

# The Woodland Workbook

## Logging



# Maintaining Woodland Roads



*This rutted, poorly draining woodland road needs maintenance work.*

Almost anything that is constructed requires maintenance, and woodland roads are no exception. Because roads are one of the most important and costly features of your woodland property, you should take proper steps to insure their continued usefulness and value.

Ignoring or delaying necessary maintenance can lead to damage that is more costly to repair than the

original road construction. Good maintenance also helps insure safety and necessary access, and it enhances the efficiency of vehicle and equipment travel over your property.

Experience has shown that proper road maintenance is essential to the protection of soil and water resources. Roads create surfaces that water cannot easily penetrate, they expose bare mineral soil, and they cross natural drainages.

These conditions set the stage for soil erosion, landslides, and sediment movement to nearby streams. Good road design minimizes these problems with provisions for drainage and exposed soil, but only with continued maintenance can you insure the effectiveness of important design features.

For these reasons, you are legally required by Oregon's Forest Prac-

tices Act to properly maintain your woodland road system.

Road maintenance includes a range of activities, from culvert and ditch cleaning to grading of road surfaces. Depending on the time and equipment available, you may be able to do some or all of this work yourself.

## Planning ahead

All too often, woodland road maintenance activities resemble road reconstruction because considerable damage was done before any action was taken. This can be a very costly and difficult approach. Planned road maintenance can eliminate such problems or can help keep them small and manageable.

### Know your road system

The first step towards a good maintenance plan is to have a clear concept of your road system and what you must deal with. A map of your property and the road system can be very useful in determining such things as road mileages and approximate area of roadside.

Notes and markings on the map can identify features that require special attention: culverts, wet areas, steep grades, areas prone to slumping, traffic control gates, and so forth. This information can be particularly valuable if your resources of time, equipment, and money are limited.

### Inspect regularly and during heavy rains

Regular road inspection is another important aspect of good maintenance of woodland roads.

This publication describes the most common and important road maintenance activities and helps you determine which of these tasks you may be able to perform. Planning maintenance activities is a vital step towards an effective and economical maintenance program, so this subject will be discussed first.

The desirable level and frequency of inspection will vary with the individual road. Newly constructed roads, roads located in problem areas (wet spots, unstable ground, etc.), and roads receiving heavy use will need the greatest attention.

Inspect these roads before the rainy season, and also during and after large storms or snowmelt. You can learn a lot during wet weather

when you can see the road drainage system in action—or *inaction!* Look especially for overflowing ditches and culverts, puddles on the road surface, and fresh slumps or gullies in cut and fill slopes.

### Plan the operation

Once an inspection has helped identify the location and type of maintenance needed, decide how you will conduct the maintenance. Equipment needs will vary. An important task like culvert cleaning usually requires nothing more than a hand shovel (figure 1).


Road grading, on the other hand, is best done with heavy equipment specially designed for the job. Some general information on equipment requirements and suitability for different types of road maintenance is summarized in table 1.

Another important decision is, can you do the work yourself? The answer to this question depends upon your skills, your available time



Figure 1.—A hand shovel is all you need for some important maintenance work like culvert cleaning.

