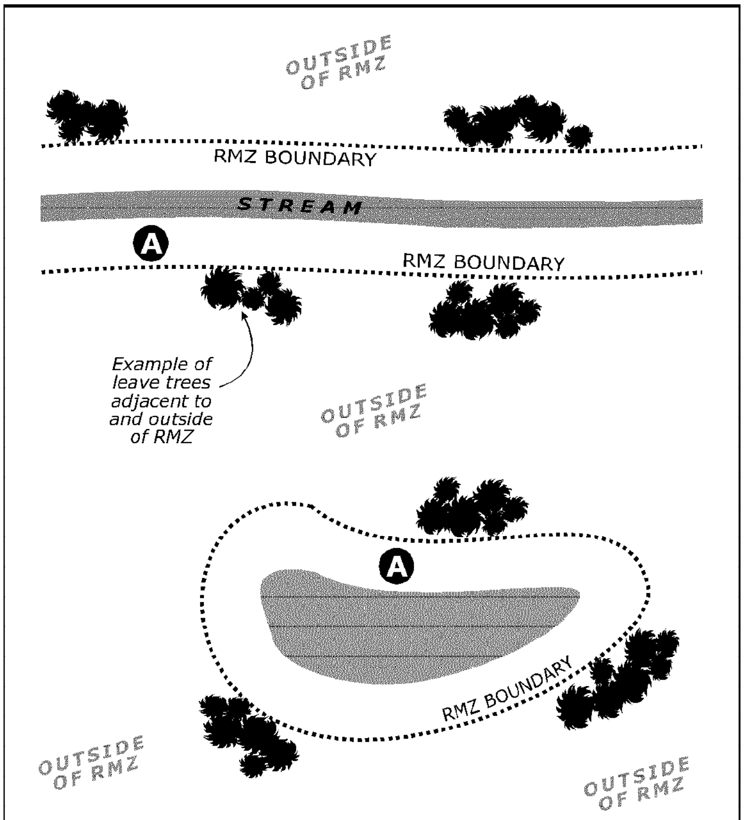
[1]Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

[2]Filter strip guidelines apply adjacent to all water bodies. See *General Guidelines: Maintaining Filter Strips.*

[3]For a listing of current designated trout streams (and their designated tributaries) and designated trout lakes, contact regional DNR fisheries offices (see *Resource Directory)*, local zoning offices or the legislative web site at: www.revisor.leg.state.mn.us/arule/6264

Figure GG-7

Designated Trout Streams (and Their Designated
[illegible]
Even-Age Management
RMZ Width and Residual Basal Area Recommendations



EVEN-AGE MANAGEMENT RECOMMENDATIONS

Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area	Adjacent Area*
all sizes	A **150'**	60 ft.^{2}/acre	5% patch

*Concentrate leave trees adjacent to the RMZ in clumps, strips or islands, varying in size with a minimum size of 1/4 acre. **The area of the RMZ cannot be used when calculating the recommended minimum of 5% leave trees.**

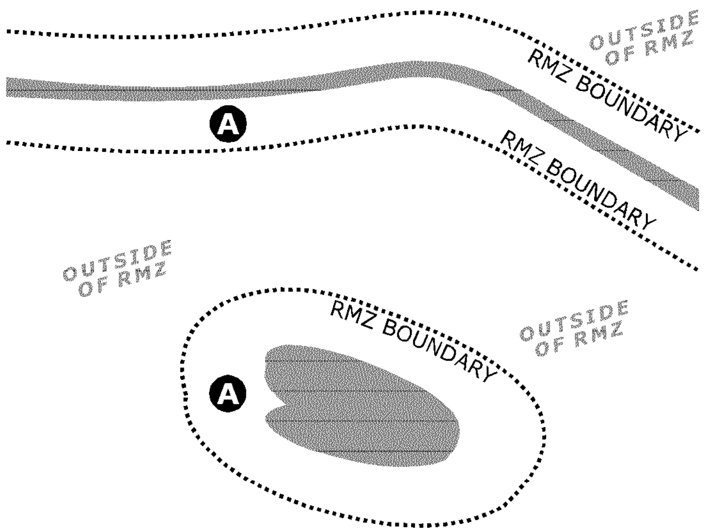
Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

Figure GG-8

Designated Trout Streams (and Their Designated

Uneven-Age Management

RMZ Width and Residual Basal Area Recommendations



UNEVEN-AGE MANAGEMENT RECOMMENDATIONS

Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area
all sizes	A **200'**	80 ft.^{2}/acre

Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands)

RMZ WIDTH AND RESIDUAL BASAL AREA RECOMMENDATIONS

If forest management activities occur adjacent to a non-trout stream, non-trout lake or open water wetland, begin by referring to the following table, text and figures:

- ❒ Table GG-3 (general recommendations; will make reference to specific tables as appropriate)
- ❒ Description of General Forest Types (including Figs. GG-9 through GG-12)

Important Considerations

Four important considerations relate to these guidelines:

- ❒ **Stream width is estimated at the bankfull elevation** at the narrowest portion of a straight channel segment within the management area.
- ❒ **RMZ width is measured as slope distance** (the linear distance along the ground), not horizontal distance, **except** when the ground is level, in which case slope distance and horizontal distance are the same.
- ❒ **Residual basal area recommendations represent the density of residual trees**, measured in ft^2/acre, immediately following any forest management activities that remove trees.
- ❒ **No minimum tree diameter is established** when measuring for basal area reserves.

Table GG-3

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands): RMZ Width and Residual Basal Area Recommendations[1,2]

Forest Type	Sedge, Grass, Shrubs	Swamp Forests	Swamp Forests	High Bank Forests	High Bank Forests	Upland Forests	Upland Forests
Depth to Water Table[3]	< 6"	6" - 18"	6" - 18"	> 10 feet	> 10 feet	> 1.5 feet	> 1.5 feet
Soil Moisture Condition	Wet	Wet	Wet	Dry-Moist	Moist	Dry-Moist	Moist
Silvicultural System	Not Applicable	Even-Age	Uneven-Age	Even-Age	Uneven-Age	Even-Age	Uneven-Age
Representative Species and Forest Cover Types	Alders, willows, sedges, grasses, mosses	Black spruce, tamarack	Northern white cedar, black ash	Aspen, birch, jack pine, red pine, balm o'Gilead, balsam fir, red oak, bur oak, white oak	Maple/ basswood, red oak, white pine, white oak, bur oak, balsam fir, ash/elm/ cottonwood, red maple, white spruce	Aspen, birch, jack pine, red pine, balm o'Gilead, red oak, balsam fir, bur oak, white oak	Maple/basswood, red oak, white pine, white oak, bur oak, balsam fir, ash/elm/ cottonwood, red maple, white spruce

table continues on page 47

Table GG-3 (cont d)

table begins on page 46

Forest Type	Sedge, Grass, Shrubs	Swamp Forests	Swamp Forests	High Bank Forests	High Bank Forests	Upland Forests	Upland Forests
RMZ recom-mendations and references to specific tables.	Leave undisturbed or manage with prescribed fire to mimic natural disturbance.	Use clearcut harvest to the water's edge to prevent high-risk wind-throw.	Reserve unless effective regeneration can be assured.	Use clearcut, fire, or site preparation to the edge of the high bank forest. For management on bank slope, use filter strip guidelines and see Table GG-4 for width and residual basal area recommendations.	See Table GG-6 for width and residual basal area recom-mendations.	See Table GG-4 for width and residual basal area recom-mendations.	See Table GG-6 for width and residual basal area recom-mendations.

[1]Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

[2]Filter strip guidelines apply adjacent to all water bodies. See *General Guidelines: Maintaining Filter Strips.*

[3]Average depth to the water table during the growing season.

Description of General Forest Types

Sedge/grass/shrub forest: An area adjacent to a stream, lake or open water wetland that is covered by grasslike sedges or shrubs and where the soils are wet. The depth to the water table in these areas averages less than 6 inches.

Depending on the site and ecological history, dominant plant species are alders, willows, sedges, grasses or mosses. See Figure GG-9.

Swamp forest: An area adjacent to a stream, lake or open water wetland where the depth to the water table is between 6 and 18 inches, and the soils are wet.

Depending on the site and ecological history, dominant tree species are black spruce, tamarack, northern white cedar or black ash. See Figure GG-10.

High bank forest: An area immediately adjacent to a stream or lake where the depth to the water table is more than 10 feet, soil moisture ranges from moist to dry, the hillside bank rises steeply above the water, and the water body cuts into the hillside bank, which results in its eroding. Roots from trees growing on the terrace above the water do not reach the water table and therefore do not provide much bank stability.

Depending on the site and ecological history, dominant tree species are aspen, birch, jack pine, red pine, balm o'Gilead, red oak, bur oak, white oak, maple/basswood, balsam fir, ash/elm/cottonwood, red maple or white spruce. See Figure GG-11.

Upland forest: An area adjacent to a stream, lake or open water wetland where the depth to the water table is at least 1.5 feet, and soil moisture ranges from moist to dry.

Depending on the site and ecological history, dominant tree species are aspen, birch, jack pine, red pine, balm o'Gilead, red oak, bur oak, white oak, maple/basswood, balsam fir, ash/elm/cottonwood, red maple or white spruce. See Figure GG-12.

Figure GG-9

Profile of a Sedge/Grass/Shrub Forest

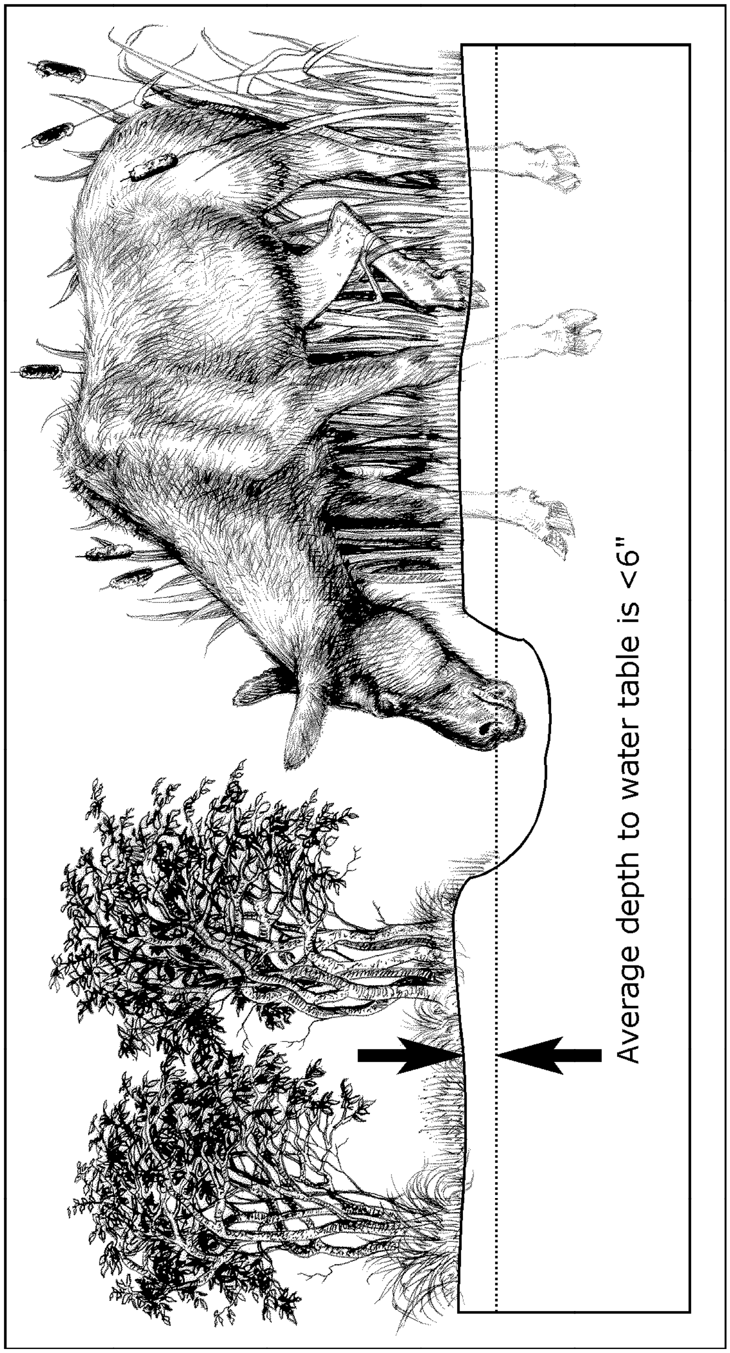
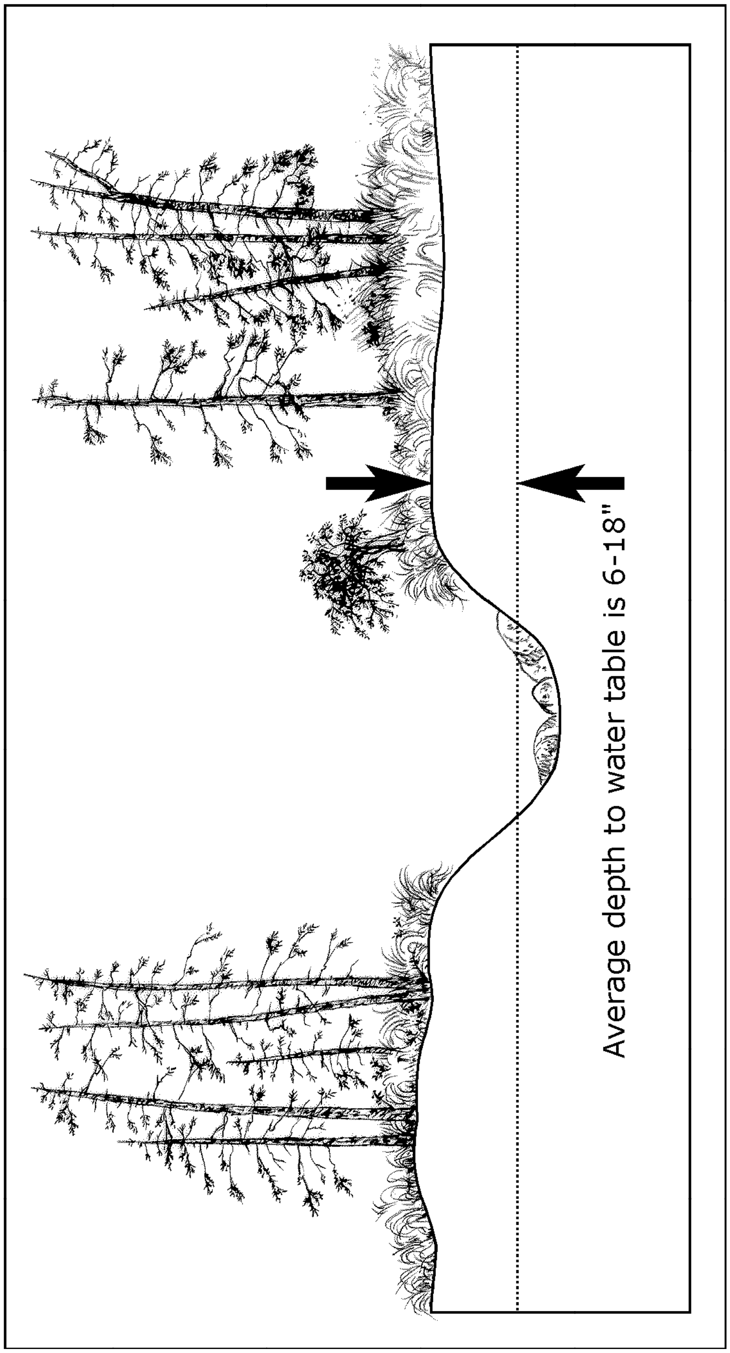


Figure GG-10



Profile of a Swamp Forest

Figure GG-11

Profile of an Upland Forest

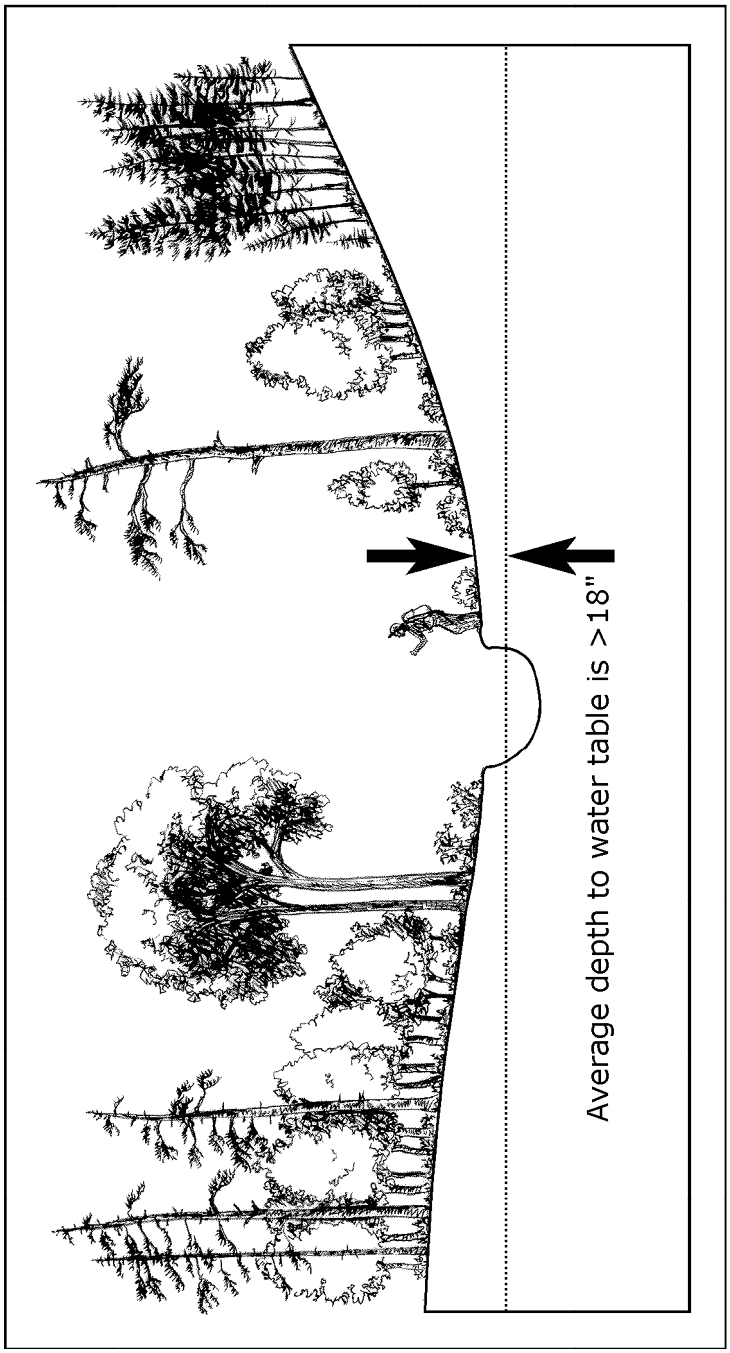
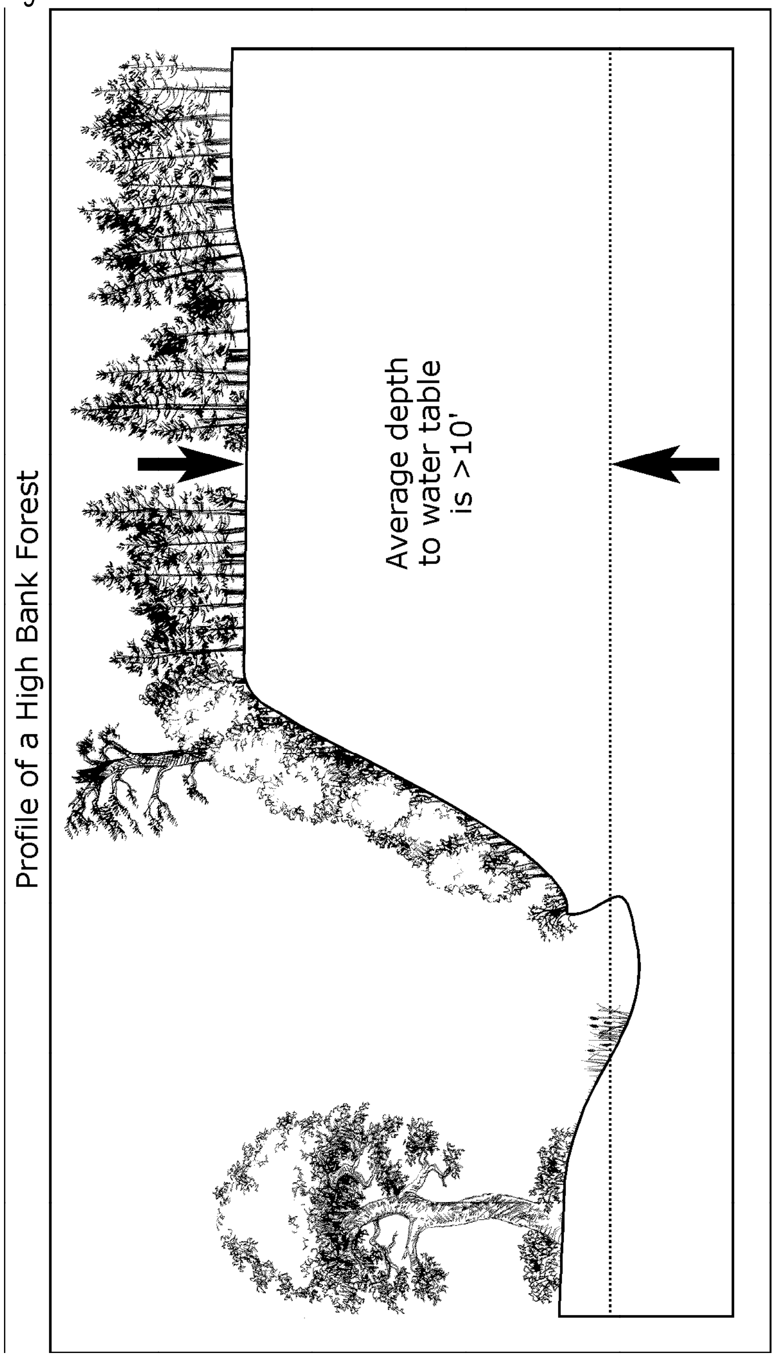


Figure GG-12


Profile of a High Bank Forest
Average depth
to water table
is >10'

EVEN-AGE MANAGEMENT

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands)

RMZ WIDTH AND RESIDUAL BASAL AREA RECOMMENDATIONS

After consulting Table GG-3 (paged 46-47) and the Description of General Forest Types (pages 48-52), refer to the following tables and figures for specific RMZ width and residual basal area recommendations for **even-age management**, as well as management considerations that can aid in decision-making:

- ❒ Table GG-4 (specific recommendations)
- ❒ Table GG-5 (management considerations)
- ❒ Fig. GG-15 (management considerations)

- ❒ Fig. GG-13 (streams)
- ❒ Fig. GG-14 (lakes and open water wetlands)

Important Considerations

Four important considerations relate to these guidelines:

❒ **Stream width is estimated at the bankfull elevation** at the narrowest portion of a straight channel segment within the management area.

❒ **RMZ width is measured as slope distance** (the linear distance along the ground), not horizontal distance, **except** when the ground is level, in which case slope distance and horizontal distance are the same.

❒ **Residual basal area recommendations represent the density of residual trees**, measured in ft²/acre, immediately following any forest management activities that remove trees.

❒ **No minimum tree diameter is established** when measuring for basal area reserves.

Table GG-4

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands): *Even-Age Management* RMZ Width and Residual Basal Area Recommendations[1,2]

Water Body	Size	Recommended Minimum		Adjacent Area[3,4]
		RMZ Width (slope distance) (in feet)	**Residual Basal Area** (ft^2/acre)	
Non-Trout Streams (see Fig. GG-13)	> 10 feet wide	100	25-80 (see Table GG-5)	5% patch
Non-Trout Streams (see Fig. GG-13)	3-10 feet wide	50	25-80 (see Table GG-5)	5% patch
Non-Trout Streams (Perennial) (see Fig. GG-13)	< 3 feet wide	50	25-80 (see Table GG-5)	not applicable

table continues on page 55

Figure GG-4 (cont'd)

table begins on page 54

Non-Trout Streams (Intermittent) (see Fig. GG-13)	< 3 feet wide	not applicable	not applicable	not applicable
Non-Trout Lakes/ Open Water Wetlands (see Fig. GG-14)	≥ 10 acres	100	25-80 (see Table GG-5)	5% patch
Non-Trout Lakes/ Open Water Wetlands (see Fig. GG-14)	< 10 acres	50	25-80 (see Table GG-5)	5% patch

[1]Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design*.

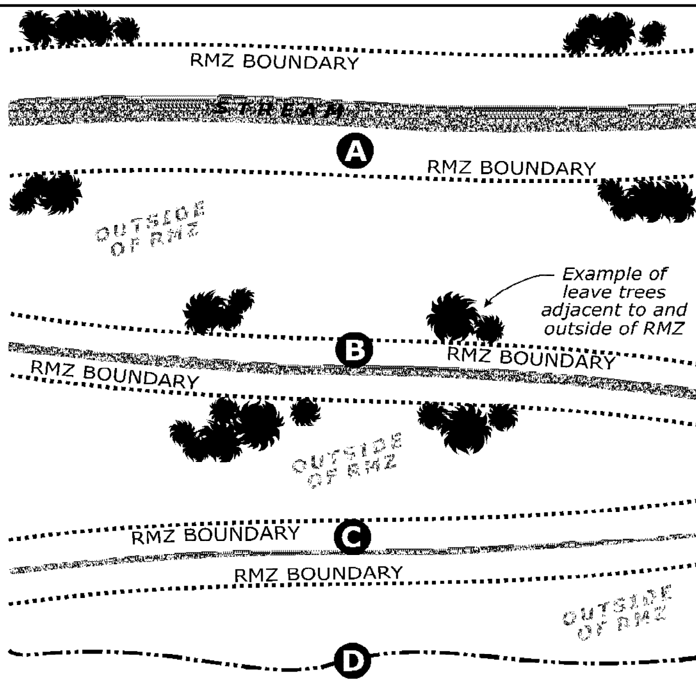
[2]Filter strip guidelines apply adjacent to all water bodies. See *General Guidelines: Maintaining Filter Strips*.

[3]Following harvest, concentrate leave trees adjacent to the RMZ in clumps, strips or islands, varying in size with a minimum size of 1/4 acre per clump and occupying a minimum of 5% of the area adjacent to the RMZ. These leave trees add windfirmness to the RMZ, improve water conservation, increase energy inputs to the aquatic system, and enhance the microclimate affecting the aquatic system. The area of the RMZ cannot be used when calculating the recommended minimum of 5% of leave trees retained in clumps, strips or islands Also refer to *Flexibility Considerations* and *Guidelines Provide a Menu, Not a Mandate* (page 6).

[4]Refer to county and local zoning ordinances and visual quality guidelines. See *Timber Harvesting: Reducing Visual Impacts of Apparent Harvest Size*.

Figure GG-13

Perennial and Intermittent Non-Trout Streams in High Bank and Upland Forests:
Even-Age Management
RMZ Width and Residual Basal Area Recommendations



EVEN-AGE MANAGEMENT RECOMMENDATIONS

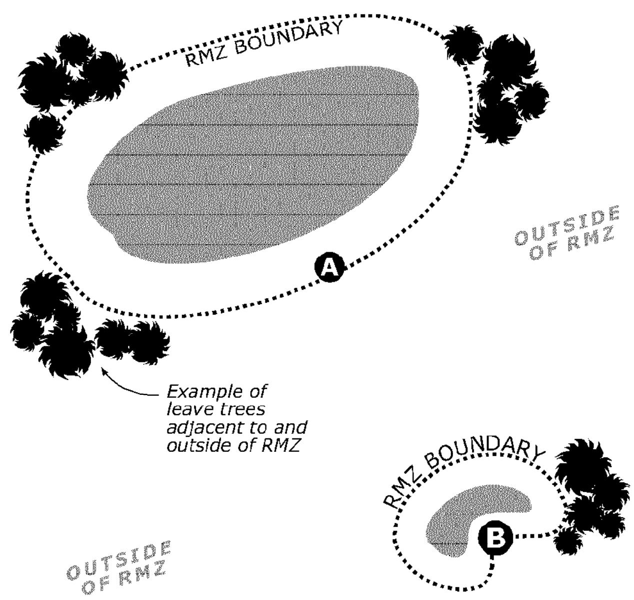
Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area	Adjacent Area*
>10' wide	A **100'**	25-80 ft.^{2}/acre	5% patch
3-10' wide	B **50'**	25-80 ft.^{2}/acre	5% patch
<3' wide *perennial*	C **50'**	25-80 ft.^{2}/acre	not applicable
<3' wide *intermittent*	D not applicable	not applicable	not applicable

*Concentrate leave trees adjacent to the RMZ in clumps, strips or islands, varying in size with a minimum size of 1/4 acre. **The area of the RMZ cannot be used when calculating the recommended minimum of 5% leave trees.**

Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

Figure GG-14

Non-Trout Lakes and Open Water Wetlands
in High Bank and Upland Forests:
Even-Age Management
RMZ Width and Residual Basal Area Recommendations



EVEN-AGE MANAGEMENT RECOMMENDATIONS

Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area	Adjacent Area*
≥10 acres	A **100'**	25-80 $ft.^2$/acre	5% patch
<10 acres	B **50'**	25-80 $ft.^2$/acre	5% patch

*Concentrate leave trees adjacent to the RMZ in clumps, strips or islands, varying in size with a minimum size of 1/4 acre. **The area of the RMZ cannot be used when calculating the recommended minimum of 5% leave trees.**

Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

Table GG-5

Relative Impact of Residual Basal Area on Accomplishing Landowner Management Objectives...

