

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings

Forest Management Practices Fact Sheet Managing Water Series #1

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Introduction

Building and using roads, skid trails, landings, and stream and wetland crossings can cause nonpoint source pollution. Operators can locate *control points* and connect them to form the most efficient layout for roads, trails, landings, stream and wetland crossings, and other project features. This will limit erosion, help meet landowner objectives, improve safety, and reduce costs.

Where Used

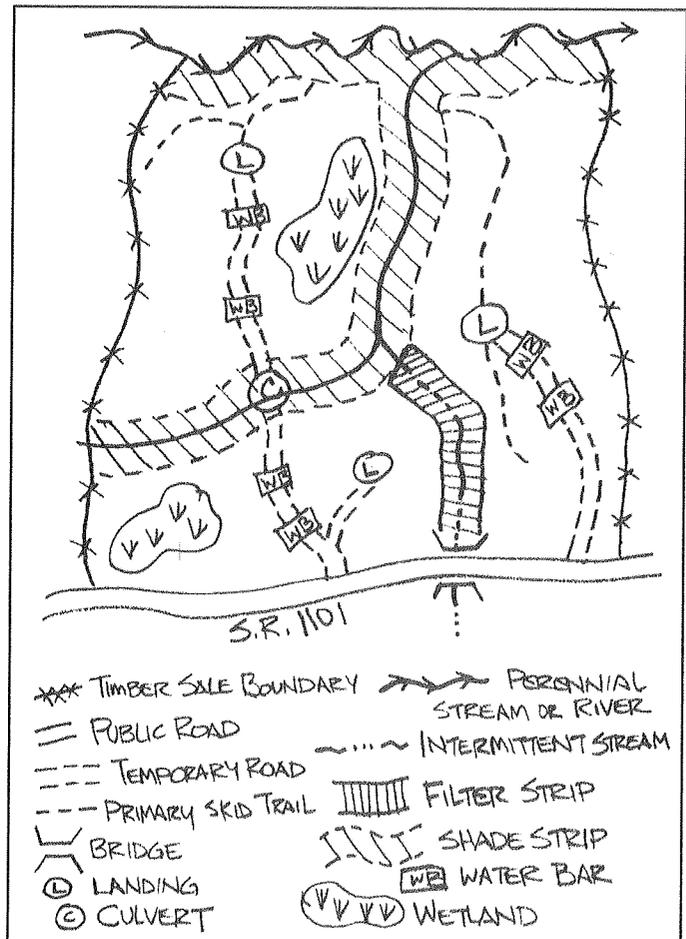
Identify control points when planning any forest management activity.

Application

Control points provide a framework for planning access and activity on a site. To begin planning, locate topographic features that will make construction of roads, landings, or other facilities easier. Next, find areas that limit construction (e.g., property lines, gas and power lines, rock bluffs, steep terrain, cultural resources).

Select a safe, effective access point. This is Control Point A. Identify routes that avoid the need for crossing streams or wetlands, or, if necessary, that cross them at appropriate sites. These are the B control points.

Next, locate a potential landing. This is Control Point C. If there are any steep slopes, they may become Control Point D. Potential gravel sites, locations of wildlife dens, or other features may become other control points.



Site planning map

Create a map with all control points marked. This will help everyone understand features to avoid or use.

Here are the major control points, summarized:

- **Control Point A (access to the area);**
- **Control Point B (stream/wetland crossing);**
- **Control Point C (landing location);**
- **Control Point D (steep topography).**

When planning access to a tract:

- ▶ Minimize the total number and mileage of roads and trails.
- ▶ Try to link roads and trails with other uses on neighboring lands.
- ▶ Avoid building roads and trails in the bottom of a draw. In the winter, you may need to make an exception, due to the difficulty of scaling icy or snow-packed hills.
- ▶ Consult an engineer for help planning roads and skid trails.
- ▶ Consult your state's Best Management Practices booklet for more information about planning the location of roads, landings, and skid trails.
- ▶ Use topographic maps, aerial photos, plat maps, and other tools as well as thorough reconnaissance of the site when planning your operation.

Advantages

Siting and using control points gives the operator a clear plan. It minimizes damage and reduces construction and maintenance costs.

Disadvantages

Siting roads, skid trails, landings, and stream or wetland crossings requires more planning time, especially for field reconnaissance.

Related Fact Sheets in This Series

Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

Cooperators

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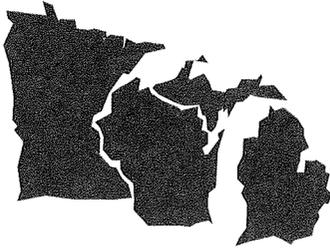
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Managing Water on Roads, Skid Trails, and Landings

Forest Management Practices Fact Sheet Managing Water Series #2

Introduction

Water moving over forest roads, skid trails, and landings causes erosion. Sediment that reaches water bodies can hurt aquatic organisms. Soil also makes water appear muddy and can carry in nutrients and chemicals. *Water diversion devices* can reduce erosion. In fact, by controlling water speed and volume on the top one-third of the road, erosion can be reduced by more than 65 percent.

Where Used

Operators use water diversion techniques on forest roads, skid trails, and landings.

Application

Water diversion techniques include the following:

Water bars divert water from a road into vegetation on either side. Water bar spacing varies with the slope (grade) of the road. Types of water bars include:

Earth-berm water bars are built with soil and are used mainly on closed roads or trails. Operators also use them during logging operations on roads with steeper slopes.

Logging debris and logs are used on closed roads and skid trails.

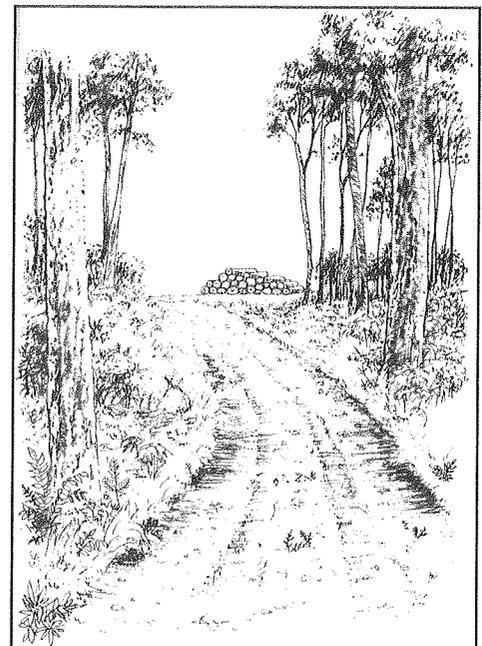
Conveyor belts, old snowmobile treads, and other similar material can be used in place of soil to build water bars. Straw bales, staked onto roads or trails, also can divert runoff.

Broad-based dips are wide depressions that channel water. Operators use them on active roads and skid trails with slopes of 10 percent or less.

Open-top culverts are installed across the surfaces of active roads and skid trails.

Shaping roads and trails using *crowning*, *insloping*, or *outsloping* can help control erosion. On crowned roads, the road surface slopes from the center to each side. Operators use crowning on high-volume roads with two-way traffic. On insloped roads, the traffic surface slopes down to the uphill side of the road. Insloped roads usually require a ditch and a cross-drainage culvert to move water to the other side of the road. On outsloped

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Temporary road

roads, the traffic surface slopes to the downhill side. Operators use outsloping and insloping on low-volume, single lane roads and trails.

