3A: Preharvest Planning

Management Measure for Preharvest Planning

Perform advance planning for forest harvesting that includes the following elements where appropriate:

(1) Identify the area to be harvested including location of water bodies and sensitive areas such as wetlands, threatened or endangered aquatic species habitat areas, or high-erosion-hazard areas (landslide-prone areas) within the harvest unit.

(2) Clearly mark these sensitive areas with paint or flagging tape, or in another highly visible manner, prior to harvest or road construction.

(3) Time the activity for the season or moisture conditions when the least effect occurs.

(4) Consider potential water quality effects and erosion and sedimentation control in the selection of silvicultural and regeneration systems, especially for harvesting and site preparation.

(5) Reduce the risk of occurrence of landslides and severe erosion by identifying high-erosion-hazard areas and avoiding harvesting in such areas to the extent practicable.

(6) Consider additional contributions from harvesting or roads to any known existing water quality impairments or problems in watersheds of concern.

Perform advance planning for forest road systems that includes the following elements where appropriate:

(1) Locate and design road systems to minimize, to the extent practicable, potential sediment generation and delivery to surface waters. Key components are:
- locate roads, landings, and skid trails to avoid to the extent practicable steep grades and steep hillslope areas, and to decrease the number of stream crossings;
- avoid to the extent practicable locating new roads and landings in Streamside Management Areas (SMAs); and
- determine road usage and select the appropriate road standard.

(2) Locate and design temporary and permanent stream crossings to prevent failure and control effects from the road system. Key components are:
- size and site crossing structures to prevent failure;
- for fish-bearing streams, design crossings to facilitate fish passage.

(3) Ensure that the design of road prism and the road surface drainage are appropriate to the terrain and that road surface design is consistent with the road drainage structures.

(4) Identify and plan to use road surfacing materials suitable to the intended vehicle use for roads that are planned for all-weather use.

(5) Design road systems to avoid high erosion or landslide hazard areas. Identify these areas and consult a qualified specialist for design of any roads that must be constructed through these areas.

Each state should develop a process (or utilize an existing process) that ensures that the management measures in this chapter are implemented. Such a process should include appropriate notification, compliance audits, or other mechanisms for forestry activities with the potential for significant adverse nonpoint source effects based on the type and size of operation and the presence of stream crossings or SMAs.

Management Measure Description

The objective of this management measure is to ensure that forestry activities, including timber harvesting, site preparation, and associated road construction, are planned with water quality considerations in mind and conducted without significant nonpoint source pollutant delivery to streams or other surface waters. Road system planning is an essential part of this management measure because road construction is the main soil destabilizing activity carried out in forestry, and avoidance is the most cost-effective means of dealing with unstable terrain (Weaver and Hagans, 1994).

A basic tenet of road planning is to minimize the number of road miles constructed in a watershed through basin-wide planning. A second tenet is to locate roads to minimize the risk of water quality impacts. Good road location and design can greatly reduce the sources and transport of sediment. Road systems can be designed to minimize the length and surface area of roads and skid trails, the size and number of landings, and the number of stream crossings, and to locate all of these road system elements as far from surface waters as feasible. Minimizing stream crossings is especially important in sensitive watersheds.

Preharvest planning includes consideration of the potential water quality and habitat effects of the component parts of the harvest, including the harvesting system (e.g., clear-cut or selective cut); the yarding system (e.g., skyline cable or ground skidding); the road system; and postharvest activities such as site preparation. Water quality considerations can most effectively be incorporated into preharvest planning by determining which pollutants are likely to be generated during each of the phases of the harvest and how best to ensure that they are kept out of surface waters. Reviewing Section 2 can help with the task of identifying the pollutants, and Section 3 provides information on the BMPs that will minimize their entry into surface waters.

The water quality effects of yarding can be reduced with thoughtful preharvest planning. Yarding done with ground skidding equipment can cause much more soil disturbance than cable yarding. McMinn (1984) compared a skidder logging system and a cable yarder for their relative effects on soil disturbance (Table 3-1). With the cable yarder, 99 percent of the soil remained undisturbed (the original litter still covered the mineral soil), whereas the amount of soil remaining undisturbed after logging by skidder was only 63 percent. Whether cable yarding, ground skidding, or skyline yarding is best for the particular harvest is based on whether the stand is even-aged or uneven-aged, the terrain, cost, and other factors. Among these other factors should be the need and means to protect water quality.

