FORESTRY OPERATIONS (FWM 413)

Roads, skid trails and landings are all part of a forest transportation system. Roads connect the forestland to existing public roads. They provide forest access for such activities as managing timber, improving fish and wildlife habitat, fighting fires, and recreation. Forest roads located, constructed or maintained poorly are the largest source of non point source pollution from forest management activities. Roads over steep slopes and stream crossings hold the greatest potential for degrading water quality. There are three types of forest roads: temporary roads, permanent seasonal roads, and permanent all-season forest roads. Make sure to identify the type of road system you need during your planning phase.

• **Temporary Roads:** These are the most common type of forest road. They are designed and constructed for short-term use during a specific project such as timber harvesting. These roads are used only when the ground is frozen or firm. When the project is complete, the temporary road is closed, all stream crossing structures are removed, and the road is
naturally or artificially replanted with trees.

• **Permanent Seasonal Roads:** These are maintained as part of the permanent road system, seasonal roads are designed for use only when the ground is frozen or firm. These roads are generally narrower than all-season roads, built to lower engineering standards, and have minimal surface gravel.

• **Permanent All-season Forest Roads:** These roads usually have gravel surfaces and are designed for year-round use. However, there may be some restrictions on use at various times of the year.

Integrated Resource
Management Considerations

A well-planned access system is a sound method of reducing erosion and sedimentation in areas requiring frequent or temporary access. Proper location and construction of roads will provide for safety, longer
operating periods, lower maintenance and operating costs, and minimal impacts to forest resources. Servicing as many acres of forest with as few roads as possible is a sound method of reducing impacts to forest resources from road construction.

FACTORS IN DECISION-MAKING

• The number, size and design of forest access roads will be influenced by the frequency of access, amount of anticipated traffic, seasons during which access is required, and safety concerns.

• Distribution of necessary management activities will affect the number and location of access roads.

• Choices regarding road construction standards and
maintenance activities will be influenced by site characteristics, and the value of the resources served. Culverts and ditches may be necessary with any road construction technique.

• Surfacing can be the major cost of low-volume road construction. Alternatives should be evaluated according to expected use and potential impact on sediment load. Where grades make the potential for surface erosion significant, the road should be surfaced with materials such as crushed rock, compacted gravel, sod, or asphalt that will minimize
potential water quality and soil productivity impacts.

MINIMIZING THE IMPACTS OF ROADS

• Visual impacts and excessive noise can result from poor design, construction and maintenance of forest access roads. Take into account the following considerations when planning to reduce noise and visual impacts associated with the design and use of forest access roads:

- Noise from traffic, especially large trucks, buses and heavy equipment.
- Potential increased costs of building forest access roads to accommodate visual quality concerns, and potential increased costs of using existing roads that require travelling greater distances.
- The limited road construction season that generally coincides with the tourist season.
- Traffic during wet periods that can increase maintenance needs, and create unsightly ruts and mudholes.

• Visual impacts and noise impacts created by gravel pits are not compatible with recreational user sensitivities. Take into account the following considerations when planning to reduce noise and unsightliness related to gravel pits:

- Local sources of gravel are necessary for efficient, cost-effective road building and maintenance.
- Recreational use of gravel pits may cause conflicts.

• Site-specific soil, topographic and forest inventory information will assist resource managers or landowners in planning road location and layout.

• Because roads take soils out of production, effort should be made to keep the length and width of roads to a minimum without sacrificing safety.

• To minimize road mileage and reduce costs, coordination with adjacent landowners may be desirable.

• The greatest potential for soil erosion occurs immediately after construction. Disturbed areas should be shaped and stabilized as soon as possible to minimize erosion potential.

• Seed disturbed areas (landings and skidroads) as soon as feasible in order to re-establish desirable species, and retard possible invasion by non-native invasive species.

ROAD MAINTENANCE NEEDS

• The purpose of maintenance procedures is to ensure measures taken to minimize impacts on forest resources are working, and continue to work into the future. Surfacing materials and the amount of use determine the level of maintenance required.

• Roads that are open for use require more maintenance than roads that are closed to vehicular traffic. Inactive roads (roads currently not in use) whether closed temporarily or permanently, require occasional work
to reduce potential impacts on streams, lakes, wetlands, and seasonal ponds.

• Road layout, construction methods and erosion, and access control all contribute to the longevity, utility, safety, and maintenance cost of roads.

• Monitor for non-native invasive species, control their spread, and eradicate them if possible. Clean equipment as needed.