Cross-drainage culverts let water (not in a stream channel) move from one side of the road to the other without crossing the surface.

Roadside and diversion ditches are best built during initial construction. They discharge runoff into vegetated areas well away from open water.

Operators can armor any of the above with riprap materials underlain with geotextile. (Geotextile is a fabric mat that lets water drain through it while supporting materials above.) This works well for any area where water turns sharply or flows rapidly (e.g., the face of a check dam that diverts water in another direction, the inlet or outlet of a culvert, or points where water empties onto a steep slope).

Advantages

Heavy equipment can quickly destroy some devices. Improperly built road ditches can make erosion problems worse. It's hard to build devices during frozen conditions. Installation and maintenance can require time and money.

Disadvantages

Maintain all structures and road and trail surfaces until the area is closed and permanently stabilized by vegetation.

Maintenance

Water diversion devices improve operating conditions. They increase the lifespan of roads and reduce maintenance costs. Good planning and proper use of these practices can reduce long-term costs for the operator and landowner.

Cost

Relative cost ranking for installation and maintenance:

<u>Practice</u>	<u>Relative Cost</u>
Water bars	Low – Moderate
Broad-based dips	Moderate
Crowning	Moderate
Insloping/outsloping	Moderate
Road ditches	High
Open-top culverts	High

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); *Earth-Berm Water Bars* (FS-6972); *Using Logging Debris or Logs to Build Water Bars* (FS-6973); *Conveyor Belt Water Bars* (FS-6974); *Broad-Based Dips* (FS-6975); *Open-Top Culverts* (FS-6976); *Shaping Roads and Trails* (FS-6977); *Roadside and Diversion Ditches* (FS-6978); *Cross-Drainage Culverts* (FS-6979); *Project Closure* (FS-6980); *Making and Using Measurement Tools—Basal Area* (FS-6981); and *Making and Using Measurement Tools—Slope* (FS-6982).

Cooperators

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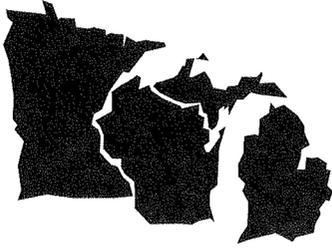
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Earth-Berm Water Bars

Forest Management Practices Fact Sheet Managing Water Series #3

Introduction

Earth-berm water bars are narrow, earthen ridges built across roads or trails. They divert water off and away from roads or trails into vegetated areas before it causes erosion. When properly built, they prevent exposed soil from moving, protecting the area until it is revegetated.

Where Used

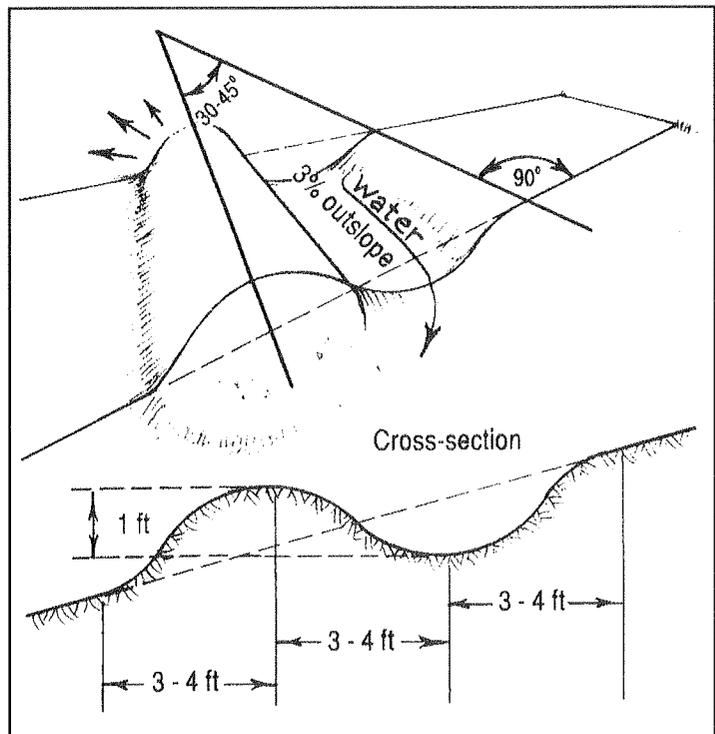
Earth-berm water bars are usually built on closed logging roads and trails, since they are hard to drive over and wear down quickly. They can be used on skid trails during logging, particularly when broad-based dips and other measures aren't feasible.

Practice Description

To build an earth-berm water bar, excavate a trench at a 30- to 45-degree angle across the traffic surface. Use the excavated material to build a berm on the downhill side of the trench. (You may use logs to reenforce an earth-berm water bar or to substitute for part of the soil needed in rocky areas.) Make the top of the berm at least 12 inches higher than the bottom of the trench. Make sure the outlet of the trench is at least 3 inches lower than the upper end.

Extend water bars slightly beyond both ends of the road to keep water from flowing around them. Direct diverted water into a stable, vegetated area, not into open water. To make a water bar easier to drive over, widen it by increasing the distance between the bottom of the dip and the top of the berm, maintaining the correct height.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.



Water bar installation

Space earth-berm water bars according to the grade. Your state's BMP guidelines will contain information about correct spacing of water bars in your area.

Advantages

Properly built earth-berm water bars are very effective in diverting water off roads, trails, and landings. They also limit undesirable traffic following closure.

Disadvantages

Earth-berm water bars are hard to drive over and may be difficult to maintain. They don't work well for active traffic surfaces during most operations. Frozen soils and rock may limit their use. They require caution when blading to maintain the road or trail.

Maintenance

Maintain earth-berm water bars until the area is successfully revegetated. Rebuild berms as needed if they are damaged by logging equipment.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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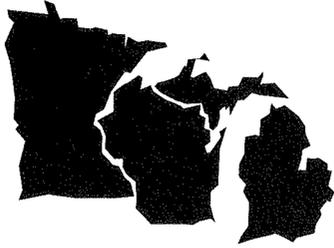
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Using Logging Debris or Logs to Build Water Bars