Table 3-1. Comparison of the Effect of Conventional Logging System and Cable Miniyarder on Soil in Georgia (McMinn, 1964)

Disturbance Class[a]	Cable Skidder	Miniyarder
Undisturbed	63%	99%
Soil exposed	12%	1%
Soil disturbed	25%	0%

[a] Undisturbed = original duff or litter still covering the mineral soil.
Exposed = litter and duff scraped away, exposing mineral soil, but no scarification.
Disturbed = Mineral soil exposed and scarified or dislocated.

Preharvest planning is the time to consider how harvested areas are to be replanted or regenerated to prevent erosion and effects on water bodies after the harvest has occurred. At the same time, it is important to consider other activities that have occurred recently, will coincide with the harvesting, or are scheduled to occur in the watershed where harvesting is to take place, as well as the overall soil, habitat, and water quality conditions of the watershed. Other activities within the watershed that can also stress water systems include land use changes from forest to agriculture, residential development or other construction, and applications of pesticides or herbicides. Cumulative effects on soils, water quality, and habitats from other activities and the proposed forest practices can result in excessive erosion and pollutant transport, and detrimental receiving water effects (Sidle, 1989). Cumulative effects are influenced by forest management activities, natural ecosystem processes, and the distribution of other land uses within a watershed. Forestry operations such as timber harvesting, road construction, and chemical use can increase runoff of nonpoint source pollutants and thereby contribute to preexisting impairments to water quality.

A previously completed cumulative assessment might exist for the area to be harvested, in which case it can be determined whether water quality problems, if any, in the watershed are attributable to the types of pollutants that might be generated by the planned forestry activity. If more pollutants of the same types are likely to be generated as a result of the harvesting activity, adjustments to the harvest plan or use of management practices beyond those normally used might be necessary. For instance, consider selecting harvest units with low sedimentation risk, such as flat ridges or broad valleys; postponing harvesting until existing erosion sources are stabilized; or selecting limited harvest areas using existing roads. The need for additional measures, as well as the appropriate type and extent, is best considered and addressed during the preharvest planning process.

During preharvest planning, it is also particularly important to plan implementation of management practices to be used to control sediment delivery from sources that are characteristically erosion-prone and lead to water quality impairment at stream crossings, landings, road fills on steep slopes, road drainage structures, and roads located close to streams. Constructing roads through high-erosion-hazard areas can lead to serious water quality degradation and should be avoided when possible. Some geographical areas (e.g., the Pacific coast states) tend to have more serious erosion problems (landslides, major gullies, etc.) after road construction than other areas. Factors such as climate, slope steepness, soil and rock characteristics, and local hydrology influence this potential. A person trained to recognize high-erosion hazard areas should be involved with preharvest planning.

Erosion hazard areas are often mapped by public agencies, and these maps are one tool to use in identifying high-erosion-hazard sites. The U.S. Geological Survey has produced geologic hazard maps for some areas. The USDA Natural Resources Conservation Service (NRCS) and Agricultural Farm Service Agency (FSA), as well as state and local agencies, might also have erosion-hazard-area maps.

Benefits of Preharvest Planning

The Virginia Department of Forestry found that preharvest planning is one of the three BMPs that are crucial to water quality protection. The other two are the establishment and use of streamside management areas (SMAs) and properly designed and constructed stream crossings. Although all BMPs are considered to be important, these three were found to be the most important to preventing water quality degradation.

In a study conducted by Black and Clark (no date), sediment concentrations were compared from stream waters in an unlogged watershed, a watershed where a harvesting operation with thorough preharvest planning had been conducted, and a watershed where a harvesting operation with no preharvest planning had been conducted. Sediment concentrations in the water from the unlogged watershed averaged 4 parts per million (ppm), those in the water from the watershed with the planned logging operation averaged 5 ppm, and those from the watershed with the unplanned harvest averaged 31 ppm (Figure 3-1). Preharvest planning in this study took into consideration road siting and construction techniques, landing siting, yarding techniques, and other BMPs intended to minimize erosion and sediment loss.