MANAGEMENT CONSIDERATIONS FOR ALL RMZs

Landowner Management Objectives	Residual Basal Area[1] (ft^2/acre)
(low residual basal area) ❒ Maximum volume removed from timber harvest ❒ Best overall natural regeneration (aspen, birch, jack pine, spruce) ❒ Facilitates red pine, spruce, jack pine planting	25
❒ Wildlife habitat: early successional vegetation ❒ White pine underplanting ❒ Partial (< 50%) shading of water bodies ❒ Release conifer understory	40
❒ 50% shading of water bodies ❒ Wildlife habitat: mixed species and age diversity ❒ Cover for wildlife travel corridor ❒ Selective timber harvest ❒ Full shading of water bodies	60
❒ Nutrient and food input into aquatic system ❒ Wildlife habitat: contiguous closed canopy ❒ Aesthetics *(high residual basal area)*	80

continuum

table continues on page 59

[1]Consider seeking professional assistance when determining appropriate residual basal area silvicultural guidelines for desired even-age species. See *Resource Directory*.

Table GG-5 (cont d)

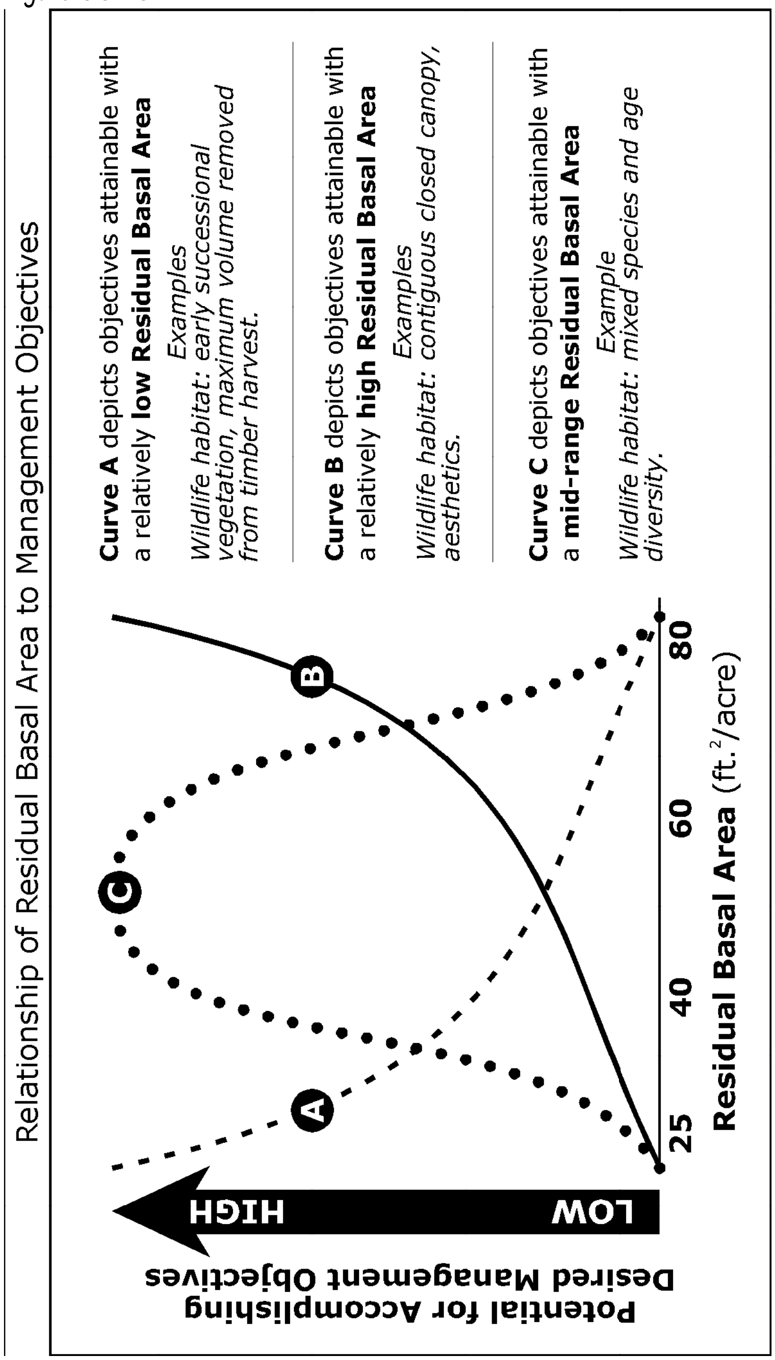
...in High Bank and Upland Forests: *Even-Age Management* (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands)

RIPARIAN FUNCTION	
Temperature Moderation (Shading), Coarse Woody Debris and Fine Litter Inputs, and Shoreline/Bank/Channel Stabilization	Retention of Sediment or Nutrients Associated with Surface or Subsurface Runoff
The protection and maintenance of these riparian functions may be reduced at this basal area for a period of time. To increase the protection and maintenance of these functions, landowners may want to consider retaining higher basal areas near (especially within one mature tree length of) the water body. See *Recognizing Tradeoffs,* page 32.	Retaining ground vegetation and retention of a relatively undisturbed forest floor is important to control sediment and chemical release into aquatic systems. See *Maintaining Filter Strips,* page 22.
There should be a reasonable to high level of protection and maintenance of these riparian functions in this basal area range. Leaving this amount of residual basal area, however, may impact natural or artificial regeneration of shade-intolerant species such as aspen or red pine on the site. Consider tradeoffs between the protection and maintenance of riparian functions and other landowner objectives for the site. See *Recognizing Tradeoffs,* page 32.	

table begins on page 58

See also Figure GG-15, page 60.

Figure GG-15


Relationship of Residual Basal Area to Management Objectives
Potential for Accomplishing Desired Management Objectives
HIGH
LOW
A
B
C
25
40
60
80
Residual Basal Area (ft.²/acre)
Curve A depicts objectives attainable with a relatively low Residual Basal Area
Examples
Wildlife habitat: early successional vegetation, maximum volume removed from timber harvest.
Curve B depicts objectives attainable with a relatively high Residual Basal Area
Examples
Wildlife habitat: contiguous closed canopy, aesthetics.
Curve C depicts objectives attainable with a mid-range Residual Basal Area
Example
Wildlife habitat: mixed species and age diversity.

UNEVEN-AGE MANAGEMENT

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands)

RMZ WIDTH AND RESIDUAL BASAL AREA RECOMMENDATIONS

After consulting Table GG-3 (page 46-47) and the Description of General Forest Types (pages 48-52), refer to the following table and figures for specific RMZ width and residual basal area recommendations for **uneven-age management**:

- ❒ Table GG-6 (specific recommendations)

- ❒ Fig. GG-16 (streams)
- ❒ Fig. GG-17 (lakes and open water wetlands)

Important Considerations

Four important considerations relate to these guidelines:

❒ **Stream width is estimated at the bankfull elevation** at the narrowest portion of a straight channel segment within the management area.

❒ **RMZ width is measured as slope distance** (the linear distance along the ground), not horizontal distance, **except** when the ground is level, in which case slope distance and horizontal distance are the same.

❒ **Residual basal area recommendations represent the density** , measured in ft²/acre, immediately following any forest management activities that remove trees.

❒ **No minimum tree diameter is established** when measuring for basal area reserves.

Table GG-6

All Other Water Bodies (Non-Trout Streams, Non-Trout Lakes and Open Water Wetlands): Uneven-Age Management RMZ Width and Residual Basal Area Recommendations[1,2]

Water Body	Size	Recommended Minimum	
		RMZ Width (slope distance) (in feet)	**Residual Basal Area**[3] (ft^2/acre)
Non-Trout Streams (see Fig. GG-16)	> 10 feet wide	200	80
Non-Trout Streams (see Fig. GG-16)	3-10 feet wide	100	80
Non-Trout Streams (Perennial) (see Fig. GG-16)	< 3 feet wide	50	80

table continues on page 63

Table GG-6 (cont'd)

table begins on page 62

Non-Trout Streams (Intermittent) (see Fig. GG-16)	< 3 feet wide	not applicable	not applicable
Non-Trout Lakes/ Open Water Wetlands (see Fig. GG-17)	all sizes	200	80

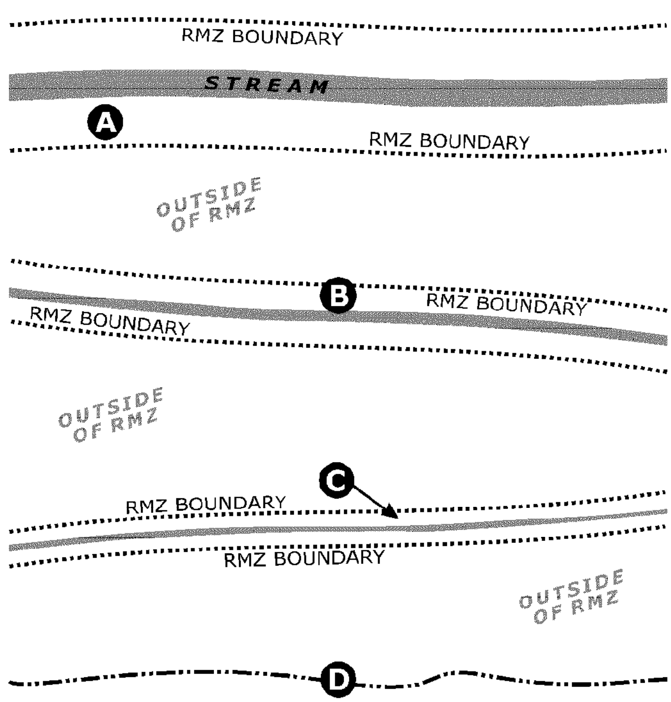
[1]Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design*.

[2]Filter strip guidelines apply adjacent to all water bodies. See *General Guidelines: Maintaining Filter Strips.*

[3]Consider seeking professional assistance when determining appropriate residual basal area silvicultural guidelines for desired uneven-age species. See *Resource Directory.*

Figure GG-16

Perennial and Intermittent Non-Trout Streams
in High Bank and Upland Forests:
Uneven-Age Management
RMZ Width and Residual Basal Area Recommendations



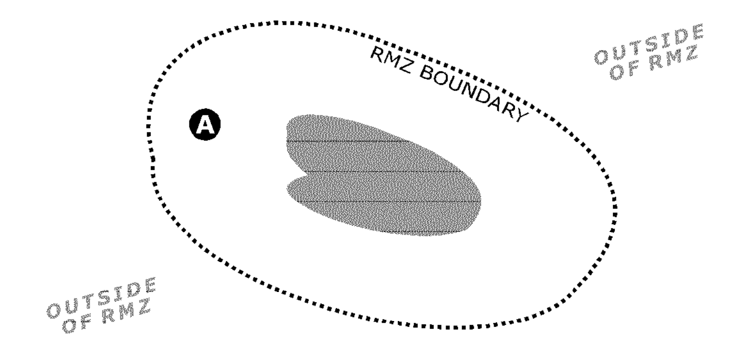
UNEVEN-AGE MANAGEMENT RECOMMENDATIONS

Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area
>10' wide	A 200'	80 ft.^{2}/acre
3-10' wide	B 100'	80 ft.^{2}/acre
<3' wide *perennial*	C 50'	80 ft.^{2}/acre
<3' wide *intermittent*	D [illegible]	[illegible]

Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

Figure GG-17

Non-Trout Lakes and Open Water Wetlands in High Bank and Upland Forests:
Uneven-Age Management
RMZ Width and Residual Basal Area Recommendations



UNEVEN-AGE MANAGEMENT RECOMMENDATIONS

Size	Recommended Minimum RMZ Width *(slope distance)*	Recommended Minimum Residual Basal Area
all sizes	A **200'**	80 ft.^{2}/acre

Forest management may be conducted within the RMZ. Review *Flexibility Considerations* and *Incorporating Riparian Guidelines into Plan Design.*

OPERATIONAL ACTIVITIES

Protecting Cultural Resources

Some types of cultural resources are protected by federal or state law. See *Part 2, Cultural Resources: Cultural Resource Management and the Law.* For sources of information and assistance, see *Resource Directory.*

U When practical or feasible, avoid management activities within cultural resource areas.

U Delineate cultural resource areas using flagging, signs or other appropriate methods. Communicate with loggers and equipment operators to assure clear understanding that there is to be no work in the marked area.

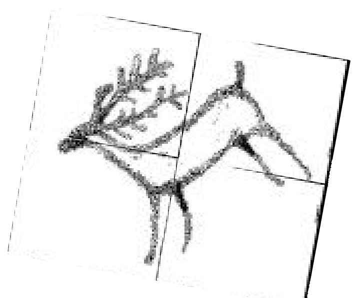
U When it is not practical or feasible to avoid cultural resource areas during forest management activities, protect resources by applying one or more of the following procedures:

- Use temporary fencing, barricades or other measures to restrict the movement of heavy equipment and machinery in the cultural resource area.
- Temporarily brace walls and board up windows and doors of historic buildings.
- Prevent potential structural damage or deterioration of historic buildings and structures that might result from heavy equipment operation.
- Avoid felling trees directly onto historic buildings, structures, or surface features of archaeological sites.
- Use temporary protection such as slash, corduroy, tire mats or fill over geotextile.
- Place fill over archaeological sites to prevent soil compaction and erosion.
- Revegetate archaeological sites to prevent erosion.

U For cultural resources that cannot be protected from damage, consider data recovery (professional excavation of archaeological sites or documentation of above-ground cultural resources). For sources of information and assistance, see *Resource Directory.*

U If a human burial site is accidentally discovered during operations, cease operations immediately in the vicinity of the discovery. Contact the Office of the State Archaeologist and your local law enforcement agency. For sources of information and assistance, see *Resource Directory.*

U For accidental discovery of other types of cultural resources (such as archaeological artifacts), temporary suspension is not required, but it is recommended. Suspending operations in the immediate vicinity of the cultural resource will allow time to contact a cultural resource professional or develop plans to initiate procedures to avoid or reduce damage to the cultural resource.



U When cultural resources are discovered during forest management activities:

- Safeguard the condition of the cultural resource by preventing further damage, loss or deterioration.
- Investigate and document the cultural resource in order to determine its significance and conservation potential. For information on documenting a cultural resource, see *Resource Directory.*
- Adjust work schedules to allow time for data recovery or other mitigation measures.

U Monitor the effectiveness of cultural resource management practices during forest management operations.

Managing Equipment, Fuel and Lubricants

U Designate a specified area for draining lubricants from equipment during routine maintenance. The area should allow all waste lubricants to be collected and stored until transported off-site for recycling, reuse or disposal at an approved site.

U Provide maintenance vehicles with necessary equipment to collect and store lubricants drained during repair activities. Breakdowns could require that lubricants be drained from equipment at locations away from the designated collection area *It is illegal To burn the residues or drain these materials directly onto the ground (Minn. Rule 7045.0845).*

U Provide waste containers in maintenance areas or vehicles for collecting solid wastes, such as oil containers, grease tubes, oil filters and other trash.

U Recycle or properly dispose of collected solid waste materials at an approved solid waste site. *It is illegal to burn these wastes (Minn. Statute 88.171).*

U Locate fuel and maintenance areas away from open water, on upland sites whenever practical, and at locations where a potential spill can be contained and properly treated with minimal risk of surface water or ground-water contamination. Whenever practical, place them outside the filter strip or riparian management zone (whichever is wider). When operating on wetland areas, an upland site may also be the preferred location for fueling and maintenance.

U Report all petroleum spills of five or more gallons. Direct all reports to the Minnesota Duty Officer. The two 24-hour phone numbers are (651) 649-5451 (Metro Area) and (800) 422-0798 (Greater Minnesota). The Minnesota Duty Officer will contact appropriate state agencies.

U Thin-spread any soil contaminated by spills of petroleum products of less than 5 gallons.

Protecting the Normal Flow of Streams and Wetlands

U Mark the presence of seeps and springs and avoid damaging their normal flow during management operations. Establish filter strips and employ other wetland protection measures as applicable. See *General Guidelines: Maintaining Filter Strips.*

U Avoid disturbances such as ruts, soil compaction and addition of fill, which can interrupt or redirect the flow of water though a wetland. Such disturbances can also impact the depth of the water table or the extent of flooding or draining that occurs in a wetland, significantly altering the plant and animal community in that wetland.

U Approach water crossings at or near right angles to the stream direction, and use measures to minimize streambank disturbances.

Wetland Inclusions and Seasonal Ponds

❒ **Wetland inclusions** are wetland basins within an upland site.

❒ **Seasonal ponds:** Sometimes called *vernal pools*, seasonal ponds are depressions in the soil surface where water pools during wet periods of the year, typically in spring and fall.

- A seasonal pond will have an identifiable edge caused by annual flooding and local topography.
- The edge is best identified during the spring or fall, but it may be identified during dry periods by the lack of forest litter in the depression. Such depressions typically are fishless and retain water for longer periods than puddles.
- **Note**: The leaf litter is replenished annually but is consumed during inundated periods and noticeably depleted thereafter. Deciduous litter will likely be consumed faster and more thoroughly than conifer litter.

A wetland inclusion is a wetland basin within an upland site. *Photo courtesy of Minnesota DNR*

Protecting Wetland Inclusions and Seasonal Ponds

Considerations

❒ Vegetation is important in protecting the functionality of wetland inclusions and seasonal ponds. The desired amount of leave trees and other vegetation left on a site following forest management activity will depend on site characteristics and landowner objectives.

❒ Residual vegetation should provide significant shading to prevent excessive warming of soil and water, while also preventing sedimentation due to mineral soil exposure. Residual vegetation should also provide key habitat features, such as coarse woody debris and leaf litter.

❒ Targeting application of leave tree guidelines around these water bodies (such as retaining on even-age harvest units a minimum of 5% of the harvest area in clumps and/or 6-12 scattered leave trees per acre) will maintain the shading and structure needed while simultaneously providing habitat for cavity-nesting birds and other wildlife.

The following guidelines are designed to help protect the functionality of wetland inclusions and seasonal ponds:

❑ **Limit forest management activities** to minimize mineral soil exposure. See *General Guidelines: Maintaining Filter Strips.*

❑ **Avoid disturbances such as ruts, soil compaction, excessive disturbance to litter layer, and addition of fill,** which can interrupt or redirect the flow of water though a wetland inclusion or seasonal pond. Such disturbances can also impact the depth of the water table or the extent of flooding or draining that occurs in a wetland inclusion or seasonal pond, as well as the integrity of the ground layer, significantly altering its plant and animal community.

Retaining Leave Trees (live trees)

❑ **Retain leave trees** according to the following characteristics related to species, size and condition. Specific recommendations for numbers and distribution of leave trees (such as retaining on clearcuts a minimum of 5% of the harvest area in clumps and/or 6-12 scattered leave trees per acre) can be found in *Timber Harvesting: Leave Trees* and *Timber Stand Improvement: Operational Activities*.

Note: Retaining leave trees to benefit one resource may simultaneously fulfill guidelines focused on another resource. For example, leave trees retained to benefit cavity-nesting wildlife may also provide benefits for visual quality, mast, water quality, cultural resources or wetland habitat.

❒ Species: A mix of species is desirable, but preference should be given to particular species for their longevity, windfirmness or cavity potential. TSI (timber stand improvement) operations often favor retention of one or more preferred tree species, but retention of a mix of naturally occurring species is desired. Recognize that all tree species have some value to particular wildlife, and that it is necessary to work with what is available on a particular site.

Table GG-7 characterizes leave trees as excellent, good or fair in terms of longevity, windfirmness and cavity potential. Windfirmness may vary based on site characteristics.

Table GG-7

Leave Tree Preferences for Longevity, Windfirmness and Cavity Potential

Excellent	Good	Fair
white pine	aspens	white birch
oaks	red pine*	balsam fir*
elms	tamarack	jack pine*
ashes	cedar	black spruce*
sugar maple	red maple	balsam poplar
yellow birch	white spruce*	
basswood	black cherry	
	hickories	
	box elder	
	cottonwood	
	walnut	
	hackberry	

**Leaving these species in the overstory imposes a risk of insect and disease infestation to understory regeneration of that same species.*

❐ Size: Larger-diameter leave trees are generally more valuable to wildlife, but smaller trees have the potential to grow over time and provide habitat as a harvested stand regenerates. Therefore, leave a range of sizes on each managed site as follows:

- Leave trees should be at least 6 inches DBH (diameter at breast height), if possible.
- About 50% of leave trees should be greater than 12 inches DBH.
- At least 1-2 trees per clump or per acre should be greater than 18 inches DBH (or the largest size class available).

❐ Condition: While trees with some degree of decay or existing cavities have immediate benefits to wildlife, retaining some sound, windfirm trees will provide future snag and cavity needs as a harvested stand regenerates. Therefore, plan to leave trees with a range of conditions on managed sites:

- Include some trees showing signs of decay or trees with cavities.
- Leave some larger, healthy dominants or codominants.
- Leave some smaller, healthy, non-suppressed trees.

Retaining cavity trees enhances the quality of wildlife habitat in forested areas. *Photo courtesy of Minnesota DNR*

U Avoid felling or damaging any canopy individuals of rare or declining tree species in the state, specifically eastern hemlock, butternut, chinkapin (yellow) oak, honey locust, and Kentucky coffee-tree. Minimize damage to advance regeneration of these species.

U Allow some individuals of longer-lived species to reach ages of 200–300 years old in managed stands. Such longer-lived species include sugar maple, yellow birch, white pine, red pine, bur oak or red oak. Leave large cull trees standing.

U Exceptions to leave tree guidelines may be made for a number of reasons, including:

- Operator safety (of loggers, aerial spray applicators and others)
- Public safety (including hazard trees near rights-of-way, recreation sites or airport vicinities)
- Specific silvicultural applications (such as genetic considerations for seed reproduction systems)
- Visual quality
- Surrounding landscape concerns (such as sites adjacent to sharp-tailed grouse management units)
- Forest insects and diseases (such as dwarf mistletoe on black spruce, gypsy moth and pine bark beetles)

Providing Coarse Woody Debris

U Avoid having equipment disturb pre-existing large down logs, stumps and uprooted stumps.

U If a snag must be dropped, leave it where it falls whenever possible.

U Create at least 2 to 5 bark-on down logs greater than 12 inches in diameter per acre, if fewer than this number already exist. In choosing candidates for leave logs, consider the following:

- Hollow butt sections or other defective lengths of at least 6 feet are preferred.

- Sound logs and 6-inch to 12-inch diameter logs may be used if they represent the best available candidates.

Both aquatic and terrestrial coarse woody debris enhance aquatic and wildlife habitat in forested areas. *Photo courtesy of Minnesota DNR*

• Hardwood logs have more hollows or cavities and are favored by certain amphibians.

• Conifer logs decay more slowly and thus remain present as structure on a site longer than hardwoods.

• Using pines as down logs, especially in summer, increases the risk of bark beetle damage to adjacent healthy pines.

U Scatter leave logs across the site, including a few near wetlands.

U If a site includes riparian areas, create 4 leave logs per acre in the riparian management zone, if fewer than this number already exist. The overall average number for the site, however, can remain at a minimum of 2 per acre.

U Exceptions to guidelines for providing coarse woody debris may be made for a number of reasons, including:

• Alignment of skid trails

• Specific silvicultural applications (such as insect pests)

• Visual quality issues

Post-Operational Activities and Followup Visits

U If a road will provide access to a cultural resource, consider closing the road after the operation is completed.

U Remove flagging, signs or other markings that identify a cultural resource when a forest management activity is completed.

U If slash, corduroy or fill over geotextile was used for temporary protection of cultural resources, it is preferable in most cases to leave it in place. If tire mats were used, remove them.

U Restore watercourses to approximate their natural condition by removing temporary drainage structures and stabilizing the soil along the banks.

U Stabilize bare soil areas and install water diversion devices and erosion control barriers where appropriate to prevent or minimize erosion and sedimentation from roads, skid trails and landings into surface water and cultural resource areas.

- Seed and fertilize as appropriate.

- Fill in ruts as necessary, weighing the benefits of filling in ruts on skid trails against the potential for additional impact to soil productivity as a result of equipment used to eliminate ruts.

- Inspect erosion control measures periodically and maintain or remove as needed.

U Place traffic barriers where appropriate to prevent vehicles from disturbing recently stabilized areas. Barriers should be visible and well marked, and they should not present a safety hazard.

U Conduct followup visits to areas where structures (such as culverts or water bars) or other protection measures (such as seeding of bare areas) are used to minimize impacts on water quality and wetlands. Such followup visits can help assure that the protection measures remain functional.

Forest Road Construction and Maintenance

CONTENTS

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.

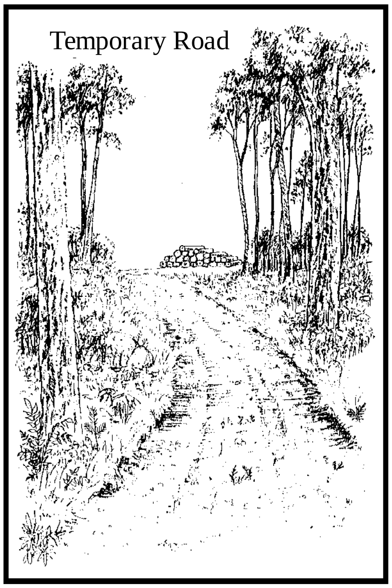


Figure ROAD-1

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.

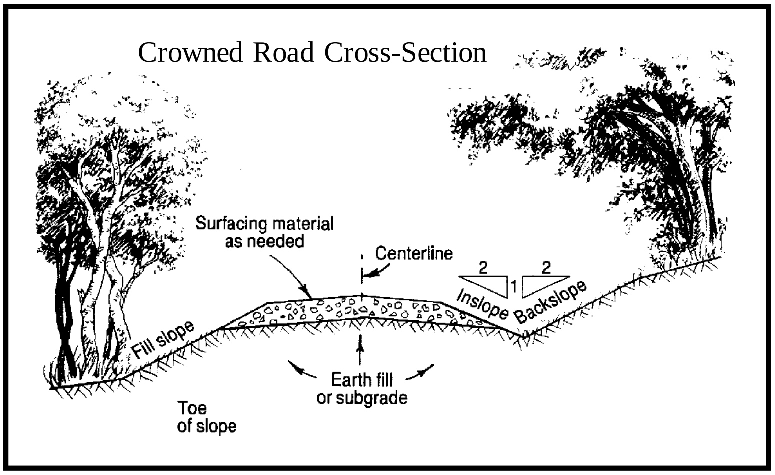


Figure ROAD-2

❒ **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.

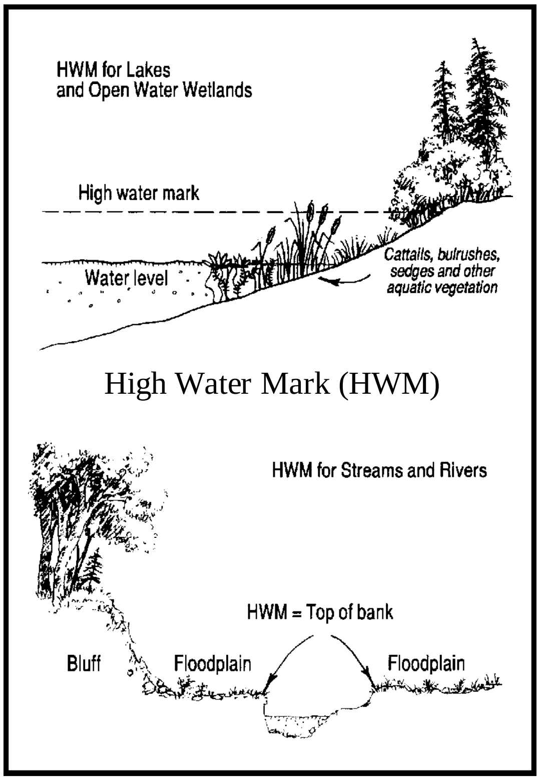


Figure ROAD-3

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:**

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

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

U Locate roads and trails to minimize visibility from nearby vantage points, such as scenic overlooks, streams and lakes.

U Reduce visual penetration with appropriate curves in the road alignment.

U Minimize total road mileage and ground disturbance required to meet landowner objectives and anticipated traffic loads.

U Avoid tracking mud onto highways by using appropriate road surface material.

*In areas classified as less sensitive:**

U Consider visual quality to the extent possible.

U 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.

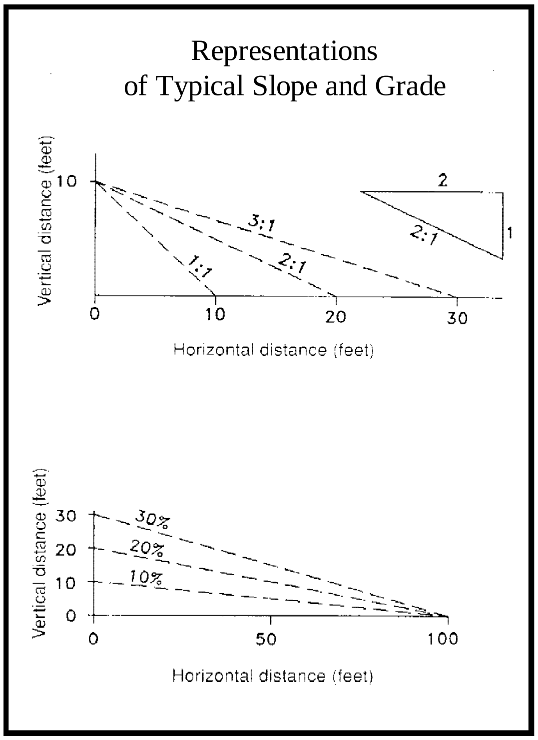


Figure ROAD-4

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.

U 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.

U 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.

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

U 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.

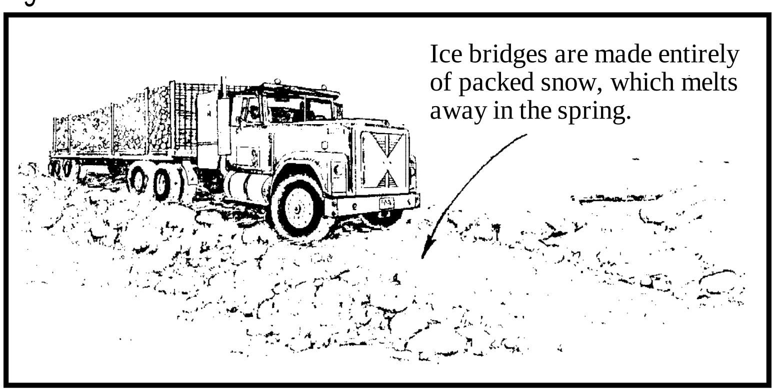
U Construct crossings to prevent water from backing up.