Forest Management Practices Fact Sheet Managing Water Series #4

Introduction

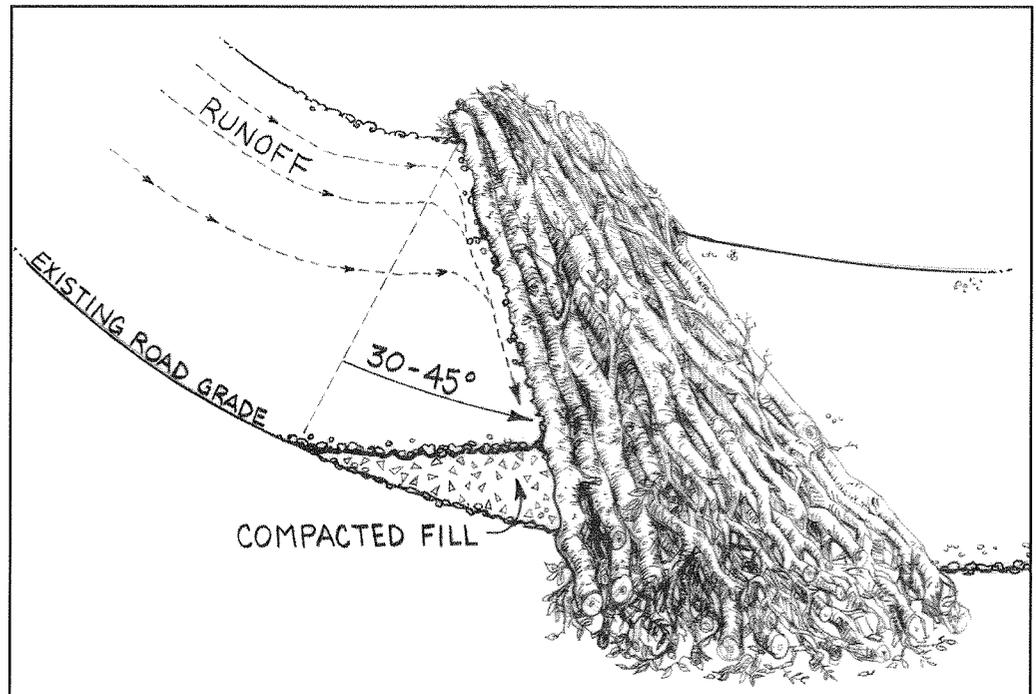
Water moving over forest roads and skid trails can cause erosion. Sediment deposited in streams, rivers, and lakes can hurt fish and other aquatic organisms. Nutrients and chemicals attached to soil can pollute water.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Logs or logging debris (slash) consisting of branches, broken tops, and brush can be used to create temporary water bars. Operators build *logging debris water bars* across traffic surfaces to divert water into vegetated areas. This reduces erosion and helps maintain the road. Water bars made from logging debris are not as effective as those made from soil, since water can filter through. Still, they can be used in many applications. They work best in low traffic areas with low slopes.

Where Used

Log and slash water bars are best placed where use of more substantial water diversion options is limited, for example, on roads and trails with limited traffic or slope, or when forest operations are shut down for a short time. They also can be used when soil is frozen or when shallow, rocky soils make it difficult to build earth-berm water bars.



Slash water bar

Application

When building a slash water bar:

- ▶ Place the log or slash at a 30- to 45-degree angle to the road or skid trail. For slash, build a mat at least 3 feet wide.
- ▶ Make sure water bars are high enough to prevent water from running over them.
- ▶ Pack slash down using a truck, dozer, or other heavy vehicle. Keep slash in continuous contact with the soil across the road. Fill gaps with soil or more slash. Water should not be able to run through the slash.
- ▶ Bind logs together or stake them down to help hold them in place when traffic passes over them.
- ▶ Remove berms or other obstructions from the lower end of the water bar to allow water to move off the road. Water should flow into a stable vegetated area, away from open water.
- ▶ Space log and slash water bars at least as close as you would earthen water bars. See your state's water quality BMP guidelines for spacing information.

Advantages

Log and slash water bars can be easily made from material at the site. They can be used on frozen soils or rocky areas. If used properly, they can reduce overall costs for maintaining the road.

Disadvantages

Constructing logging slash water bars takes time and resources. The water bars need to be maintained. You may need to fill ruts to divert water with slash water bars. Logging slash water bars are less effective than other water diversion devices. They require caution when blading during road or trail maintenance.

Maintenance

Check and rebuild water bars periodically to ensure that there are no gaps.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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Conveyor Belt Water Bars

Forest Management Practices Fact Sheet Managing Water Series #5

Introduction

Forest roads can be leading sources of nonpoint source pollution. By controlling water runoff, this pollution (mostly sediment) can be reduced. In fact, if water speed and volume can be controlled on the top one-third of the road, erosion problems can be reduced by more than 65 percent. Water bars can slow the velocity of water and divert it into vegetated areas.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Conveyor belts, old snowmobile treads, and similar material can be used instead of soil to build water bars. The material is buried on edge in the traffic surface. It bends over to let vehicles easily pass, but diverts water off of the road. These structures work with most vehicle traffic.

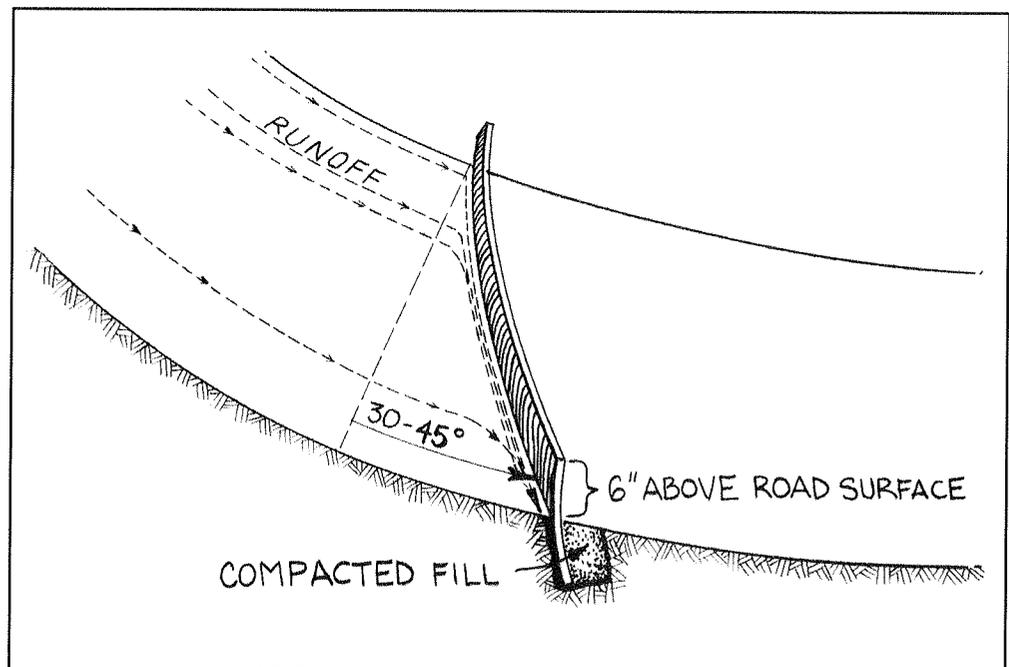
Where Used

Conveyor belt water bars can be used where other options would restrict road use. The best locations are active management projects with significant traffic.

Application

When building conveyor belt water bars:

- ▶ Dig a trench at a 30- to 45-degree angle to the road or skid trail. The face of the cut should be on the uphill side.



Conveyor belt water bar

- ▶ Place the conveyor belt against the face of the cut. Leave at least 6 inches of belt above the surface of the road. Refill the trench and compact the soil. If necessary, nail a two-by-eight board to the base of the belt to keep it straight and to hold it in the ground.
- ▶ Remove berms or other obstructions from the lower end of the water bar to allow water to move off the road. Water should flow into a stable vegetated area, away from open water.
- ▶ Space conveyor belt water bars as you would earthen water bars. See your state's water quality BMP guidelines for spacing information.
- ▶ Old snowmobile treads and other similar material can be used in place of conveyor belts.

Advantages

Conveyor belt water bars let recreational vehicles use the road or trail more safely than other water bar structures. Conveyor belt water bars are relatively inexpensive because low-cost salvage materials can be used.

