Forest Road Construction and Maintenance

CONTENTS

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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.

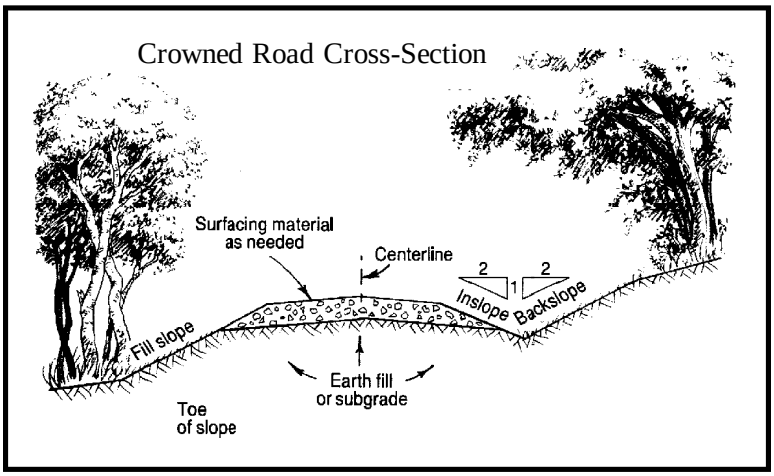


Figure ROAD-2

❒ 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

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 Consider future management activities that may utilize common roads for adjacent stands or ownerships.

U Minimize total road mileage and ground disturbance required to meet landowner objectives.

U 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.

U Establish appropriate stabilization, drainage and erosion control measures, to be applied on a daily basis during all phases of an operation.

U 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.

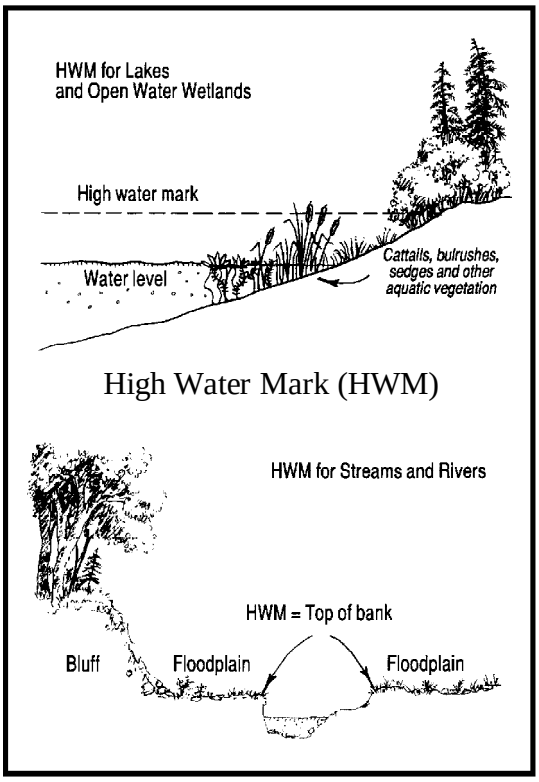


Figure ROAD-3

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.

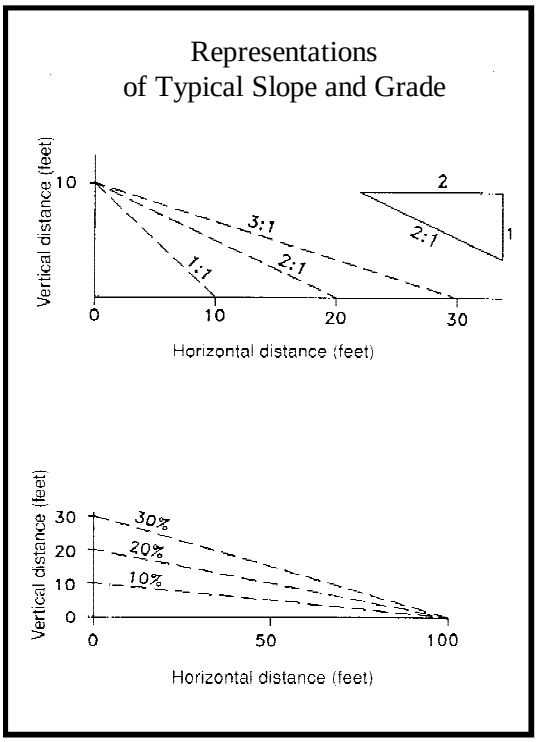


Figure ROAD-4

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.