Table 1—*Equipment used in woodland road maintenance*

Maintenance activity	Shovel, chainsaw, truck winch, etc.	Farm tractor with blade	Bulldozer with blade	Other heavy equipment
Generally increasing skill requirements and per-hour costs 				
<b>Road surfaces</b>				
Grading	Suitable for limited spot treatment of potholes and ruts.	Feasible with blade or road drag. May lack power.	Adequate, but lacks speed and control of grader.	Grader excellent. Truck-pulled road drag may be adequate.
Chemical applications	Suitable for limited spot treatments.	Adequate to excellent with sprayer/spreader attachments.	Not suitable.	Trucks with sprayer/spreader attachments excellent.
Snow plowing	4-wheel drive vehicle with plow adequate for light jobs.	Adequate for light to moderate jobs.	Adequate but slow. Suitable for heavy work.	Grader and large truck with plow good to excellent. Front-end loader good for localized heavy work.
<b>Drainage structures</b>				
Ditch cleaning	Suitable for spot treatments.	Feasible with suitable blade and power.	Adequate with angled blade. Lacks speed and control of grader.	Grader excellent. Front-end loader or backhoe useful for localized heavy work.
Culvert cleaning	Excellent.	Usually unsuitable.	Not suitable.	Usually unsuitable.
Culvert removal, repair, or replacement	Feasible with polypropylene pipe, metal pipe more difficult.	Adequate for light work.	Adequate.	Backhoe excellent. Front-end loader adequate for light to moderate tasks.
<b>Roadsides</b>				
Slump and slide cleanup	Suitable for spot treatment of very small problems.	Adequate for light to moderate work.	Adequate.	Backhoe and front-end loader excellent.
Erosion seeding and planting	Suitable for small areas.	Suitability depends on available attachments.	Not suitable.	Specialized seeding and planting equipment excellent, but costly.
Vegetation control	Suitable for small areas.	Mower attachments may be adequate to excellent.	Not suitable.	Truck-mounted sprayers and other specialized equipment excellent, but costly.
<b>Traffic control</b>				
Construction of water bars, road dips	Not suitable.	Adequate for light to moderate work.	Adequate.	Backhoe, front-end loader may be adequate.
Tillage of road surfaces	Not suitable.	Adequate to excellent for light to moderate work with tillage attachments.	Adequate to excellent for moderate to heavy work with tillage attachments.	Usually unsuitable.

and financial resources, and the equipment you have available to you. The information in table 1 can provide some initial ideas about what tasks you may be able to perform.

If you decide that outside help is necessary to do all or part of the work, you will need to find a suitable operator, develop a work contract, and check the work as it progresses. *Road Construction on Woodland Properties* (Extension Circular 1135; see "Further reading," page 11) includes some guidelines that can be useful when taking these steps.

Be sure to consider other forestry and construction activities on your property when road maintenance is needed. If you are planning a logging operation, include road maintenance as part of the logging contract. The heavy use that your roads will receive during logging makes this an important contract requirement.

For example, logging contracts can include provisions for water bar construction or soil tillage on roads that are scheduled for closure.

If new roads are to be constructed on your property, consider establishing a maintenance contract with the operator who constructs the roads. Talk to neighboring landowners about joining together to hire a contractor to reduce the cost of operations like grading.

### **Get the job done!**

Do not delay necessary maintenance work. You will have more flexibility, of course, when dealing with maintenance needs that are

identified during the dry season.

However, even at this time excessive delays can cause certain problems (such as potholes or overgrown vegetation) to become worse.

During wet weather, delays in cleaning a blocked culvert or ditch quickly can result in a damaged road section that will require costly reconstruction. Include provisions for rapid treatment of emergency situations in your road maintenance plan. Making advance contacts or agreements with local contractors or equipment suppliers can help reduce frustrations and costs when emergencies do arise.

### **Keep good records**

Finally, woodland properties and operations differ enough from one to another that experience can be a highly valuable guide for future activities. Keep good records of your maintenance operations—type, location, timing, and cost. Talk to other woodland owners in your area about their experience in maintaining their roads.

With good records and exchange of local information, you will be much more likely to find the most cost-effective and environmentally acceptable plan for maintaining your woodland road system.

## **Maintenance activities**

### **Road surfaces**

#### **Road Grading**

Maintaining the road surface helps insure that water moves quickly to the roadside, and it keeps road strength and trafficability adequate for the intended use. Most serious damage to road surfaces starts with excess water, so special attention to surface drainage maintenance is a worthwhile investment.

Roads normally are constructed with a crown or side slope for surface drainage, but vehicle traffic and conditions like freezing and thawing can quickly reduce their effectiveness (see figure 2). Road grading repairs these drainage features and smooths out ruts and potholes that affect road strength and trafficability.