Disadvantages

Conveyor belt water bars can be easily damaged by cable or grapple skidders or tracked machines. They work best with trucks, forwarders, and other rubber-tired traffic. They require caution when blading to maintain roads or trails.

Maintenance

Conveyor belt water bars work best with rubber-tired traffic. Tracked machines or skidders dragging loads may tear or pull up the belt. Rough use or substantial traffic may require frequent replacement.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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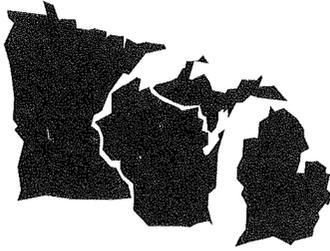


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Broad-Based Dips

Forest Management Practices Fact Sheet Managing Water Series #6

Introduction

Broad-based dips are gentle waves on the surface of forest roads. They minimize erosion by directing water movement off the road. Water flows into the bottom of the dip and drains into stable, vegetated areas at the side of the road.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

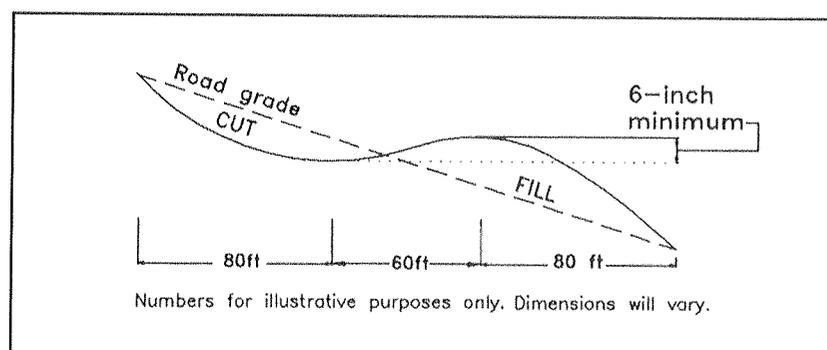
Where Used

Broad-based dips can serve two functions: 1) to divert surface flow off a traffic surface, and 2) to permit water to drain across it. They are best suited for grades of less than about 10 percent. They don't discourage traffic—the gradual nature of the dip assures that vehicles can safely use the road or trail.

Application

Include broad-based dips in the initial construction of a road, trail, or landing. The basic idea is to excavate a dip, build up a berm, and make sure there is an outlet for the water. If possible, use the assistance of a qualified engineer. When building a broad-based dip:

- ▶ Excavate at a 30- to 45-degree angle to the road.
- ▶ Allow at least 150 feet for the entire dip.
- ▶ Build the top of the berm at least 18 inches higher than the bottom of the dip.
- ▶ Dig the outlet of the dip at least 3 inches lower than the upper end. Water will flow across it and out into the adjoining vegetated area instead of pooling in the bottom of the dip.
- ▶ Space broad-based dips the same as cross-drainage culverts. Individual spacing recommendations vary from state to state. See your state's water quality BMP guidelines for spacing information.



Broad-based dip installation

- ▶ Where rutting is a concern, use gravel or other crushed stone on the berm and dip of the structure to protect the road surface.

Advantages

Broad-based dips work well on actively used roads or trails. They require less maintenance than water bars and culverts. They do not inhibit normal vehicle traffic. They eliminate the need for water bars when the road is closed.

Disadvantages

Broad-based dips require more advance planning than water bars or open-top culverts. They should not be used for grades of more than 10 percent or where large or frequent water flows are expected.

Maintenance

Make sure side drainage areas are vegetated, and that water does not drain directly into streams, lakes, or wetlands.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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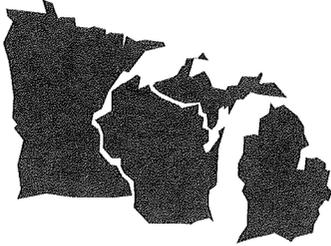
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Open-Top Culverts

Forest Management Practices Fact Sheet Managing Water Series #7

Introduction

Traffic surfaces such as forest roads and trails can contribute a lot of sediment and other pollutants to nearby wetlands, lakes, and streams. Open-top culverts are one option to help prevent such pollution.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Open-top culverts can serve two functions. They divert water off a traffic surface and permit water to drain across it. They are most frequently built from logs or lumber. Concrete and steel may be used for permanent installations. Design recommendations for concrete and steel will not be discussed here.

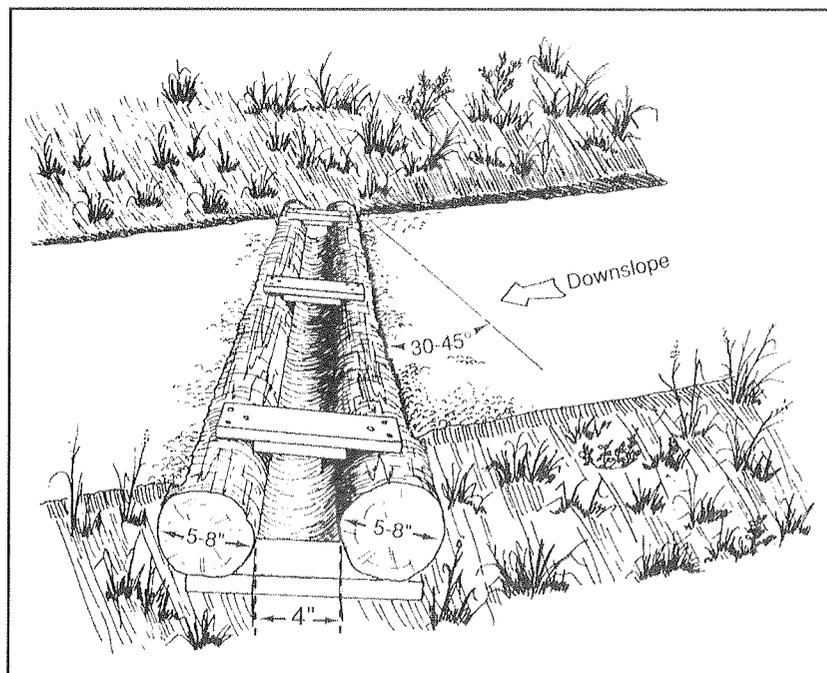
Where Used

Open-top culverts are most often used on temporary or low-traffic seasonal roads and trails because they require more maintenance than most other options. They should be removed when the road or trail is closed permanently.

Application

When building an open-top culvert:

- ▶ Make the culvert 6 inches deep and wide enough to be easily cleaned. The width of a shovel is convenient.



- ▶ Nail spacers between the side boards or logs to keep them in place and stabilize the structure.
- ▶ Remove roadside berms or other obstacles that might block water moving from the outlet. Water should flow into a stable, vegetated area away from the road and open water.
- ▶ Install the culvert at an angle as close to the direction of flow of the water as practical. This minimizes turbulence that can erode the soil around the inlet. Do not turn the water more than 45 degrees.
- ▶ Space open-top culverts according to your state's water quality BMP manual. Use water bar spacing when the main purpose is to divert water off a traffic surface. Follow broad-based dip and cross-drain culvert spacing if cross-drainage is the main goal.