Of course, BMPs are effective only when properly designed, constructed, implemented, and maintained. Too often, BMPs are not installed early enough in the process to effectively control nonpoint source pollution, or they are not maintained properly, which can lead to their failure and to sedimentation or other forms of pollution. In general, poor BMP effectiveness can be attributed to one or more of the following:

- A lack of time or willingness to plan timber harvests carefully before cutting begins.
- A lack of skill in or knowledge of designing effective BMPs.
- A lack of equipment needed to implement effective BMPs.
- The belief that BMPs are not an integral part of the timber harvesting process and can be engineered and fitted to a logging site after timber harvesting has been completed.

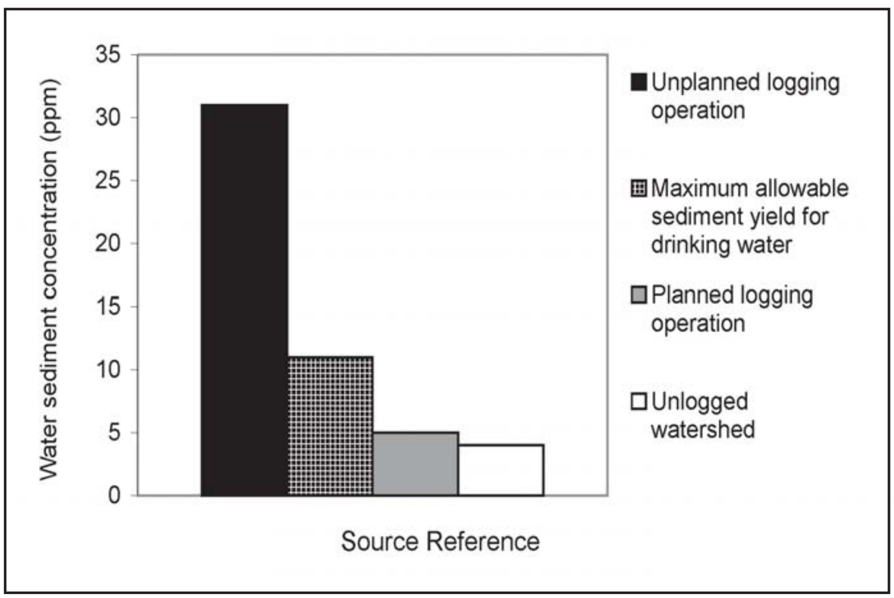


Figure 3-1. Comparison of sediment concentrations in runoff from various forest conditions to drinking water standard (after Black and Clark, nd).

Best Management Practices

Harvest Planning Practices

◆ *Use topographic maps, aerial photographs, soil surveys, geologic maps, and seasonal precipitation information—as slow long duration precipitation can be as limiting as high intensity short duration rainfall—to augment site reconnaissance to lay out and map harvest units. Identify and mark, as appropriate:*

- Sensitive habitats that need special protection, such as threatened and endangered species nesting areas.
- Streamside management areas.
- Steep slopes, high-erosion-hazard areas, and landslide-prone areas.
- Wetlands.

◆ *In warmer regions, schedule harvest and construction operations during dry periods or seasons. Where weather permits, schedule harvest and construction operations during the winter to take advantage of snow cover and frozen ground conditions.*

◆ *Consider potential water quality and habitat effects when selecting the silvicultural system as even-aged (clear-cut, seed tree, or shelterwood) or uneven-aged (group or individual selection). The yarding system, site preparation method, and any pesticides that will be used can also be considered during preharvest planning. As part of this practice, consider the potential effects from and extent of roads needed for each silvicultural system.*

◆ *In high-erosion-hazard areas, trained specialists (geologist, soil scientist, geotechnical engineer, wild land hydrologist) can identify sites that have high risk of landslides or that might become unstable after harvest. These specialists can recommend specific practices to reduce the likelihood of erosion hazards and protect water quality.*

◆ *Determine what other harvesting activities, chemical applications, or other potentially polluting activities are scheduled to occur in the watershed and, where appropriate, conduct the harvest at a time and in such a manner as to minimize potential cumulative effects.*

Road System Planning Practices

Road Location Practices

◆ *Preplan skid trail and landing locations on stable soils and avoid steep gradients, landslide-prone areas, high-erosion-hazard areas, and poor-drainage areas.*

- Plan to minimize roads, stream crossings, landings, skid trails, and activities on unstable soils and steep slopes.
- Locate landings outside of SMAs and ephemeral drainage areas.
- Locate new roads and skid trails outside of SMAs, except where necessary to cross drainages.