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



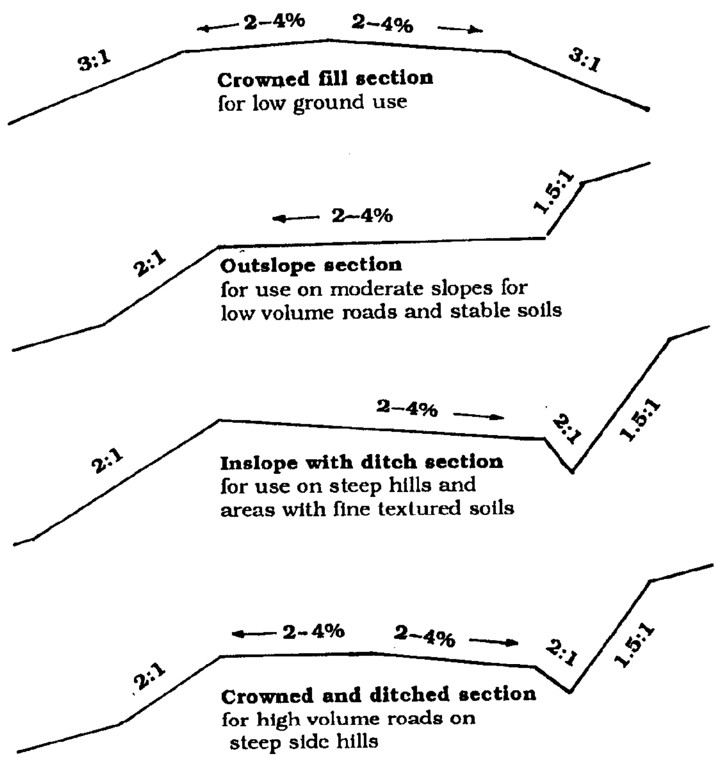
Drainage

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

Typical Road Profiles for Drainage and Stability



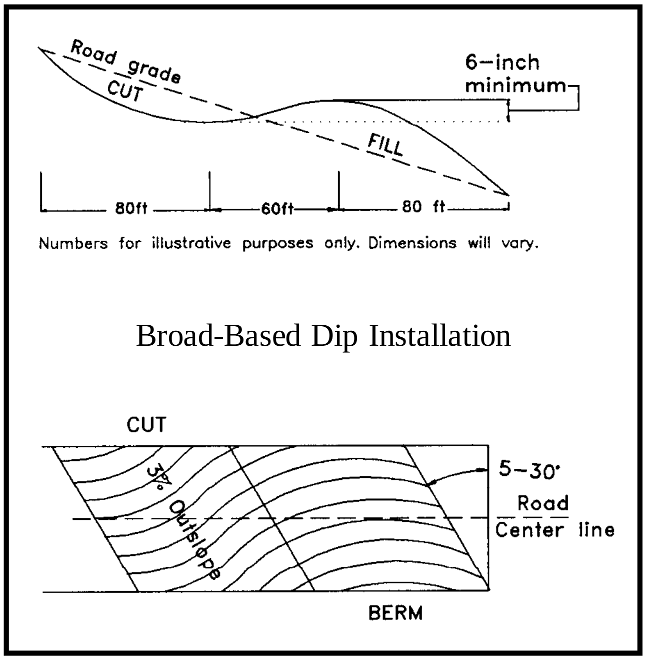


Figure ROAD-7

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

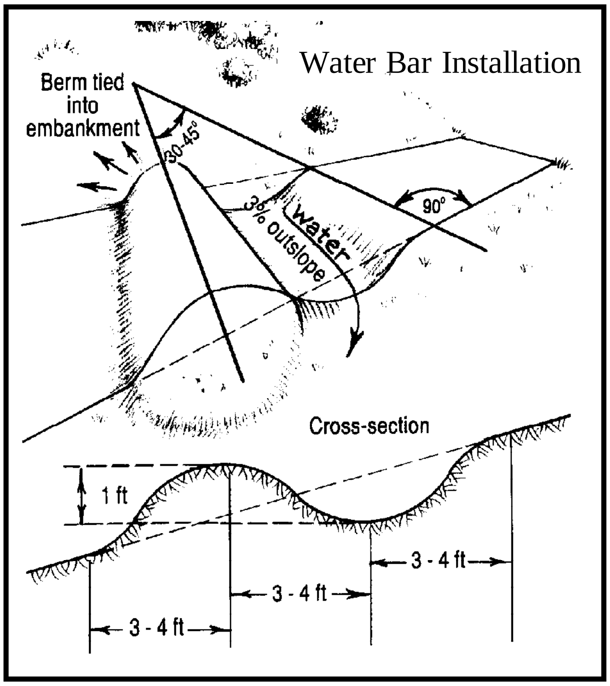


Figure ROAD-8

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

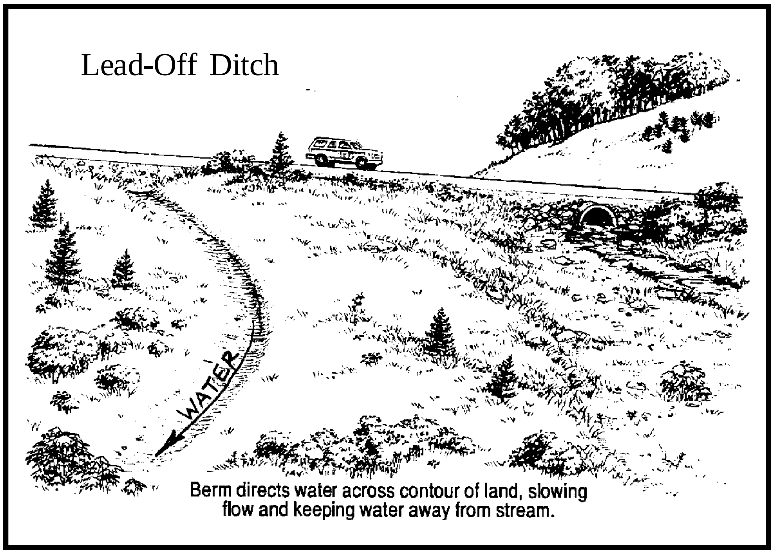


Figure ROAD-9

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:**

- Utilize merchantable timber within road clearings.
- 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:**

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

*In areas classified as less sensitive:**

- Encourage utilization of all merchantable right-of-way timber.
- Avoid creating a corridor of debris.
- Do not leave jackstrawed or overturned stumps in immediate foreground.
- 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:**

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

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

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

U 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.

U 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).

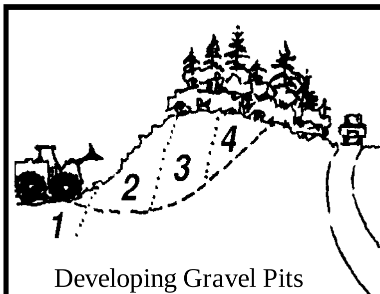
*In areas classified as less sensitive:**

U Use methods and applications consistent with integrated resource management principles.

U 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.

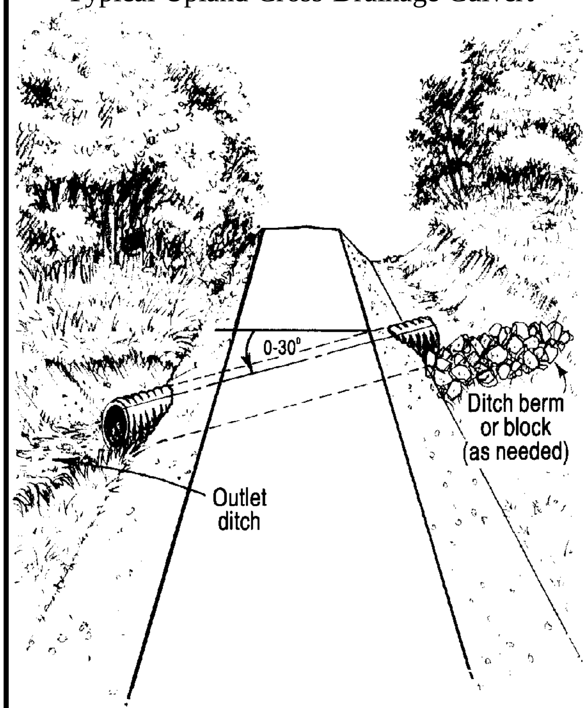
Drainage

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



Angle of culvert placement for
low-velocity flows may be less than 30°.

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

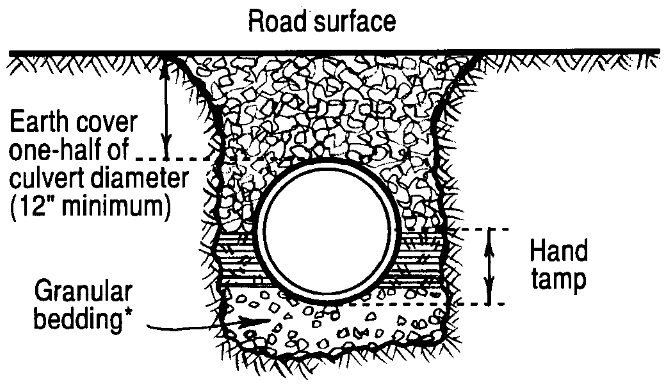


Figure ROAD-12

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

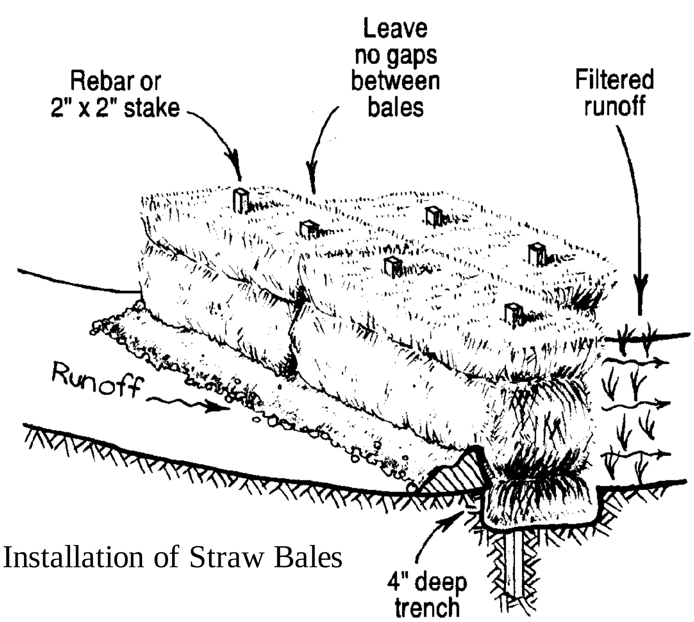
U Stabilize bare soil areas to reduce erosion. A vegetative cover is recommended along all roadsides. Where necessary, mulch and seed disturbed soil as soon as practical after construction. For sources of recommendations for seed mixes and fertilizer use, see *Resource Directory*.

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.

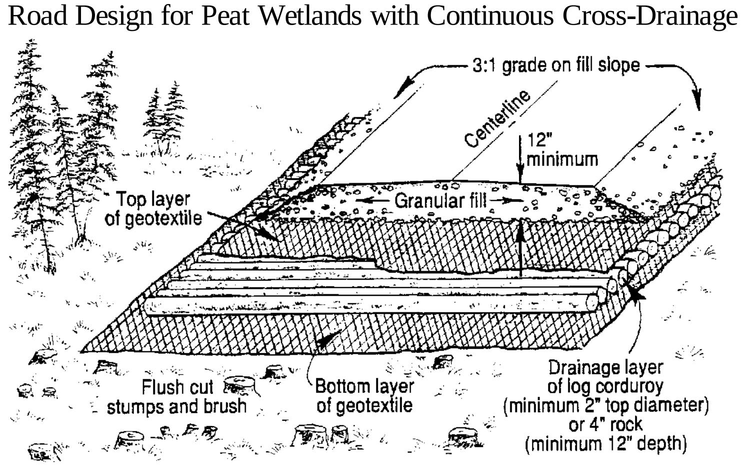
U Shape and stabilize borrow pits and excess material.

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.

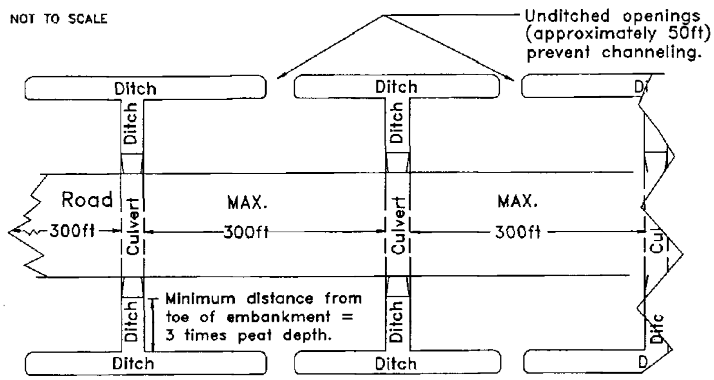
Figure ROAD-14

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

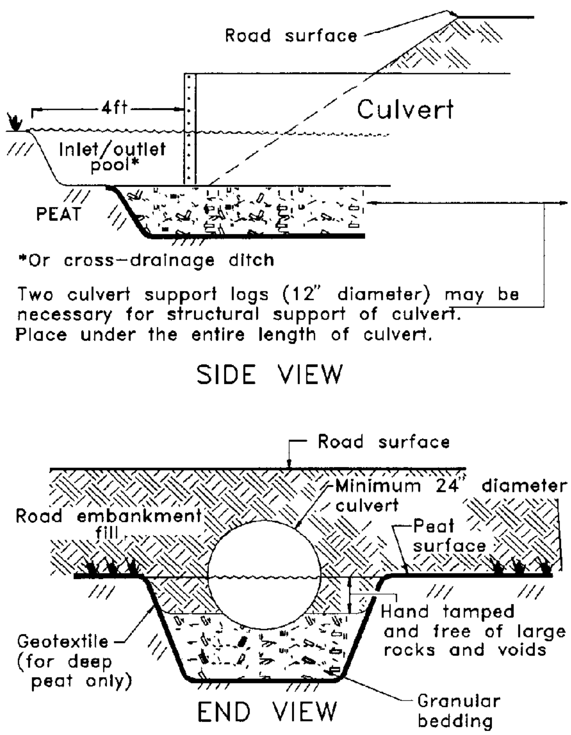


Figure ROAD-16

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:

U **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.

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 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.

U **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.

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

U **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.

U **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.

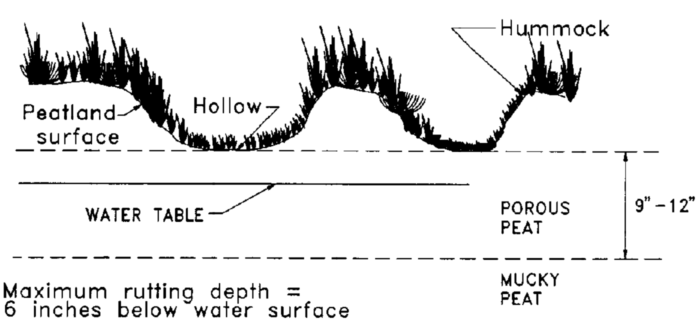
U **Avoid clearing practices that result in berms of soil** or organic debris building up on either side of the road clearing. Such berms can disrupt normal water flow.

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:

U Control access to minimize maintenance requirements.

U Install appropriate drainage structures as necessary and maintain in working order.

U Place a barrier to traffic, and post "Road Closed" signs at the beginning of the road when closing roads.

U Provide periodic inspection and maintenance of road surfaces as necessary.

For permanent closure:

- **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.

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

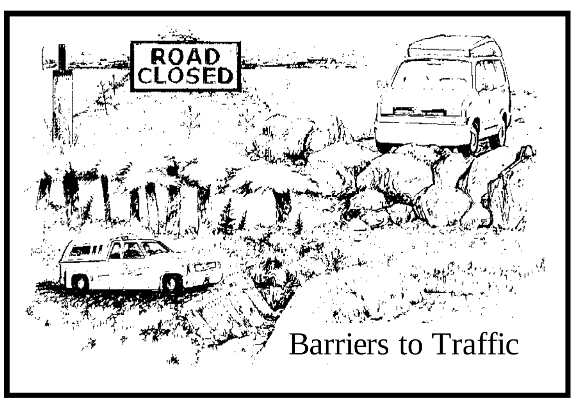
- **Remove structures** that would require continuing maintenance (such as culverts and bridges) even after a road is abandoned.

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

- **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



Timber Harvesting

CONTENTS

FIGURES

TABLE

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

Timber harvesting involves planning harvest and reforestation; cutting trees and moving them to a landing; processing, sorting and loading; and transporting materials.

The Benefits of Guidelines

Benefits to cultural resources: Timber harvesting guidelines can minimize the potential effects of harvesting activities, such as mixing of surface soils, rutting, compaction and erosion, which can damage certain kinds of cultural resources. Guidelines for construction of roads and landings, felling, skidding and slash management can help to protect cultural resources.

Benefits to forest soils: Timber harvesting guidelines are designed to help protect the physical, chemical and biological properties of forest soils by minimizing the effects of soil compaction and rutting, erosion and nutrient removal that can result from timber harvesting activities. Reducing these potential impacts can maintain root penetration, availability of water, water absorption by plants, availability of oxygen and other gases in the soil, and the degree to which water moves laterally and vertically through the soil. Guidelines can also minimize the need for expensive rehabilitation of highly impacted soils.

Benefits to riparian areas: Timber harvesting guidelines can minimize the alteration 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: Timber harvesting guidelines can moderate the potential adverse visual quality impacts from timber harvesting activities and help reduce the impression of poor harvesting and utilization. Guidelines related to perceived harvest size, slash, landings and snags have the greatest potential to enhance visual quality.

Benefits to water quality and wetlands: Timber harvesting guidelines provide protection to water quality and wetlands by minimizing potential nonpoint source pollution resulting from soil disturbance, disruption of vegetative cover, and timber harvesting activities in close proximity to streams, lakes and wetlands. Guidelines to help maintain vegetative cover can also help riparian areas moderate water temperatures. Guidelines that address equipment operations and maintenance can help protect water quality, and guidelines to minimize rutting in wetlands help maintain normal water flows.

Benefits to wildlife habitat: Timber harvesting guidelines reduce the potential for timber harvesting activities to disturb sensitive sites, rare species, water features and unique habitats. Guidelines related to timber harvesting, especially clearcutting, are aimed at maintaining structural components on a site (including live trees, snags, woody debris, shrubs and ground cover) that are needed by forest wildlife now and as the stand regenerates.

Considerations

Protecting soil and water resources

❒ **Appropriate reforestation goals should be considered** before beginning harvest activity. The plan should include site preparation techniques, if needed, and species selection prior to harvest. It may include natural regeneration of existing species.

❒ **Special soil conditions and topographic features** make some areas of the state more sensitive than others to soil disturbance. Two primary examples of these localized sensitive areas are the blufflands of southeast Minnesota and the Nemadji River Basin south of Duluth.

❒ **When working in areas** with special soil conditions and topographic features that make them more sensitive to disturbance than others, the landowner, resource manager or operator needs to increase the intensity of planning compared to other forested regions of the state. Planning should address long-term development and maintenance needs.

❒ **Soil impacts can be minimized** by limiting the soil area impacted by infrastructure (roads, landings and primary skid trails), and by careful consideration of timing, equipment being used, and harvesting methods. Planning considerations include carefully determining appropriate operating seasons for any given soil, as well as using harvest layouts, strategies and equipment that minimize the surface area of a site that is trafficked.

❒ **Appropriate timber harvesting strategies and practices** can be employed to ensure that timber harvesting practices do not reduce the productive capacity of forest soils through removal of nutrients or disruptions of nutrient cycles. On most Minnesota forest soils, nutrient removal through harvest is not a concern. However, guidelines should be applied in specific situations and site conditions, with the goal of balancing the level of nutrients removed through timber harvest with natural nutrient inputs.

❒ **Susceptibility to compaction and rutting** on wetlands is dependent on several factors, including level of equipment trafficking, type of equipment used, soil type (mineral soil or peatland), soil water content at the time the silvicultural activity is conducted, and season of activity. In general for mineral soil wetlands, compaction and rutting increase as soil texture becomes finer and soil water content increases. In unfrozen peatland, deep rutting can bring muck to the surface and block normal water flow.

❒ **Wetlands are highly productive sites** for a variety of ecologic functions, as well as for the enhancement of water quality. All forest management operations in or adjacent to wetlands should be planned and conducted in a manner that protects these functions.

❒ **Using appropriate forest management guidelines for harvesting activities** will minimize the potential for sediment, chemical, nutrient and debris movement into streams, lakes, wetlands, seasonal ponds and ground water. Guidelines will also minimize thermal (heating) impacts on surface waters.

❒ **Employing loggers who have been trained in guideline implementation** can aid in proper and efficient application of site-level timber harvesting guidelines.

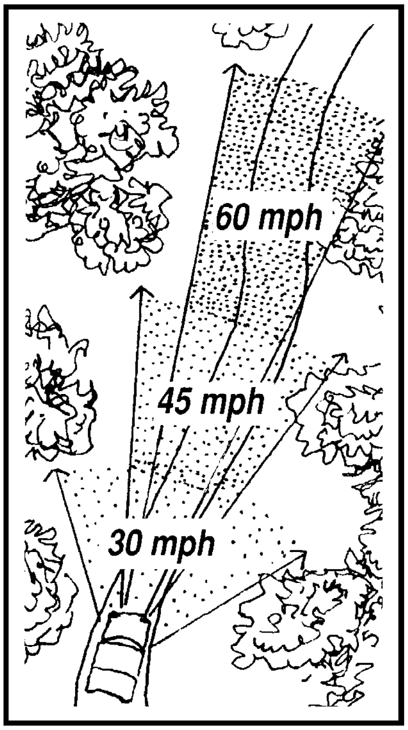


Figure TH-1: Travel speed affects apparent field of vision and observation time.

Visual impacts

❒ Travel speed affects the apparent field of vision and the observation time, which impact the users' levels of concern. See Figure TH-1.

❒ Type of harvest (clearcut vs. partial cut, for example) affects user perception of apparent size.

❒ Stand condition and health should be considered along with visual impacts.

❒ Desired future condition of a particular stand should be considered along with visual impacts.

❒ Proximity to recreational use areas results in enhanced user concerns regarding apparent size of harvest.

Managing slash

❒ Slash is unavoidable when timber harvesting.

❒ Slash treatment has a definite cost.

❒ Slash near streams, lakes and wetlands is subject to special regulation.

❒ Slash provides soil nutrients.

Landings

❒ Size and number of landings are affected by species, products developed, size of sale and timber sale design.

❒ Topography can limit both placement and number of landings.

❒ Proximity of harvest to travel routes or use areas can affect placement of landings.

❒ Proposed future use of landing area (as a parking area along a recreational trail or as a wildlife opening, for example) can affect size and placement of landing.

❒ Landing treatment practices may result in additional cost, no change in cost, or a savings in cost.

Snags

❒ Snags represent a potential safety hazard for logging operations.

❒ Snags can limit effective growth of future plantations by occupying space that could otherwise be used by healthy trees.

❒ Snags may increase the potential risk of lightning fires.

❒ Snags enhance the quality of wildlife habitats, providing nesting, denning, feeding and roosting sites, as well as escape areas.

❒ Snags may increase insect and disease problems for regeneration of a new stand.

Design Outcomes To Maintain Soil Productivity

Timber harvesting should be designed and conducted to achieve the following beneficial outcomes regarding soil productivity:

- Soil in a condition that favors regeneration and growth of native vegetation and trees
- No more than 1-3% of the timber harvest area occupied by roads and landings (Small or irregularly shaped units may result in higher percentages.)
- No more than 10-15% of the timber harvest area occupied by primary skid trails, with access to the rest of the site (1-2 pass trails) occupying no more than an additional 20-30% of the area (Small or irregularly shaped units may result in higher percentages.)
- Minimal rutting in primary skid trails, roads and landings; and avoidance of rutting in the general harvest area
- Minimal change to the hydrologic condition of the site
- Minimal loss of nutrients on nutrient-sensitive site
- Nutrient removal from timber harvest resulting in no reduction to tree growth or change in vegetative composition of the site
- Bare soil areas stabilized from surface erosion, with soil erosion control measures properly applied and functional on skid trails, roads and landings

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.

PLANNING AND DESIGN

IMPORTANT! Review General Guidelines:

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

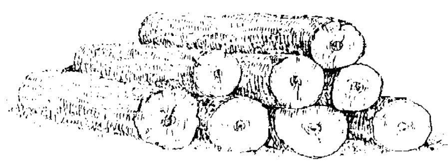
U Consider water quality concerns as management objectives are established:

• Include provisions for water protection in the timber sale contract.

• Avoid building landings, skid trails and roads in wetlands.

• Where avoidance is not practical, the resource manager, logger, contractor or landowner should minimize impacts by limiting the extent of wetland activities.

U Consider soil or site conditions that may dictate specific timing, harvest methods or equipment to be used, or that may lead to weather-related or seasonal closure of the operation.



U When designing timber sales (including layout, size and shape):

• Consider and incorporate forest management goals, harvesting efficiencies and site impacts.

• Use natural features and avoid artificial patterns where possible. These natural features may correspond to changes in topography, soils, wetland interfaces and timber types.

U If practical and feasible, protect cultural resource areas:

• Exclude cultural resource areas from timber sale area.

• Keep roads, skid trails and landings away from cultural resource areas.

• If harvest will take place on or near a cultural resource, consider applying guidelines in *Timber Harvesting: Protecting Sensitive Areas* (page 20).

Progressive Timber Harvest Pattern

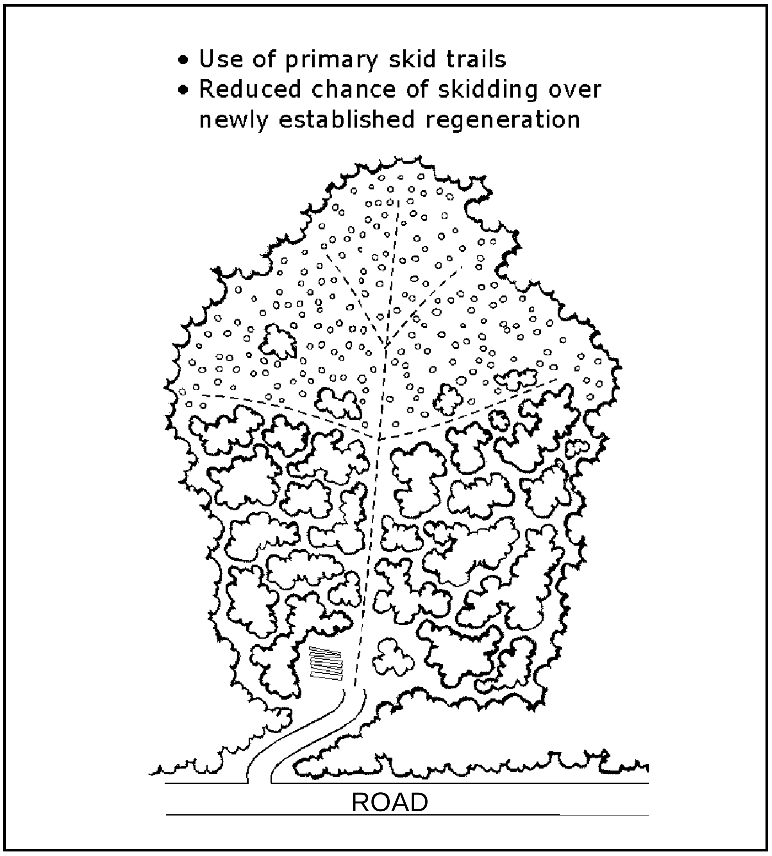


Figure TH-2

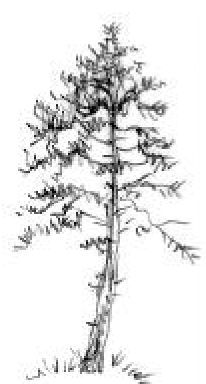
U Plan a progressive harvesting technique that avoids trafficking over pre-cut areas where possible. See Figure TH-2.

U Mimic natural disturbance by leaving some live trees, snags and reserve patches in clearcut harvest areas. Consider leaving fingers and fire shadow areas next to wetlands in fire-dependent forest types. See Figure TH-3, and see *General Guidelines: Retaining Leave Trees.*

U Create a variety of patch sizes within selection harvests.

U For aspen or hardwood cover types on well-drained sandy soils or on shallow soils (8 inches or less) over bedrock, consider one or more of the following guidelines:

- Convert or manage site for tree species that store fewer nutrients in the bole and bark of the tree, such as red pine or jack pine.
- Retain or redistribute slash on the site.
- Avoid full-tree harvesting or full-tree skidding that piles slash, or redistribute slash back onto the site.
- During non-frozen seasons, leave slash in small piles or drags along skid trails or in the skid trails themselves, rather than trafficking off of established trails, because the negative effects of soil trafficking outside of skid trails may outweigh the benefits of redistributing slash.
- Add nutrients to the site, such as municipal sludge, ash or commercial fertilizer. For sources of technical assistance before applying nutrients, see *Resource Directory*.
- Avoid shortened rotations.
- Consider extending harvest rotation age.