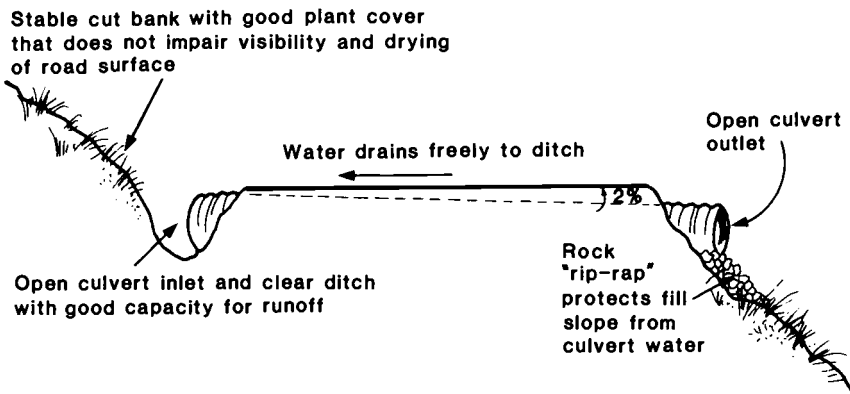
*Road graders* are the most effective machines for grading activities. These vehicles use a wide blade underneath the chassis to shape and smooth the road surface (figure 3).

Although a *bulldozer* is less efficient than a grader, you can use one with a blade for road grading. Where only minor surface repairs are needed, you can use a truck or farm tractor to pull a *road drag*.

This is simply a heavy wooden or metal platform that is pulled along to smooth the road surface and fill in ruts. Regardless of the type of equipment used, the blade or edge used for smoothing and shaping should be kept even and sharp to insure the effectiveness and accuracy of the resurfacing operation.

Conduct your grading operations between late spring and early fall, when the soil is neither dusty or muddy. Soils that are slightly moist are more readily shaped and compacted by grading machinery.

## WELL - MAINTAINED ROAD



## POORLY MAINTAINED ROAD

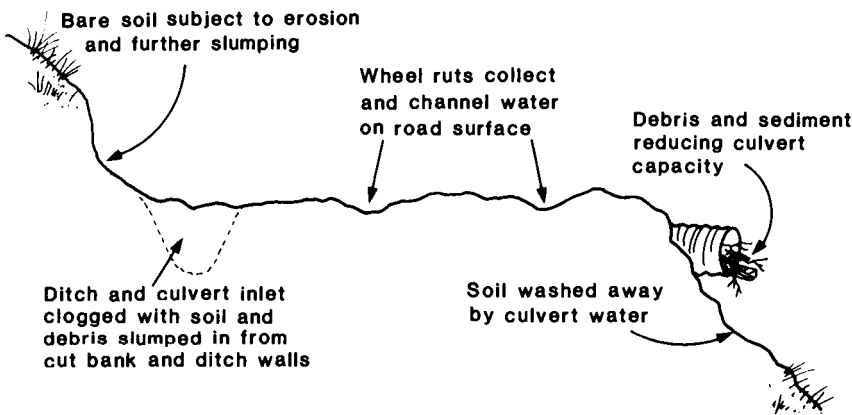


Figure 2.—Examples of some important differences between well-maintained and poorly maintained woodland roads

Potholes and ruts often show up during and just after winter, so early grading operations may be necessary to avoid problems from spring rains. Where winter and spring rutting are less of a problem, grading operations just before the fall rainy season may be most effective.

Grading more than once a year may be necessary on roads used for log hauling or other heavy activity. Heavy traffic can damage road dips and other special drainage features (see *Designing Woodland Roads*, Extension Circular 1137; see "Further reading," page 11, for further information); these should be fully restored before the rainy season. Even on lightly used roads, special

attention may be needed on steep sections or curves where added wear takes place.

Although quite expensive at the start, rocking heavily used roads or problem areas can substantially reduce maintenance requirements. Other potential benefits of rocked roads include extended road life and season of use, improved safety and trafficability, and decreased erosion problems. More information can be found in *Rocking Woodland Roads* (Extension Circular 859; see "Further reading," page 11).

Before the grading operation, it may be necessary to loosen hardened or heavily rutted road surfaces mechanically. A bulldozer or grader with a set of ripper shanks is effective, but you can use a front-mounted brush blade.

Where potholes remain or ripping cannot be done, fill holes with crushed gravel and compact them. Pothole repair is most effective and permanent when the road is relatively dry, but emergency repairs during other periods often can prevent more serious damage.

During the grading, be careful not to waste road material into drainage ditches and onto fill slopes. This is especially important in steep terrain where loaded fill slopes are likely to cause landslides.