- Locate roads away from stream channels where road fill extends within 50 to 100 horizontal feet of the annual high water level. (Bankfull stage is also used as a reference point for this.)

◆ *Systematically design transportation systems to minimize total mileage.*

- Compare layouts for roads, skid trails, landings, and yarding plans, and determine which will result in the least soil disturbance and erosion.
- Locate landings to minimize skid trail and haul road mileage and disturbance of unstable soils.

◆ *Identify areas that would need the least modification for use as log landings and use them to reduce the potential for soil disturbance. Avoid using areas, such as ephemeral drainages, that could contribute considerably to nonpoint source pollution if high precipitation occurs during the harvest. Use topographic maps and aerial photographs to locate these areas.*

◆ *Plot feasible routes and locations on aerial photographs or topographic maps to assist in the final determination of road locations. Compare the possible road location on-the-ground and proof the layout to ensure that the road follows the contours. Design roads and skid trails to follow the natural topography and contour, minimizing alteration of natural features.*

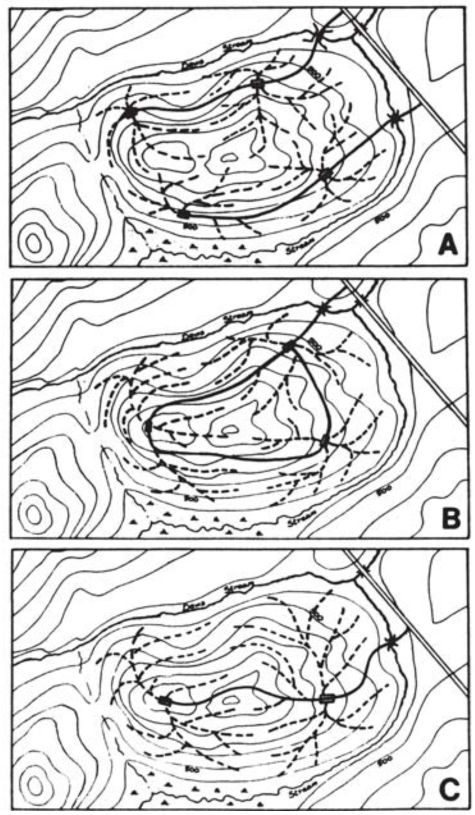
Proper design can reduce the area of soil exposed by construction activities. Figure 3-2 presents a comparison of road systems. Following the natural topography and contours can reduce the amount of cut and fill needed and consequently reduce both road failure potential and cost. Ridge routes and hillside routes are good locations for ensuring stream protection because they are removed from stream channels and the intervening undisturbed vegetation acts as a sediment barrier. Wide valley bottoms are good routes if stream crossings are few and roads are located outside SMAs.

◆ *Plan the management of existing and future roads and road systems to minimize environmental problems arising from them.*

Roads analysis is an integrated ecological, social, and economic approach to transportation planning addressing both existing and future road systems. The U.S. Forest Service's Roads Analysis procedure, developed by a team of Forest Service scientists and managers, is designed to help national forest managers bring their road systems into balance with current social, economic, and environmental needs. The top priority is to provide road systems that are safe for the public, responsive to public needs, environmentally sound, affordable, and efficient to manage. A roads analysis provides scientific information used to inform decision makers about effects, consequences, options, priorities, and other factors. This information is essential to plan efficiently and manage the forest transportation crisis. The iterative procedure for conducting the roads analysis consists of six steps aimed at producing needed information and maps (USDA Forest Service, 1999):

- **Step 1**: Set up the analysis. The analysis is designed to produce an overview of the road system. An interdisciplinary team develops a list of information needs and a plan for the analysis.
- **Step 2**: Describe the situation. The interdisciplinary team describes the existing road system in relation to current forest management plans. Products from this step include a map of the existing road system, descriptions of access needs, and

Permanent Haul Road
Temporary Haul Road
Skid Road (or Trail)
Bridge (water crossing)
Landing



Plans A, B, and C show three ways to place truck and skid roads on a cutting unit. The comments next to each plan indicate why Plan C is best.