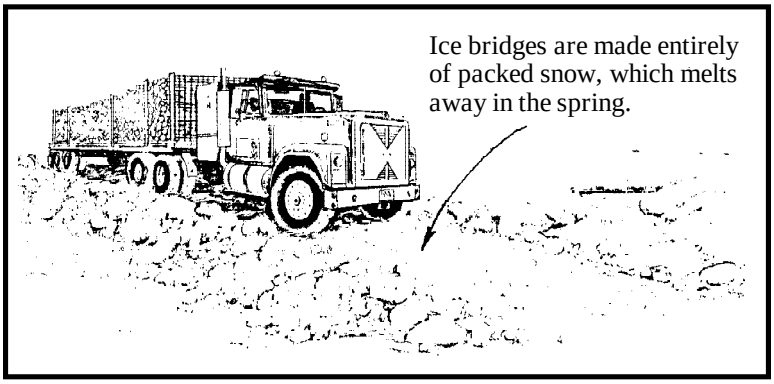
U Construct crossings to prevent water from backing up.

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

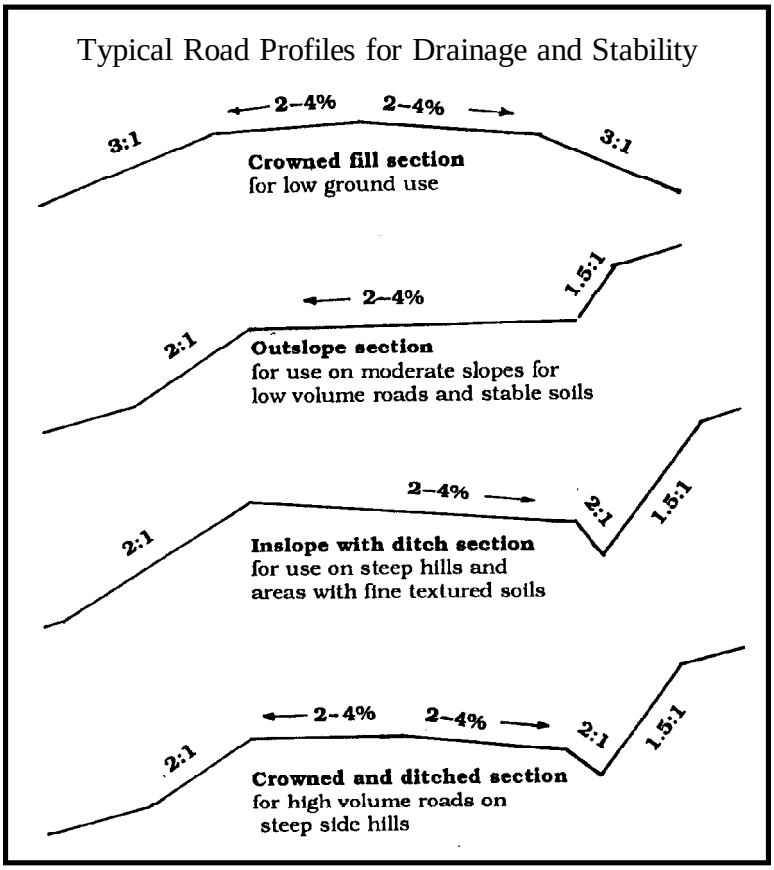


Drainage

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



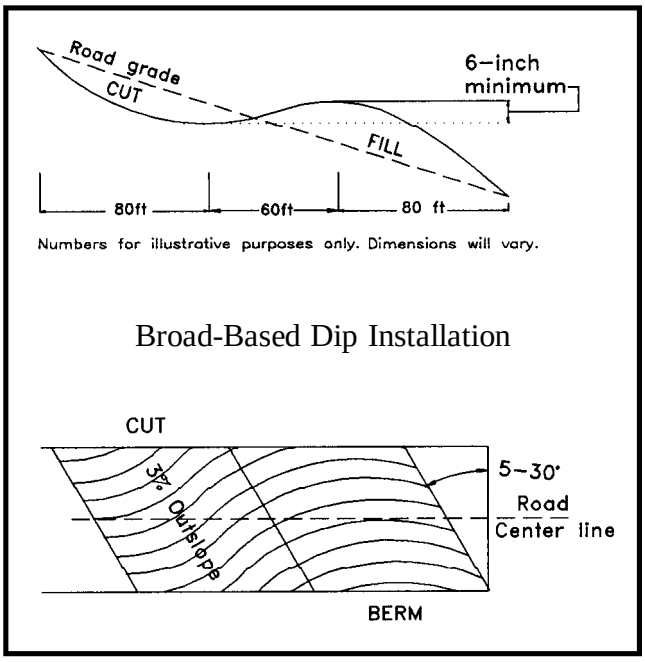


Figure ROAD-7

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