Fingers and Fire Shadows

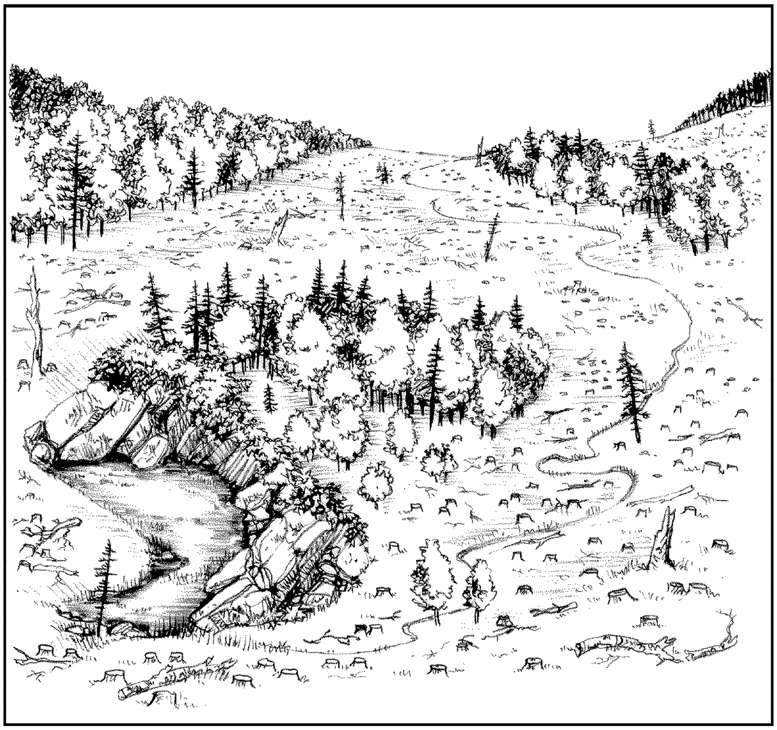


Figure TH-3

U For organic soils deeper than 24 inches, consider one or more of the following guidelines:

- Retain or redistribute slash on the site.
- Avoid full-tree harvesting or full-tree skidding that piles slash, or redistribute slash back onto the site.
- Add nutrients to the site, such as municipal sludge, ash or commercial fertilizer. For sources of technical assistance before applying nutrients, see *Resource Directory*.
- Avoid shortened rotations.
- Consider extending harvest rotation age.

Additional Considerations

K **Consider whether a legacy patch is needed.** See *Part 2, Wildlife Habitat: Additional Consideration: Legacy Patches,* for information about legacy patches.

K **Consider maintaining the diversity of mast sources** on the site, as well as some level of current production of mast sources. For example, maintain landings as openings or avoid machinery operation in pockets of fruit-producing shrubs.

Reducing Visual Impacts of Apparent Harvest Size

*In areas classified as most sensitive:**

U Limit apparent harvest size to 5 acres or less by:

- Leaving patches of trees to break up the harvest area.
- Using one or more of the techniques listed below.

*In areas classified as moderately sensitive:**

U Limit apparent harvest size to 5–10 acres by:

- Leaving patches of small unmerchantable species in the harvest area.
- Using one or more of the techniques listed below.

*In areas classified as less sensitive:**

U Follow standards and guidelines that best achieve integrated resource management objectives for the area.

Techniques for limiting apparent harvest area size:

U Create narrow openings into harvest area to limit view from public roads, lakes and rivers, or recreation areas. See Figure TH-4.

U Utilize natural terrain. See Figure TH-5.

U Shape clearcuts to look more like natural openings where ownership patterns allow. See Figure TH-6.

U Adjust contiguous linear feet of harvest frontage along travel routes relative to travel speed.

U Consider multiple-stage cuts or other management methods such as shelterwood and selective harvesting. See Figure TH-7.

*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.

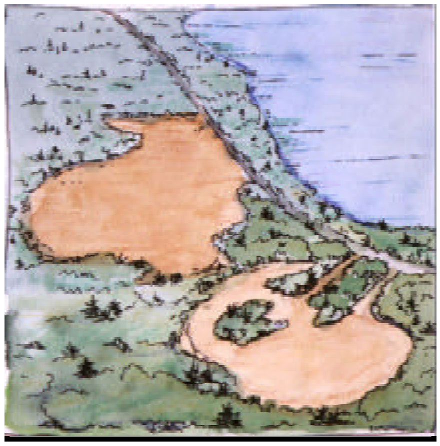
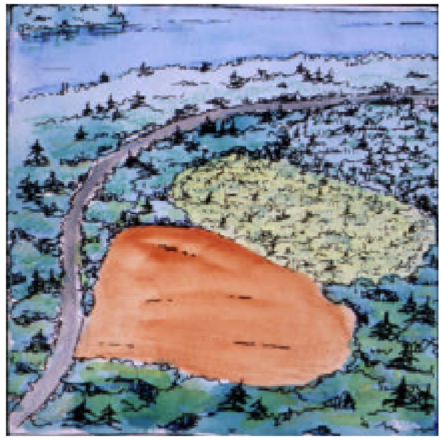


Figure TH-4: The impact of a highly visible harvest (upper left) is reduced by the use of narrow openings into the harvest area (lower right). A vegetative island further blocks the view into the harvest area.

Figure TH-5: Using natural terrain to screen clearcuts from view can reduce the apparent size of a harvest area.

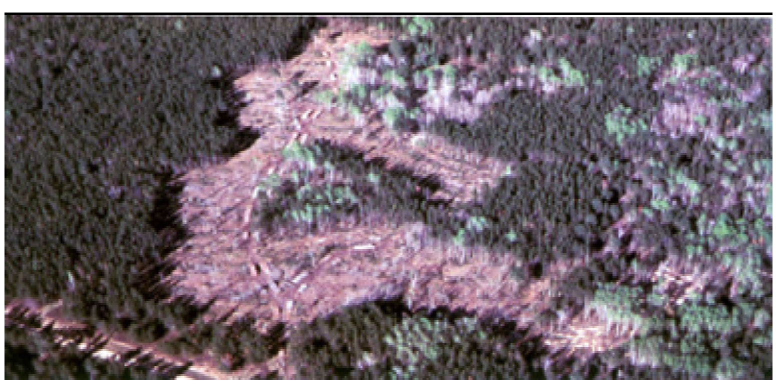
Figure TH-6: Shaping clearcuts to resemble natural openings (above) is more visually pleasing than geometric clearcut areas (below). The top opening also uses a vegetative island to reduce apparent size from the road.

Figure TH-7: Multiple-stage cutting (right) can reduce apparent harvest area size.



Vegetative islands (below) provide leave trees for wildlife habitat, serve as legacy patches, and help to reduce the apparent size of this clearcut from the main road (far right). This clearcut has also been shaped to resemble a natural opening. *Photo courtesy of Superior National Forest*

This aerial view of harvest activity in a clearcut area (below) reflects several visual quality management practices, including natural shaping, large vegetative islands and a narrow opening into the area that limits visual penetration from the road (lower left). *Photo courtesy of Chippewa National Forest*



OPERATIONAL ACTIVITIES

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

Other guidelines that apply:

For activities involving:	Refer to these guidelines:
Constructing and maintaining forest roads	Forest Road Construction and Maintenance

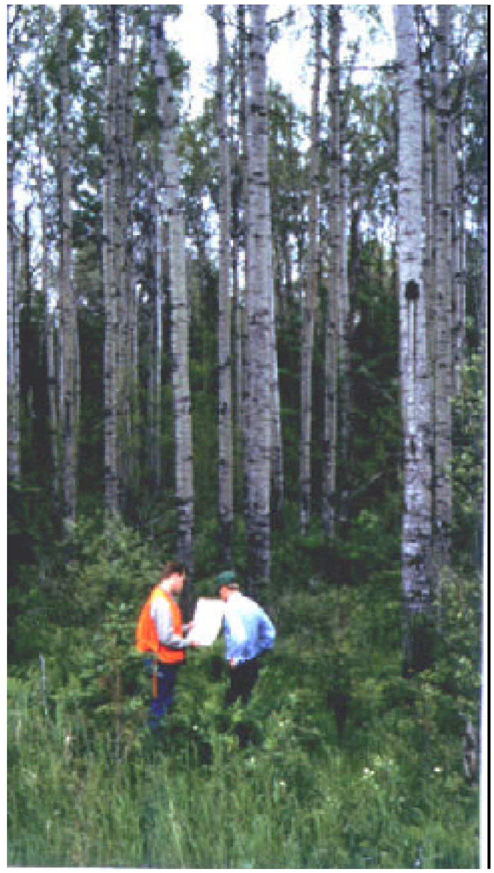
U **Conduct on-site meetings** with the logger, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, timber harvest specifications and site conditions.

Protecting Sensitive Areas

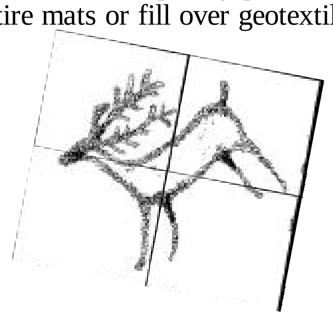
U **Avoid sensitive areas discovered during the actual timber harvest** that were not previously identified. Sensitive areas include areas with special soil conditions and topographic features that make them more sensitive to disturbance than others.

U **Employ harvesting techniques** that minimize the need to operate equipment on steep slopes (such as winching logs off steep slopes or cable yarding). Employ appropriate harvesting techniques and equipment when harvesting on steep slopes.

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, contract specifications and site conditions. *Photo courtesy of Potlatch Corporation*



❑ If harvest will take place in the area of a cultural resource, employ measures to reduce soil disturbance, including (but not limited to) hand felling, cable skidding, limited-area feller buncher, low ground pressure (LGP) equipment, cut-to-length systems, and temporary protection such as slash, corduroy, tire mats or fill over geotextile.



Landings

U Specify the number and location of landings as part of the harvesting agreement.

U Size landings to the minimum required for the acres to be harvested, the equipment likely to be used, and the products to be cut.

U Plan roads and landings to occupy no more than 1-3% of the timber harvest area. See Figure TH-8.

U Locate landings so that they are:

- On upland areas whenever practical
- On stable ground
- Outside of filter strips or the riparian management zone (RMZ), whichever is wider, where practical. (See *General Guidelines: Maintaining Filter Strips and General Guidelines: Managing Riparian Areas.*
- Away from areas where a cultural resource is present

U Avoid landings in locations that will concentrate runoff from surrounding areas onto the landing.

U Avoid locating landings and yarding areas on open water wetlands.

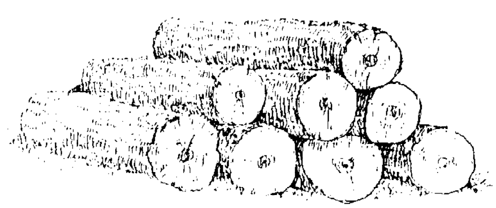
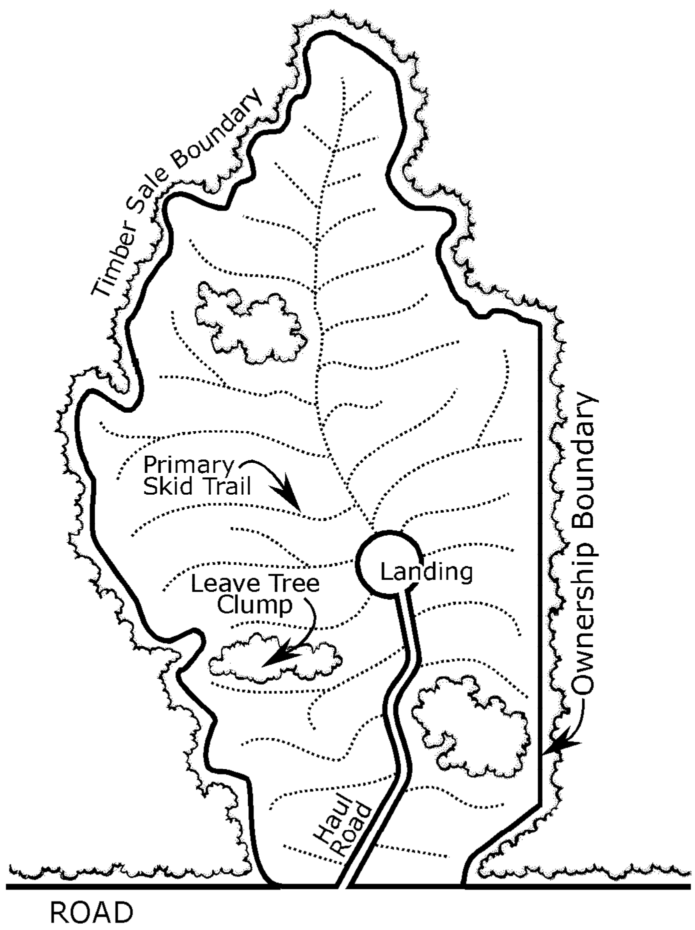


Figure TH-8

Sample 20-Acre Timber Sale



An Example of Infrastructure Proportions

1% Road (16' wide x 560' long)

1% Landing (.2 acre)

10% Primary Skid Trails (12' wide x 7,400' long)

Reducing Visual Impacts of Landings

*In areas classified as most sensitive:**

- **Avoid landings within view of travel routes** or recreation areas. See Figure TH-9.

*In areas classified as moderately sensitive:**

- **When possible, avoid landings within view** of travel routes or recreation areas.
- **If it is not possible to avoid landings** within view of travel routes, screen landings from view as long as possible during logging.

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

- **Keep number of landings to a minimum.**
- **Remove all products promptly** when development of visible landings is necessary.
- **Dispose of grubbed stumps and trees** so as not to be visible.
- **Treat any slash** at landings as soon as possible.
- **Seed, plant and regenerate landings** promptly.
- **Remove all trash from landings** upon completion of harvesting.
- **Plan landings** to access future sales.

*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.

*In areas classified as less sensitive:**

U Avoid landings within a travel route right-of-way.

U Consider locating landings outside of maintained road right-of-way whenever possible.

U Remove all trash from landings upon completion of harvesting.

U Locate landings for best economy and reuse on subsequent sales.

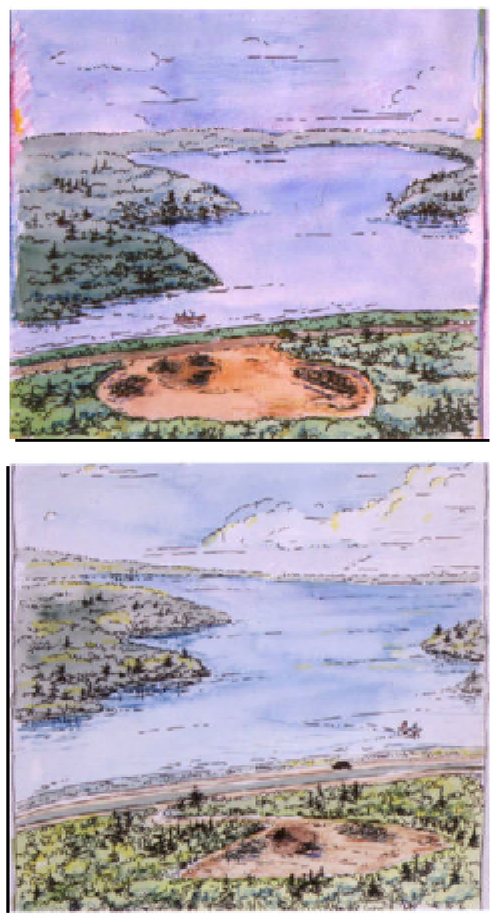


Figure TH-9: In visually sensitive areas, a recommended practice is to avoid placing landings within view of travel routes or recreational areas. The landing and slash piles above are in full view of travelers and recreational users along the adjacent travel route and waterway. The landing and slash piles below are hidden from the travel route and waterway as a result of the dogleg access road.

Skidding and Skid Trails

U **Locate, design, construct and maintain skid trails** to minimize damage to cultural resources or to the residual stand; minimize rutting; maintain surface and subsurface water flows in wetlands; and reduce erosion and sedimentation.

U **Lay out skid trails** to minimize the number of skid trails and site disturbance while also achieving necessary operating efficiency.

- If practical and feasible, keep skid trails away from cultural resource areas.

- Avoid locating skid trails in filter strips and riparian management zones (RMZs). See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

- Avoid operation of equipment on slopes steeper than 50%.

- Limit primary and secondary skid trails to no more than 10-15% of the timber harvest area. For the rest of the site, limit access to no more than 20-30% of the area using trails for no more than 1-2 passes with heavy equipment. (Small or irregularly shaped units may result in higher percentages of area occupied by infrastructure.)

- Skid low on a slope or across a slope to minimize erosion.

- Minimize long, straight skid trails that channel water. If long stretches cannot be avoided by careful siting, provide adequate drainage to avoid concentration of surface water flow. Divert water by proper shaping of the trail surface and by using broad-based dips, lead-off ditches or water bars. See *Forest Road Construction and Maintenance: Drainage.*

U **Use full-tree skidding** rather than tree-length skidding in the vicinity of a cultural resource, if practical and feasible.

U Concentrate equipment traffic on primary and secondary skid trails. Maximize the area not impacted by traffic by concentrating equipment movements to common trails. Skidders should always use skid trail routes, rather than the shortest distance, to travel to and from landings.

U Prepare skid trails for anticipated traffic needs, to avoid unnecessary maintenance or relocation of trails. Techniques can include packing of snow or ground cover to ensure freezing, or the use of appropriate wetland road construction methods to provide a stable trail surface.

U Maintain skid trails in good repair so that additional skid trails are not required.

U Reuse skid trails for thinning operations as trails for future thinnings and final harvest.

U If skid trails do not hold up (resulting in excessive rutting or requiring the need to create new skid trails), curtail operations until soils dry out.

Other guidelines that apply:

For activities involving:	Refer to these guidelines:
Skid trails	Forest Road Construction and Maintenance

Minimizing Rutting

U Minimize rutting in primary skid trails, roads and landings; and avoid rutting in the general harvest area.

U If rutting occurs in the general harvest area (outside of primary skid trails), use alternative operating techniques, such as the following:

- Shifting harvest operations to a stable portion of the harvest area
- Using low ground pressure (LGP) equipment
- Using slash on skid trails as a driving surface
- Reducing loads carried by logging equipment
- Packing the snow or ground cover with LGP equipment to enhance freezing and permit off-trail operation of equipment

U If alternative operating techniques fail to eliminate rutting, stop harvesting operations.

Managing Slash

U Favor practices that allow for dispersed slash on the site, rather than piling slash, where dispersed slash does not conflict with management objectives or reforestation. When piling slash, piles should be kept away from cultural resources.

U If moving slash on-site is desirable, use equipment that minimizes soil disturbance.

U Keep logging residue out of all streams, lakes and open water wetlands, except in cases where residue placement is specifically prescribed for fish or wildlife habitat. Make reasonable effort to keep logging residue out of all wetland inclusions, seasonal ponds and non-open water wetlands.

Reducing Visual Impacts of Slash

*In areas classified as most sensitive:**

- **Encourage full utilization of all species** in the harvest area.
- **Avoid slash piles or windrows visible from travel routes** and recreation areas.
- **Eliminate or minimize slash within the first 50 feet** from travel routes or recreation areas.
- **Limit slash not screened from view beyond 50 feet** from travel routes or recreation areas to a maximum height of 2 feet.

*In areas classified as moderately sensitive:**

- **Encourage maximum utilization** of all felled trees in the harvest area.
- **Minimize visual exposure to slash piles** and windrows.
- **Limit slash not screened from view** to a maximum height of 2 feet.

*In areas classified as less sensitive:**

- **Avoid obtrusive piles** in the foreground of visible areas.
- **Use appropriate slash disposal** to meet silvicultural goals.
- **Limit slash not screened from view** to a reasonable height to avoid a negative visual effect.

*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.

Visible slash is unsightly, as demonstrated in this blowdown site. In visually sensitive areas, eliminate or minimize slash within the first 50 feet from travel routes or recreation areas. *Photo courtesy of Superior National Forest*

Water Quality and Wetlands

U Minimize the crossing of intermittent or perennial streams and open water wetlands. On both upland and lowland sites, install bridges, culverts, snow or ice bridges, fords or other means, if necessary, to prevent repeated soil and streambank disturbance where no practical alternative exists to crossing a stream. **IMPORTANT: Such activity may require a permit from the DNR.** See *Appendix H: Work Activities That Do Not Require a DNR Protected Waters Permit.*

U Approach water crossings at or near right angles to the stream direction, and use measures to minimize streambank disturbances.

U Incorporate water diversion devices where needed during timber harvest activity (including water bars, tops and branches, ditch blocks and lead-offs). Divert surface flow before it enters landings or a water body. Incorporate water diversion devices during construction rather than as a remedial activity. See *Forest Road Construction and Maintenance: Drainage.*

U To prevent repeated rutting deeper than 6 inches on wetlands, shift harvest operations to a stable portion of the harvest area or alter operating techniques. Alternative operating techniques include:

- Employing low ground pressure (LGP) equipment

- Using slash on skid trails as a driving surface

- Minimizing the amount of off-trail equipment operation to reduce the area disturbed by heavy equipment

- Waiting for colder weather to freeze down the site, or enhancing freezing of site by packing snow and ground vegetation with LGP equipment.

U If repeated rutting deeper than 6 inches cannot be avoided with existing or alternative techniques, cease wetland timber harvesting operations. See Figure TH-10.

Peat Wetland Surface in Relation to Water Table

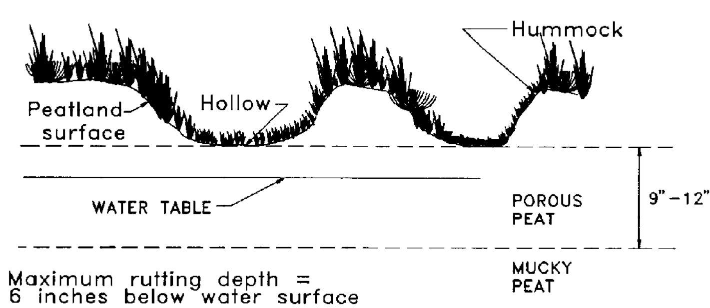


Figure TH-10: The water table (solid line) is near the bottom of the hollows (upper dotted line). Operations should stop when ruts reach 6 inches below the water table or 6 inches below the bottom of the hollows, whichever is lower. Peat is usually still porous 9 inches below the hollows, and ruts will 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 Perpetuating Oak

U Use appropriate management methods (including clearcut, shelterwood and group selection) to perpetuate oak types or oaks within other cover types, while retaining some trees on-site for continued mast production during stand regeneration. If no oaks can be left on a site, ensure that acorn-producing stands occur nearby for wildlife use during regeneration of the cut stand.

U Manage oak stands and other hard mast-producing trees on extended rotations, growing trees to large diameter to maximize mast production. Maintain oak in well-stocked stands by retaining vigorous trees with dominant crowns, as large crowned trees produce more mast. As older stands become less productive, their regeneration is one approach to long-term mast production.

Additional Consideration

K Consider retaining oak inclusions when harvesting non-oak cover types.

Snags provide habitat for wildlife. *Photo courtesy of Potlatch Corporation*

Snags (standing dead trees)

U Leave all snags possible standing in harvest areas.

U Exceptions to leaving all snags may be made for reasons related to visual quality. When leaving snags in areas classified as most sensitive or moderately sensitive:

- Avoid leaving snags in the foreground.

- Hide scattered snags with vegetative islands, or locate snags around the edge of an opening to allow for camouflage by background trees of similar color and texture.

Leave Trees (live trees)

Leave trees are live trees retained on a site for resource benefits.

Two general options are recommended for retaining leave trees:

- Retaining leave trees in clumps, strips or islands
- Retaining scattered individual leave trees

This harvest area demonstrates implementation of several guidelines, including retaining leave trees and snags, dispersing slash throughout the site, and keeping slash low to the ground. These practices protect the soil, enhance wildlife habitat and reduce negative visual impacts. *Photo courtesy of Minnesota DNR*

Both options accomplish the management goals of retaining leave trees. Plans for retaining leave trees may utilize one of these options or, when appropriate, they may use the two options in combination.

U OPTION 1: Retain leave trees in clumps, strips or islands occupying a minimum of 5% of each clearcut harvest unit, using the following considerations and guidelines to aid in planning and design:

- With the exclusion of even-age management within riparian management zones (RMZs), trees left to protect cultural resources, visual quality, wetland inclusions, seasonal ponds, mast or other resources may be counted toward the 5% minimum recommendation. This consideration reflects the concept of overlapping guidelines where, in some instances, applying a guideline to benefit one resource may simultaneously fulfill guidelines focused on another resource.

- For even-age management, leave tree clumps, strips or islands should be positioned adjacent to the riparian management zone.

- **Benefits of clumping leave trees include:**

  —Potential to meet multiple management objectives simultaneously

  —Visual quality

  —Equipment maneuverability

  —Longevity and durability of leave trees

  —Potential for greater biodiversity within clumps

  —Easier application in larger harvest units

  —Breakup of harvest area and reduction in apparent harvest size

  —Better regeneration of intolerants on the rest of the site

  —Potential to provide nesting sites for some interior forest species when clumps exceed 2 acres

  —Increased animal feeding efficiency and protection from predators

- **Clumps, islands or strips should:**

  —Be distributed throughout a harvest unit

  —Be adjacent to the RMZ for even-age management

  —Vary in size, with a minimum of 1/4 acre per clump

  —Center around or coincide with such features as:

    * Wetland inclusions and seasonal ponds (see *General Guidelines: Protecting Wetland Inclusions and Seasonal Ponds*)

    * One or more large (> 18 inches DBH) active den trees or cavity trees

    * Mast trees

    * Preferred tree species (such as large white pine)

    * Raptor nests or rookeries

    * Sensitive communities or sites

- **Minimal harvesting within clumps is acceptable** as long as the integrity of the clump or key leave trees is not disturbed, and as long as the clump is not doubling as a legacy patch.

U OPTION 2: As an alternative or supplement to clumps, employ scattered individual leave trees, especially if they are larger, windfirm specimens of preferred species. Scattered leave trees may be easier to apply to small or narrow harvest units than clumps. Use the following guidelines for scattering individual leave trees:

- On most clearcut sites where this method is employed, leave 6-12 trees standing per acre, selecting trees preferentially. For preferred characteristics, see *General Guidelines: Retaining Leave Trees.*

- On certain clearcut sites, there may be no leave trees or as many as 15 or more leave trees per acre, depending on local conditions or landowner objectives, but the majority (80%) of these sites and their overall harvest acres should retain an average of 6-12 per acre. See Table TH-1.

- On non-clearcut sites (including selection or partial-cut), be sure that the remaining stand includes a minimum of 6 cavity trees, potential cavity trees and/or snags per acre.

- Distribute leave trees throughout the harvested site as much as possible.

Cavity trees enhance the quality of wildlife habitat. *Photo courtesy of Itasca County Land Department*

Suggested Numbers of Leave Trees for Clearcut Harvests Using Scattered, Individual Leave Trees
(Clumped leave trees are preferred in most cases)

Management or Sale Area Size	Approx. number of leave trees per acre	Approx. spacing (in feet) if evenly distributed	Forest Type
SMALLER THAN AVERAGE or narrow units with adjacent mature forest	0	—	OPEN/BRUSH
	3	120'	LOWLAND DECIDUOUS
	6	**85'**	LOWLAND CONIFER
AVERAGE size/width harvest units	**9**	**70'**	UPLAND CONIFER; UPLAND DECIDUOUS
LARGER than average or broad harvest units	**12**	**60'**	UPLAND MIXED; UPLAND WITH WETLAND INCLUSIONS
	15+	54'	

CONTINUUM

80% of clearcuts employing scattered leave trees fall in this range (6–12 trees per acre; 85'–60')

Note: Numbers of vertebrate species using cavity trees varies among habitats. The number of leave trees should reflect the variation among habitats and among site conditions.

Table TH-1

U During initial harvest entries of seed tree or shelterwood cuts, select ultimate leave trees using the following guidelines:

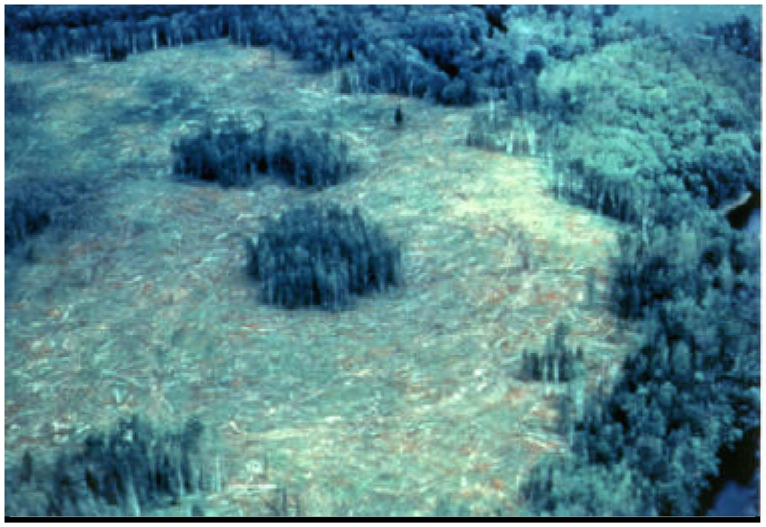
- Leave a variety of sizes and species of trees, along with the intended seed/shelter trees, to be retained during the final harvest.
- Plan for and protect integrity of reserve tree clumps in initial harvest entries.
- Prevent damage to leave trees in initial and followup harvest entries.

U Exceptions to the above leave tree and snag guidelines may be made for a number of reasons, including:

- Operator safety (of loggers, aerial spray applicators and others)
- Public safety (hazard trees near rights-of-way, recreation sites or airport vicinities)
- Specific forest management applications (such as genetic considerations for seed reproduction systems)
- Visual quality
- Alignment of skid trails
- Surrounding landscape concerns (sites adjacent to sharp-tailed grouse management units, for example)
- Forest insects and diseases (such as dwarf mistletoe on black spruce, gypsy moth and pine bark beetles)

U Protect conifer regeneration (less than 4 inches DBH) when harvesting mixed deciduous coniferous stands. See *Leave Trees* (page 33) and *General Guidelines: Retaining Leave Trees* for guidelines on retention of mature conifer trees. Clumps of conifers are preferable to scattered trees.

U Retain mast trees with bear claw marks on trunk, which indicate a preferred food source.

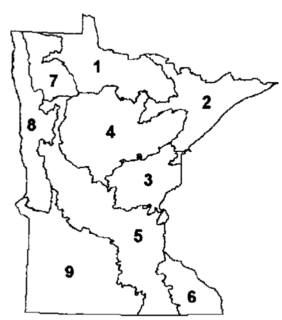


Retaining conifer clumps in a clearcut is preferable to leaving scattered trees.

Additional Considerations

K Consider providing wildlife security cover and access to food when designing timber sales in Ecoregions 5 and 6. If the width of a harvest area exceeds 300-400 feet, and/or the size exceeds 40 acres, consider retaining travel lanes where topography does not already provide such cover. Travel lanes should be large enough to economically manage as a stand.