Advantages

Open-top culverts are inexpensive. They can be built from logs and lumber and installed with hand tools on site. They permit easy movement of all vehicles.

Disadvantages

Open-top culverts need frequent maintenance to keep them in good working order.

Maintenance

Clean soil, slash, and other debris frequently from open-top culverts. Remove culverts when the site is closed to prevent plugging.

Related Fact Sheets in This Series

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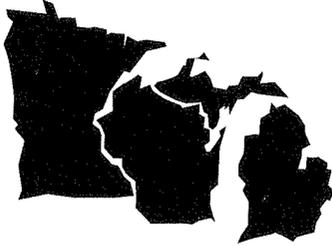
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Shaping Roads and Trails

Forest Management Practices Fact Sheet Managing Water Series #8

Introduction

Water running down forest roads and trails can erode surfaces, moving soil and other pollutants into nearby lakes, wetlands, and streams. One way to prevent this is to shape road surfaces so water runs off of them into nearby vegetation, rather than pooling or flowing along the surface.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Properly shaping roads reduces erosion and maintenance costs. Such roads are strong enough to safely handle traffic. Three options for road shaping are crowning, insloping, and outsloping. In a cross-section, this appears as:

- crowning — sloped from the center to the outside;
- insloping — sloped into the uphill side;
- outsloping — sloped out to the downhill side.

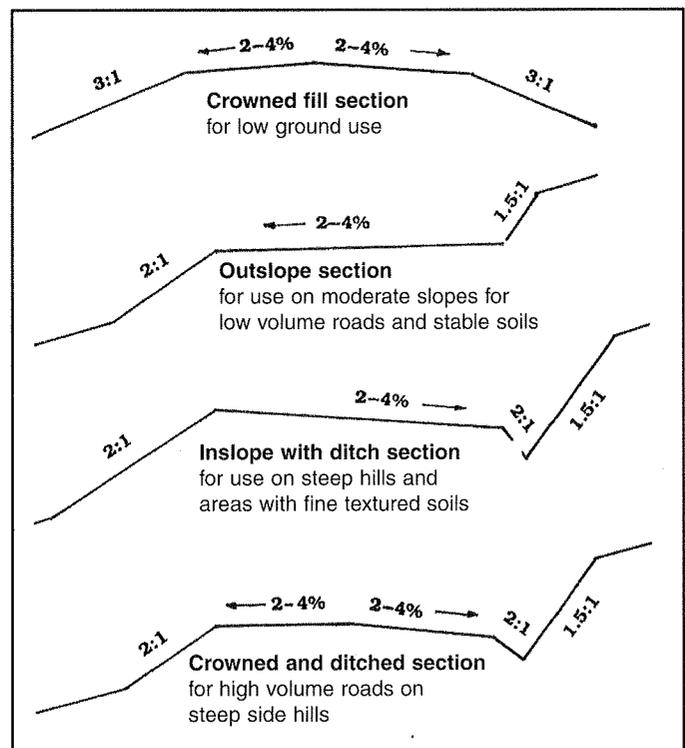
Where Used

Crowned roads are best suited for heavy traffic. Insloping and outsloping are more commonly used for low volume roads, skid trails, and landings. Outsloping reduces the need for ditches and cross drainage. However, for safety reasons, insloping is commonly used on curves on steep hills.

Application

Consider the terrain and location when deciding which shape of road to build. When properly shaping roads:

- ▶ Design the low point of the traffic surface to be at least 2 inches lower than the highest point.
- ▶ When cutting into a hillside (cut-and-fill) to build a traffic surface, make both the cut (uphill) and fill (downhill) side slopes as gentle as practical so they can be easily revegetated.



Typical road profiles for drainage and stability

Make slopes less than 3 feet high whenever possible to reduce the risk of slumping. Seed and mulch side slopes when needed.

- ▶ Don't bury debris in the road base. This causes uneven settling, which can lead to erosion and frost heaving.
- ▶ Compact fill material or allow it to settle before using the road. This helps the road become firm enough to support equipment and keeps the base material free of water. Ultimately, this reduces maintenance and erosion.
- ▶ Use gravel or other stable material to surface traffic areas on steep slopes or where heavy traffic is expected.

Crowned roads are normally designed for two-way traffic. They often require ditches and may need gravel or other surfacing material. Outsloping is most commonly recommended because there is less need for ditching.

Advantages

Proper shaping reduces maintenance needed on a road. It limits erosion, increases the number of operable days, and extends the service life of the surface. Traffic can continue to use roads and trails that are properly shaped.

Disadvantages

Roads and trails require regular maintenance to retain their shape. Costs to build and maintain these roads are moderate.

Maintenance

Outsloped roads are the least expensive to build and maintain. Crowned and insloped roads, along with any ditches, must be maintained more frequently to retain their shape and function.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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Roadside and Diversion Ditches

Forest Management Practices Fact Sheet Managing Water Series #9

Introduction

Roadside ditches move water alongside a road or trail to a point where it can safely be diverted into vegetated areas away from lakes, wetlands, and streams. *Diversion ditches* lead water away from the road at a point where this doesn't occur naturally. This keeps runoff, which might be polluted with soil and other materials, from entering water bodies.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

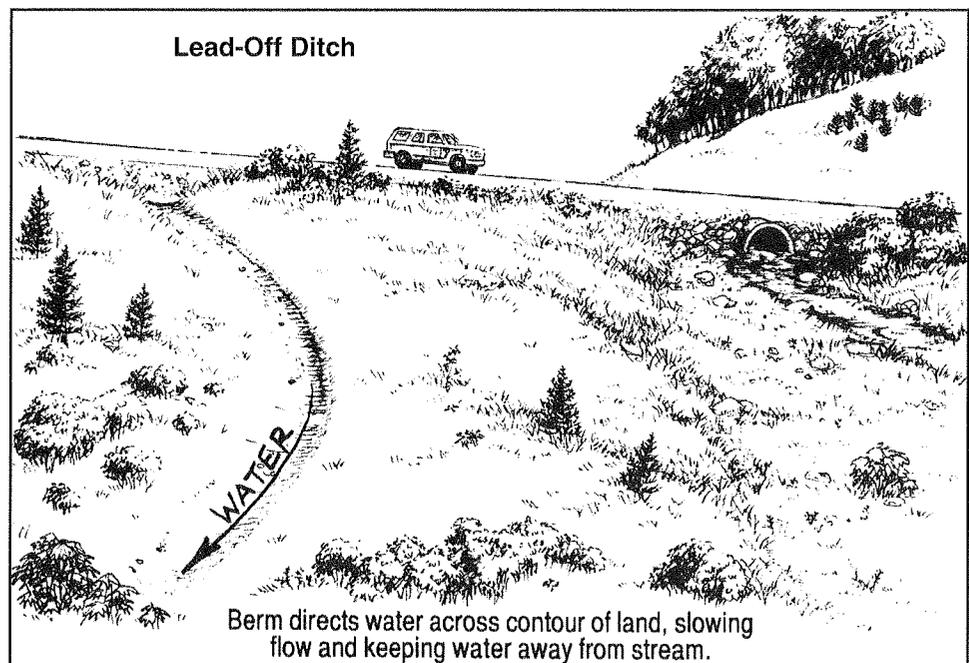
Where Used

Operators use ditches wherever the natural topography doesn't let water move away from a road, trail, or landing. Roadside ditches are built when there are natural points where water drains away from the road. Diversion ditches are used when natural drainage points can't be found for long stretches. They may be placed every 300 to 500 feet. Operators may build them at low points where water could be trapped. They also can be used on the approach to a stream or wetland crossing.