Operations that generate excessive spoils may eventually alter the road profile to a point where reconstruction is necessary. Over-grading on rocked roads can wear down or displace costly rock surfacing.

In addition, excess grading spoils along roadsides can smother stabilizing vegetation and can be highly susceptible to erosion. Roadside soil piles from grading may restrict necessary road drainage. In some situations, however, planned berms are desirable for routing of drainage

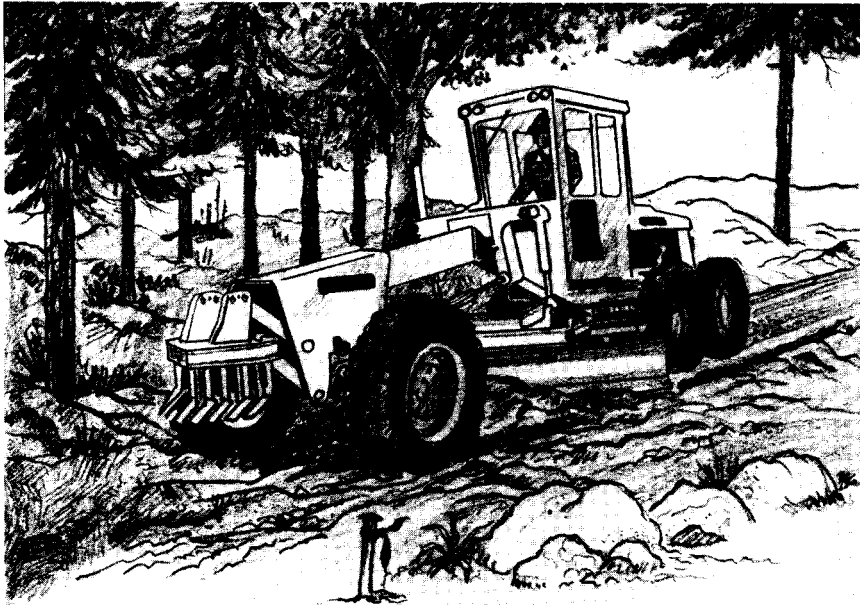


Figure 3.—A road grader at work

water, and these should be preserved or repaired.

You can minimize overgrading and related problems through slow, controlled use of the grader or other machinery. This can also help protect culvert installations, which can decrease flow capacity and strength when damaged by heavy machinery. You can further limit damage to ditches, culverts, cutbanks, and fills by insuring that the grader stays on the running surface of the road during operation.

#### **Chemical applications**

Application of chemicals such as oil or salt represents another type of maintenance activity for road surfaces. Used crankcase oil often is used to reduce dust problems during dry weather. Surprisingly large amounts of road surface can be lost as dust, so this practice also serves to decrease rutting.

Special assistance and equipment may be needed, however, and these applications can be costly if more than a limited area requires treatment.

In addition, since oil can be a serious pollutant in streams and other water bodies, it is important to observe some application guidelines. For example, do not apply oil to a poorly graded road, if rain is expected, or in cold weather (less than 55°F). Apply oil only where it is needed. Do not apply it heavily or

spill it. Do not apply near streams and drainages; such areas can be identified to the applicator with roadside flagging.

Various salts can be used for the same purposes as oil, or they can serve as deicing agents. Both uses can be costly. Since these compounds can also act as pollutants, follow the application guidelines above. Where you use salts for road deicing, consider plowing or sanding as possible alternatives.

#### **Snow plowing**

Snow plowing may be necessary for access on some woodland properties. Plowing should not disturb the running surface of the road, so it is usually desirable to leave some snow to protect the surface. Four-wheel drive vehicles or farm tractors with plow attachments can be effective and economical, but bulldozers and graders may be needed where snows are deep.

Road graders have more control than bulldozers and are less likely to disturb the road surface. Avoid piling snow in ditches and drainages; rather, move snow to well-drained locations on the road shoulder.

Finally, you should recognize that snow plowing can increase the need for other types of road maintenance, because the roads are accessible when they are especially susceptible to damage (for example, during spring thaw).

## Drainage structures

Ditches, culverts, and other drainage features are designed to handle the water that runs off the road surface and the surrounding landscape. All must be maintained to function properly. Gulying, landslides, and other major problems along forest roadways often can be traced to drainage structures that no longer move water properly because of inadequate maintenance.