K Consider retaining more than the recommended number of leave trees in harvest sites of greater than 100 acres. This practice would better mimic natural disturbances, such as fire and windstorm.



Post-Operational Activities

IMPORTANT! Review General Guidelines:

, Post-Operational Activities and Followup Visits

U **Evaluate the harvest operation and plan future adaptations** at post-harvest conferences with the logger and landowner.

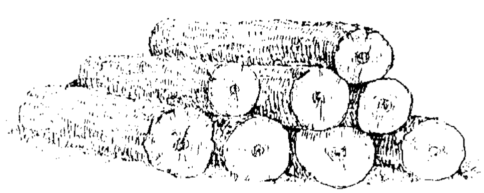
U **Plan for removal of equipment and cut material** from wetland areas at the end of the winter season prior to thawing.

U **Avoid removing soil from the general harvest area** to rehabilitate roads, landings and skid trails. Use already disturbed soil, if needed, rather than disturbing additional soil.

U **Rehabilitate landings and skid trails** when necessary to mitigate soil compaction and reduce erosion.

Additional Consideration

K **Consider scarifying the soil** in the vicinity of conifer seed trees to enhance regeneration of these species.



Mechanical Site Preparation

CONTENTS

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

Site preparation on forest lands is the practice of altering site conditions to favor the establishment, survival and growth of a desired tree species, browse or other vegetation. Site preparation can be accomplished through mechanical means, prescribed fire, the use of herbicides, or any combination of these approaches.

Mechanical site preparation accomplishes two goals:

- ❒ It facilitates planting, direct seeding and natural regeneration.
- ❒ It provides partial initial control of vegetation competing with crop trees for light, water and nutrients.

Common mechanical site preparation techniques include patch scarification, row scarification, raking, disking, bedding, roller chopping and shearing. Herbicides are often applied in conjunction with mechanical site preparation, to increase control of competing vegetation.

The guidelines in this section focus on mechanical site preparation. For chemical use, either in conjunction with or in place of mechanical site preparation methods, refer to the guidelines in *Pesticide Use* for additional information related to non-mechanical site preparation methods. For prescribed burning, refer to the guidelines in *Fire Management.*

The Benefits of Guidelines

Benefits to cultural resources: Mechanical site preparation guidelines can minimize disturbance of cultural resources that may not have been affected by harvest activities, particularly if harvest was conducted during the winter. Guidelines address soil disturbance and erosion concerns in particular.

Benefits to forest soils: Mechanical site preparation guidelines can minimize excessive exposure of mineral soil, compaction or rutting of soil, removal of surface soil, increased erosion, and impacts on the nutrient balance of the site. By maintaining good soil conditions, guidelines can help assure that the goals of site preparation are accomplished (favoring the establishment, survival and growth of a desired tree species).

Benefits to riparian areas: Mechanical site preparation 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: Mechanical site preparation guidelines can reduce both the visual impacts of site preparation activities and also the duration of time that the effects of these activities are visible.

Benefits to water quality and wetlands: Mechanical site preparation guidelines can protect water quality and wetlands. Guidelines can minimize potential erosion, runoff and resulting sedimentation that may occur as a result of site preparation practices that expose or compact mineral soil on erodible slopes or in areas where the prepared site is located adjacent to open water or wetlands. Guidelines that address equipment operations and maintenance can help protect water quality.

Benefits to wildlife habitat: Mechanical site preparation guidelines can help to maintain ground cover, shrubs, woody debris, snags, naturally regenerating tree seedlings and other live trees important to wildlife on a site.

Considerations

❒ **Maintaining good soil condition is critical** to accomplishing the goals of site preparation (to favor the establishment, survival and growth of a desired tree species). Practices that result in excessive exposure of mineral soil, compaction or rutting of soil, or removal of surface soil should be avoided. If soils are negatively impacted in the process of site preparation, then the “advantage” of the site preparation is reduced either through poor establishment, poor survival or, more often, lowered growth and productivity.

❒ **Properly planned harvest operations** should include consideration of mechanical site preparation needs. Site preparation methods that minimize the potential for surface erosion should be evaluated prior to implementation of site preparation operations.

❒ **Selecting the appropriate technique**, intensity and timing of a site preparation activity is important in maintaining the soil productivity of a site. Heavy equipment should be operated on a site when adverse soil impacts are unlikely.

❒ **Mechanical site preparation techniques and intensity** for a given site should be determined by soil/site conditions, crop tree species and site preparation objectives. Specific site conditions (including soil characteristics, topography, vegetation, access and distance to surface water) dictate what techniques may work best or provide the best operating window for any given site. Some sites may be planted with no site preparation other than removing the overstory.

❒ **Practices that result in exposure of mineral soil or soil compaction** on erodible slopes should not be used where surface erosion or runoff is likely to result in sedimentation of water or wetlands. For sources of information and planning assistance, see *Resource Directory.*

❒ **Activities that disturb soil,** such as disking, scarification, rock raking and shearing, may not be appropriate within cultural resource areas.

❒ **Contour preparation methods can minimize erosion,** as well as the cost of remedial action or repair.

❐ **Site preparation methods vary considerably,** depending on the desired regeneration species.

❐ **Every site preparation method has a different cost.** For any method being considered, costs (both short-term and long-term) should be balanced against effectiveness of the method in attaining visual quality objectives.

❐ **Composition and condition of the original stand** can impact the regeneration method chosen for a particular site.

Design Outcomes To Maintain Soil Productivity

Site preparation activities should be designed and implemented to achieve the following beneficial outcomes regarding soil productivity:

- Soil in a condition that favors the establishment, survival and long-term growth of the desired tree species
- Displacement of only enough soil as needed to effectively accomplish tree establishment
- Site preparation techniques employed so that surface soils 1) remain intact; 2) are only displaced a short distance (such as in scalping); or 3) are incorporated (such as in disking)
- Slash dispersed on the site, rather than piled or windrowed, where appropriate
- Site preparation practices employed so that they avoid funneling water (such as furrowing, scarification and scalping on the contour)

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

Planning and Design Considerations

U **Consider alternative methods** of site preparation, such as non-mechanical, or combinations of mechanical and non-mechanical methods, to accomplish site preparation goals while minimizing disturbance. Examples include:

• Utilizing harvest operations to accomplish preparation goals. For example, full-tree skidding can be used for preparation of black spruce or jack pine seed and can eliminate the need for additional re-entries, trafficking or site disturbance, especially on steep slopes.

• Chemical treatments, prescribed burning and hand scarification should be given serious consideration as alternatives to mechanical site preparation, especially on steep slopes, highly erodible soils, or soils sensitive to additional trafficking.

U Design mechanical treatments of regenerating stands to protect reserve areas and structural habitat components retained in previous stand treatments.

U Favor practices that do not remove surface soils or only remove surface soils from the small areas in which an individual seedling will be planted.

U Favor practices that allow for dispersed slash or slash in small piles on the site, rather than piling or windrowing, where slash does not conflict with management objectives or reforestation.

U Select appropriate species and stocking levels for reforestation, and plan site preparation intensity accordingly.

U Plan for a diversity of tree species where possible.

U Design practices to avoid direct runoff of sediment into water and wetlands.

Timing and Intensity of Activities

U Enter a site the fewest number of times necessary, and avoid multiple passes of equipment over the same spot.

U Time site preparation activities and use proper equipment to minimize rutting and compaction of soils.

U Avoid shearing and raking operations on organic soils except under frozen conditions.

Reducing Visual Impacts of Mechanical Site Preparation

*In areas classified as most sensitive:**

U Use low-impact site preparation methods, such as patch or row scarification.

U Use spot or strip treatment of herbicides, rather than broadcast treatment applications.

U Initiate revegetation efforts as soon as possible.

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

U Use land contours in site preparations.

U Avoid the effect of linear straight rows and resulting visual penetration immediately alongside travel routes or recreation areas.

U Avoid or screen windrows and slash piles.

*In areas classified as moderately sensitive:**

U Initiate revegetation efforts as soon as appropriate.

*In areas classified as less sensitive:**

U Follow standards and guidelines that best achieve integrated resource management objectives for the area.

*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.

Favor practices that allow for dispersed slash or slash in small piles on the site, rather than piling or windrowing. *Photo courtesy of Chippewa National Forest*

Selecting Application Methods

U To increase success of oak regeneration, use such pre- and post-harvest techniques as burning, stump sprout thinning or scarification.

U Consider targeted mechanical site preparation methods (low intensity, spot or band) in preference to broadcast applications. Regenerating oak, an important mast species, may warrant more liberal application.

U Use patch or row scarification as the preferred mechanical site preparation method for artificial regeneration when terrain or soil type necessitates minimal soil disturbance.

U If moving slash on-site is desirable, use equipment that minimizes soil disturbance.

OPERATIONAL ACTIVITIES

MPORTANT! 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 contractor, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, contract specifications and site conditions.

Managing Slash and Windrows

U **Where shearing or windrowing slash is necessary,** avoid scraping soil material or forest floor into windrows or piles. Preferred practices include:

- Shearing and raking under frozen conditions
- Light raking, which only removes slash

U **Avoid placing residues into wetland areas** from operations on upland sites. Deposit residues in stable upland locations.

U **Locate windrows and slash disposal piles** so as to:

- Avoid cultural resources
- Minimize interference with natural drainage patterns

- Be outside of filter strips, riparian management zones and leave tree strips. Refer to *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

- Follow contours when possible to mitigate the effects of overland flow.

Protecting Resources

U Scarify or trench only the area necessary for seedling establishment and growth.

U Operate equipment following contours of the land where appropriate, as long as operator safety is maintained.

U Protect existing conifer regeneration less than 4 inches DBH in formerly mixed deciduous coniferous stands during site preparation. Clumps of conifer are preferable to scattered trees.

U Avoid operations during periods of saturated soil conditions when such operations may cause rutting, compaction or accelerated erosion.

Additional Considerations

K Consider scarifying the soil in the vicinity of conifer seed trees to enhance regeneration of these species.

K Consider maintaining the diversity of mast sources on the site, as well as some level of current production of mast sources. For example, maintain landings as openings or avoid machinery operation in pockets of fruit-producing shrubs.

POST-OPERATIONAL ACTIVITIES

IMPORTANT! Review General Guidelines:

- Post-Operational Activities and Followup Visits

U Regenerate site as soon as possible after site preparation.

U Evaluate success of site preparation methods relative to site conditions and silvicultural prescriptions.

U Monitor and manage the site to ensure success of establishment, so that the operation will not have to be repeated.

Pesticide Use

CONTENTS

TABLE

REMEMBER:

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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 sustainability of our forest resources.

INTRODUCTION

The purpose of a pesticide application is to assist in meeting forest management, utility and rights-of-way objectives by promoting the establishment, survival, growth or maintenance of a desired species or condition through the use of chemical compounds or biological agents that control undesirable plants, animals, insects or diseases.

The Benefits of Guidelines

Benefits to cultural resources: Pesticide use guidelines can help assure that vegetation that is part of a cultural property is not altered, which can diminish the value of the cultural property. Guidelines can also minimize the effects of herbicide applications on natural resources that are used by traditional communities for subsistence and other cultural practices.

Benefits to riparian areas: Pesticide use guidelines can minimize alteration 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: Pesticide use guidelines can reduce the visual impacts of dead standing vegetation during the growing season or summer tourist season.

Benefits to water quality and wetlands: Pesticide use guidelines can protect water quality from pesticide residues during all phases of the pesticide use cycle. Guidelines can also help protect vegetative cover and minimize toxic effects on aquatic organisms. Guidelines that address equipment operations and maintenance can help protect water quality.

Benefits to wildlife habitat: Pesticide use guidelines encourage application methods that retain desirable ground cover, shrubs, live trees, insects or other invertebrates, thus maintaining on-site species diversity.

Considerations

❐ **Planning is the essential first step** in reducing pest problems. Maintaining water quality and protecting other resources is an important consideration in all aspects of pesticide operation planning.

❐ **Vegetation that is part of a cemetery** is protected by law and must not be damaged or altered by herbicide application.

❐ **If the project area is on ceded lands** or within the boundaries of a reservation, consult tribal cultural resource specialists to determine whether there are any concerns about traditional cultural practices in or near the project area. See *Resource Directory*. For locations of ceded lands, see *Appendix E: Ceded Lands and Reservation Boundaries.*

❐ **The effective treatment time for most herbicides** is during the active growing season, which corresponds with the summer tourist/recreational use season.

❐ **Broadcast application methods may have a greater visual quality impact** than band or spot treatment methods.

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

Incorporating Integrated Pest Management Strategies

U Employ integrated pest management (IPM) strategies.

Pesticide use should be considered as part of an overall program to control pest problems. Integrated pest management (IPM) strategies have been developed to control forest pests without relying solely on chemical pesticides.

These strategies incorporate a balanced combination of chemical, biological and cultural activities to control forest pests.

A good IPM program has four steps:

- Identify problems.
- Select tactics.
- Consider economic factors, including whether it pays to use pesticides.
- Evaluate the program.

For sources of information on IPM programs, see *Resource Directory*.

Characteristics Affecting Contamination Potential

The three main pesticide characteristics that can greatly affect a pesticide's potential to contaminate surface or ground water are solubility, adsorption and half-life.

❒ **Solubility** is the ability of a pesticide to dissolve in water. The greater the solubility, the greater the chance that the pesticide will leach to ground water or move in solution in surface water. Pesticides with very low water solubilities tend to remain at the soil surface and potentially move to surface water attached to sediment carried in runoff.

❒ **Adsorption** is the inherent ability of a pesticide to attach to soil particles. Some pesticides stick very tightly to soil, while others are easily dislodged:

- The greater a pesticide's ability to adsorb to soil particles, the less the potential for that pesticide to move (except by soil erosion in surface runoff).
- Conversely, the lower a pesticide's ability to adsorb to soil particles, the greater the potential for that pesticide to leach to ground water or move in solution in surface runoff.

Adsorption increases as soil organic matter increases. An index or measure of soil adsorption is expressed by the Koc value.

❒ **Half-life** is the time it takes for a pesticide in soil to be degraded so that its concentration decreases by one-half. Each pesticide will have successive half-lives that will continually decrease concentrations by one-half.

The **persistence** of the pesticide in soil is the time it takes for the pesticide to degrade to the point where it is no longer active. Pesticides that do not break down quickly can be a hazard if they move to ground water or surface water in toxic forms.

Table PEST-1 provides information on pesticide characteristics that influence the potential for the chemicals to leach to ground water. In a given situation, pesticides with the highest water solubilities, greatest persistence, lowest affinities for adsorption to soil particles, and highest application rates have the greatest potential for movement in surface runoff and for leaching to ground water.

Table PEST-1

Pesticide Characteristics Influencing Leaching Potential

Characteristic	*Threshold value for high leaching potential**
Water solubility	30 mg/liter or greater
Adsorption to soil organic matter (Koc)	Less than 300-500
Field dissipation half-life	Greater than 3 weeks

**No one value will indicate leachability.*

For sources of assistance in evaluating pesticide alternatives and determining potential pesticide loss due to surface runoff or leaching, see *Resource Directory.*

Selecting Pesticides

When the decision is made to use pesticides, choose products suitable for use on the target species and registered for the intended uses.

U Use only pesticides registered by the U.S. Environmental Protection Agency and the Minnesota Department of Agriculture. See *Resource Directory.*

U Read and follow all label directions carefully prior to using any pesticide.

U Maintain current labels and Material Safety Data Sheets (MSDS). The MSDS is a source of cautionary information and data.

U Evaluate other factors besides effectiveness and cost when selecting among pesticide options. Factors that influence potential impacts on water quality and other forest resources include site characteristics, pesticide characteristics, application conditions, delivery systems and application techniques.

For pesticide characteristics that affect contamination potential, see Table PEST-1. For additional information on registered pesticides, see *Resource Directory.*

U Select only pesticides labeled for aquatic use on sites where surface water is present at the time of application.

U Select pesticides, application methods, equipment and formulations that:

1) Minimize the potential for pesticide drift.

2) Minimize pesticide residue movement to surface water and ground water.

Selecting Application Methods

U Design chemical treatments of regenerating stands to protect reserve areas and structural habitat components retained in previous stand treatments.

U Promote protection or growth of mast species and browse by employing chemical site preparation methods that target pesticide application (low intensity, spot, band) in preference to broadcast applications. Regenerating oak, an important mast species, may warrant more liberal application.

U Use pesticide application equipment that minimizes soil disturbance.

U Consider non-broadcast application of pesticides where appropriate. Limit broadcast application of pesticides, particularly from the air, to situations where it is the only feasible management option.

U If pesticides must be applied to sites containing endangered, threatened or special concern species (ETS species), select pesticides, application methods, equipment and formulations to protect those species. For sources of assistance regarding ETS species, see *Part 2: Endangered, Threatened and Special Concern Species* and the *Resource Directory*.

Ground application of pesticides limits unintended effects on the forest overstory. *Photo courtesy of Minnesota DNR*

Reducing Visual Impacts of Treated Vegetation

*In areas classified as most sensitive:**

- Favor non-herbicide treatment methods.

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

- Favor band treatment or spot treatment over broadcast treatment.
- Leave untreated or selectively treated areas adjacent to travel routes and recreation areas.
- Favor late-season or dormant-season herbicides.

*In areas classified as less sensitive:**

- Use methods of application consistent with integrated resource management principles.

*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.

Spill Response

Forestry pesticides that are spilled can enter surface water or ground water. Spills near or in geologically sensitive areas have a high probability of a portion of the spill reaching ground water.

U **Contact the Minnesota Duty Officer** whenever a spill occurs. Phones are answered 24 hours per day. In the Metro Area, call (651) 649-5451. In Greater Minnesota, call (800) 422-0798. The Minnesota Duty Officer will contact appropriate state agencies.

U **Treat spills properly.** Recommended steps include the following:

- Act quickly.
- Protect yourself.
- Control the spill. (Stop the leak.)
- Contain the spill. (Keep it from spreading.)
- Guard the site.
- Notify the authorities.
- Clean up the spill.

U **Maintain an adequate spill kit** that includes:

- Detergent or soap
- Hand cleaner and water
- Activated charcoal, adsorptive clay, vermiculite, kitty litter, sawdust or other adsorptive materials
- Lime or bleach to neutralize pesticides in emergency situations
- Tools such as a shovel, broom, dustpan and containers for disposal
- Proper protective clothing and equipment

OPERATIONAL ACTIVITIES

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 contractor, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, contract specifications and site conditions.

Proper pesticide management practices make efficient use of chemicals while preventing or minimizing impacts on surface water, ground water and other forest resources. Residues of pesticides used in forestry can affect these resources at any time—from transporting of pesticides to container and waste disposal.

Transportation of Pesticides

U Inspect all containers prior to loading, and ensure that all caps, plugs and bungs are tightened.

U Select transportation routes to minimize the impact of a potential spill on water quality.

Storage of Pesticides

U Locate pesticide storage facilities at sites that minimize the possibility of impacts on water quality in case accidents or fires occur.

U Avoid storing pesticides on or adjacent to treatment areas. Where impractical, select unloading and operational storage locations where spills resulting from accidents or vandalism will not have impacts on water quality.

U Use storage buildings that have floors constructed of concrete or other impermeable materials, so that spills are easy to clean up. Storage buildings should contain drains or sills with sumps large enough to contain the contents of the largest container stored in the buildings.

U Avoid storing pesticides for extended periods in buildings not equipped to contain a complete spill from the largest container being stored.

Mixing and Loading Operations

U Review the label before opening the container to ensure familiarity with current use directions.

U Exercise care and caution during mixing and loading of pesticides.

U Avoid mixing near wells or where pesticide spills could enter open water or wetlands.

U Mix and load pesticides outside of riparian management zones, filter strips and other reserve areas.

U Transport and store hoses used to fill pesticide application equipment in a manner that prevents direct contact with pesticides, gasoline or oils, or surfaces on which these substances have been spilled.

U Fill equipment from water sources before introducing pesticides into mixing or application equipment.

U Replace pour caps and close bags or other containers immediately after use.

U Avoid leaving a spray or mix tank unattended while it is being filled.

U Provide an air gap between the water source and the mixture surface to prevent backsiphoning.

- **Avoid filling pesticide mixing or application equipment directly** from a public water supply unless the outlet from the public water supply is equipped with a backflow prevention device.

- **Avoid filling pesticide mixing or application equipment directly** from surface water unless the equipment contains proper and functioning anti-backsiphoning mechanisms.

- **Triple rinse all empty plastic and metal pesticide containers** and add the rinse water to the spray solution.

Pre-Application Activities

- **Ensure that pesticide applicators are properly licensed** in the appropriate category by the Minnesota Department of Agriculture when a license is required. See *Resource Directory*.

- **Protect vegetation** that is part of a cultural resource (such as historic homestead sites) if it will be impacted by herbicide applications.

- **Mark the boundaries of the area** for treatment.

- **Refer to label directions** before applying a pesticide.

Timing and Weather Considerations

- **Avoid applying insecticides during the spring bloom** when pollinators are most active. If there is a choice, spray earlier or later.

- **Avoid applying pesticides when the likelihood of significant drift exists.**

- **Use a drift control agent** where appropriate.

U Consider applying pesticides near dawn or dusk, when wind speeds are generally lowest.

U Apply pesticides when wind speeds are 6 mph or less for aerial application and 10 mph or less for ground broadcast application.

U Limit broadcast applications (both aerial and ground) to appropriate temperature and relative humidity conditions. High temperatures enhance loss of volatile pesticides and the rate of evaporation of droplets. Relative humidity also influences the rate of evaporation, with the rate increasing with decreases in humidity.

Applying Pesticides

U Check all application equipment carefully, particularly for leaking hoses and connections and plugged or worn nozzles.

U Calibrate spray equipment periodically to achieve uniform pesticide distribution and rate.

U Select a nozzle type that produces the largest drops at a given rate and pressure appropriate to the chemical being applied.

U Employ the lowest reasonable equipment pressure when applying pesticides.

U Mix pesticides in upland areas, where practical.

U Apply pesticides in accordance **with** the product label.

U Avoid applying pesticides on small wetland inclusions in upland areas unless that application is part of the management objective. If unable to avoid pesticide use in these areas, select only pesticides labeled for aquatic use when surface water is present at the time of application.

U Avoid broadcast application methods within filter strips and riparian management zones (RMZs). Appropriate treatments within filter strips and RMZs include:

- Use of pesticides labeled for aquatic use
- Manual or mechanical treatments
- No treatment
- Spot, banded, stump, basal bark, hack and squirt, frill or injection treatments
- Use of less soil-mobile pesticides
- Increasing filter strip width when using toxic to highly toxic insecticides

Additional Consideration

K Consider maintaining the diversity of mast sources on the site, as well as some level of current production of mast sources. For example, leave shoulders of roads or plantation spot failures untreated, or maintain landings as openings.

Protecting Water Resources

U Avoid applying pesticides directly to water except where specifically labeled for application to water. For pesticides not labeled for aquatic or ditchbank use, avoid riparian management zones, filter strips or shade strips and other reserve areas adjacent to all streams, lakes, wetlands and ditches that contain water at the time of application.

U Prohibit aircraft that are transporting pesticides from crossing open water where practical. Aircraft also should not fly down the course of any recognizable stream. Where stream crossings cannot be avoided, they should be made at right angles to the stream course. Chemical application should be shut off during turns and over water.

U **Select potential heliport or helipad locations** with consideration for two conditions that could affect water quality: 1) flight patterns in relation to water bodies; and 2) locations adjacent to water bodies.

POST-OPERATIONAL ACTIVITIES

IMPORTANT! Review General Guidelines:

- Post-Operational Activities and Followup Visits

Equipment Cleanup

U **Avoid cleaning pesticide application equipment** in surface waters.

U **Clean equipment** in areas where pesticide residues will not enter streams, lakes, wetlands or ground water.

U **Clean all mixing and loading equipment thoroughly** after each use.

U **Rinse mixing apparatus** at least three times.

U **Apply rinsate in spray form** to the area to be treated.

U **Avoid discharge of rinse water in wetland areas** that are not part of the application site.

Container and Waste Disposal

U Dispose of pesticide wastes and containers according to state and federal laws. Some pesticide wastes are specifically identified as hazardous wastes by law; these must be handled and disposed of in accordance with hazardous waste regulations. For sources of information about proper management of waste pesticides, see *Resource Directory*.

U Rinse all empty plastic and metal pesticide containers three times, and add the rinse water to the spray solution. To properly triple-rinse containers:

1. Empty the pesticide into the spray tank and allow the pesticide container to drain.

2. Fill the container 10% to 20% full with water (or solvent, in some cases), rinse, and pour the rinse water into the spray tank.

3. Repeat Step 2 two more times and apply rinsate to the spray site.

4. Apply all leftover solutions and rinsates to the treatment area.

U Puncture and flatten containers not intended for return to the manufacturer.

U Dispose of triple-rinsed containers in one of two ways:

- By recycling through an approved program. A list of dealers or locations who recycle these containers is available at county University of Minnesota Extension offices.

- As ordinary solid waste at a landfill licensed by the Minnesota Pollution Control Agency.

U Refer to the product label for additional information on proper disposal.

Reforestation

CONTENTS

FIGURE

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 sustainability of our forest resources.

INTRODUCTION

Reforestation includes the process of planting (or otherwise regenerating) and establishing a desired forest community on a given site. An important part of reforestation is the selection of an appropriate tree species or forest community to manage.

Common reforestation techniques include both natural and artificial methods:

- **Natural regeneration methods** include root suckering, stump sprouting or natural seeding.
- **Artificial regeneration methods** include aerial and ground seeding, machine planting and hand planting.

Artificial regeneration methods include aerial and ground seeding, machine planting and hand planting. *Photo courtesy of Minnesota DNR*

The Benefits of Guidelines

Benefits to cultural resources: Reforestation guidelines can minimize damage to cultural resources resulting from reforestation of cut-over sites. Guidelines can protect archaeological sites from erosion, compaction and rutting, which can destabilize historic buildings, structures and historic areas.

Benefits to forest soils: Reforestation guidelines can help minimize exposure of mineral soil, compaction or rutting of soil, removal of surface soil, increased erosion, or impacting the nutrient balance of the site.

Benefits to riparian areas: Reforestation guidelines can minimize alteration 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 also have a positive impact on aesthetics, wood products and recreation. Reforestation guidelines provide flexibility to exceed mineral soil exposure recommendations within the filter strip guidelines, if needed, to successfully regenerate certain desired species.

Benefits to visual quality: Reforestation guidelines help address the potential negative visual impacts of artificial regeneration by promoting natural-appearing stands.

Benefits to water quality and wetlands: Reforestation guidelines provide opportunities to reduce the potential for increased erosion and subsequent sedimentation of water bodies and wetlands due to reforestation activities that protect mineral soil from exposure. Guidelines that address equipment operations and maintenance can help protect water quality and wetlands.

Benefits to wildlife habitat: Reforestation guidelines encourage approaches to regeneration of cut-over sites that result in tree species diversity, appropriate species selection for a particular site, and maintenance of habitat structure.

Considerations

❒ **Increasing planting complexity** may increase planting costs.

❒ **Management methods associated with natural-appearing stands** (such as mixed-species planting and randomized spacing) can have increased long-term costs.

❒ **Leaving residual trees** can require increased disease-control measures, especially when residuals and regeneration are the same species.

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

Other guidelines that apply: In addition to specific reforestation guidelines and related general guidelines provided below, refer to the following forest management activity sections for additional guidelines appropriate to reforestation activities.

For activities involving:	Refer to these guidelines:
Building, maintaining, relocating or closing roads	Forest Road Construction and Maintenance
Use of heavy equipment	Mechanical Site Preparation
Pesticide use	Pesticide Use

Species Selection

U **Select suitable tree species** to regenerate. Consider such factors as:

- Site capabilities
- Existing natural regeneration
- Historical vegetation
- Variation in growth rates and seed production
- Mixing of deciduous and coniferous species
- Sunlight requirements

U **Choose seed or seedlings from a locally adapted source.**

U **Use pre- and post-harvest techniques that will increase success of oak regeneration where appropriate,** including burning, stump sprout thinning or scarification.

Reducing Visual Impacts Due to Species Selection During Reforestation

*In areas classified as most sensitive:**

- Promote a mixture of species, both naturally occurring and planted.
- Encourage and maintain diversity within the stand.
- Favor long-lived species where appropriate to minimize frequency of management activities.

*In areas classified as moderately sensitive:**

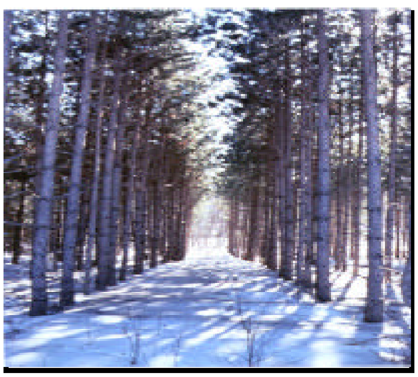
- Use species appropriate for site.
- Promote a mixture of species, both naturally occurring and planted.

*In areas classified as less sensitive:**

- Choose species consistent with integrated resource management principles.

*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.

Promoting a mixture of species encourages and maintains diversity, which also provides wildlife habitat diversity and the positive visual impact of a natural-appearing landscape. *Photo courtesy of Superior National Forest*



Promote natural-appearing stands by avoiding planting rows perpendicular to travel routes, which can result in a negative visual impact. *Photo courtesy of Minnesota DNR*

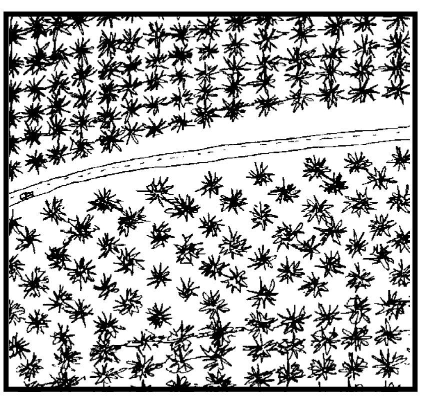


Figure REF-1: To avoid the perception of unnatural straight rows (as shown above the travel route), plant irregular or offset rows for the first few rows along a travel route (as shown below the travel route) to discourage visual penetration and increase the perception of a natural stand.