Application

When building ditches on forest roads:

- ▶ Build ditches during grading operations.
- ▶ Construct the side slopes of roadside ditches at a low angle (2:1 ratio) so they are stable and easily vegetated.



- ▶ Build the diversion ditch so it intersects the roadside ditch at a 30- to 45-degree angle. It should intersect the roadside ditch line at the same depth. The diversion ditch should turn slowly to follow the contour of the slope. Gradually reduce the ditch size along the contour to allow the water to spread out.
- ▶ Space diversion ditches along the roadbed to reduce the volume and velocity of roadside ditch waters and prevent ponding next to the road.
- ▶ Use the fill from cutting the diversion ditch to build a berm along the downhill side. This minimizes overflow.
- ▶ Stabilize exposed surfaces in a ditch until the area is vegetated. Seed, mulch, and or use hay bales.

Advantages

Road and diversion ditches permit handling of water in locations where the topography limits other options. This improves drainage of the road or trail surface and base. The road dries faster and is less rutted and muddy.

Disadvantages

Costs for constructing roadside diversion ditches are high.

Maintenance

Ditches need to be maintained and kept free of clogging debris.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Cross-Drainage Culverts (FS-6979); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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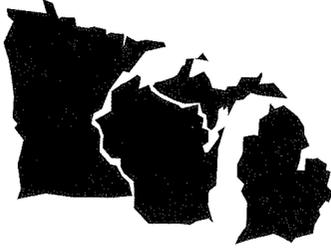
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Cross-Drainage Culverts

Forest Management Practices Fact Sheet Managing Water Series #10

Introduction

Cross-drainage culverts let water that isn't confined to a perennial or intermittent stream channel move from one side of the road to the other without crossing the surface. Proper use of cross-drainage culverts can improve water quality while allowing forest operations to continue.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Where Used

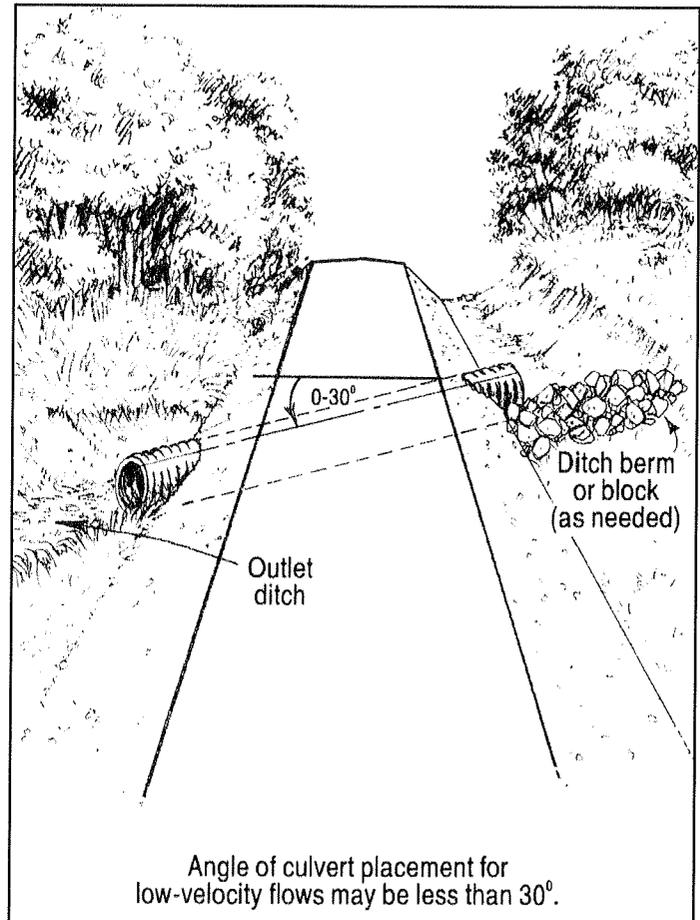
Operators can place cross-drainage culverts at regular intervals along grades, below banked seepages, and where water will run directly onto log landings or forest roads and trails.

Application

When installing cross-drainage culverts:

- ▶ Use culverts that are at least 12 inches in diameter to prevent plugging. Plugged culverts could cause a backup and damage the traffic surface. Larger culverts may be needed where roadside ditch flows or other factors might result in high volumes of water.
- ▶ Extend culverts 1 foot beyond the base of the road fill on each side.
- ▶ Place the culvert so the bottom is at the same level as the bottom of the ditch or adjoining slope.

Typical upland cross-drainage culvert



- ▶ Locate the low end of the culvert at least 2 inches lower than the upper end. Follow the natural slope of the land from end to end whenever practical.
- ▶ Place the culvert so the water is turned no more than 30- to 45-degrees from its direction of flow. Sharper turns create turbulence that can erode the fill around the culvert.
- ▶ Firmly pack material around culverts, especially around the bottom half. This will firmly anchor them and fill will not easily wash out.
- ▶ Cover tops of culverts with at least 12 inches of fill, or to a depth of one-half of the pipe diameter (whichever is greater). This minimizes damage to pipes during road maintenance. It also distributes the weight of passing vehicles, preventing culverts from crushing.
- ▶ Consider placing riprap around the inlet or outlet of a culvert. This will prevent erosion due to turbulent water flow. Riprap is most effective when it is placed on top of a geotextile material. (Geotextile is a fabric mat that allows water to drain through it while supporting materials above.)
- ▶ Space culverts according to your state's water quality BMP guidelines. Spacing between culverts decreases as road grades increase.

Advantages

Culverts move water from one side of the road or landing to the other without eroding surfaces.

Disadvantages

Culverts are expensive to install and require frequent maintenance.

Maintenance

Keep culverts free of debris at all times. Otherwise, they will plug up and become ineffective. Adequately drain road grades during placement of culverts.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Project Closure (FS-6980); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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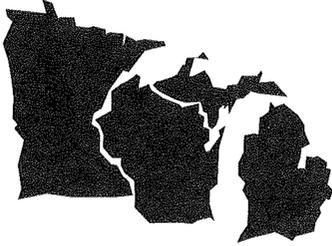
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Project Closure

Forest Management Practices Fact Sheet Managing Water Series #11

Introduction

After forest activities have ended, forest roads and trails remain. If these roads aren't maintained, they may erode and contaminate area waters. However, steps can be taken to either temporarily or permanently close roads and limit erosion. Closing roads also reduces maintenance costs.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