PROTECTING WATER QUALITY AND WATER FLOW

• Incorporating guidelines to protect water quality into overall road project design can minimize the potential impact of wetland roads on water quality, as well as alterations to normal water flow patterns.

• Effective road construction techniques minimize the disturbance to the natural flow of water over the landscape, and ensure the structural integrity of the road embankment. The goals are to provide a simple road structure of adequate strength to support heavy vehicle traffic, and provide drainage structures to pass water at its normal level through the road corridor.

UPLAND FOREST ROADS

Decisions made at the planning stage will affect a road's construction costs, long-term maintenance needs, service life, and the amount of non-point source pollution it causes. Loggers and landowners should plan, locate and design the road system together.

1. Plan road systems that minimize the number, width and length of roads to limit the total area of the site disturbed. Remember to:
- Consider future uses of the road system
- Coordinate development with adjoining landowners when possible; and
- use temporary roads where practical

2. Use existing roads when they provide the best long-term access. Consider relocating existing roads if doing so improves access and reduces environmental impacts. Reconstruct existing roads to provide adequate drainage and safety. Do not disturb stable road surfaces.

3.Select road locations that allow for drainage away from the road.

4. Minimize the number of stream crossings.

5. Identify optimum stream crossing locations before locating the rest of the road. Optimum locations include straight and narrow stream channels
with low banks and firm rocky soil. Roads should approach streams with the least gradient possible.

6. Where possible, locate roads on well-drained soils.

7. Locate roads outside riparian management zones except at stream crossings.

8. Road grades should not exceed 10 percent. If road grades greater than 10 percent are necessary, limit grade length to minimize erosion, or break the grade using drainage structures. Graveling the road surface on steep grades can also help maintain stability. Note: Optimum road grades should be less than five percent

9. Locate roads to follow natural contours and minimize cut-and-fills. Balance cut-and-fills to minimize the need for fill or removing excess
Materials.

STREAM CROSSING DESIGN AND CONSTRUCTION

1.Operating equipment in or near perennial or intermittent stream channels may add sediment directly to streams. Stream crossings poorly located or constructed may erode stream banks.

2.As roads approach a stream crossing, proper road drainage is critical to avoid sedimentation in streams. Three common stream crossing structures include culverts, bridges and fords.

3.Stream crossings must be designed, constructed and maintained to safely handle expected vehicle loads and minimize disturbance of stream banks, channels, and, ultimately, aquatic organisms. Consider streambed material, stream size, storm frequency, flow rates, intensity of use (permanent or temporary), and the passage of fish when planning crossings.

FORDS

Use fords for crossing dry streambeds, or where fording would cause minimal water quality impacts.

1. Locate fords where stream banks are low.
2. Streambeds should have a firm rock or gravel base. Otherwise, install stabilizing material such as reinforced concrete planks, crushed rock, riprap, or rubber mats on streambeds.

STREAM CROSSING

1. A permit is required to construct a ford or install a culvert/bridge across any navigable intermittent or perennial stream. A stream is navigable if it has bed and banks, and it is possible to float a canoe or other small craft in the waterway on a regular reoccurring basis – even if only during spring runoff.

2. Use soil stabilization practices on exposed soil at stream crossings. Use seed and mulch, and install temporary sediment control structures such as straw bales or silt fences immediately following construction to minimize erosion into streams. These practices must be maintained until the soil is permanently stabilized

3. Design, construct and maintain stream crossings to avoid disrupting the migration or movement of fish and other aquatic life. Bridges or arch culverts that retain the natural stream bottom and slope are preferred for this reason.

4. Install stream crossings using materials that are clean, non-erodible and non-toxic.

5. Install stream crossing structures at right angles to the stream channel.
6.Minimize channel changes and the amount of excavation or fill needed at the crossing.
7. Limit construction activity in the water to periods of low or normal flow. Keep use of equipment in the stream to a minimum.
8. Construct a bridge or place fill directly over a culvert higher than the road approach to prevent surface runoff from draining onto the crossing structure and into the stream.
9. Divert road drainage into undisturbed vegetation, preferably outside the RMZ, so the drainage does not directly enter the stream.
10. Stabilize approaches to bridge, culvert and ford crossings with aggregate or other suitable material to reduce sediment entering the stream.
11. Anchor temporary structures on one end with a cable or other device so they do not float away during high water. Install them so they can be easily removed when no longer used, regardless of the season.