Reducing Visual Impacts Due to Planting Layout and Design

*In areas classified as most sensitive:**

U Do not plant rows perpendicular to travel routes or recreation areas.

U Plant irregular or offset rows to encourage natural-appearing stands. See Figure REF-1.

U Use wider initial spacing to minimize number of re-entries to the site and to encourage establishment of other species.

*In areas classified as moderately sensitive:**

U Avoid rows perpendicular to travel routes or recreation areas.

U Use wider spacing along sensitive boundaries.

*In areas classified as less sensitive:**

U Choose species and plantation design consistent with integrated resource management principles.

*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.

OPERATIONAL ACTIVITIES

IMPORTANT! Review General Guidelines:

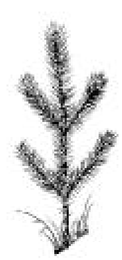
- Protecting Cultural Resources
- Managing Equipment, Fuel and Lubricants
- Protecting the Normal Flow of Streams and Wetlands
- Protecting Wetland Inclusions and Seasonal Ponds
- Retaining Leave Trees
- Providing Coarse Woody Debris

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

Additional Considerations

K **Consider reintroducing** yellow birch, white pine, red oak, black walnut, and/or white cedar to mesic hardwood sites where they once existed.

K **Consider scarifying the soil** in the vicinity of conifer seed trees to enhance regeneration of these species.



Timber Stand Improvement

CONTENTS

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 sustainability of our forest resources.

INTRODUCTION

Timber stand improvement (TSI) includes activities or treatments that improve the composition, structure, condition, health and growth of even-age or uneven-age stands.

Such activities may include mechanical or chemical treatment of vegetation that competes with desirable trees; removing diseased or dying trees; thinning; pruning; and post-harvest treatments on natural regenerating stands.

These practices are intended to do three things:

- ❒ Increase the value of the stand
- ❒ Improve the growth and form of crop trees
- ❒ Manipulate stand composition

Row thinning is an example of a timber stand improvement activity that increases the value of the stand, improves the growth and form of crop trees, and manipulates stand composition. *Photo courtesy of Minnesota DNR*

The Benefits of Guidelines

Benefits to cultural resources: TSI guidelines can minimize the direct or indirect effects of timber stand improvement activities (such as mixing of surface soils, rutting, compaction and erosion) on certain kinds of cultural resources. Guidelines particularly address the use of heavy equipment, which can be of most concern to protection of cultural resources.

Benefits to forest soils: TSI guidelines can help minimize the effect of equipment trafficking on soils, thus reducing soil compaction, rutting and erosion. Reducing these potential impacts eases root penetration, availability of water, ease of water absorption by plants, available amounts of oxygen and other gases in the soil, and the degree to which water moves laterally and vertically through the soil.

Benefits to riparian areas: TSI guidelines address TSI activities that can alter the 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: TSI guidelines can minimize visual impacts of some TSI activities that result in alterations to the stand or the accumulation of debris.

Benefits to water quality and wetlands: TSI guidelines address the potential for increased erosion and subsequent sedimentation of water bodies and wetlands as a result of TSI activities exposing mineral soil. Guidelines that address equipment operations and maintenance can help protect water quality and wetlands.

Benefits to wildlife habitat: TSI guidelines can help avoid reductions in overall species diversity on a site while maintaining or enhancing structural diversity.

Considerations

❐ Timing of TSI activities should take into account disease and insect cycles that may be enhanced by the presence of slash.

❐ Restricted operating hours (to regulate noise near recreation areas) may affect the cost of TSI activities.

❐ Additional slash disposal requirements (to control disease or to enhance visual quality) may affect the cost of TSI activities.

❐ TSI (including removal of brush and small suppressed trees) can allow people to see into the stand.

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

In addition to specific TSI guidelines and related general guidelines provided below, refer to the following forest management activity sections for additional guidelines appropriate to TSI.

For TSI activities involving:	Refer to these guidelines:
Felling trees	Timber Harvesting
Application of pesticides	Pesticide Use
Trafficking sites with heavy equipment	Mechanical Site Preparation and Timber Harvesting
Road building or access development	Forest Road Construction and Maintenance

OPERATIONAL ACTIVITIES

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

❑ **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, contract specifications and site conditions.

❑ **Allow for a diversity of species and ages** when implementing TSI activities.

u **Avoid cultural resources** when mechanically strip thinning with heavy equipment.

u **Leave standing a minimum of 6 cavity trees**, potential cavity trees, and/or snags per acre during TSI operations. These trees and snags should be distributed throughout the site as much as possible. For preferred characteristics, see *General Guidelines: Retaining Leave Trees.*

u **Rehabilitate landings and skid trails** where necessary to mitigate soil compaction and reduce erosion.

Additional Considerations

K **Consider retaining some stems of non-commercial species** (such as ironwood and bluebeech) in TSI operations to maintain natural diversity and/or mast production on site.

K **Consider creating snags during commercial thinning of even-age, low-diversity stands** (such as old-field pine plantations). Girdling, topping or herbicide injection may be used to kill selected trees and create snags where none exist. Physical injury will induce fungal decay to create a potential cavity tree. (These techniques, if applied to pines in summer, will increase risk of bark beetle infestation to adjacent healthy pines.)

K **Consider maintaining the diversity of mast sources on the site**, as well as some level of current production of mast sources. For example, avoid operations in pockets of fruit-producing shrubs.

Reducing Visual Impacts of Timber Stand Improvement

*In areas classified as most sensitive:**

- **Time TSI operations** so that they will not occur during periods of peak recreational use.
- **Treat slash and debris from TSI operations** (by lopping, removing, crushing or burning) whenever possible. Keep slash height below 2 feet. See *Timber Harvesting: Managing Slash*.
- **Reduce noise** in early morning, late evening and other appropriate times whenever possible near residences, businesses and outdoor activity areas.
- **Inform and educate recreational users** regarding the concept and benefits of TSI prior to, during and after TSI activities.

*In areas classified as moderately sensitive:**

- **Avoid TSI operations during periods of peak recreational use** whenever possible.
- **Inform and educate recreational users** regarding the concept and benefits of TSI prior to, during and after TSI activities.
- **Treat slash and debris** as per guidelines *in Timber Harvesting: Managing Slash*.

*In areas classified as less sensitive:**

- **Use methods and applications** consistent with integrated resource management objectives for the area.

*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.

Fire Management

CONTENTS

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INTRODUCTION

The term fire management includes both prescribed burning and fire suppression:

- **Prescribed burning** is the intentional application of fire to wildland fuels (in either their natural or modified state) under specified environmental conditions.

- **Wildfire suppression** is the effort to control, contain or extinguish wildfires in order to protect life, property and resources.

The Benefits of Guidelines

Benefits to cultural resources: Fire management guidelines can help protect surface features of archaeological sites, cemeteries, historic buildings and structures from the adverse effects of fire. Guidelines for construction of fire breaks and movement of heavy equipment can minimize direct or indirect disruption of soils, rutting, compaction and erosion that can damage cultural resources.

Benefits to forest soils: Fire management guidelines address concerns related to those soils in Minnesota that are particularly sensitive to the effects of fire—especially intensive slash burns where fuels are close to the ground. Fire management guidelines can help minimize the potential for these slash burns to reduce soil productivity.

Benefits to riparian areas: Fire management guidelines can minimize alteration 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; maintaining 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 water quality and wetlands: Fire management guidelines address concerns related to the exposure of mineral soil from the burning of organic matter and from fuelbreak construction, the release of plant nutrients following burning, and increased post-burn surface temperatures, which can increase nonpoint source pollution. Guidelines that address equipment operations and maintenance can help protect water quality and wetlands. Properly applied guidelines also help ensure maximum benefits of fire to wetland ecosystems.

Benefits to wildlife habitat: Fire management guidelines address the potential for both wildfires and prescribed burns to eliminate important structural habitat components on a site, such as snags and coarse woody debris. Guidelines can minimize the potential adverse effects of fire on unprotected sensitive sites, unique habitats and rare species.

Considerations

❒ **Safety and the protection of life and property** are the priority in fire management.

❒ **Other fire management considerations should include** protection of cultural resources, forest soils, riparian areas, water quality and wetlands, and wildlife habitat.

❒ **Making fire management personnel aware** of cultural resources, through training and advance planning, can help protect cultural resources.

❒ **Slash burning, where fuels are close to the ground,** can in some cases reduce soil productivity by consuming the forest floor and superheating the surface of some soils (particularly dry sandy soils). This results in reduced water-holding capacity, volatilization of some nutrients, and allowing other nutrients to become rapidly available for plant uptake, runoff or leaching.

❒ **Because pulp and paper industries cannot accept charred wood,** merchantability may be negatively affected by burning in standing timber.

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

Burn Plan Development

U Consult with local DNR offices for technical advice and assistance in prescribed burning. See *Resource Directory*.

U Obtain a DNR permit prior to burning as required under Minn. Statute, Chapter 88.17. See *Resource Directory*.

U When planning burns in or near wetland areas and seeps, avoid damaging the hydrology on sites during management operations.

U Plan prescribed burns to increase success of oak regeneration where applicable.

U Consult with the Office of the State Archaeologist and the Minnesota Indian Affairs Council if there are burial sites within prescribed burn areas. For sources of information and assistance, see *Resource Directory*.

U Include cultural resource information in both wildfire suppression and prescribed burn plans. Important information includes:

- Locations of known cultural resources

- Locations of high probability areas for the occurrence of cultural resources

- List of professional cultural resource managers and tribal representatives who can be contacted for assistance. For sources of information and assistance, see *Resource Directory*.

U Minimize impacts of fuel break construction by applying one or more of the following guidelines:

- Consider such alternatives as herbicide use, mowing or other non-erosion-causing practices for fuel break maintenance on areas where prescribed fire will be used on a recurring basis.

- Use natural or in-place fuel breaks (such as roads, streams, lakes and wetlands) where appropriate, as an acceptable way to minimize the need for artificial fuel break construction.

- Consider the use of fire retardant in place of plowed fuel breaks where fuel break construction would result in unacceptable soil erosion, water quality degradation or damage to cultural resources.

- When artificial fuel breaks must be used, place fuel breaks, fueling and maintenance areas outside of filter strips or the RMZ, whichever is wider, whenever practical. See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

- Locate fuel breaks on the contour whenever possible, and avoid straight uphill-downhill placement.

The goal of this prescribed burn is to underburn pine for regeneration. *Photo courtesy of Minnesota DNR*

U **When conducting prescribed burns,** use low- or moderate-burning intensity so that the minimum amount of forest floor is consumed consistent with meeting the objectives of the burn, especially for dry sandy soils or shallow soils over bedrock.

U **Avoid placement of piles for burning** within filter strips or drainage channels adjacent to streams, lakes and wetlands.

Additional Consideration

K **Consider maintaining the diversity** of mast sources on the site, as well as some level of current production of mast sources. For example, establish fuel breaks around key pockets of mast-producing shrubs along the edges of prescribed burn sites.

OPERATIONAL ACTIVITIES

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 contractor, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, contract specifications and site conditions.

Pre-Ignition Activities

U **Delineate cultural resource areas** and carefully consider the effects of prescribed burns on them.

U **Pre-position fire-fighting personnel** and equipment at cultural resources that are susceptible to damage by fire.

U **If cultural resources cannot be avoided** within prescribed burn areas:

- Treat above-ground features with fire retardant.
- Protect below-ground archaeological sites from compaction and rutting.

U **Protect the largest coarse woody debris** from prescribed burning.

U **Control the pattern and timing of burn ignition** by evaluating existing or developing conditions on the ground.

Managing Fuel Breaks and Accesses

- **Construct fuel breaks** outside of cultural resource areas. Use cultural resource professionals or tribal representatives to help determine fuel break location. For sources of information and assistance, see *Resource Directory*.

- **Construct fuel breaks only deep enough and wide enough** to control the spread of the fire.

- **Avoid construction of fuel breaks** for fire management that result in drainage directly into a water body.

- **Provide adequate filter strips** when constructing fuel breaks that expose bare soil near wetlands.

- **Use fuel break construction methods in wetlands** that do not expose bare soil whenever practical. These may include wet lines, existing constructed or natural barriers, foam or retardants. If techniques result in exposure of bare soil, such areas must be restored if wetland hydrologic functions are impacted.

- **Maintain erosion control measures** as needed on fuel breaks. For sources of seeding and fertilizing recommendations, see *Resource Directory*. Refer also to water bar construction and spacing specifications in *Forest Road Construction and Maintenance: Drainage*.

- **Employ suitable water diversion structures** on fuel breaks, 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.

- **Monitor the effectiveness** of cultural resource management practices during prescribed burns and wildfire suppression activities.

- **Control access** to sensitive cultural resources.

Protecting Water Quality and Wetlands

U Establish unburned zones containing no fuel breaks to protect water quality in situations where steep slopes, highly erodible soils, or the likelihood of substantial organic matter removal are present. See *General Guidelines: Maintaining Filter Strips* and *General Guidelines: Managing Riparian Areas.*

U When working with foam or retardants near lakes, streams or wetlands:

- Follow manufacturer recommendations.
- Prevent or minimize runoff of fire-retardant chemicals into water by keeping filter strip areas off-limits to retardant use.
- Avoid cleaning fire-retardant application equipment in lakes or streams.

POST-OPERATIONAL ACTIVITIES

IMPORTANT! Review General Guidelines:

- Post-Operational Activities and Followup Visits

U Stabilize erodible soils through such techniques as seeding, mulching and water bars. For sources of seeding and fertilizing recommendations, see *Resource Directory.* Refer also to recommended water bar construction and spacing specifications in *Forest Road Construction and Maintenance: Drainage.*

U Assess the condition of cultural resources that may have been affected by prescribed burning or wildfire suppression activities.

U **Field inspect the burned area** to identify cultural resources that may not have been previously identified but have been newly exposed by the fire.

U **Remove temporary fire management features** that are inappropriate to the historic character of adjacent cultural resources.

U **Restore water source sites** used for fire management activities as soon as practical following control, or at the completion of mop-up activities.

Forest Recreation Management

CONTENTS

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 sustainability of our forest resources.

The goal of forest recreation management is to select, develop, operate and maintain forest recreation areas to provide quality outdoor experiences for the recreational user. *Photo courtesy of Minnesota DNR*

INTRODUCTION

The goal of forest recreation management is to select, develop, operate and maintain forest recreation areas to provide quality outdoor experiences for the recreational user.

The Benefits of Guidelines

Benefits to cultural resources: Recreation management guidelines address the fact that campgrounds, boat landings and other recreational facilities tend to be located in areas that have high sensitivity for cultural resources. Guidelines can help assure that construction and operation of such facilities do not adversely affect cultural resources through soil disturbance, rutting, compaction and erosion. Guidelines also address issues of public use that may increase the potential for deliberate vandalism or inadvertent disturbance of sensitive sites.

Benefits to riparian areas: Recreation management guidelines address the fact that development of trails, campsites or other recreational facilities can alter the 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; maintaining 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 water quality and wetlands: Recreation management guidelines help assure that development of trails, campsites or other recreational facilities do not disturb sensitive sites or water features, thus reducing sedimentation to water bodies and wetlands. Guidelines that address equipment operations and maintenance can help protect water quality and wetlands.

Benefits to wildlife habitat: Recreation management guidelines can minimize the disturbance to sensitive sites, rare species, water features or unique habitats that may occur directly or as a result of development of trails, campsites and other recreational facilities, or indirectly through increased human use of an area that such facilities bring.

Considerations

❒ **Planning for recreational development** should address cultural resource issues in terms of both protection and interpretation. Existing cultural resource inventories should be reviewed early in the planning process. If no information is available, field inspections should be conducted before development plans are finalized to determine presence or absence of cultural resources.

❒ **If cultural resources are present** in the development area, it may be possible to modify construction plans to reduce or eliminate damage to the resources. Cultural resource professionals can help determine the best approaches to mitigation of potential damage. For sources of information and assistance, see *Resource Directory.*

❒ **Recreational developments provide opportunities for education** through interpretation of on-site cultural resources. For sources of information and assistance, see *Resource Directory.*

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.

PLANNING

IMPORTANT! Review General Guidelines:

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

CONSTRUCTION OF RECREATION AREAS

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 contractor, landowner and resource manager prior to moving equipment onto a site. Such meetings can help assure common understanding of landowner objectives, contract specifications and site conditions.

Protecting Cultural Resources

U Select and designate borrow areas and gravel quarries prior to the start of construction to avoid cultural resource locations.

U Select and designate the staging area for equipment prior to the start of construction to avoid cultural resource locations. If avoidance is not feasible or practical:

• Use “fill-only” construction techniques in the area of the cultural resource.

• Construct temporary crossings over the cultural resource (including slash, tire mats, or fill over geotextile).

U Do not allow surfaces in archaeologically sensitive areas to erode, slump or wash out. Implement temporary stabilization methods to preserve the shape, slope, elevation and contours of archaeological sites and historic features. Stabilization should not alter the historic character of the cultural resource.

U If practical and feasible, avoid cultural resource areas when constructing recreational facilities.

U If it is not possible to completely avoid a cultural resource, minimize or eliminate soil disturbance and erosion in the vicinity of the resource by:

- Minimizing cut sections and following existing contours to the extent possible
- Avoiding unnecessary disturbance to the ground surface
- Considering data recovery if it is not possible to avoid impacting the resource

For sources of information and assistance, see *Resource Directory*.

Archaeologists excavate a site in advance of development of a new recreational facility. *Photo courtesy of State Parks Cultural Resource Program*

Protecting Water Quality and Soil Productivity

U Install and maintain appropriate erosion control structures to protect water quality and soil productivity. See also appropriate erosion and water control guidelines in *Forest Road Construction and Maintenance: Alignment and Location* and *Drainage.*

PUBLIC USE CONSIDERATIONS

Recreational Traffic

U In areas that will receive a lot of traffic (pedestrian or vehicular), periodically inspect the facility to determine whether the cultural resource is being damaged by public use of the area. If so, special protective measures may be desirable.

U When operating within the riparian management zone, confine recreational off-highway vehicle use and other non-foot traffic to trails that are designed, constructed and maintained using guidelines for skid trails and forest roads. Refer also to appropriate guidelines in *Timber Harvesting: Skidding and Skid Trails* and *Forest Road Construction and Maintenance.*

Public Education Opportunities

U Retain flagging, signs or other markings on cultural resource areas in cases where they might be appropriate long-term protection

RESOURCE DIRECTORY

Contents

RESOURCE DIRECTORY

The Resource Directory provides additional information and identifies resources to contact for assistance with many different forest management activities.

Directory organization: The directory is organized by topic, with a brief description of assistance available from various agencies and organizations. When telephone numbers are not provided, consult the government pages of local telephone directories for the numbers of local agencies and departments listed.

Begin with local sources of assistance: Contact local information sources first. In many instances, they can provide appropriate site-specific help based on firsthand knowledge of the area in question. If additional help is needed, these local sources will recommend appropriate regional or state resources.

A Guide to Acronyms

The following acronyms are used in the Resource Directory:

BWSR:	Minnesota Board of Water and Soil Resources
COE:	U.S. Army Corps of Engineers
DNR:	Minnesota Department of Natural Resources
Extension:	University of Minnesota Extension Service
FSA:	Farm Service Agency
LGU:	Local government unit
MDA:	Minnesota Department of Agriculture
MGS:	Minnesota Geological Survey
MNDOT:	Minnesota Department of Transportation
MPCA:	Minnesota Pollution Control Agency
NRCS:	Natural Resources Conservation Service
SWCD:	Soil and Water Conservation District
USDA:	U.S. Department of Agriculture
USFS:	U.S. Forest Service
USF&WS:	U.S. Fish and Wildlife Service
USGS:	U.S. Geological Survey

General Resource Management Information via the Web

The following Web sites provide general resource management information, as well as links to other Web sites with more specific information:

Minnesota Department of Natural Resources:
http://www.dnr.state.mn.us

Minnesota Pollution Control Agency:
http://www.pca.state.mn.us

Natural Resource Management and Stewardship: Information and Educational Materials

Contact the appropriate Extension office linked to the University of Minnesota's College of Natural Resources:

Extension Forest Resources (St. Paul)
(612) 624-3020
e-mail: extfor@forestry.umn.edu
Web: http://www.cnr.umn.edu/FR/extension

Extension Wildlife (St. Paul)
(612) 624-3298
Web: http://www.fw.umn.edu/Extension/extension.html

Cloquet Forestry Center
(218) 879-0850

Itasca County Extension Office (Grand Rapids)
(218) 327-7366
e-mail: itasca@extension.umn.edu

Contact area colleges or universities:

Central Lakes College (Brainerd)
Natural Resources Program
(218) 855-8079 or (800) 933-0346

Itasca Community College
(218) 327-4200
e-mail: iccinfo@it.cc.mn.us
Web: www.it.cc.mn.us

Vermillion Community College
(218) 365-7248
Web: www.lcd.mnscu.edu/vcc

University of Minnesota-Crookston
Natural Resources Department
(218) 281-8129

Additional sources of information:

Minnesota Forestry Association (Grand Rapids)
(218) 326-3000 or (800) 821-TREE
e-mail: tweber@northernnet.com

DNR Information Center (St. Paul)
Metro Area: (651) 296-6157
Greater Minnesota: (888) MINN-DNR (646-6367)
TDD for the hearing impaired: (651) 296-5484
or (800) 657-3929

University of Minnesota Extension Service Distribution Center
(612) 624-4900 or (800) 876-8636
e-mail: order@extension.umn.edu
Web: www.extension.umn.edu/DC/ordering.html

Developing Forest Management Plans

The primary sources of assistance available for developing forest management plans are the DNR Division of Forestry, consulting foresters, industrial foresters and some local SWCD offices, as well as environmental and conservation organizations, the USFS and the USF&WS. The DNR Division of Forestry cooperates with other plan preparers to assure that landowners receive appropriate assistance.

Because types of services, scope of assistance and fee structures (if any) vary, be sure to have a clear idea of the type of assistance desired before making initial contacts.

Minnesota's Forest Stewardship Program provides voluntary long-range planning for individual landowners through the development of Forest Stewardship Plans. An overview of the Forest Stewardship Program is available at the following Web site: http://willow.ncfes.umn.edu/woodstew/wdstew.htm (*Do not precede with www.)*

The program also provides additional technical assistance to landowners implementing plans, including assistance with state and federal cost-share programs. (See *Implementing Plans: Cost-Share Programs*, page 9.)

DNR Division of Forestry: The DNR provides forest management planning assistance through its Private Forest Management Program. For assistance, contact local DNR Division of Forestry offices (see government listings in local telephone directories), or contact the DNR Private Forest Management Program at (651) 296-5970.

Consulting foresters: For a current listing of consulting foresters, check the Yellow Pages, contact local DNR Division of Forestry offices, or contact Extension offices (see page 7) for a copy of *Technical Assistance for Private Woodland Owners in Minnesota.*

Forest product companies with Private Forest Management Programs: For a current listing of companies offering Private Forest Management Programs, contact Extension offices (see page 7) for a copy of *Technical Assistance for Private Woodland Owners in Minnesota.*

Local SWCD offices: For a current listing of SWCD offices with Stewardship Plan preparers who provide forestry assistance, contact Extension offices below for a copy of *Technical Assistance for Private Woodland Owners in Minnesota*, or call local SWCD offices to determine whether they provide this service (see government listings in local telephone directories).

Technical Assistance for Private Woodland Owners in Minnesota

Technical Assistance for Private Woodland Owners in Minnesota is a directory that includes information on choosing a consultant, as well as a key to available services.

The directory also includes a detailed listing of private consultants, forest product companies with Private Forest Management Programs, SWCDs providing forestry assistance, and non-governmental organizations providing forestry assistance.

This directory is available at no charge from the following Extension offices:

Extension Forest Resources (St. Paul)
(612) 624-7222
e-mail: extfor@forestry.umn.edu
Web: www.cnr.umn.edu/FR/extension

Cloquet Forestry Center
(218) 879-0850

Itasca County Extension Office (Grand Rapids)
(218) 327-7366
e-mail: itasca@extension.umn.edu

Sources of Planning Tools

Soil surveys, soil interpretations and erosion control

Contact local SWCD offices or local NRCS offices (see government listings in local telephone directories).

Aerial photographs

DNR Division of Forestry
Resource Assessment Unit
Grand Rapids, MN
(218) 327-4449

USGS EROS Data Center
Sioux Falls, SD
(605) 594-6151
Web: http://edcwww.cr.usgs.gov/eros-home.html

Current aerial photos for much of Minnesota are also available for viewing and downloading from ForNet at www.ra.dnr.state.mn.us/

Topographic maps

Local retailers: Topographic maps are available in a number of retail locations throughout the state, including:

Local sporting goods stores, outfitters, bookstores and engineering supply stores. (Check the Yellow Pages under "Maps.")

The Map Store in Minneapolis at (612) 339-4117
or in St. Paul at (651) 227-6277

Local libraries: Check with local libraries for availability of maps.

Geological Survey:

MGS: (612) 627-4782
USGS: (800) USA-MAPS

Web: http://mapping.usgs.gov

National Wetland Inventory (NWI) maps

Available for viewing:
Local SWCD offices (see government listings in local telephone directories)

Available for purchase:
Minnesota's Bookstore (St. Paul)
(651) 297-3000 or (800) 657-3757

Implementing Plans: Cost-Share Programs

Landowners wishing to install conservation practices may receive cost-share assistance through a variety of local, state and federal programs. Many of these programs are available to help private landowners plant trees and shrubs. Most programs require an approved Forest Stewardship Plan.

Program requirements, emphasis, funding and availability may vary with time and location. Contact local foresters, local FSA offices, or local SWCD offices for current information.

Environmental Quality Improvement Program (EQIP): Provides approximately 75% reimbursement of establishment costs for plantings greater than one acre. Contact local FSA, NRCS or DNR Division of Forestry offices (see government listings in local telephone directories).

Forestry Incentives Program (FIP): Provides approximately 50% reimbursement of establishment costs for tree plantings greater than 10 acres. Timber management is the main goal. An approved Forest Stewardship Plan is required. Contact a plan preparer, or local NRCS or DNR Division of Forestry offices (see government listings in local telephone directories).

Minnesota Forestry Association-LCMR Program (MFA-LCMR): Provides both technical and cost-sharing assistance to non-industrial private forest landowners. Funds are available for management activities that enhance fish and wildlife habitat, provide recreation opportunities, improve the aesthetic quality of forests, or increase the supply of timber and other forest products. The program is designed to enhance and increase the diversity of forest land benefits. An approved Forest Stewardship Plan is required. Contact a plan preparer or local DNR Division of Forestry offices (see government listings in local telephone directories).

Conservation Reserve Program (CRP): Provides 50% of establishment costs and 10 to 15 years of annual payments as an incentive to retire highly erosive cropland. A special focus called Conservation Reserve Enhancement Program (CREP) exists in the Minnesota River Valley. Contact local FSA, NRCS or DNR Division of Forestry offices (see government listings in local telephone directories).

Reinvest in Minnesota (RIM): Similar to CRP, except that RIM is targeted to areas that will benefit wildlife. Provides 75% of actual cost for long-term easements and 100% of actual cost for perpetual easements. Contact local SWCD, DNR Division of Forestry or DNR Wildlife offices (see government listings in local telephone directories).

Stewardship Incentives Program (SIP): Provides up to 50% cost-share assistance to non-industrial private forest landowners for management activities that enhance fish and wildlife habitat, provide recreation opportunities, improve the aesthetic quality of forests, or increase the supply of timber and other forest products. The program is designed to enhance and increase the diversity of forest land benefits. An approved Forest Stewardship Plan is required. Contact a plan preparer or local DNR Division of Forestry offices (see government listings in local telephone directories).

Wetland Establishment and Restoration Program (WERP): Provides payments for conservation easements and cost-share assistance for wetland restoration and protection. Landowners are reimbursed up to 75% of actual cost for perpetual easements. Contact local FSA, NRCS or USF&WS offices (see government listings in local telephone directories).

State Cost-Share Program: Assists landowners in the installation of permanent non-production-oriented soil and water conservation practices. Cooperators are eligible to receive up to 75% cost-sharing of specified erosion control and water quality practices. Contact local SWCD offices (see government listings in local telephone directories) or BWSR at (651) 296-3767.

American Tree Farm System

The American Tree Farm System provides recognition and certification for quality forest management of non-industrial private forest lands. The program is sponsored by the American Forest Foundation. More information is available from Stewardship Plan preparers, or contact local DNR Division of Forestry offices (see government listings in local telephone directories), consulting foresters or forest product companies with Private Forest Management Programs.

Implementing Plans: Sources of Forester and Logger Assistance with Timber Sales and Road Design

Unless a landowner has expertise and experience with conducting timber sales or designing roads, it is advisable to seek assistance from both professional foresters and professional loggers.

Because types of services, scope of assistance and fee structures vary, be sure to have a clear idea of the type of assistance desired before making initial contacts.

Sources of forester assistance: For a current listing of sources of forester assistance, contact Extension offices (see page 7) for a copy of *Technical Assistance for Private Woodland Owners in Minnesota*, or call Minnesota Forest Industries at (218) 722-5013.

Sources of logger assistance: For sources of logger assistance, contact the following organizations:

Minnesota Logger Education Program
(218) 722-5442
e-mail: mlep@cp.duluth.mn.us

Minnesota Timber Producers Association
(218) 722-5013

Associated Contract Loggers
(218) 753-2532
e-mail: loggers@rangenet.com

Cultural Resource Inventories

Inventories of recorded cultural resources in Minnesota are maintained in several places.