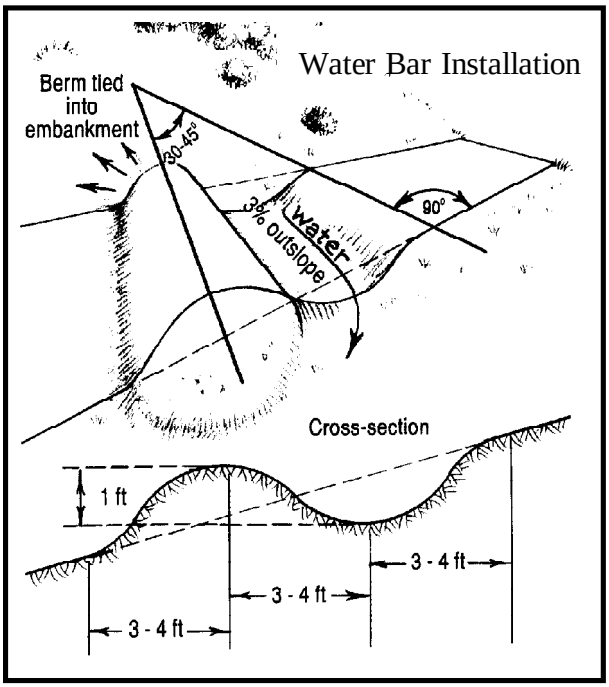


Figure ROAD-8

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

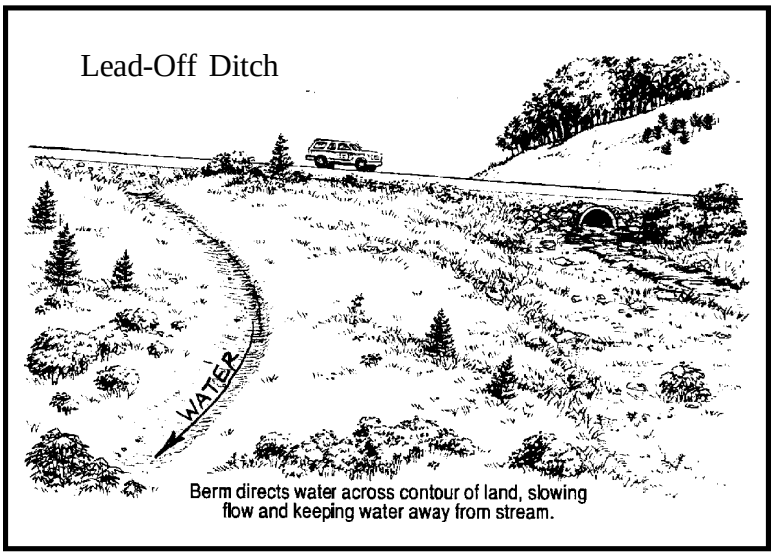


Figure ROAD-9

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*

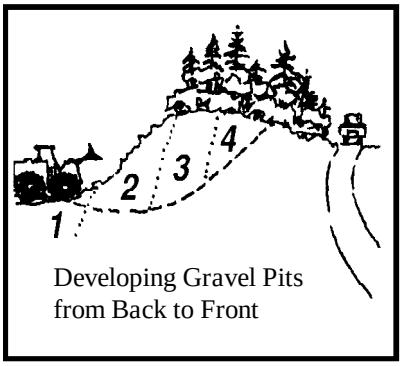


Figure ROAD-10: Develop gravel pits from back to front, moving toward predominant viewer or vantage