PIPE CULVERTS FOR STREAM CROSSING

1. Install pipe culverts long enough so that road fill does not extend beyond the ends of a culvert.
2. Install permanent culverts that are large enough to pass flood flows, and are a minimum of 12 inches in diameter. Culverts that are too small can plug up with debris and result in the road washing out, or in flooding upstream. Wisconsin law states that

the landowner and/or contractor are responsible to obtain a flood easement from any affected property
owners upstream of culvert crossings that are not designed to pass the 100-year flood.
3. Install culverts so there is no change in the stream bottom elevation. Culverts should not cause damming or pooling.
4. Firmly compact fill material around culverts, particularly around the bottom half. Cover the top of culverts with fill to a depth of one-third of the pipe diameter or at least 12 inches, whichever is greater, to prevent crushing.
5. Use riprap around the inlet of culverts to prevent water from eroding and undercutting the culvert. For permanent installations, use filter fabric under the riprap. In addition, consider using flared-end culvert sections for inlets .
6. Keep culverts clear and free of debris so that water can pass unimpeded at all times. This is especially important in areas where beaver are present.

ROAD CONSTRUCTION AND DRAINAGE

The most effective method to control erosion on forest roads is to keep water from accumulating on the road surface. Fast-moving water can easily erode soil from road surfaces and ditches, but road erosion can be
controlled when water drains off the road surface, and is dispersed into vegetation and ground litter.
1.Design and construct roads to remove water from road surfaces to keep roads dry and structurally sound.
2. Construct stable cut-and-fill slopes that will regenerate easily, either naturally or artificially.
3. Do not bury debris in the road base. It causes uneven settling that can lead to erosion and frost-heaving that creates mud holes.
4. Compact the road base material or allow it to settle before using the road to reduce the amount of water that soaks into it. This will increase the road's carrying capacity, reduce road maintenance, and reduce erosion.
5. Surface the road with gravel where steep grades, erodible soils or high-traffic volume make the potential for surface erosion significant.
6. Locate gravel pits outside RMZs using proper location, development and soil stabilization practices to minimize erosion from the pits.

DRAINAGE STRUCTURES

Road-drainage structures include cross-drains (pipe culverts, open-top culverts, broad-based dips, and waterbars) and water-diversion structures. Cross-drains allow water from roadside ditches to move from one side of the road to the other.
1. Where necessary to protect water quality, install road-drainage structures to remove storm water or seepage from the road surface and ditches. Space these structures at intervals close enough to minimize waterflow volume and speed, avoiding ditch erosion. As road grades increase, use drainage structures more often
2. Where necessary, provide erosion protection for outflows from road-drainage structures to minimize erosion and disperse the water, allowing it to soak into the soil. Riprap, mulch and/or seeding may be necessary

PIPE CULVERTS FOR CROSS-DRAIN

1. Install pipe culverts to provide cross-drainage on road grades at regular intervals immediately above steep grades, below bank seepages, and where water will run onto log landings or forest roads.
2. Install pipe culverts long enough so that road fill does not extend beyond the end of a culvert.
3. Install cross-drain pipe culverts at grades at least two percent more than the ditch grade, and angled30º to 45º to improve inlet efficiency
4. Select the size of cross-drain culverts according to the size of the road and area drained by the ditch. To avoid clogging, permanent culverts should be at least 12 inches in diameter.
5. Install pipe culverts on a surface of compacted granular material. Firmly compact fill material around culverts, particularly around the bottom half. Cover the top of the culvert with fill to a depth of one-third of the pipe diameter, or at least 12 inches (whichever is greater) to prevent crushing.
6. Use riprap around the inlet of culverts to prevent water from eroding and undercutting the culvert.

OPEN TOP CULVERTS

Open-top culverts provide cross-drainage and road-surface drainage, and are usually installed on seasonal or temporary roads
1. Install open-top culverts to provide cross-drainage immediately above steep grades, below bank seepages, where water will run onto log landings or forest roads, and on road grades at regular intervals.
2. Clean open-top culverts frequently since they easily

BROARD BASED DIPS

Broad-based dips can provide cross-drainage and road-surface drainage for roads and skid trails with a gradient of 15 percent or less. Broad-based dips can be used instead of culverts, usually at lower cost and with lower maintenance. Dips are not used for draining seeps, or for intermittent or permanent streams
1. Construct broad-based dips deep enough to provide adequate drainage and wide enough to allow trucks and equipment to pass safely.
2. Place a surface of crushed stone or gravel on the dip, and mound for soils and conditions where rutting may occur. A waterbar is a shallow trench with a mound (or berm) which provides cross-drainage and intercepts runoff from skid trails, recreational trails, firebreaks, or inactive or closed roads. Constructing a waterbar will minimize erosion and provide conditions for natural or artificial regeneration
3. Place waterbars at a 30º to 45º angle with a cross-drainage grade of two percent.