The most comprehensive statewide database is administered jointly by the Office of the State Archaeologist and the State Historic Preservation Office. Contact either agency by phone and request information about cultural resources in a specific area. For individual parcels of land, expect to receive a response within a few days. For information about a large land area (such as an entire county) or a number of separate parcels of land (such as corporate holdings), it is advisable to make special arrangements to obtain the data:

Office of the State Archaeologist
Fort Snelling History Center
St. Paul, MN 55111
(612) 725-2411

State Historic Preservation Office
Minnesota History Center
345 Kellogg Blvd. West
St. Paul, MN 55102
(651) 296-5434

Separate inventories of cultural resources are also maintained by federal agencies, some reservations and some state agency divisions. For detailed descriptions of coverage area, content and restrictions on distribution for these inventories, see *Appendix B: Cultural Resource Inventory Sources in Minnesota.*

Identifying, Assessing and Managing Cultural Resources

The following agencies can provide assistance in identifying, assessing and managing cultural resources:

Office of the State Archaeologist
Fort Snelling History Center
St. Paul, MN 55111
(612) 725-2411

State Historic Preservation Office
Minnesota History Center
345 Kellogg Blvd. West
St. Paul, MN 55102
(651) 296-5434

Minnesota Indian Affairs Council
1819 Bemidji Avenue
Bemidji, MN 56601
(218) 755-3825

It may be advisable in some cases to obtain the services of a consultant. For a list of firms that do cultural resource management work in Minnesota, contact the State Historic Preservation Office at (651) 296-5434.

For questions about treatment of an unplatted cemetery, or for assistance in verifying the presence of a cemetery on a particular property, contact the Office of the State Archaeologist at (612) 725-2411.

When working within the boundaries of a reservation or within ceded lands (see *Appendix E*), consider consulting with tribal cultural resource specialists during project planning. For current information on whom to contact, call the Minnesota Indian Affairs Council at (218) 755-3825.

Documenting Cultural Resources

Landowners, loggers and resource managers are encouraged to document cultural resources discovered during field operations. For assistance, contact the Office of the State Archaeologist at (612) 725-2411. The most important information to record is:

- ❐ Where is the cultural resource located (township, range, section and quarter-section)?
- ❐ What kind of resource is it? (Describe observed features such as cellar depressions, grave markers, surface artifacts and other features.)
- ❐ If possible, include a sketch map showing the location of the resource relative to roads, lakes, streams and property lines.

Petroleum Spills

Notification of petroleum spills: Contact the Minnesota Duty Officer for petroleum spills of 5 gallons or more. Phones are answered 24 hours a day:

Metro Area	(651) 649-5451
Greater Minnesota	(800) 422-0798

The Minnesota Duty Officer will contact appropriate state agencies.

Nonpoint Source Pollution

MPCA Division of Water Quality regional offices:

Brainerd	(218) 828-2492
Detroit Lakes	(218) 847-1519
Duluth	(218) 723-4660
Marshall	(507) 537-7146
Rochester	(507) 285-7343

MPCA Division of Water Quality (St. Paul)
(651) 296-6300 or (800) 657-3864
TDD for the hearing impaired: (651) 282-5332 or (800) 627-3864

Wetland Protection

Contact LGUs, local SWCD offices (see government listings in local telephone directories) or BWSR offices. A listing of LGUs is available from BWSR and SWCD offices.

Contact BWSR in St. Paul at (651) 296-3767, or contact BWSR regional offices:

Metro	(651) 282-9969
Duluth	(218) 723-4752
Bemidji	(218) 755-4235
Brainerd	(218) 828-2383
New Ulm	(507) 359-6074
Rochester	(507) 285-7458
Marshall	(507) 537-6060

Contact COE at one of the following three offices:

Brainerd	(218) 829-8402
Two Harbors	(218) 834-6630
St. Paul	(651) 290-5366

Fish and Wildlife Habitat

Both the DNR and the USF&WS can provide information on practices to maintain or improve fish and wildlife habitat. DNR offices can also provide current listings of designated trout streams (and their designated tributaries) and designated trout lakes.

DNR: Contact local DNR Fisheries or DNR Wildlife offices (see government listings in local telephone directories), or contact a regional DNR Fisheries or Wildlife office:

	Fisheries offices	**Wildlife offices**
Bemidji	(218) 755-3959	(218) 755-3958
Grand Rapids	(218) 327-4414	(218) 327-4413
Brainerd	(218) 828-2624	(218) 828-2615
New Ulm	(507) 359-6000	(507) 359-6000
Rochester	(888) MINN-DNR	(888) MINN-DNR
Metro	(651) 772-7950	(651) 772-7942

Or contact the DNR Division of Fisheries and Wildlife (St. Paul) at the following numbers:

Fisheries Section	(651) 296-3325
Wildlife Section	(651) 296-1325

Minnesota Web site:
http://www.dnr.state.mn.us/fish_and_wildlife/

USF&WS:

USF&WS Private Lands Office for Minnesota (St. Cloud)
(320) 253-4682

Agassiz National Wildlife Refuge (Thief River Falls)
(218) 449-4115

Tamarac National Wildlife Refuge (Rochert)
(218) 847-2641

Rice Lake National Wildlife Refuge (McGregor)
(218) 768-2402

Endangered, Threatened or Special Concern Species

Endangered, threatened or special concern species in Minnesota

DNR Natural Heritage and Nongame Research Program
Ecological Services
(651) 297-2276 (general)
(651) 296-8324 (regarding a particular parcel of land)
Web: http://www.dnr.state.mn.us/fish_and_wildlife/natural_heritage.html

Federal Endangered Species Act, federally listed species or the endangered species listing process

USF&WS
Office of Endangered Species
(612) 725-3548, ext. 205

Minnesota Web site:
http://www.dnr.state.mn.us/fish_and_wildlife/endangered_species/index.html

Federal Web site:
http://www.fws.gov/r9endspp/endspp.html

Visual Sensitivity Classification Information

Aitkin County
Aitkin County Land Department (Aitkin) (218) 927-7364
Aitkin DNR Forestry Office (218) 927-4040
Hill City DNR Forestry Office (218) 697-2476

Becker County
Becker County Land Department (Detroit Lakes) (218) 846-7307
Detroit Lakes DNR Forestry Office (218) 847-1596

Beltrami County
Beltrami County Natural Resources Management (Bemidji)
(218) 759-4163
Bemidji DNR Forestry Office (218) 755-2890
Blackduck DNR Forestry Office (218) 835-6684

Carlton County
Carlton County Land Department (Carlton) (218) 384-9179
Cloquet DNR Forestry Office (218) 879-0880
Moose Lake DNR Forestry Office (218) 485-5400

Cass County
Cass County Land Department (Backus) (218) 947-3338
Backus DNR Forestry Office (218) 947-3232
Pequot Lakes DNR Forestry Office (218) 568-4566
Brainerd DNR Forestry Office (218) 828-2565
Deer River DNR Forestry Office (218) 246-8343

Clearwater County
Clearwater County Land and Forestry Department (Bagley)
(218) 694-6227
Bagley DNR Forestry Office (218) 694-2146

Cook County
Cook County Land Department (Grand Marais) (218) 387-3000, ext. 152
Grand Marais DNR Forestry Office (218) 387-3037

Crow Wing County
Crow Wing County Land Commissioner's Office (Brainerd)
(218) 828-3963
Brainerd DNR Forestry Office (218) 828-2565
Pequot Lakes DNR Forestry Office (218) 568-4566

Hubbard County
Hubbard County Land Department (Park Rapids) (218) 732-4270
Park Rapids DNR Forestry Office (218) 732-3309
Bemidji DNR Forestry Office (218) 755-2890

Itasca County
Itasca County Land Department (Grand Rapids) (218) 327-2855
Deer River DNR Forestry Office (218) 246-8343
Effie DNR Forestry Office (218) 743-3694
Hibbing DNR Forestry Office (218) 262-6760

Koochiching County
Koochiching County Land and Forestry Department (International Falls) (218) 283-6295
Littlefork DNR Forestry Office (218) 278-6651
Effie DNR Forestry Office (218) 743-3694
Hibbing DNR Forestry Office (218) 262-6760
Orr DNR Forestry Office (218) 757-3274
Baudette DNR Forestry Office (218) 634-2172

Lake County
Lake County Forestry Department (Two Harbors) (218) 834-8340
Two Harbors DNR Forestry Office (218) 834-6600

Lake of the Woods County
Baudette DNR Forestry Office (218) 634-2172

Mille Lacs County
St. Cloud DNR Forestry Office (320) 255-4279

Pine County
Pine County Land Department (Sandstone) (320) 245-2819
Hinckley DNR Forestry Office (320) 384-6146
Moose Lake DNR Forestry Office (218) 485-5400

St. Louis County
St. Louis County Land Department (Duluth) (218) 726-2606
- Duluth Area Office (218) 729-8480
- Virginia Area Office (218) 749-7132
- Cook Field Office (218) 666-2079
- Ely Field Office (218) 365-3106

Cloquet DNR Forestry Office (218) 879-0880
Hibbing DNR Forestry Office (218) 262-6760
Tower DNR Forestry Office (218)753-4500
Orr DNR Forestry Office (218) 757-3274

Water Crossings

Design standards; installation of bridges and culverts: Contact local SWCD or NRCS offices, county highway departments or local road authorities, or local MNDOT offices (see government listings in local telephone directories).

Permit requirements: Permits are required for work in waters and wetlands designated by the DNR in the Protected Waters and Wetlands Inventory. For permit requirements, contact DNR Division of Waters local offices (see government listings in local telephone directories) or DNR regional offices. In some instances, further review is required by the COE or local ditch authority.

Regional DNR Division of Waters offices:

Bemidji	(218) 755-3973
Grand Rapids	(218) 327-4416
Brainerd	(218) 828-2605
New Ulm	(507) 359-6053
Rochester	(507) 285-7430
Metro	(651) 772-7910

Integrated Pest Management

Contact DNR regional forest health specialists:

Bemidji	(218) 755-2891
Grand Rapids	(218) 327-4115
Brainerd	(218) 327-4234
Rochester	(507) 285-7431
Metro	(651) 772-7927

Contact USFS:

State and Private Forestry
Forest Health Protection
(651) 649-5262

Pesticide Use

Proper pesticide use; recommendations on rates and applicability of various pesticides: Contact MDA at (651) 296-6121.

Proper use of specific pesticide products: Contact pesticide company representatives.

Regulation of forestry-applied pesticides in Minnesota: Contact MDA at (651) 296-6121.

Pesticide use as it pertains to endangered and threatened species in Minnesota: Contact the Endangered Species Protection Program, MDA Agronomy Services Division, at (651) 297-7269.

Applicator training and licensing for state certification: Contact MDA at (651) 297-2746.

Licensing of certified applicators: Contact MDA at (651) 296-6121.

Pesticide certification workshops: Contact Minnesota Pesticide Information and Education at (612) 447-1187 or MDA at (651) 297-2746.

Disposal of waste pesticides: Contact the MDA Waste Pesticide Collection Program at (651) 297-4870 or (800) 657-3986. Web: http://www.mda.state.mn.us

List of dealers who recycle pesticide containers: Contact MDA at (651) 296-6121.

Notification of pesticide spills: Contact the Minnesota Duty Officer whenever a spill occurs. Phones are answered 24 hours a day:

Metro Area	(651) 649-5451
Greater Minnesota	(800) 422-0798

The Minnesota Duty Officer will contact the appropriate state agencies.

Fertilizing and Seeding

Fertilizer and seed mixture recommendations for exposed soil: Contact local SWCD, NRCS or DNR offices (see government listings in local telephone directories).

Prescribed Burning

Obtaining a burning permit: Contact local DNR Division of Forestry offices, state fire wardens, USFS district offices and fire wardens, LGUs or other designated county authorities (see government listings in local telephone directories).

Establishing goals and conducting prescribed burns: Contact local DNR or USFS offices (see government listings in local telephone directories).

GLOSSARY

Adsorption: The inherent ability of a pesticide to bind to surfaces of soil particles. The greater the potential for a pesticide to adsorb to soil particles, the less the potential for the pesticide to move in solution.

Alignment: The horizontal route or direction of an access road. It is made up of straight line tangent sections and curves.

All-season road: A permanent road 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 for this type of road, depending on anticipated traffic load.

Archaeology: The field of science that studies past human culture through the examination of remaining material evidence.

Archaeological site: A geographic location where archaeological artifacts, features and other materials are found.

Artifact: An object manufactured, modified or used by humans.

Bankfull elevation: The height of the streambank at which the stream cannot hold any more water without it beginning to spill out onto the floodplain.

Barriers: Obstructions to pedestrian, horse or vehicular traffic intended to restrict traffic.

Basal area: The cross-sectional area of a live tree at 4.5 feet above ground. Basal area may be measured in square feet per tree or square feet per acre.

Berm: A low earth fill constructed in the path of flowing water to divert its direction, or constructed to act as a counter-weight beside the road fill to reduce the risk of foundation failure.

Biodiversity: The variety and abundance of species, their genetic composition, and the communities and landscapes in which they occur, including the ecological structures, functions and processes occurring at all of these levels.

Borrow pit: That area from which soil is removed to build up the road bed, sometimes directly adjacent and parallel to a road.

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

Burial mound: An earthwork constructed to cover or enclose one or more human burials. In Minnesota, construction of burial mounds was a common cultural practice between about 2500 and 800 years ago.

Cache pit: A cultural feature, usually excavated into the ground, that was used to store foodstuffs or other items. Cache pits are often found in areas where resources such as maple sap and wild rice have been gathered.

Cavity tree: A hollow tree used by wildlife for roosting and reproduction by wildlife.

Ceded lands: Public lands within original reservation boundaries on which American Indian treaty rights can be exercised. See *Appendix E: Ceded Lands and Reservation Boundaries.*

Cemetery: Any location at which there are one or more human interments. All cemeteries in Minnesota are protected by law, without regard to age, ethnic affiliation or current land ownership.

Certificate of exemption: A document from a local government unit describing activities exempt from provisions of the Minnesota Wetland Conservation Act.

Coarse woody debris: Stumps and fallen trunks or limbs of more than 6-inch diameter at the large end.

Connectivity: The degree of linkage among similar habitat patches across a landscape.

Corduroy: Logs placed over a wetland to reinforce the natural root mat for the purpose of stabilizing the road foundation.

Crown: The part of a tree bearing live branches and foliage.

Crown closure: The degree to which the forest floor is shaded by tree crowns when the sun is immediately overhead. Complete crown closure occurs when the crowns of trees touch and effectively block sunlight from reaching the forest floor.

Cull logs: Logs that do not meet merchantability standards.

Cultural resource: An archaeological site, cemetery, historic structure, historic area or traditional use area that is of cultural or scientific value.

Cultural resource management: The range of activities aimed at understanding, preserving and providing for the enjoyment of cultural resources. It includes research related to cultural resources, planning for actions affecting them, and stewardship of them.

Cultural resource management professional: An individual trained in the principles and methods of cultural resource management. The Secretary of the Interior's Professional Qualifications Standards outline recommended levels of education and experience for CRM professionals in archaeology, history and other disciplines. See *Appendix D: Qualifications Standards for Cultural Resource Professionals*.

Cultural resource potential: The likelihood that a given location contains one or more cultural resources.

Culture: A system of beliefs, values, customs, traditions and other features that are shared by a group of people.

Culvert: A metal, wooden, plastic or concrete conduit through which water can flow.

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

Data recovery: The process of collecting data about a cultural resource, in order to preserve the scientific, historical or cultural information that makes the resource significant. For archaeological sites, data recovery usually involves formal excavation.

DBH (diameter at breast height): The diameter, including bark, of a standing tree at breast height (measured at 4.5 feet above ground on the uphill side of the tree).

Dip: An economical, relatively trouble-free structure for providing effective drainage of forest roads. Dips are considerably lower in cost than culverts, so time spent in careful construction is well justified.

Disking: A mechanical method of scarifying the soil to reduce competing vegetation and prepare a site to be seeded or planted. See *scarification.*

Ditch: An open channel to conduct water.

Drainage structure: Any device or land form constructed to intercept or aid surface water drainage.

Drift: The movement of pesticides through the air to non-target areas, either as solid or liquid particles, or as vapor.

Earthwork: A cultural feature constructed by excavating or piling soil in a deliberate manner. Burial mounds, cache pits and building berms are examples of earthworks.

Ecological classification system: An approach to categorizing and delineating, at different levels of resolution, areas of land and water having similar characteristic combinations of the physical environment (such as climate, geomorphic processes, geology, soil and hydrologic function) and biological communities (plants, animals, microorganisms and potential natural communities).

Ecoregion: A land area characterized by similar geology, climate, topography, plant communities, soil types and other factors. Minnesota has nine ecoregions.

Endangered species: A species threatened with extinction throughout all or a significant portion of its range.

Erosion: The process by which soil particles are detached and transported by water, wind and gravity and deposited downslope or downstream.

ETS species: Endangered, threatened and special concern species *(see individual definitions).*

Evaluation (of cultural resources): The process of determining which cultural resources are important. Cultural resource management professionals often use the National Register of Historic Places criteria for evaluating significance because of their flexibility and broad application. See *Appendix C: National Register Criteria for Evaluation of Cultural Resources.*

Even-age management: A planned sequence of treatments designed to maintain and regenerate a stand with one or two age classes. The range of tree ages is usually less than 20% of the rotation.

Extended rotation: Substantially increasing the rotation age of a forest stand beyond the current optimum economic rotation age. Forest stands where extended rotation is applied are called extended rotation forests (ERFs).

Feature (archaeological): Any non-portable archaeological evidence. Examples include cellar depressions, building berms, foundations or trash heaps.

Felling: The process of severing trees from stumps.

Fill: Any solid material added to or redeposited in a wetland that would alter its cross-section, obstruct flow patterns, change wetland boundaries, or convert the wetland to a non-wetland.

Filter strip: An area of land adjacent to a water body that acts to trap and filter out suspended sediment and chemicals attached to sediment before it reaches the surface water. Harvesting and other forest management activities are permitted in a filter strip as long as the integrity of the filter strip is maintained and mineral soil exposure is kept to a minimum.

Fire retardant: Any substance that reduces the flammability of combustibles by chemical or physical action.

Floodplain: The area adjacent to a watercourse or water basin that has been or may be covered by a regional flood.

Ford: A place where a perennial or intermittent stream may be crossed by a vehicle. It may be necessary to reinforce the stream crossing to bear intended traffic.

Forest community: All organisms within and dependent on a forest ecosystem for all or part of their needs.

Forest ecosystem: A community of plants, animals and microorganisms, and the physical environment they inhabit, in which trees are the dominant life form.

Forest floor: All dead vegetation on the mineral soil surface in the forest, including leaf litter and unincorporated humus.

Forest management: The multiple-use management of forest resources for sustained yields of wood, water, forage, wildlife and recreation. Multiple use includes timber management, watershed management, range management, wildlife management, fisheries management and recreation management.

Forest road: A temporary or permanent road connecting the most remote parts of the forest to existing public roads. Forest roads provide access to forest lands for timber management, fish and wildlife habitat improvement, fire control and a variety of recreational activities.

Formulation: The pesticide product as purchased, usually consisting of a mixture of active and inert ingredients.

Fuel break: A natural or constructed barrier used to stop the spread of fire by removing fuel or rendering fuel inflammable by use of water or fire retardants. Examples include constructed firelines, wetlines and water barriers.

Functions: The physical, chemical and biological processes in a forest, including photosynthesis, decomposition and nutrient cycling.

Gabion: A woven wire basket filled with stones of minimum size that will not pass through the openings in the basket. Individual baskets are laid in place like building blocks, and then filled to form retaining walls and erosion-resistant surfaces.

Geotextile: A product used as a soil reinforcement agent and as a filter medium. Geotextile is made of synthetic fibers manufactured in a woven or loose non-woven manner.

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

Ground water: The subsurface water supply in the saturated zone below the level of the water table.

Habitat: The sum total of environmental factors (including food, water and cover) that a species needs to survive and/or reproduce in a given area.

Half-life: The time it takes for a pesticide in soil to be degraded so that its concentration decreases by one-half.

Hard mast: Nuts and seeds, typically produced by overstory mature trees (such as oaks and hickories); conifer seeds are also included.

Harvesting (timber harvesting): The felling, skidding, processing, loading and transporting of forest products.

High bank forest: An area immediately adjacent to a stream or lake where the depth to the water table is more than 10 feet, soil moisture ranges from moist to dry, the hillside bank rises steeply above the water, and the water body cuts into the hillside bank, which results in its eroding. Roots from trees growing on the terrace above the water do not reach the water table and therefore do not provide much bank stability. Depending on the site and ecological history, dominant tree species are aspen, birch, jack pine, red pine, balm o'Gilead, red oak, bur oak, white oak, maple/basswood, balsam fir, ash/elm/cottonwood, red maple or white spruce.

Highly erodible soil: Soil on slopes greater than 35% that is considered to be in the severe category for potential erosion.

High water mark: The highest level at which water has remained long enough to leave its mark upon the landscape. Generally, it is the point where the natural vegetation changes from predominantly terrestrial to aquatic.

Historic area: An area in which there are features (structures, archaeological sites, or a combination of the two) that reflect historic uses. Examples include roads and trails, formal plantings, parks and building complexes.

Historic building: Any complex construction created and used by people to shelter their social, cultural and economic activities. Common types of historic buildings in forested areas include houses, barns, sawmills, churches, hotels and schools. See also *historic structure.*

Historic structure: A functional construction built for a purpose other than providing shelter. Examples include fire towers, rail grades, bridges, dams, silos, kilns and canals. See also *historic building.*

Impact: A loss in quantity, quality or biological diversity.

Inclusion: A small patch or stand of vegetation situated within a larger patch or stand. Inclusions are distinguishable on aerial photographs or in the field as distinct patches, but are typically too small or insignificant to be practically mapped or managed independently of the surrounding stand. See also *stand.*

Infiltration: The process by which water passes through the soil surface.

Infrastructure: The network of access roads, approaches, trails and landings used to move equipment onto and around a forest management site.

Integrated pest management (IPM): Selection, integration and use of management actions based on scientific knowledge of forest systems, including insects and pathogens, in order to achieve desirable economic, ecological and sociological forest management goals.

Intermittent streams: Streams with well-defined channels, banks and beds that flow only certain times of the year, when they receive water from springs or runoff. During dry years, these streams may cease to flow entirely or may be reduced to a series of separate pools.

Label: The information printed on or attached to the pesticide container or wrapper.

Landing: A place where trees and logs are gathered in or near the forest for further processing or transport.

Leaching: Downward movement of a pesticide or other soluble material through the soil as a result of water movement.

Lead-off ditch: A ditch to remove water from a road or skid trail to a vegetated area.

Leave log: All or part of a felled live tree that is deliberately left on a site to provide fresh coarse woody debris. See *coarse woody debris.*

Leave trees: Live trees selected to remain on the site to provide present and future benefits, including shelter, resting sites, cavities, perches, nest sites, foraging sites, mast and coarse woody debris.

Leave tree strip: An area of land of variable width adjacent to a water body where trees are retained to provide resources benefits.

Legacy patch: An area within a managed site that protects soil organic matter and the organisms associated with it, and that will aid in recolonization of the adjacent managed area.

Local government unit: A city council, town board, county board of commissioners or watershed management organization.

Mast: Nuts, seeds, catkins, flower buds and fruits of woody plants that provide food for wildlife.

Material Safety Data Sheet (MSDS): The basic hazard communications tool that provides details on chemical and physical dangers, safety procedures and emergency responses for a particular chemical.

Midden: In archaeology, a pile or scatter of debris created as a byproduct of some human activity. Middens often mark old homestead and logging camp locations.

Minnesota Indian Affairs Council (MIAC): An organization created by statute to serve as a liaison between the State of Minnesota and the 11 tribal governments within the state. MIAC administers a program designed to protect cultural resources related to American Indian heritage and culture, and it shares authority for treatment of Indian cemeteries with the Office of the State Archaeologist.

Mulching: Using organic residues (such as grass, straw or wood fibers) or commercially available alternatives as a covering for exposed forest soil. This mulch covering protects exposed soil, helps control erosion and facilitates revegetation.

Mycorrhiza (pl. mycorrhizae): A mutually beneficial association of fungi and roots of plants.

National Register of Historic Places: A nationwide program which recognizes sites, structures, objects, buildings and districts that are significant in national, regional, state or local history, architecture or archaeology.

Natural community: A group of native plants and animals that interact with each other and their environment in ways not greatly altered by modern human activity.

Nonpoint source pollution: Diffuse pollution that enters a water body from over the landscape. Nonpoint source pollution reaches streams, lakes, wetlands and ground water through leaching, surface runoff and erosion.

Nutrient cycling: The process by which nutrient elements move into, out of, and within an ecosystem.

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

Obligate species: A species able to survive in only one environment. An osprey is a riparian obligate species, because it requires an environment that includes suitable nesting trees near water bodies containing fish.

Obliterate: To unbuild, decommission, deactivate or dismantle a road; to deny use, eliminate travelway functionality, and remove the road from the forest development road system; to return the road corridor to resource production by natural or designed means.

Old forest: A forest community distinguished by old trees and related structural features characteristic of later stages of stand and successional development.

Open water wetland: Shallow to deep open water generally having readily observable surface water. Water depth varies from a few inches to less than 10 feet. According to the USF&WS wetland classification system, it includes Type 3 (shallow marsh), Type 4 (deep marsh) and Type 5 (shallow open water) wetlands (Shaw and Fredine 1956).

Office of the State Archaeologist (OSA): A state office that enforces provisions of law related to private cemeteries and archaeological sites. The office also maintains inventories of recorded archaeological sites and cemeteries in Minnesota.

Overstory: That portion of the trees in a forest of more than one story, forming the upper or uppermost canopy.

Patch: Unit of land with relatively similar biological and/or physical characteristics.

Peat: Unconsolidated material consisting of organic matter accumulated under conditions of excessive moisture.

Perennial streams: Streams with well-defined channels, banks and beds that exhibit essentially continuous flow. These streams flow year round, but surface water may not be visible during extreme drought.

Permanent road: A forest road intended to be left in place for the long term.

Persistence: The time it takes for a pesticide in soil to degrade to the point where it is no longer active.

Pesticide: A chemical compound or biological agent used for the control of undesirable plants, animals, insects or diseases.

Potential cavity tree: A tree at least 6 inches in diameter showing signs of physical injury or decay and susceptible to excavation by birds.

Prescribed burning: The controlled application of fire to wildland fuels in either their natural or modified state, under specified environmental conditions. These conditions allow the fire to be confined to a predetermined area, while at the same time producing the fire intensity and rate of spread required to attain planned resource management objectives.

Presettlement wetlands: Wetlands that existed in Minnesota prior to and at the time of European settlement.

Primary skid trail: An arterial route used by skidders or forwarders to haul trees and logs to the landing. Primary skid trails are heavily traveled routes which are fed by a system of secondary skid trails of less frequent travel. Primary skid trails are typically traversed 10 or more times by heavy equipment.

Puddles: Depressions in the soil surface where water pools during wet periods. A puddle will not have a noticeable difference in forest litter compared to the surrounding area.

Raking: A mechanical method of removing stumps, roots and slash from a future planting site.

Reserve area: A portion of the management area set aside for a special purpose or use or to protect specific resources.

Residuals: Trees selected to remain on the site to provide present and future benefits.

Rhizome: A rootlike, usually horizontal stem growing under or along the ground, sending out roots from its lower surface and leaves or shoots from its upper surface.

Riparian area: The area of land and water forming a transition from aquatic to terrestrial ecosystems along streams, lakes and open water wetlands.

Riparian management zone (RMZ): That portion of the riparian area where site conditions and landowner objectives are used to determine management activities that address riparian resource needs. It is the area where riparian guidelines apply.

Riprap: A layer of boulders or rock fragments placed over soil to protect it from the erosive forces of flowing water.

Rotation age: The number of years between the formation or regeneration of an individual tree, crop or stand and its final cutting or demise.

Runoff: In forest areas, that portion of precipitation that flows across a drainage area on the land surface and in open channels.

Ruts: Depressions made by the tires of such vehicles as skidders, log trucks and pickup trucks, usually under wet conditions.

Rutting: The creation of depressions made by the tires of such vehicles as skidders, log trucks and pickup trucks, usually under wet conditions.

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

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

Seasonal ponds: Sometimes called *vernal pools,* seasonal ponds are depressions in the soil surface where water pools during wet periods of the year, typically in spring (vernal) and fall (autumnal). A pond will have an identifiable edge caused by annual flooding and local topography. The edge is best identified during the spring or fall, but it may be identified during dry periods by the lack of forest litter in the depression. Such depressions typically are fishless and retain water for longer periods than puddles. (*Note:* The leaf litter is replenished annually but is consumed during inundated periods and noticeably depleted thereafter. Deciduous litter will likely be consumed faster and more thoroughly than conifer litter.)

Secondary skid trail: A skidding route used to haul felled trees or logs from the back portions of a site to the secondary skid trails. Secondary skid trails branch out from a primary skid trail and are less heavily traveled. Secondary skid trails are traversed from 3 to 10 times by heavy equipment.

Sedge/grass/shrub forest: An area adjacent to a stream, lake or open water wetland that is covered by grasslike sedges or shrubs and where soils are wet. The depth to the water table in these areas averages less than 6 inches. Depending on the site and ecological history, dominant plant species are alders, willows, sedges, grasses or mosses.

Seeps and seepage wetlands: Small wetlands (often less than an acre or two) that generally occur where ground water comes to the surface. Soils at these sites remain saturated for some portion or all of the growing season and often stay wet throughout the winter.

Sediment: Solid material in suspension, being transported, or moved from its original location by air, water, gravity or ice.

Sensitive communities: Those communities that are sensitive to disturbance, including some kinds of forest management activities. Minimizing levels of disturbance is often critical to their well-being. Sensitivity may be linked to human activity, disruption of water flowage, alteration of stand structure or composition, or some other factor. Sensitive communities include certain native plant communities (sometimes referred to as natural communities), such as seepage swamps and calcareous fens.

Sensitive sites: Those sites that are sensitive to disturbance, including some kinds of forest management activities. Minimizing levels of disturbance is often critical to their well-being. Sensitivity may be linked to human activity, disruption of water flowage, alteration of stand structure or composition, or some other factor. Some examples of sensitive sites include colonial waterbird tree-nesting sites and overwintering cover for rattlesnakes.

Shade tolerance: The capacity of a plant to grow under low light conditions, typically caused by canopy shading.

Shearing: The operation of cutting off trees and brush at ground level by pushing a bulldozer blade along the frozen surface in winter.

State Historic Preservation Office (SHPO): A branch of the Minnesota Historical Society that administers the National Register program for Minnesota, maintains cultural resource inventories, and conducts project reviews required under federal law.

Silt curtain: Filter fabric weighted at the bottom and attached to a flotation device at the top. A silt curtain is used to isolate an active construction area within a lake or wetland and prevent silt-laden water from migrating out of the construction zone.