point. In this illustration, Stage 1 has been completed, Stage 2 is in process, and Stages 3 and 4 will follow. Leaving the area adjacent to the road beyond Stage 4 untouched could result in no negative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

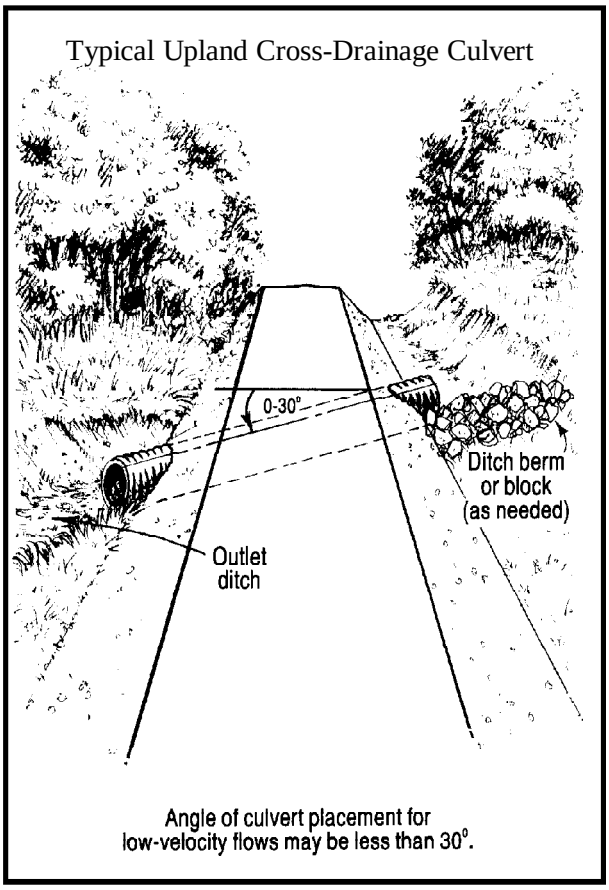


Figure ROAD-11

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.