### Ditch cleaning

Just after construction, roadside ditches usually are adequate to handle most drainage requirements. As time passes, however, ditch walls and road cut banks often slump down into the ditch (see figure 2). Debris may also collect in ditches when nearby areas are logged, or vegetation may block the flow of water.

An open ditch is essential for good road drainage, so ditch cleaning is the most important and common ditch maintenance activity. On many woodland properties, some hand shovel work can be very effective in clearing small slumps and obstructions that block drainage water. This approach is also unlikely to disturb any nearby stabilized soil or vegetation.

For larger ditch cleaning tasks, heavy equipment may be necessary. Graders are often chosen because the same equipment can be used for both ditch cleaning and road grading. Standard procedure with a grader is to angle the blade so that the corner cuts and clears a V-shaped ditch. One set of grader wheels may be set in the ditch to help keep the vehicle oriented and the ditch well compacted.

You can use bulldozers or farm tractors with blades like a grader to clear ditches, although bulldozers have less control. Front-end loaders and backhoes may be useful for heavy cleaning tasks like large cut bank slumps, but these machines are rather slow and inefficient for more extensive routine cleaning.

Keep in mind, though, that heavy equipment is not always necessary nor desirable for many important ditch cleaning jobs.

The soil and weather conditions that are desirable for grading are also desirable for ditch cleaning. Slumps and other localized ditch obstructions, however, may require treatment as soon as you discover them, to avoid more serious problems. This situation often occurs during wet weather, and it is especially important to take extra care in using heavy equipment at this time.

Recently constructed ditches often require more maintenance than those that have had time to stabilize. Logging also may increase ditch maintenance needs because of the debris it generates and the heavier road usage it requires.

Regardless of the age or use of the road, *inspect ditches regularly* during the rainy season. Existing and potential problems are most obvious at this time, and this information can help you focus your resources most effectively.

Look for blockage and overflow problems. They may indicate the need for ditch or culvert cleaning, larger ditches or culverts, or more culverts. Ditchline erosion may show a need for more or larger culverts—or some type of ditch stabilization such as compaction or armoring with gravel or rock.

During ditch maintenance operations, avoid disturbing stable, vegetated ditches and roadsides, unless drainage clearly is reduced or obstructed. Disturbing stabilized areas actually can *increase* erosion and maintenance problems.

A common problem occurs when the ditch is cut too deeply into the cut bank during cleaning; this promotes slumping of the bank slope.

Avoid damage to culvert inlets during ditch maintenance operations, to sustain their function and capacity. Mark culvert locations with strong, stable stakes and flagging to reduce this type of damage.

### Culvert cleaning

The most important type of maintenance for culverts is prompt removal of any material that restricts water flow. Clear woody debris, leaves, mud, and gravel from within the culvert and from the inlet and outlet.

Large debris is especially important to remove because it can greatly reduce water flow by itself and by trapping additional material—and it is unlikely to flush through the culvert.

Hand cleaning of culverts (figure 1) is best because it reduces the possibility of structural damage. At a minimum, inspect and clean culverts just before each rainy season.

Inspection and cleaning during wet weather can be effective in preventing more serious problems, and these activities may be required in logged areas and other problem locations.

Marked culvert locations can substantially improve the efficiency of inspection activities, as well as help to reduce damage from heavy equipment.

Certain preventive measures can be used to reduce culvert problems and the need for cleaning and other maintenance. For example, drainages and ditches that supply water to culverts should be cleaned of floatable debris for no less than 20 feet above the inlet, and preferably 100 to 200 feet above it.

This cleaning can be especially effective near recently logged areas and landings. Another approach is to install some type of rack or grate at the inlet to catch material before it becomes trapped or wedged within the culvert. These *trash racks* will require regular cleaning, but this work should be quicker and easier than cleaning the culvert itself.

Road grading and ditch cleaning activities may also damage culvert inlets and outlets. Repair this damage quickly, to reduce clogging and maintain pipe capacity. Occasionally, a culvert may be damaged so severely that you must replace it. A lightweight polypropylene culvert can be a suitable replacement for metal pipe, and it is much easier to handle and install.