Plan A layout: 2 bridges
4 landings
3 miles of haul road

Comment: Road and bridge construction costs too high. Skid distance too short. Too much steep downhill skidding. Too many landings on too steep land. Two bridges are unnecessary.

Plan B layout: 1 bridge
3 landings
3.5 miles of haul road

Comment: Loop road unnecessary. Skid distances too short. Erosion minimized up hill skidding.

Plan C layout: 1 bridge
2 landings
2 miles of haul road

Comment: Haul road follows high ground. Minimal road construction. Ideal skidding distances. Erosion minimized by uphill skidding. Least number of landings. Only one bridge required.

Figure 3-2. An example of laying out sample road systems for comparison purposes (Hynson et al., 1982).

information about physical, biological, social, cultural, economic, and political conditions associated with the road system.

- **Step 3**: Identify issues. The interdisciplinary team, in conjunction with the public, identifies important road-related issues and the information needed to address them. The interdisciplinary team also determines data needs associated with analyzing the road system in the context of the important issues, for both existing and future roads. The output from this step includes a summary of key road-related issues, a list of screening questions to evaluate them, a description of the status of relevant available data, and a list of additional data needed to conduct the analysis.
- **Step 4**: Assess benefits, problems, and risks. After identifying the important issues and associated analytical questions, the interdisciplinary team systematically examines the major uses and effects of the road system, including the environmental, social, and economic effects of the existing road system and the values and sensitivities associated with unroaded areas. The output from this step is a synthesis of the benefits, problems, and risks of the current road system and the risks and benefits of building roads into unroaded areas.

- **Step 5**: Describe opportunities and set priorities. The interdisciplinary team identifies management opportunities, establishes priorities, and formulates technical recommendations that respond to the issues and effects. The output from this step includes a map and a descriptive ranking of management options and technical recommendations.
- **Step 6**: Report. The interdisciplinary team then produces a report and maps that portray management opportunities and provide supporting information important for making decisions about the future characteristics of the road system. This information sets the context for the development of proposed actions to improve the road system and for future amendment and revision of forest plans.

◆ *Consider using or upgrading existing roads to minimize the total amount of road construction necessary whenever practical and when less adverse environmental impact would be caused.*

Existing roads should be used where they are in good condition or can be feasibly upgraded, unless using the roads would cause more water quality impacts than building a new road elsewhere (Weaver and Hagans, 1994). When an existing road is available on the side of a drainage opposite the harvest site, consider using it instead of constructing a new road to minimize the amount of soil disturbance due to new road construction. Avoid using existing or previously-used roads, however, if they are likely to create water quality problems, such as if they were constructed next to streams in valleys.

Road Design Practices

◆ *In moderately sloping terrain, plan for road grades of less than 10 percent, with an optimal grade of between 3 percent and 5 percent. In steep terrain, short sections of road at steeper grades can be used if the grade is broken at regular intervals. On steep grades, vary road grades frequently to reduce culvert and road drainage ditch flows, road surface erosion, and concentrated culvert discharges.*

Gentle grades are desirable for proper drainage and economical construction. Steeper grades are acceptable for short distances (200-300 feet), but an increased number of drainage structures might be needed above, on, and below the steeper grade to reduce runoff potential and minimize erosion. Heavy traffic on steep grades can result in surface rutting that renders crowning, outsloping, and insloping ineffective. On sloping terrain, no-grade road sections are difficult to drain properly and are best avoided when possible.

◆ *Design skid trail grades to be 15 percent or less, with steeper grades only for short distances.*

◆ *In designing roads for steep terrain, avoid the use of switchbacks through the use of more favorable locations. Avoid stacking roads above one another in steep terrain by using longer span cable harvest techniques.*

◆ *Avoid locating roads where they will need fills on slopes greater than 60 percent. When necessary to construct roads across slopes that exceed the angle of repose, use full-bench construction and/or engineered bin walls or other stabilizing techniques.*

◆ *Plan to use full-bench construction and remove fill material to a suitable location where constructing road prisms on side slopes greater than 60 percent.*

◆ *Design cut-and-fill slopes to be at stable angles, or less than the normal angle of repose, to minimize erosion and slope failure potential.*

The degree of steepness that can be obtained is determined by the stability of the soil. Figure 3-3 presents recommended stable backslope and fill slope angles for different soil materials.