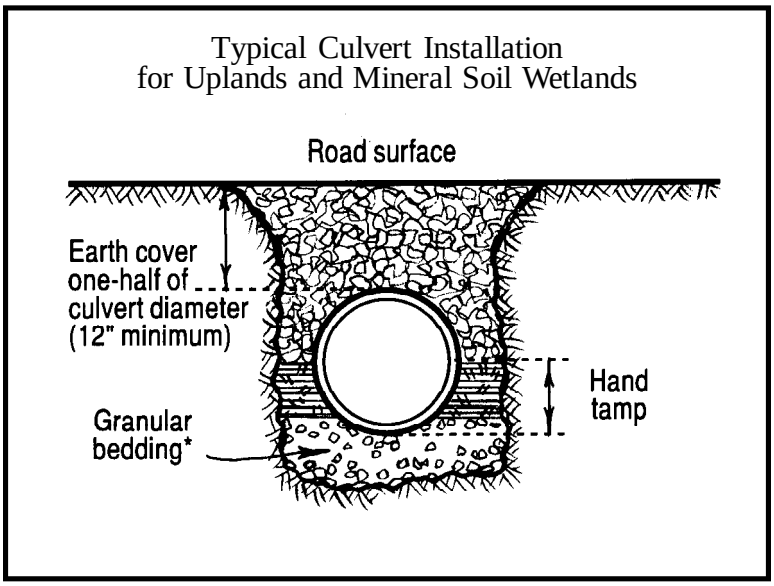


Figure ROAD-12

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

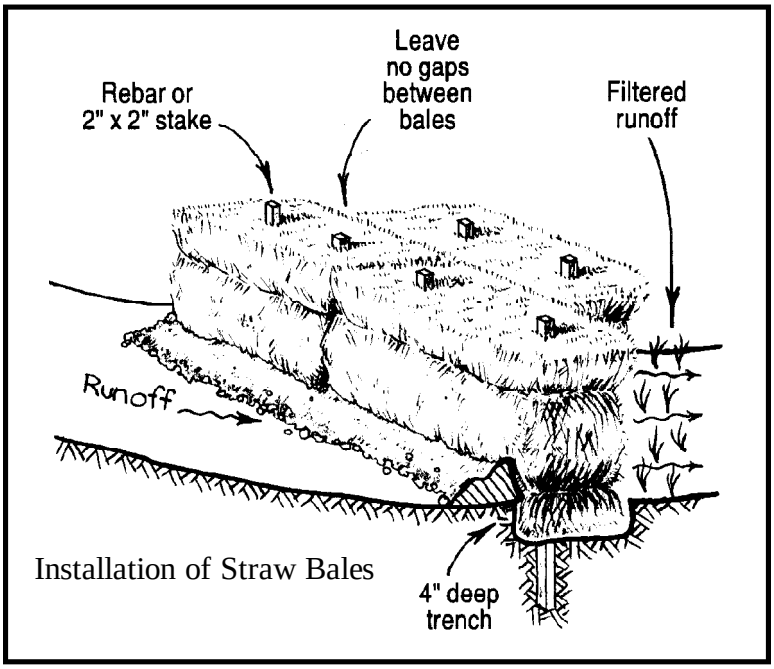
U Stabilize bare soil areas to reduce erosion. A vegetative cover is recommended along all roadsides. Where necessary, mulch and seed disturbed soil as soon as practical after construction. For sources of recommendations for seed mixes and fertilizer use, see *Resource Directory*.

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?

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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

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

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

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

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

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.

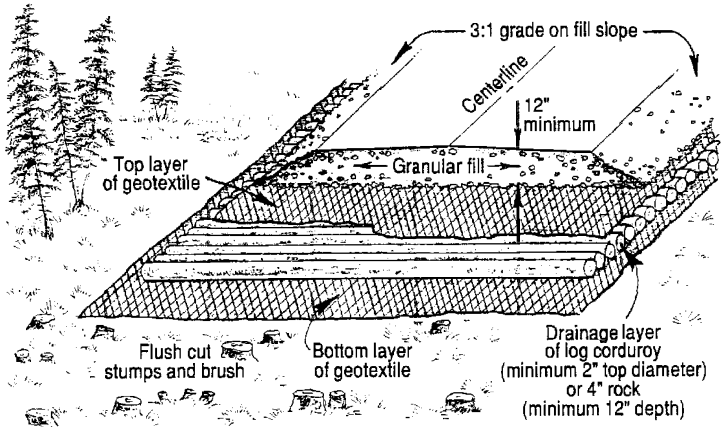
U Shape and stabilize borrow pits and excess material.

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.

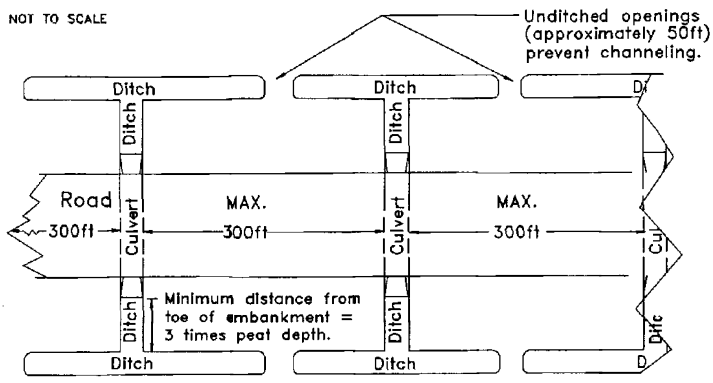
Figure ROAD-14

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).