In addition to regular cleaning, be sure to maintain the area near each end of the culvert. For example, scouring of soil at the culvert inlet or outlet can become increasingly worse if you do not remedy it in some way. Rock *rip-rap* can be used to armor such areas against further erosion (see figure 2).

Avoid waterfalls at culvert outlets, because falling water is a powerful force for erosion. If this occurs, you will probably need extra rip-rap to absorb the energy of the water, or you can add a culvert half-round to extend from the outlet down to stable ground.

## **Bridges**

Bridges present some special maintenance requirements in the woodland road system. Regular inspection of abutments and immediate repair of any damage are essential. For safety and to prevent excess wear, keep the running surface free of soil and debris, preferably using hand tools or light equipment.

Keep bridge approaches well-drained and graded (with grading conducted *away* from the bridge). Rocking of bridge approaches can be helpful in reducing surface soil and debris problems and related maintenance needs.

## **Roadsides**

Maintenance activities along roadsides on woodland properties are aimed primarily towards erosion problems, vegetation establishment, and vegetation control. Cut and fill slopes created by road construction can be steep, lacking in vegetation, and subject to altered drainage patterns.

Each of these conditions can promote erosion. In other areas, there may be too much roadside vegetation, creating visibility and safety problems and delaying drying of the road surface.

### **Slumps and slides**

In steep terrain, slumps and slides sometimes occur on cut-and-fill slopes, blocking ditches (figure 2), and other drainages—providing a sediment source for nearby streams. Clean these up promptly, especially during wet weather; transport the slide spoils to a location where they will not create additional erosion problems.

However, in some instances (such as certain fill slope slides) it may be best to leave the slide area as is, since any added disturbance may cause further instability. Professional assistance (Oregon forest practices forester, consulting engineer, etc.) may be needed to properly judge questionable situations.

Areas where roadside slides occur frequently may require special measures to prevent further instability. Added provisions for drainage may be effective; consider installing more culverts or various types of subsurface drains.

Piles of large (greater than 6 inches in diameter), sharp-angled rock added to the base of unstable cut banks may also be helpful. Proper use of these and other stability techniques often requires significant engineering expertise and expense, however.

### **Erosion control vegetation**

Slide scars and other areas of exposed soils along roadsides are very susceptible to gullying and other erosion problems. Vegetative cover can help stabilize these areas by shielding the soil from raindrop impact and holding it in place with a well-anchored root system.

If natural vegetation does not quickly invade and cover areas of exposed soil, it may be necessary to make erosion control seedings or plantings. Renewed efforts to establish erosion control vegetation are sometimes needed where initial efforts after road construction or other disturbance have failed or have had only partial success.

Grasses and other low-lying vegetation usually are most desirable for roadside erosion control. A mix of species can be used to help insure



establishment and possibly provide forage for wildlife or livestock.

It is important to match the plant species to local soil and climate conditions and to seed or plant when establishment is most likely, (usually in the spring or fall when temperatures are moderate and the soil has sufficient moisture). Fertilization and mulching of exposed soil with straw or other material can also improve establishment, although repeated applications may be necessary.

You will find more specific information on successfully establishing erosion-control vegetation in the publication *Seeding to Control Erosion Along Forest Roads* (Extension Circular 885; see "Further reading," page 11). Local offices of the Soil Conservation Service and the Agricultural Stabilization and Conservation Service also can provide helpful advice, particularly in recommending species and practices that are likely to be most successful in your area.

Vegetation will not solve every erosion problem. Large slides, for example, can take place in unstable terrain, whether or not vegetation is present. Deep gullies are often difficult to stabilize with vegetation, and instead these may require filling with rock or gravel or some type of check dam structure.

Again, it may be necessary for you to seek professional assistance to evaluate and remedy such problems.

### Vegetation control

In some locations (especially in western Oregon), roadside vegetation may become so overgrown that some type of vegetation control is necessary. Such control can help improve vehicle safety because of increased visibility. It can reduce road surface maintenance and improve trafficability because roads exposed to the sun and wind are likely to dry out faster.

Water flows more easily in ditches that are no longer clogged with vegetation. Be careful, however, to balance vegetation-control activities with provisions for sufficient cover for erosion protection.