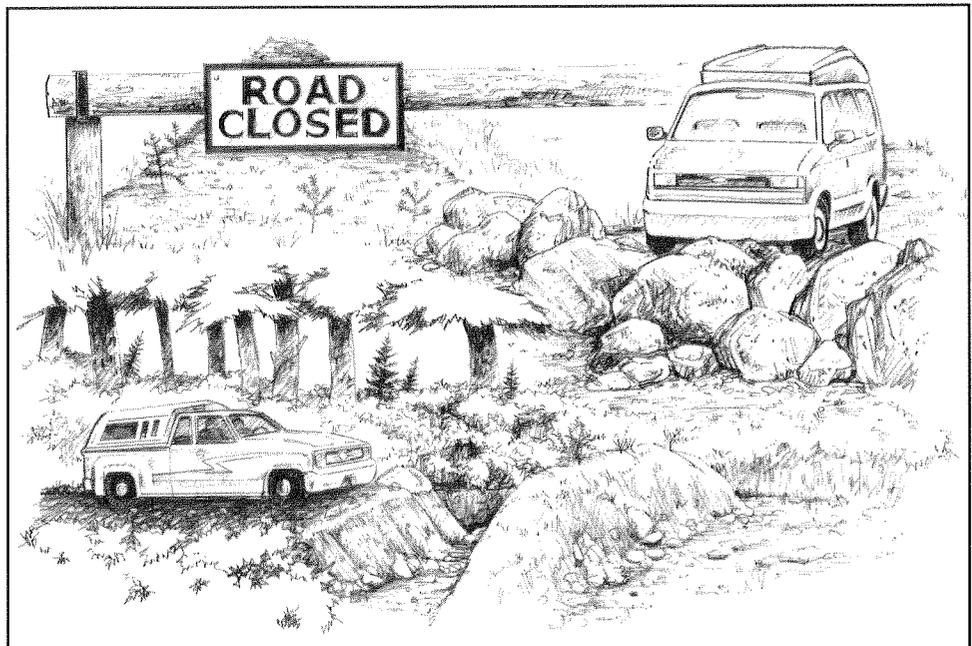
Where Used

Project closure measures should be used for all forest roads, trails, and landings that are to be temporarily or permanently closed. Temporary closure may be needed during breakup or wet periods to protect a traffic surface. Permanent closure should be considered whenever use will cease for more than five years.

Application

When temporarily closing a road:

- ▶ Place barriers and signs indicating "road closed" at the beginning of the forest road.
- ▶ Stabilize the road by seeding and fertilizing disturbed surfaces. Generally, seed mixtures should include fast-growing annual species. They will quickly stabilize the soil and permit perennial native species to reestablish themselves on the site. Any perennials found in seed mixtures should be native species. For more information, contact your local Soil and Water Conservation District (SWCD), Department of Natural Resources (DNR), Cooperative Extension Service, or Natural Resource Conservation Service (NRCS) offices.



- ▶ Keep existing drainage structures in good working order during closure. Clean debris from culverts and ditches. Install additional drainage structures if needed. Place debris away from open water and away from structures.
- ▶ Reduce travel during spring and other muddy times when roads can be damaged by traffic.
- ▶ Inspect the road occasionally to check conditions and schedule repairs.
- ▶ Repair road surfaces by filling in ruts and holes with gravel or compacted fill.

When permanently closing a road:

- ▶ Keep traffic from entering the road by posting signs and placing barriers.
- ▶ Place water bars where necessary.
- ▶ Remove culverts, bridges, and related structures. They will fail without long-term maintenance.
- ▶ Reshape stream crossings to the previous channel shape.
- ▶ Stabilize all exposed surfaces with mulch, hay bales, water bars or other materials. Seed and fertilize as needed (see temporary closure for more information).

Advantages

Properly closing forest projects results in cleaner water and improved habitat. In the long run, proper closure of all roads, trails, and landings, and regular maintenance on temporarily closed roads can save money.

Disadvantages

Proper closure of roads, trails and landings requires additional advance planning and effort.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); Managing Water on Roads, Skid Trails, and Landings (FS-6971); Earth-Berm Water Bars (FS-6972); Using Logging Debris or Logs to Build Water Bars (FS-6973); Conveyor Belt Water Bars (FS-6974); Broad-Based Dips (FS-6975); Open-Top Culverts (FS-6976); Shaping Roads and Trails (FS-6977); Roadside and Diversion Ditches (FS-6978); Cross-Drainage Culverts (FS-6979); Making and Using Measurement Tools—Basal Area (FS-6981); and Making and Using Measurement Tools—Slope (FS-6982).

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Making and Using Measurement Tools—Basal Area

Forest Management Practices Fact Sheet Managing Water Series #12

Introduction

There are a variety of *measurement tools* that can help assess a woodland. The tools can be sophisticated pieces of equipment (such as prisms) that are purchased from vendors or they can be homemade devices. This fact sheet will describe how to make and use a homemade tool for estimating basal area.

Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

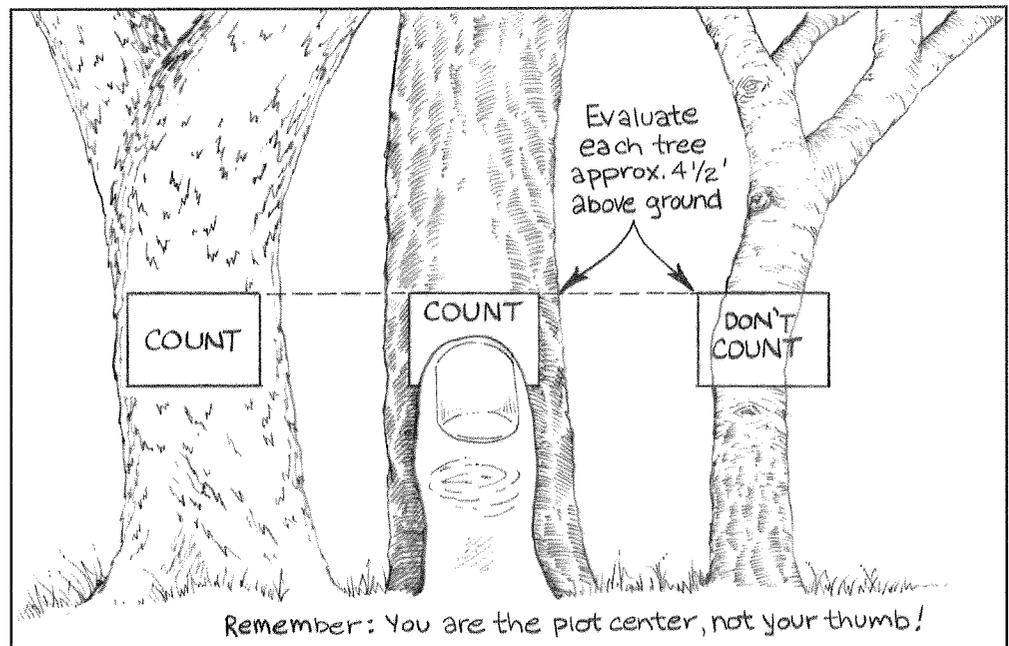
Basal area is the cross-sectional area of a tree 4.5 feet above ground. The basal area of all trees in a given land area describes the degree to which an area is occupied by trees and is generally expressed in square feet per acre (ft²/acre). Basal area is useful in determining whether enough trees remain to provide adequate shade within shade strips. (Shade strips are bands of vegetation along streams, lakes, and wetlands. They help moderate water temperatures.)

Application

Basal area of a land area can be estimated by holding an object such as a washer, penny, or thumb a fixed distance from your eye. Use the following formula to calculate the distance to hold the object from your eye:

$$\text{Distance from eye} = \text{width of object} \times 33$$

For example, a thumb with a width of 0.75 inches should be held 24.75 inches away from your eye ($0.75 \times 33 = 24.75$). You can maintain that distance while using the tool by stretching a string of the appropriate length between your eye and the object.