- Use retaining walls, with properly designed drainage, to reduce and contain excavation and embankment quantities. Vertical banks can be used without retaining walls if the soil is stable and water control structures are adequate.
- Balance excavation and embankments to minimize the need for supplemental building material and to maximize road stability.
- Avoid the use of road fills at drainage crossings as water impoundments unless they have been designed as an earthfill dam (in which case they might be subject to section 404 requirements). These earthfill embankments need outlet controls to allow draining prior to runoff periods and a design that permits flood flows to pass.

◆ *Try to avoid springs wherever possible. However, where they must be crossed, provide drainage structures for springs that flow to roads and that flow continuously for longer than 1 month, rather than allowing road ditches to carry the flow to a drainage culvert.*

Avoiding springs will limit disruptions to the natural hydrology of an area and limit the extent to which roads can become integrated into an area's drainage system. Unmanaged springs can compromise sections of roads and contribute to erosion and sedimentation.

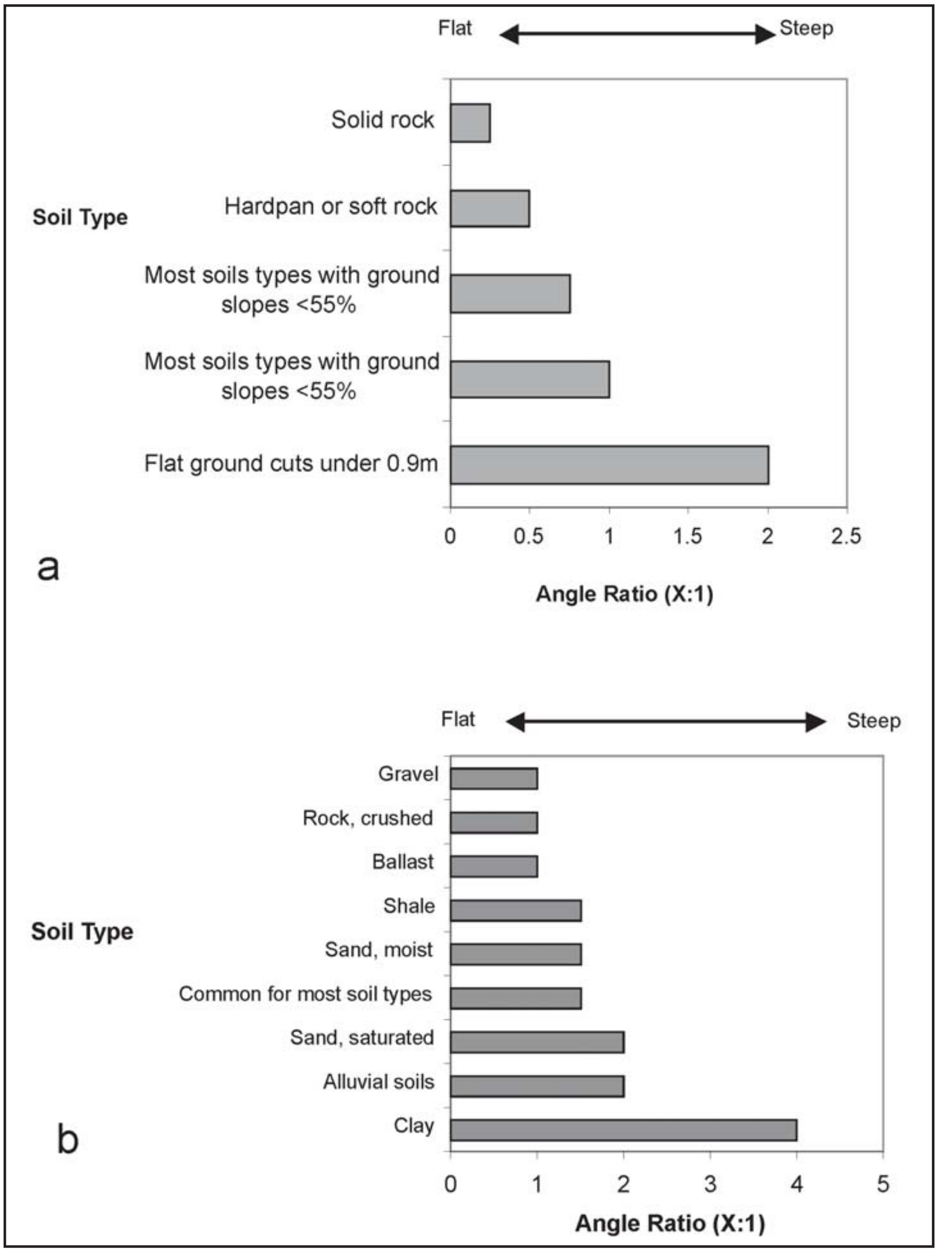


Figure 3-3. Maximum recommended stable angles for (a) backslopes and (b) fill slopes (after Rothwell, 1978).

- ◆ *Design roads crossing low-lying areas so that water does not pond on the upslope side of the road.*
  - Use overlay construction techniques with suitable nonhazardous materials for roads crossing muskegs.
  - Provide cross drains at short intervals to ensure free drainage and avoid ponding, especially in sloping areas.
  - Provide adequate cross drainage to maintain natural dispersed hydrologic flows through wet areas.
- ◆ *Plan water source developments, used for wetting and compacting roadbeds and surfaces, to prevent channel bank and stream bed effects.*
- ◆ *Design access roads such that they do not provide sediment to the water source.*

Road Surfacing Practices

- ◆ *Select a road surface material suitable for the intended road use and likelihood of water quality effects.*

The volume and composition of traffic, the desired service life, and the stability and strength of the road foundation (subgrade) material will determine the type of road surfacing needed. Roads that are closer to streams or other surface waters should be considered for a durable, non-erosive surface.