Roadside vegetation control is usually done manually, mechanically, or with chemical herbicides. You can use chain saws and pruning saws to cut back larger woody vegetation; machetes may be helpful in clearing small areas of brush.

Where roadside brush is especially heavy or extensive, you may need chemical herbicide applications or a mechanical mower attached to a tractor or similar vehicle.

For chemical applications, be sure to comply with all of the necessary legal requirements for intended use, applicator licensing, and application technique. *Follow the manufacturer's instructions exactly.* This is particularly important in roadside spraying because chemicals applied in these areas may move quickly in drainage water to nearby stream systems. As an extra precaution, you can flag areas near streams and other major drainages and leave them unsprayed.

### Traffic control

Restricting vehicle traffic on all or part of your woodland road system can be an effective way of reducing maintenance needs, provided that you take adequate steps before actually restricting traffic.

The specific steps that will be necessary will depend on the level of traffic control that you choose: full road closure, temporary or seasonal closure, or road open but restricted to only light use.

In selecting a suitable level of traffic control, consider such questions as:

- Is access for fire control and forest protection important?
- Will I harvest timber in the near future?
- Is access needed during the rain or snow season?
- Is access important for land management or recreation?
- Is there a problem with unauthorized road usage by recreationists or others?

You may also need to ask these questions about different parts of your road system, assigning controls that are best for specific areas.

Remember that woodland roads with any degree of traffic control still require at least periodic inspection for existing or potential maintenance needs. General maintenance will be lessened, but still needed occasionally, especially on roads with light or intermittent use. Considerable work may also be necessary to reactivate a road that has been closed for some time.

Be sure to judge carefully all of the implications of a decision for traffic control, especially full road closure. Roads that are no longer usable can reduce the value of your woodland ownership, and they can limit your available options for managing your property.

### **Traffic barriers**

An important step with any level of traffic control is to limit road access in some way. Voluntary traffic control is fine if you get a firm commitment from everyone who uses your roads, but in many instances some means of physically blocking access will be necessary.

Gates have the advantage of allowing quick access if the need arises, or if traffic control is only temporary. Gates tend to invite vandalism, however, so they should be sturdy enough to withstand considerable abuse.

Vehicles should not be able to drive around the sides of a traffic control gate. You can use large cull logs, stumps, and root wads to block areas next to a gate—or these can serve instead of a gate. These materials should be well-anchored so that a truck winch can't move them.

An effective alternative to wood barriers or gates is a large berm or trench feature. Regardless of the type of barrier that is used, it should allow access at least with a bulldozer in case of an emergency.

Where unauthorized vehicle traffic is a particular problem, you have the legal authority to close your private road to such use. This further discourages access because persons who disregard road closure notices can be fined, jailed, or both. You may wish to seek legal advice before implementing this type of road closure and enforcement.

Although livestock movement and grazing are not normally thought of as "traffic," they can damage road surfaces and cut-and-fill slopes, when they are excessive. In areas where livestock are present, consider such measures as cattle guards and fences to reduce road impacts and maintenance needs.

### **Temporary closure or light use**

Temporary road closure or restricted light use are usually the best choices for traffic control on most woodland properties. Limited access or use over the wet season can be especially effective in reducing road damage and related maintenance.

Also, these levels of traffic control often require nothing more than the installation of one or more traffic barriers. For extended periods, however, additional preparation is usually needed for closing roads.

Depending on how long you will close your road—and the need for access—you may want to remove or replace some of the road drainage structures and crossings to reduce maintenance. For example, you could remove a temporary stream crossing or replace a culvert with a road dip.

Be sure to evaluate culvert installations carefully, however, because it is often best to leave them in place and deal with some occasional maintenance. This is especially true for larger and deeply set culverts.

### **Full road closure**

Roads that you will fully close require the greatest preparation, but they will need little maintenance afterward. Again, it is important to determine what modifications you will need in the road drainage system.

Water bars and outsloped road surfaces are often desirable choices for drainage of closed roads. These features are described in *Designing Woodland Roads* (Extension Circular 1137; see "Further reading," page 11). Construction of both features generally requires the use of machinery like a bulldozer or a farm tractor with a blade.

Space water bars at least as closely as the original culverts or dips—more closely in areas that are especially likely to erode.