SOIL STABILISATION

Soil stabilization practices are used where soil is exposed, and natural regeneration is inadequate to prevent soil erosion and subsequent sedimentation into streams, lakes and wetlands. This occurs during
road construction, and when the road system is being used (active) or is closed (inactive). Practices include mulching, seeding, and installing sediment control structures.

It is always more efficient and cost-effective to prevent erosion than to repair damage after the fact.

MULCH AND SEEDING

Mulch such as straw, woodchips or bark, retains soil moisture important for seed germination, and protects the soil surface from erosion due to runoff and raindrop impact. Mulch can be used to:

1) promote natural regeneration or

2) protect seeds spread over an area.

If you seed, apply mulch immediately afterward. Netting may be necessary to hold mulch in place on steep slopes or on areas where water flow concentrates.

Seed mixtures should include fast-growing species for quick soil protection, plus perennial species for longer soil protection until native vegetation returns to the site.

Do not use mixtures that contain aggressive or non-native invasive species like reed canary grass, birds-foot trefoil, crown/hairy vetch, or tall fescue; use certified weed-free seed.

DIVERSION STRUCTURES

Diversion ditches, or berms, divert water away from roads and side ditches, and channel it into vegetation. These structures are often used before stream crossings to ensure that water will be diverted into vegetation, and not directly into a stream, lake or wetland

1. Construct diversion ditches so they intersect the roadside ditch at the same depth, and are outsloped one to three percent.

2. Use mulch and/or seed where necessary to minimize soil erosion into streams, lakes and wetlands.

3. Install sediment-control structures where necessary to slow the flow of runoff, and trap sediment until vegetation is established at the sediment source. Sediment-control structures include straw bale fencing, silt fencing and sediment traps. Maintain, clean or replace sediment-control structures until areas of exposed soil are stabilized.

ROAD MAINTENANCE

Roads must be well-maintained or water quality protection structures may quickly degrade. The following routine must be carried out regularly;

ACTIVE ROADS

1. Inspect the road system at regular intervals, especially after heavy rainfall, to detect problems and schedule repairs.
2. Clear debris from culverts, ditches, dips, and other drainage structures to decrease clogging that can lead to washouts. Place the debris where it cannot be washed back into these structures or into open water.
3. Keep traffic to a minimum during wet periods and spring breakup, to help reduce maintenance needs.
4. Shape road surfaces periodically to maintain proper surface drainage. Fill in ruts and holes with gravel or compacted fill as soon as possible to reduce erosion potential.
5. Remove berms along the edge of the road if they will trap water on the road.
6. When dust control agents are used, apply them in a manner that will keep these compounds from entering lakes, streams and groundwater. Consult a qualified road engineer for assistance in selecting the appropriate chemicals and amounts.

INACTIVE ROADS

When forest roads are inactive for extended periods, closing the system will help to protect the road surface and the water quality protection structures. Consider erecting a barrier to traffic such as a gate or berm, and post "Closed" signs at the entrance of temporarily closed roads. Stating the length of time and/or reason for closure, and inviting acceptable uses may be helpful to assure compliance.

1. Remove all temporary drainage and stream crossing structures.
2. Shape all road system surfaces to maintain proper surface drainage, if necessary.
3. Install waterbars where necessary
4. Inspect and maintain road surfaces, permanent drainage and stream crossing structures (ditches, culverts, bridges, etc.) to minimize erosion.

Road planning and location

Planning and location are the most important aspects of road development. Poor planning or location is associated with the following most common causes of road failure (Furniss et al. 1991):

Improper placement and construction of road fills

Insufficient culvert sizes

Very steep road grades

Improper placement or sidecast of excess materials

Removal of slope support by undercutting

Altering drainage by interception and concentrating surface and subsurface flows.

Because roads are long-term features, their location must be carefully chosen, to meet the landowner's need for safe access, avoid long-term maintenance problems, reduce potential for degrading water quality, and minimize costs over the short and long term. At a minimum, road locations should be flagged and approved by the landowner in advance of any construction, including all temporary road locations.