- ◆ *Where grades increase the potential for surface erosion, design roads with a surface of gravel, grass, wood chips, or crushed rocks.*
- ◆ *Where a road is to be surfaced, select an appropriately sized aggregate, appropriate percentage of fines, and suitable particle hardness to protect road surfaces from rutting and erosion under heavy truck traffic during wet periods.*

When a road is to be used for only a short time period, consider not surfacing it, and closing it and returning the surface to natural vegetation after use.

Road Stream Crossing Practices

- ◆ *Lay out roads, skid trails, and harvest units to minimize the number of stream crossings.*
- ◆ *Design and site stream crossings to cross drainages perpendicular to the streamflow. Design road segments with water turn-outs and broad-based dips to minimize runoff directly entering the stream at the crossing.*
- ◆ *Locate stream crossings to avoid channel changes and minimize the amount of excavation or fill needed at the crossing. Apply the following criteria to determine the locations of stream crossings:*
  - Construct crossings at locations where the streambed has a straight and uniform profile above, at, and below the crossing.
  - Locate the crossing so the stream and road alignment are straight in all four directions.
  - Cross where the stream is relatively narrow with low banks and firm, rocky soil.
  - Avoid deeply cut streambanks and soft, muddy soil.

- *Choose stream-crossing structures (bridges, culverts, or fords) with the structural capacity to safely handle expected vehicle loads with the least disturbance to the watercourse.*

- *Design culverts and bridges for minimal effect on water quality. Install culverts of a size that is appropriate to pass a design storm. Opening size varies depending on climate, the drainage area upstream of where the stream-crossing structure is to be placed, and the likelihood of plugging with debris.*

Consider the following guidelines for culvert sizing, but consult the state forestry agency and local hydrologists: a 50-year design storm for small diameter culverts and a 100-year design storm for large diameter culverts and bridges. Bridges or arch culverts, which retain the natural stream bottom and slope, are preferred over pipe culverts for streams used for fish migrating or spawning areas (Figure 3-4). The FishXing Web site (http://www.stream.fs.fed.us/fishxing/index.html) provides software and learning systems for fish passage through culverts.