Construction of water bars should progress from the end of the road in towards the beginning, to minimize damage of constructed bars by moving the equipment in and out. All new drainage features should be constructed and stable before the rainy season.

Another consideration for fully closed roads is revegetation of the road surfaces to help control erosion. Some natural revegetation may occur, but heavily compacted road surfaces are usually a harsh environment for plants.

It may be necessary to till these road surfaces mechanically to improve conditions for plant establishment and growth. This can be done with such implements as ripper shanks, brush rakes, or agricultural blades mounted on bulldozers or tractors.

Tillage operations and the use of heavy equipment can be coordinated with water bar construction activities for the best equipment use and to prevent damage to the water bars. Tillage operations conducted while the soil is relatively dry usually are most effective in breaking up hard surfaces. Tillage can be followed by seeding or planting to further assist vegetation establishment.

Remember that reactivating a fully closed road may involve quite a bit of work. Culverts, ditches, and the original surface grade may need reconstruction. Control of overgrown vegetation is also a common requirement on reactivated roads.

## Further reading

For OSU publications, enclose the amounts indicated and send your order to Bulletin Mailing Office, Oregon State University, Corvallis 97331.

Adams, Paul W., *Soil and Water Conservation: An Introduction for Woodland Owners*, Oregon State University Extension Service Circular 1143 (Corvallis, 1983). 25¢ plus 25¢ postage.

Adams, Paul W., *Soil Compaction on Woodland Properties*, Oregon State University Extension Service Circular 1109 (Corvallis, 1983). 50¢ plus 25¢ postage.

Berglund, Erwin R., *Seeding to Control Erosion Along Forest Roads*, Oregon State University Extension Service Circular 885 (Corvallis, 1978). 75¢ plus 25¢ postage.

Berglund, Erwin R., and Marvin Rowley, *Rocking Woodland Roads*, Oregon State University Extension Service Circular 859 (Corvallis, 1975). 25¢ plus 25¢ postage.

*Field Guide to Oregon Forest Practice Rules*, State of Oregon, Department of Forestry (revised periodically; available from Salem or local OSDF offices).

Garland, John J., *Designing Woodland Roads*, Oregon State University Extension Service Circular 1137 (Corvallis, 1983). \$1.75 plus 25¢ postage.

Garland, John J., *Planning Woodland Roads*, Oregon State University Extension Service Circular 1118 (Corvallis, 1983). 50¢ plus 25¢ postage.

Garland, John J., *Road Construction on Woodland Properties*, Oregon State University Extension Service Circular 1135 (Corvallis, 1983). 75¢ plus 25¢ postage.

*Road Maintenance*, State of Oregon, Department of Forestry, Forest Practice Note 4 (1981).

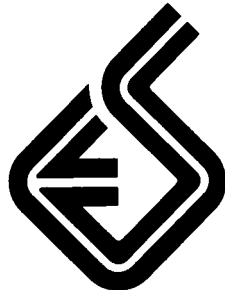
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**The Woodland Workbook** is a collection of more than 50 publications prepared by the Oregon State University Extension Service specifically for owners and managers of private, nonindustrial woodlands. The *Workbook* is organized into 10 sections containing information of long-range and day-to-day value for anyone interested in wise management, conservation, and use of woodland properties. The sections are Management Planning, Forest Measurements, Reforestation, Stand Management, Logging, Marketing Forest Products, Multiple Use, Forestry Issues, Business Management, and Woodland Assistance.

Although each woodland publication is intended to be complete in itself, you may wish to purchase the entire set in a three-ring *Woodland Workbook* binder with tabbed dividers for each section. If you wish to purchase only the three-ring binder for filing copies of our woodland publications, you may obtain the binder and dividers as a package. Or you may purchase individual *Workbook* publications as you need them.

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**Extension's forestry program** improves Oregonians' knowledge of forest resources and their options for expanding benefits from these resources. This educational program assists forest owners, managers, processors, and users in understanding small woodland production and management and use of all forest lands. Priority subjects are reforestation, growth, management, harvesting, processing and use of wood, protection of soil and water, and other multiple uses and values.

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**This publication** was prepared by Paul W. Adams, Extension watershed management specialist, Oregon State University.

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