To estimate basal area, stand in the center of a randomly selected location or plot. Hold the object the appropriate length from one eye and close the other eye. Remember these key points:

- ▶ Aim the object at a spot on the tree's trunk 4.5 feet above the ground. Only consider live trees that are larger than 5 inches in diameter at that spot.
- ▶ Count only trees with trunks that look wider than the object. They are "in." Tree trunks that are narrower than the object are "out."
- ▶ Include every other tree with a trunk the same apparent size as the object.
- ▶ Standing at plot center, evaluate all trees in your viewing area by turning to the right until you return to the starting point.
- ▶ Repeat this procedure in several different locations. The more randomly selected plots taken, the more accurate the data. Plots should be far enough apart that they don't overlap.
- ▶ Determine the average number of "in" trees by dividing the total number of "in" trees by the total number of plots.
- ▶ Multiply the average number of trees considered "in" by 10 (the basal area expansion factor that corresponds to the formula above). This will yield an estimate of the basal area per acre.

$$\text{Basal area/acre} = \text{average number of trees counted} \times 10$$

As an example, assume that a total of 30 "in" trees were counted in 5 sample plots. The average number of "in" trees per plot is 6. The basal area/acre is 6×10 , or 60 square feet/acre.

Advantages

Homemade tools for estimating basal area are less expensive and easier to use than commercially available tools. They provide accurate enough estimates of basal area to make decisions regarding shade strips.

Disadvantages

Homemade tools are less accurate than commercially available ones.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); *Managing Water on Roads, Skid Trails, and Landings* (FS-6971); and *Making and Using Measurement Tools—Slope* (FS-6982).

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Making and Using Measurement Tools—Slope

Forest Management Practices Fact Sheet Managing Water Series #13

Introduction

There are a variety of *measurement tools* that can assess a woodland. The tools can be sophisticated equipment items purchased from vendors or they can be homemade devices. This fact sheet will describe how to make and use a homemade tool for determining slope.

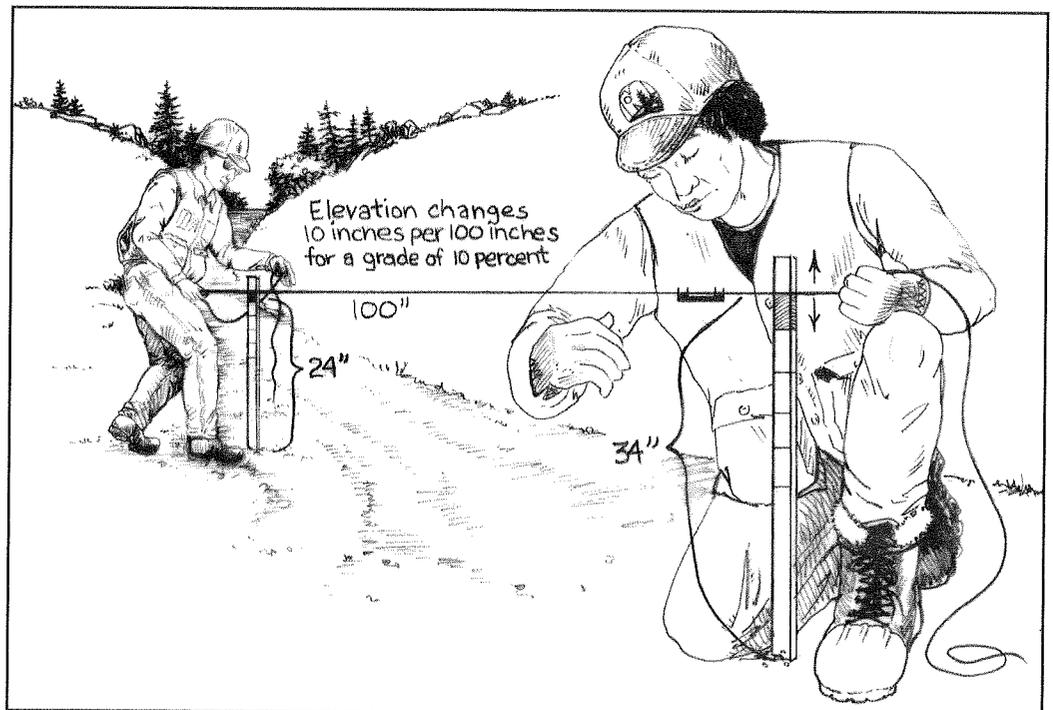
Best Management Practices (BMPs) can prevent or minimize the impact of forestry activities on rivers, lakes, streams, groundwater, wetlands, and visual quality.

Slope is the change in elevation between two points. It is expressed as a percent change in elevation per unit of distance traveled. Loggers and foresters need to determine slope when constructing roads and determining the spacing of water bars and broad-based dips. Water bars and broad-based dips help prevent erosion and keep sediment from reaching water.

Application

You can determine slope using a measurement tool made with two wooden dowels or stakes, string, a felt marker or tape, a line level, and a ruler. While the dowels or stakes do not need to be the same length, they may be easier to use if their length is equal. To make the tool:

- ▶ Lay each dowel (or stake) flat on the ground. Starting from one end of each dowel, make a mark every six inches with a felt marker or tape.
- ▶ Cut a piece of string about 10 feet long.
- ▶ Firmly tie one end of the string to one dowel at the six-inch mark farthest away from the point where you began marking that dowel.



To measure the slope:

- ▶ Select the points where the difference in slope is to be measured. Place one dowel at each point. If you pound the dowels into the ground, make sure they are at the same depth.
- ▶ Measure the distance between the dowels.
- ▶ Pull the string tight between the dowels.
- ▶ On the dowel that doesn't have the string attached to it, hold the loose end of the string at the same increment mark as on the other dowel. Attach the line level to the string.
- ▶ Slide the string up or down until the level indicates it is level. The distance the string had to be moved up or down is the difference in elevation between the two points.
- ▶ Divide the change in elevation by the distance between the two dowels. Then multiply that number by 100 to figure out the percent slope.

$$\% \text{ slope} = (\text{change in elevation/horizontal distance}) \times 100$$

As an example, assume the dowels are 100 inches apart and the string had to be moved 10 inches to make it level. The slope is then calculated as:

$$\% \text{ slope} = (10 \text{ inches}/100 \text{ inches}) \times 100 = 10\% \text{ slope}$$

Once you determine slope, you can determine the spacing between water bars and broad-based dips by referring to the appropriate table(s) in your state's water quality BMP manual.

Advantages

Homemade tools for calculating slope are less expensive than commercially available tools. They provide accurate enough estimates of slope to determine the spacing of water bars and broad-based dips.

Disadvantages

Homemade tools are less accurate than commercially available tools. They may be more difficult to use, too. Also, they are limited to measuring slope, whereas commercially available tools may have additional capabilities.

Related Fact Sheets in This Series

Project Planning: Locating Roads, Landings, Skid Trails, and Crossings (FS-6970); *Managing Water on Roads, Skid Trails, and Landings* (FS-6971); and *Making and Using Measurement Tools—Basal Area* (FS-6981).

Reference

For more information about the spacing of water bars and broad-based dips, see your state's water quality BMP manual.

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