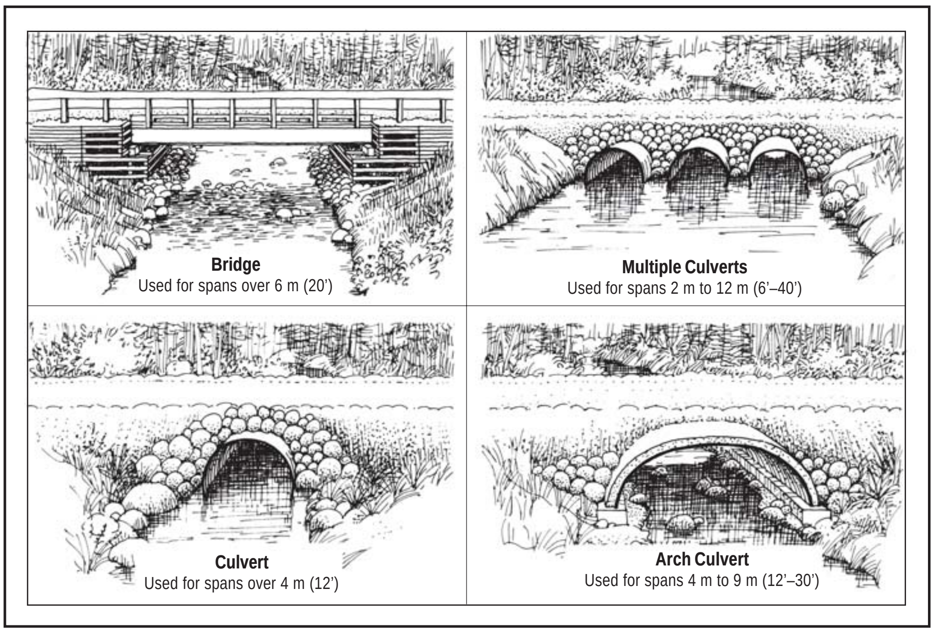


Figure 3-4. Alternative water crossing structures (Ontario Ministry of Natural Resources, 1988).

- *The use of fords is best limited to areas where the stream bed has a firm rock or gravel bottom (or where the bottom has been armored with stable material), where the approaches are both low and stable enough to support traffic, where fish are not present during low flow, and where the water depth is no more than 3 feet.*

- *Design small stream crossings on temporary roads using temporary bridges.*

Temporary bridges usually consist of logs bound together and suspended above the stream, with no part in contact with the stream itself. This prevents stream bank erosion, disturbance of stream bottoms, and excessive turbidity. Provide additional capacity to accommodate debris loading that might lodge in the structure opening and reduce its capacity.

Scheduling Practices

- ◆ *Plan road construction or improvement to allow sufficient time afterward for disturbed soil and fill material to stabilize prior to use of the road.*

Compact and stabilize roads prior to use. This reduces the amount of maintenance needed during and after harvesting activities.

- ◆ *To minimize soil disturbance and road damage, plan to suspend operations when soils are highly saturated. This will reduce sediment runoff potential and creation of ruts in the haul road, landings, skid trails, and loading areas, which in turn will prevent possible damage to vehicles. Damage to forested slopes can also be minimized by not operating logging equipment when soils are wet, during wet weather, or when the ground is thawing.*

Preharvest Notification Practices

- ◆ *Encourage timberland owners and harvesters to submit a preharvest plan to the state for review prior to performing any road work or harvesting.*

States are encouraged to adopt notification mechanisms for harvest planning that integrate and avoid duplicating existing requirements or recommendations for notification, including severance taxes, stream crossing permits, erosion control permits, labor permits, forest practice acts, plans, and so forth. For example, states might recommend that a preharvest plan be submitted by the landowner to a single state or local office. The appropriate state agency might encourage forest landowners to develop a preharvest plan. The plan would address the components of this management measure, including the area to be harvested, any forest roads to be constructed, and the timing of the activity.

Many states currently use some process to ensure implementation of management practices. These processes are typically related to the planning phase of forestry operations and commonly involve some type of notification process. Some states have one or more processes in place that serve as notification mechanisms used to ensure implementation. These state processes are usually associated with forest practices acts, erosion control acts, state dredge and fill or CWA section 404 requirements, timber tax requirements, or state and federal incentive and cost share programs. Some state education and training programs are discussed in Section 2.

It is suggested that notification be encouraged prior to:

- Timber harvesting or commercial timber cutting.
- Road construction or road improvement.
- Stream crossing construction or any work within 50 feet of a watercourse or water body.
- Reforestation.
- Pesticide, herbicide, or fertilizer applications.
- Any work in a wetland.
- Conversion of forestland to a non-forest use.