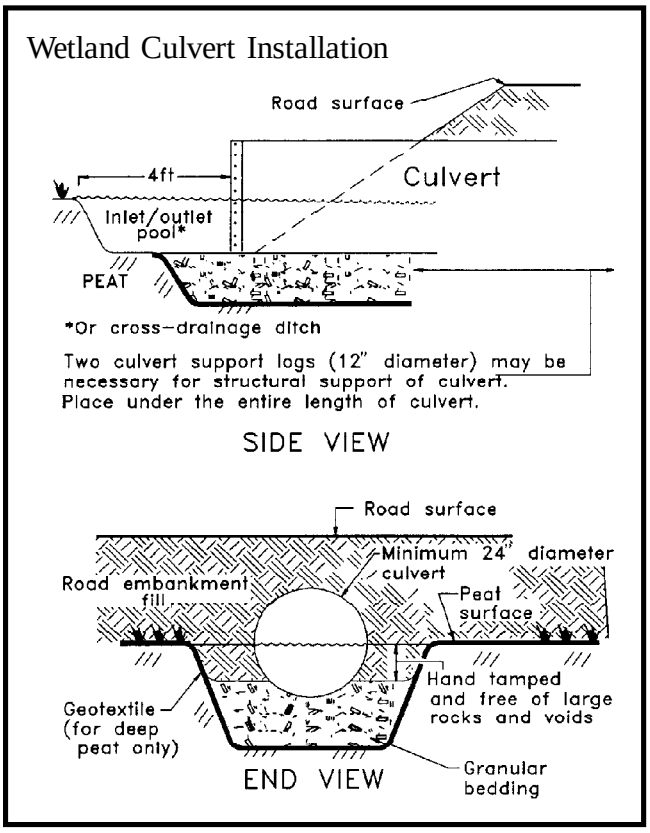


Figure ROAD-16

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.

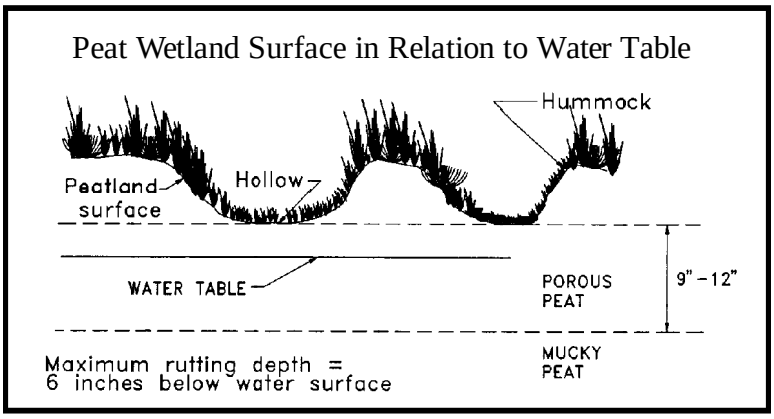
U Anchor temporary structures at one end to allow the structure to move aside during high water flows.

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



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 ex-ample,
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:

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

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

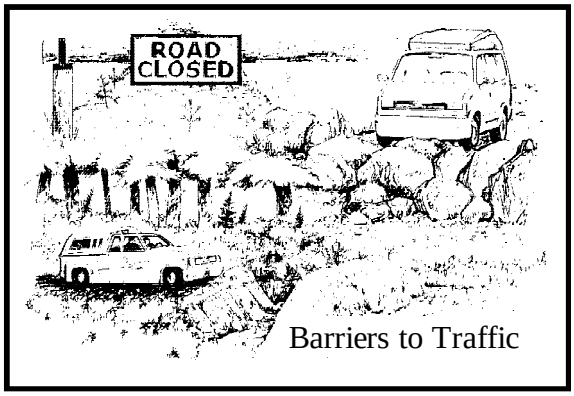
U Remove structures that would require continuing maintenance (such as culverts and bridges) even after a road is abandoned.

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

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

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

Figure ROAD-18



Barriers to Traffic