Silt fence: A temporary barrier made of geotextile and installed to prevent the off-site movement of silt material.

Silviculture: The scientific management of forest trees.

Site: An area evaluated as to its capacity to produce a particular forest or other vegetation based on the combination of biological, climatic and soil factors present.

Site preparation: The practice of altering site conditions to favor the establishment, survival and growth of a desired tree species.

Skid trail: A temporary pathway over forest soil to haul forest products to a landing.

Skidding: The act of moving trees from the site of felling to a loading area or landing.

Slash: All residual woody material created by logging or timber stand improvement.

Slope: Degree of deviation of a surface from the horizontal, measured as a numerical ratio, as a percentage or in degrees.

Snag: A standing dead tree.

Soft mast: Fruits, berries, catkins and flower buds produced by a wide variety of early successional species (such as raspberries). In later forest successional stages, soft mast is produced by shade-tolerant understory shrubs.

Soil compaction: The increase in soil density resulting from loads applied to the soil surface.

Soil productivity: The capacity of soil, in its normal environment, to support plant growth.

Solubility: The ability of a pesticide to dissolve in water or other solvents. The greater the solubility in water, the greater the chance that the pesticide will leach to ground water or move in solution to surface water.

Special concern species: A species that, although not endangered or threatened, is extremely uncommon in Minnesota or has unique or highly specific habitat requirements. Special concern species may include 1) species on the periphery of their range in Minnesota, but not listed as threatened or endangered; and 2) species that were once threatened or endangered but now have increasing, protected or stable populations.

Stand: A community of trees possessing sufficient uniformity in composition, age, arrangement or condition.

Stream: Watercourse with a definable bank, including intermittent streams with or without water (even if dry). Stream width is estimated at the bankfull elevation at the narrowest portion of a straight channel segment within the management area.

Super canopy tree: Usually a mature or overmature tree, whose crown is at least 25% taller than the majority of the dominant/ codominant trees in the stand. (*Dominant tree:* A tree whose crown extends above the general level of the main canopy of even-age stands or, in uneven-age stands, above the crowns of the tree's immediate neighbors and receiving full sunlight from above and partial light from the sides. *Codominant tree:* A tree whose crown helps to form the general level of the main canopy in even-age stands or, in uneven-age stands, the main canopy of the tree's immediate neighbors, receiving full sunlight from above and comparatively little from the sides.)

Surface soil horizons: The uppermost part of the soil (typically 3-4 inches) dominated by organic matter accumulation and including the organic "O" horizon and the mineral "A" horizon.

Sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainable forest management: Development, protection and use of forest resources for achievement of economic and social well-being without damaging the forest resource base or compromising the ability of future generations to meet their own needs.

Swamp forest: An area adjacent to a stream, lake or open water wetland where the depth to the water table is between 6 and 18 inches and the soils are wet. Depending on the site and ecological history, dominant tree species are black spruce, tamarack, northern white cedar or black ash.

Temporary road: Generally a minimum-standard road designed for short-term use during a specific project, such as a timber harvest. Use of temporary roads is typically limited to dry or frozen conditions to minimize rutting and compaction.

Threatened species: A species likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

Timber harvesting: The felling, skidding, processing, loading and transporting of forest products, roundwood or logs.

Timber stand improvement: Forest management practices intended to either improve growth and form of intended crop trees or manipulate stand composition.

Toxicity: A measure of the capacity of a pesticide to cause injury.

Traditional use area: A location which has been historically used by one or more groups of people for some type of activity, very often related to the vegetation of the area. Examples include sugar bushes, wild rice beds, and locations where people carry out religious and social activities or gather resources for craftwork or medicinal purposes.

Trout lakes: Those lakes which are designated through rule-making. The lakes designated by rule are specified by legal description (township, range and section).

Trout streams: Those streams and their associated tributaries which are designated through rule-making. The portions of the streams designated by rule are specified by legal description (township, range and section).

Turnout: A widened space in a road that allows vehicles to pass one another and slopes away (downhill) from the road.

Understory: Any plants growing under the canopy formed by others; particularly, herbaceous and shrub vegetation under a brush-wood or tree canopy.

Uneven-age management: A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. All age classes could be represented.

Upland forest: An area adjacent to a stream, lake or open water wetland where the depth to the water table is at least 1.5 feet and soil moisture ranges from moist to dry. Depending on the site and ecological history, dominant tree species are aspen, birch, jack pine, red pine, balm o'Gilead, red oak, bur oak, white oak, maple/basswood, balsam fir, ash/elm/cottonwood, red maple or white spruce.

Values: The characteristics of the forest that are beneficial to society, including protection of functions, public recreation and commercial uses.

Vernal pools: See *seasonal pond*s.

Vertical structure: The diversity of above-ground vegetative layers in the vertical profile of a stand.

Visual quality: A subjective measure of the impact that viewing an object, landscape or activity has on a person's perception of attractiveness.

Volatilization: Conversion of a solid or liquid to a gas.

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

Watercourse: Any channel having a definable bed and banks capable of conducting generally confined runoff from adjacent lands. During floods, water may leave the confining beds and banks, but, under low and normal flows, water is confined within the channel. A watercourse may be perennial or intermittent.

Water quality: The chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water table: The upper surface of the ground water, generally referred to in terms of linear depth below the soil surface.

Watershed: The surrounding land area that drains into a lake, river or river system.

Wetland inclusion: Wetland basin within an upland site.

Wetlands: Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or where the land is covered by shallow water. Wetlands must have the following three attributes:

1) A predominance of hydric soils (soils that result from wet conditions)

2) Inundation or saturation by surface water or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation (plants adapted to wet conditions)

3) Under normal circumstances, a prevalence of hydrophytic vegetation

Wildfire: Uncontrolled fire occurring in forest land, brushland and grassland.

Wildlife: All forms of life that are wild, including plants, animals and microorganisms.

Windfirm: The ability of a tree to withstand strong winds and resist windthrow (blowdown) and major breakage.

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

Windthrow: A tree or trees uprooted by the wind. Also known as blowdown timber.

APPENDICES

A: How the Guidelines Were Developed

B: Summary of Cultural Resource Inventory Sources in Minnesota

C: National Register Criteria for Evaluation of Cultural Resources

D: Qualifications Standards for Cultural Resource Professionals

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F: Determining Basal Area

G: Baseline Standards for Development of BMPs To Provide Wetland Protection

H: Work Activities That Do Not Require a DNR Protected Waters Permit

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Appendix A: How the Guidelines Were Developed

Establishing Technical Teams To Develop Guidelines

To develop guidelines as required by the Sustainable Forest Resources Act (SRFA), the Minnesota Forest Resources Council (MFRC) appointed four technical teams for the following topics: riparian management, site-level forest wildlife habitat, forest soil productivity, and cultural resources.

Two additional topics—visual quality, and water quality and wetlands—had already been addressed in previously published guidebooks.

Team members exhibited the following qualifications:

❒ A basic, if not technical, understanding of the topics to be addressed by the team

❒ A willingness to devote the time and energy required to contribute in a constructive manner to the team

❒ A commitment to develop the guidelines in the timeframe established by the MFRC

❒ A willingness to use a consensus-based process

The technical teams reflected the breadth of interests represented on the MFRC and included representatives from state and federal agencies, county land departments, colleges and universities, forest industry, American Indian tribes, logging interests, recreation interests, conservation groups, landowner groups, private consultants, utility companies and environmental organizations.

Developing Technical Guidelines

The guideline development process focused on three areas:

- ❒ Identification of issues
- ❒ Development of options to mitigate issues
- ❒ Recommendation of a range of practical and sound practices based on the best available scientific information

While the 1994 Generic Environmental Impact Statement Study on Timber Harvesting and Forest Management in Minnesota (GEIS) (Jaakko Pöyry 1994) served as the foundation document for identification of issues and guideline development, the technical teams were not limited to the issues and mitigations identified in the GEIS.

After identifying the scope of the guidelines to be developed for each of the four technical teams, the teams developed proposed guidelines for their assigned topics. This scoping and guideline development process took nearly two years to complete.

The proposed guidelines were submitted for review and evaluation by selected outside peers. Guided by this peer review, each technical team finalized its guidelines and submitted them to the MFRC.

Developing Integrated Guidelines and Determining Economic Effects

Upon completion of the technical guidelines, representatives of each technical team came together to form an integration team. The MFRC forwarded the individual technical team products, along with existing best management practices for visual quality, water quality and wetlands, to the integration team. The purpose of this team was to identify linkages between topics, address conflicting recommendations, and develop finalized, fully integrated guidelines.

The final integrated guidelines are organized by groups of practices commonly associated with timber harvesting and other forest management activities.

The MFRC directed a formal analysis of financial costs and economic effects associated with the application of the guidelines. The goal of the analysis was to identify instances where the application of the guidelines would result in adverse financial costs and economic effects, and then to explore opportunities to offset those adverse effects.

For more information, contact:

Minnesota Forest Resources Council
2003 Upper Buford Circle
St. Paul, Minnesota 55108-6146
Phone: (651) 603-0109
Fax: (651) 603-0110
Web: www.frc.state.mn.us

Appendix B: Cultural Resource Inventory Sources in Minnesota[1]

Source/Contact information	Resource types included/ Geographic coverage
Minnesota State Historic Preservation Office Cultural Resource Database State Historic Preservation Office Minnesota History Center 345 Kellogg Blvd. W. St. Paul, MN 55102-1906 Phone: (651) 296-5434 Fax: (651) 282-2374	Archaeological sites, cemeteries, standing structures, traditional cultural properties, cultural landscapes *Geographic coverage*: Statewide
State Archaeological Site File Office of the State Archaeologist Fort Snelling History Center St. Paul, MN 55111-4061 Phone: (612) 725-2411 Fax: (612) 725-2427	Archaeological sites, cemeteries, traditional cultural properties *Geographic coverage:* Statewide
Chippewa National Forest Heritage Sites Database Chippewa National Forest Route 3, Box 244 Cass Lake, MN 56633 Phone: (218) 335-8671 Fax: (218) 335-8637	Archaeological sites, cemeteries, standing structures, traditional cultural properties, cultural landscapes *Geographic coverage:* Chippewa National Forest

Source/Contact information	Resource types included/ Geographic coverage
Superior National Forest Heritage Sites Database Forest Archaeologist Superior National Forest 8901 Grand Ave. Place Duluth, MN 55801-1102 Phone: (218) 626-4320 Fax: (218) 626-4398	Archaeological sites, cemeteries, standing structures, traditional cultural properties, cultural landscapes *Geographic coverage:* Superior National Forest
Leech Lake Tribal Cultural Resource Database Preservation Officer Leech Lake Tribal Government Route 3, Box 100 Cass Lake, MN 56633 Phone: (218) 335-8095	American Indian archaeological sites, cemeteries, traditional cultural properties *Geographic coverage:* Leech Lake Reservation
Mille Lacs Tribal Cultural Resource Database Preservation Officer Mille Lacs Tribal Government HCR 67, Box 194 Onamia, MN 56359 Phone: (320) 532-4181	Archaeological sites, cemeteries, traditional cultural properties *Geographic coverage:* Mille Lacs Tribal Lands (under development)
Minnesota DNR Forestry Heritage Resources Database DNR Forestry Archaeologist Resource Assessment Office 413 SE 13th Street Grand Rapids, MN 55744 Phone: (218) 327-4449 x 243 Fax: (218) 327-4517	Archaeological sites, cemeteries *Geographic coverage:* Non-federal lands statewide

Source/Contact information	Resource types included/ Geographic coverage
Minnesota DNR State Parks Heritage Resources Database	Archaeological sites, cemeteries, structures
DNR Parks Archaeologist Division of Parks & Recreation Dept. of Natural Resources 500 Lafayette Road St. Paul, MN 55102 Phone: (651) 297-1153	*Geographic coverage:* State parks

[1]Note: This list is not exhaustive, but it identifies locations that actively maintain cultural resource databases and have staff available for assistance. Distribution of data may be restricted under state or federal law. Reliability of information varies.

Appendix C: National Register Criteria for Evaluation of Cultural Resources[1]

Criteria for Evaluation

The quality of significance in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:

- ❒ That are associated with events that have made a significant contribution to the broad patterns of our history; or

- ❒ That are associated with the lives of persons significant in our past; or

- ❒ That embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

- ❒ That have yielded, or may be likely to yield, information important in prehistory or history.

Criteria Considerations

Ordinarily cemeteries, birthplaces, or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

❒ A religious property deriving primary significance from architectural or artistic distinction or historical importance; or

❒ A building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

❒ A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his productive life; or

❒ A cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

❒ A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

❒ A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

❒ A property achieving significance within the past 50 years if it is of exceptional importance.

How To Evaluate a Property Within Its Historic Context

Understanding Historic Contexts

To qualify for the National Register, a property must be significant; that is, it must represent a significant part of the history, architecture, archaeology, engineering or culture of an area, and it must have the characteristics that make it a good representative of properties associated with that aspect of the past. This section explains how to evaluate a property within its historic context.

The significance of a historic property can be judged and explained only when it is evaluated within its historic context. Historic contexts are those patterns, themes or trends in history by which a specific occurrence, property or site is understood and its meaning (and ultimately its significance) within prehistory or history is made clear.

Historians, architectural historians, folklorists, archaeologists and anthropologists use different words to describe this phenomenon, such as trend, pattern, theme, or cultural affiliation, but ultimately the concept is the same.

The concept of historic context is not a new one; it has been fundamental to the study of history since the 18th century and, arguably, earlier than that. Its core premise is that resources, properties or happenings in history do not occur in a vacuum but rather are part of larger trends or patterns.

In order to decide whether a property is significant within its historic context, the following five things must be determined:

- ❒ The facet of prehistory or history of the local area, state, or the nation that the property represents;
- ❒ Whether that facet of prehistory or history is significant;
- ❒ Whether it is a type of property that has relevance and importance in illustrating the historic context;
- ❒ How the property illustrates that history; and finally
- ❒ Whether the property possesses the physical features necessary to convey the aspect of prehistory or history with which it is associated.

These five steps are discussed in detail below. If the property being evaluated does represent an important aspect of the area's history or prehistory and possesses the requisite quality of integrity, then it qualifies for the National Register.

Evaluating a Property Within Its Historic Context

Identify what the property represents: the theme(s), geographical limits, and chronological period, that provide a perspective from which to evaluate the property's significance.

Historic contexts are historical patterns that can be identified through consideration of the history of the property and the history of the surrounding area. Historic contexts may have already been defined in your area by the State Historic Preservation Office, federal agencies, or local governments. In accordance with the National Register Criteria, the historic context may relate to one of the following:

- ❒ An event, a series of events or activities, or patterns of an area's development (Criterion A).

- ❒ Association with the life of an important person (Criterion B).

- ❒ A building form, architectural style, engineering technique, or artistic values, based on a stage of physical development, or the use of a material or method of construction that shaped the historic identity of an area (Criterion C).

- ❒ A research topic (Criterion D).

Determine how the theme of the context is significant in the history of the local area, the state or the nation.

A theme is a means of organizing properties into coherent patterns based on elements such as environment, social/ethnic groups, transportation networks, technology, or political developments that have influenced the development of an area during one or more periods of prehistory or history. A theme is considered significant if it can be demonstrated, through scholarly research, to be important in American history.

Many significant themes can be found in the following list of Areas of Significance used by the National Register:

- Agriculture
- Architecture
- Archeology:
  - Prehistoric
  - Historic: Aboriginal
  - Historic: Non-Aboriginal
- Art
- Commerce
- Communications
- Community Planning and Development
- Conservation
- Economics
- Education
- Engineering
- Entertainment/Recreation
- Ethnic Heritage
  - Asian
  - Black
  - European
  - Hispanic
  - Native American
  - Pacific Islander
  - Other
- Explorations/Settlement
- Health/Medicine
- Industry
- Invention
- Landscape Architecture
- Law
- Literature
- Maritime History
- Military
- Performing Arts
- Philosophy
- Politics/Government
- Religion
- Science
- Social History
- Transportation
- Other

Determine what the property type is and whether it is important in illustrating the historic context.

A context may be represented by a variety of important property types. For example, the context of "Civil War Military Activity in Northern Virginia" might be represented by such properties as: a group of mid-19th century fortification structures; an open field where a battle occurred; a knoll from which a general directed troop movements; a sunken transport ship; the residences or public buildings that served as company headquarters; a railroad bridge that served as a focal point for a battle; and earthworks exhibiting particular construction techniques.

Because a historic context for a community can be based on a distinct period of development, it might include numerous property types. For example, the context "Era of Industrialization in Grand Bay, Michigan, 1875–1900" could be represented by important property types as diverse as sawmills, paper mill sites, salt refining plants, flour mills, grain elevators, furniture factories, workers' housing, commercial buildings, social halls, schools, churches and transportation facilities.

A historic context can also be based on a single important type of property. The context "Development of County Government in Georgia, 1777–1861" might be represented solely by court-houses. Similarly, "Bridge Construction in Pittsburgh, 1870–1920" would probably only have one property type.

Determine how the property represents the context through specific historic associations, architectural or engineering values, or information potential (the Criteria for Evaluation).

For example, the context of county government expansion is represented under Criterion A by historic districts or buildings that reflect population growth, development patterns, the role of government in that society, and political events in the history of the state, as well as the impact of county government on the physical development of county seats.

Under Criterion C, the context is represented by properties such as districts or buildings whose architectural treatments reflect their governmental functions, both practically and symbolically.

Determine what physical features the property must possess in order for it to reflect the significance of the historic context. These physical features can be determined after identifying the following:

- ❒ Which types of properties are associated with the historic context,
- ❒ The ways in which properties can represent the theme, and
- ❒ The applicable aspects of integrity.

Properties that have the defined characteristics are eligible for listing.

[1]Excerpted from "How To Apply the National Register Criteria for Evaluation." *National Register Bulletin 15,* U.S. Department of the Interior, National Park Service, Interagency Resources Division, Washington, D.C.

Appendix D: Qualifications Standards for Cultural Resource Professionals[1]

In the following definitions, a year of full-time professional experience need not consist of a continuous year of full-time work but may be made up of discontinuous periods of full-time or part-time work adding up to the equivalent of a year of full-time experience.

(a) History. The minimum professional qualifications in history are a graduate degree in history or closely related field; or a bachelor's degree in history or closely related field plus one of the following:

(1) At least two years of full-time experience in research, writing, teaching, interpretation or other demonstrable professional activity with an academic institution, historical organization or agency, museum or other professional institution; or

(2) Substantial contribution through research and publication to the body of scholarly knowledge in the field of history.

(b) Archaeology. The minimum professional qualifications in archaeology are a graduate degree in archaeology, anthropology, or closely related field plus:

(1) At least one year of full-time professional experience or equivalent specialized training in archeological research, administration or management;

(2) At least four months of supervised field and analytic experience in general North American archaeology; and

(3) Demonstrated ability to carry research to completion.

In addition to these minimum qualifications, a professional in prehistoric archaeology shall have at least one year of full-time professional experience at a supervisory level in the study of archaeological resources of the prehistoric period. A professional in historic archaeology shall have at least one year of full-time professional experience at a supervisory level in the study of archaeological resources of the historic period.

(c) Architectural history. The minimum professional qualifications in architectural history are a graduate degree in architectural history, art history, historic preservation, or closely related field, with coursework in American architectural history; or a bachelor's degree in architectural history, art history, historic preservation, or closely related field plus one of the following:

(1) At least two years of full-time experience in research, writing, or teaching in American architectural history or restoration architecture with an academic institution, historical organization or agency, museum, or other professional institution; or

(2) Substantial contribution through research and publication to the body of scholarly knowledge in the field of American architectural history.

(d) Architecture. The minimum professional qualifications in architecture are a professional degree in architecture plus at least two years of full-time professional experience in architecture; or a state license to practice architecture.

(e) Historic architecture. The minimum professional qualifications in historic architecture are a professional degree in architecture or state license to practice architecture, plus one of the following:

(1) At least one year of graduate study in architectural preservation, American architectural history, preservation planning or closely related field; or

(2) At least one year of full-time professional experience on historic preservation projects. Such graduate study or experience shall include detailed investigations of historic structures, preparation of historic structures research reports, and preparation of plans and specification for preservation projects.

[1] *Secretary of the Interior's Professional Qualifications Standards.* Code of Federal Regulations. Title 36, Part 61, Appendix A. September 29, 1983.

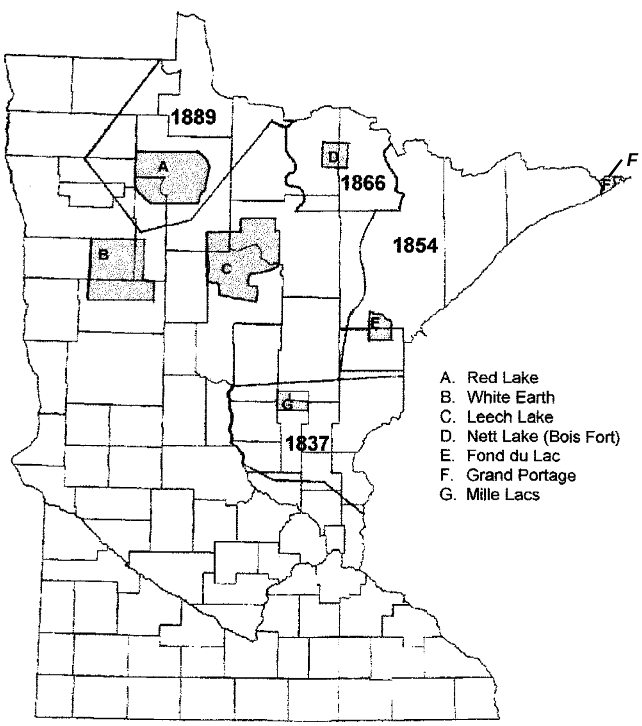
Appendix E:
Ceded Lands and Reservation Boundaries

As used within these guidelines, the term “ceded lands” refers to territories ceded to the United States Government by the Ojibwe under treaties of 1837, 1854, 1866 and 1889.

On public lands within these areas, members of the following bands retain the right to pursue traditional practices:

Mille Lacs Band (Treaty of 1837)
Fond du Lac and Grand Portage Bands (Treaty of 1854)
Bois Fort Band (Treaty of 1866)
Red Lake Band (Treaty of 1889)

When planning forest management activities in these areas, it is advisable to check with tribal representatives to determine whether there are traditional use areas in the vicinity. For sources of information and assistance, see the *Resource Directory*.



Appendix F: Determining Basal Area

Basal area is useful for a variety of applications, including determining whether enough trees remain within the RMZ (riparian management zone) to maintain and enhance riparian functions and values.

As one example of determining basal area, assume that an acre of RMZ contains 635 trees, varying in size from 1 to 15 inches in diameter as measured at 4.5 feet (DBH). See Table F-1.

For each diameter class, the basal area per acre is determined by multiplying the number of trees per acre by the basal area per tree. For example:

> A tree with a 1-inch diameter provides 0.005 ft^2 of basal area. 168 trees with a 1-inch diameter provide 0.84 ft^2 of basal area per acre (168 x 0.005 = 0.84).

Similar calculations are made for each tree diameter class found within the RMZ (in this example, from 1 inch to 15 inches).

The total basal area per acre for the RMZ is the sum of the basal area per acre for each diameter class. In this example, the 635 trees on this acre of RMZ represent a total basal area of approximately 80 ft^2/acre, which is the recommended basal area within the RMZ for uneven-age management for all water bodies. See Table F-1 next page,

Table F-1

Example of Basal Area Calculations for an RMZ Containing 80 ft^2 per Acre of Basal Area

DBH (inches)	Number of trees/acre	BASAL AREA ft^2/tree	ft^2/acre
1	168	0.005	0.840
2	107	0.022	2.354
3	93	0.049	4.557
4	77	0.087	6.699
5	52	0.136	7.072
6	33	0.196	6.468
7	26	0.267	6.942
8	21	0.349	7.329
9	17	0.442	7.514
10	13	0.545	7.085
11	10	0.660	6.600
12	8	0.785	6.280
13	5	0.922	4.610
14	3	1.069	3.207
15	2	1.227	2.454
Totals	**635 trees**		**80.011 ft^2/acre**

Using Crown Closure To Approximate Basal Area

While basal area is frequently determined using specialized tools, crown closure can also provide an approximation of the extent to which an area is occupied by trees. (See Table F-2.) Crown closure represents the degree to which the forest floor is shaded by tree crowns when the sun is immediately overhead.

Complete (100%) crown closure occurs when the crowns of trees touch and effectively block sunlight from reaching the forest floor while foliage is on the tree. Table F-2 shows the approximate relationship between crown closure and basal area across a range of species and tree diameters (Verry 1969). Since the relationship between basal area and crown closure varies by both tree species and diameter, crown closure may be different in two areas that have the same residual basal area.

A landowner could approximate basal area by estimating the percentage of crown closure at a particular location. An estimated crown closure of 70%, for example, would mean that about 70% of all sunlight is effectively blocked from reaching the forest floor, which approximates a basal area of 80 ft^2 per acre.

Table F-2

Approximate Relationship Between Crown Closure and Basal Area

Crown closure	Basal area (per acre)
30%	20 ft^2
35%	25 ft^2
50%	50 ft^2
70%	80 ft^2
75%	100 ft^2
75%	120 ft^2
80%	140 ft^2
95%	190 ft^2

Source: Verry 1969

Appendix G: Baseline Standards for Development of Best Management Practices To Provide Wetland Protection

Land use activities in wetlands, which are operating under an exemption in the Minnesota Wetland Conservation Act, should be guided by the following principles to ensure that the activities do not contribute to the loss or diminishment of wetland values and functions. Impacts to wetlands should be avoided if practical alternatives exist.

When impacts cannot be avoided, landowners, managers and operators should implement all practical measures to minimize impacts. Best Management Practices designed to meet these baseline standards will provide the necessary protection while operating in or adjacent to wetland areas and reduce the risk of being in violation of the Minnesota Wetland Conservation Act.

BMPs developed through this process do not supersede federal regulations (33 CFR, Section 323.4 and 7 CFR, Part 12).

1. **The activities should minimize impacts** to the hydrologic regime of wetlands.

2. **The activities should not take or jeopardize** the continued existence of state (Minn. Statute, Chapter 84.0895; Minn. Rule, Chapter 6134) and federal (16, Sections 1531-1544; 50 CFR, Section 17) threatened or endangered species, or adversely modify or destroy the critical habitat of such species.

3. **Activities in breeding and nesting areas for migratory waterfowl** and spawning areas in wetlands should be avoided if practical alternatives exist.

4. **The activities should minimize impacts to species of special concern** under Minn. Statute, Chapter 84.0895 and Minn. Rule, Chapter 6134 where their existence is known within the activity area.

5. In designing, constructing and maintaining roads, vegetative disturbance in wetlands should be kept to a minimum.

6. Permanent roads, temporary access roads and trails in wetlands should be held to the minimum feasible number, width and total length consistent with the management objectives, and local topographic and climatic conditions.

7. All roads, temporary or permanent, should be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) and designed to minimize impacts to wetland functions and values.

8. Discharges of dredged or fill material into wetlands to construct a road fill should be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers or other heavy equipment within wetlands that lie outside the lateral boundaries of the fill itself.

9. The design, construction and maintenance of the road crossing should allow the migration or other movement of those species utilizing the wetland.

10. Road fill should be bridged, culverted or otherwise designed to prevent the restriction of everyday surface and subsurface water flows and expected floodwater flows.

11. Fill should be properly stabilized and maintained during and following construction to prevent erosion.

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

13. All temporary fills should be removed in their entirety and the area restored to its original elevation unless removal will have a greater impact on water quality than leaving in place.

14. Material placed or discharged in wetlands should of suitable material free from toxic pollutants in toxic amounts.

Appendix H: Work Activities That Do Not Require A DNR Protected Waters Permit

Low-water ford crossings (on streams only)

No permit is required as long as
all of the following conditions are met:

• No special site preparation is necessary.

• Normal summer flow does not exceed 2 feet in depth.

• Normal low flow is not restricted or reduced.

• Crossing conforms to the shape of the natural stream channel.

• Original streambank is no higher than 4 feet.

• Construction is only gravel, natural rock, concrete, steel matting or other durable, inorganic material not more than 1 foot thick.

• Graded finished slope is no steeper than 5:1 (horizontal to vertical).

• Graded banks are seeded or mulched.

• Site is not an officially designated trout stream; trout stream tributary designated by rule; wild, scenic or recreational river; or officially designated canoe and boating route.

Temporary bridges (on streams only)

No permit is required as long as
all of the following conditions are met:

- Streambank can support bridge without pilings, foundations, culverts, excavation or other special site preparations.
- Nothing is placed in the bed of the stream.
- Bridge is capable of removal for maintenance and flood damage prevention.
- Bridge is firmly anchored at one end and can swing away during flooding.
- A minimum 3 feet of clearance exists between lowest portion of bridge and normal summer stream flow.
- [illegible]

Water level control structures (on streams only)

No permit is required as long as
all of the following conditions are met:

- The contributing watershed above the structure is 300 acres or less.
- The structure is not considered a “dam” under State Dam Safety rules.
- The structure is not on an officially designated trout stream or trout stream tributary designated by rule.

For streams with a watershed less than 5 square miles (3,200 acres)

No permit is required to construct a bridge or culvert,
or to fill or excavate the bed of a protected watercourse
having a total drainage area, at its mouth, of 5 square miles or less,
provided that *all* of the following conditions are met:

- County zoning officials and local Soil and Water Conservation District staff are given at least 7 days' prior notice and determine the project will not result in downstream erosion or sedimentation.
- The project will not divert the water to a different watershed.
- The project will not impound water by damming the watercourse.
- The watercourse is not an officially designated trout stream (or designated trout stream tributary).

Removal of existing structures

No permit is required as long as
all of the following conditions are met.

- The original lake, marsh or streambed is restored.
- All parts of the structure, including footings or pilings, are removed.
- The structure is not a water level control device and is not on an officially designated trout stream (or designated trout stream tributary).

Removal of debris

No permit is required to remove debris,
such as trees, logs, stumps and trash,
as long as the original alignment, slope or cross-section
of the lake, marsh or streambed is not altered.

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