Poor road location can concentrate runoff, which results in increased sedimentation, and can have long lasting effects and create long- term road maintenance problems (Furniss et al. 1991

Know the land

The key to good road planning is to gather as much information as possible on the area to which access is needed. If subcontracting for road building, this recommendation still applies. The subcontractor generally will not know the area as well as you do. In most cases, maps and soils information are available. Contour maps are useful on all but the flattest terrain and can usually be obtained from local, county, or State governments. They are also available from the U.S. Geological Survey. The

USDA Natural Resources Conservation Service (NRCS) will be able to provide soils information for your area.

When initially requesting maps, also request information from the State or county about rights-of-way requirements if the proposed road has the potential of entering onto a State or county road. The necessary right-of-way requirements can be met as you proceed in the planning process.

Map out the road location

After gathering the maps and related information, indicate control points on the maps. A control point is simply a land feature that limits your choice of road location. Control points can force a road through a given location or prevent the road from being built in a given location. The following is a list of control points with some general comments about each one. The list is not all-inclusive and is not intended to be.

Rock outcrops—Cross above or below these. If you have to go through them, see if the rock can be ripped or broken because this will be less costly than blasting.

Ridges—These provide good road locations.

Saddles—Look for these as points to cross ridges.

Benches—These are good road locations and also provide a good point for location of junctions, switchbacks, and landings.

Wet meadows—Avoid. If they have to be crossed, see the section on Recommendations for Wetland Forest Roads.

Sinkholes—Avoid.

Beginning and ending of road—Usually known.

Property lines—Be sure of property line locations.

Streams—Avoid crossing streams, if practical. If unavoidable, look for the best places to cross, considering the following (Furniss et al. 1991):
• Always cross at right angles.
• Cross at points where the stream is narrow.
• Minimize the number of crossings.
• Do not build in the bottom of a draw.
• Leave a buffer zone of undisturbed ground between the road and streambed, where the road runs parallel to the stream.

Approaches to public roads and highways, power lines, or other easements—State, Federal, and county regulations require permits to enter public roadways. Locations of approaches may be restricted for safety or other reasons. Road access easements need to be checked and approved before one proceeds any further.

Other items to consider, which are too broad to be called control points, are aspect and soils.

Aspect—South- and west-facing slopes will usually be drier and free of snow sooner in spring. This may be a minor consideration in your area depending on soils, precipitation, and topography.

Soils—Check the local soil survey to determine the types of soil in your area. Determine which soil characteristics react to road building and how. The county engineer or NRCS engineer can answer questions on soils in your area. Certain plants give an indication of problem soils. Contact your State agronomist for information on indicator plants for problem soils. NRCS may also have information available on plant identification. As these control points are found, locate them on a contour map and label them. You may not find all the control points in the initial investigation, so you should update your map as you progress through the planning process.

Field check the road location

Control point

Begin field checking the road location after it is mapped, by locating on the ground all the control points indicated on the map. This field check involves tying ribbon along the proposed location. The ribbon location is called the tagline, which is located on the approximate grade as drawn on the map. An abney or clinometer that shows percent grade will be needed to transfer the mapped road to the ground. To locate your tagline use a clinometer or abney and tie ribbons at eye level. Move ahead towards the next control point and look back to the previous ribbon, then tie another ribbon at eye level or at the height of the instrument being used. Distance can be determined from the map.

Curves

Two types of curves are commonly found in roads: horizontal and vertical curves. A horizontal curve is needed where the road changes direction. If the direction change is dramatic, the curve will need to be large enough to allow a log truck to negotiate the turn. A vertical curve is created where the grade changes from downhill to uphill or uphill to downhill. Planning vertical curves is also important because they can be made so abrupt that a log truck could high center at a crest. Some simple methods for laying out curves follow. Certain circumstances require switchbacks, which are also described in detail.

Horizontal Curve Layout

Two simple procedures are described for creating a horizontal curve. The first is the center stake method; the second is the stick method. The center stake method is limited to gentle terrain and good visibility. The stick method is more suited to difficult sites.

A curve should always meet the minimum turning requirements of the vehicles expected to use the road. Log trucks require a minimum of a 50-foot radius curve. Flatbed trucks used to haul heavy equipment (lowboys) must have at least a 70-foot radius curve. Grade should be adjusted through the curve to provide for safe handling of heavy equipment

Using a string or tape the length of the radius, find the center of the curve by trial and error (Figure 1). Do this by moving back and forth along the straight road segments (tangents) leading into and out of the curve with the tape at a right angle to the road until a common point, the center, is found. Now scribe an arc along the ground marking the curve. Place stakes at suitable intervals to mark the curve starting at the point of curvature (PC) and ending at the point of tangency (PT)

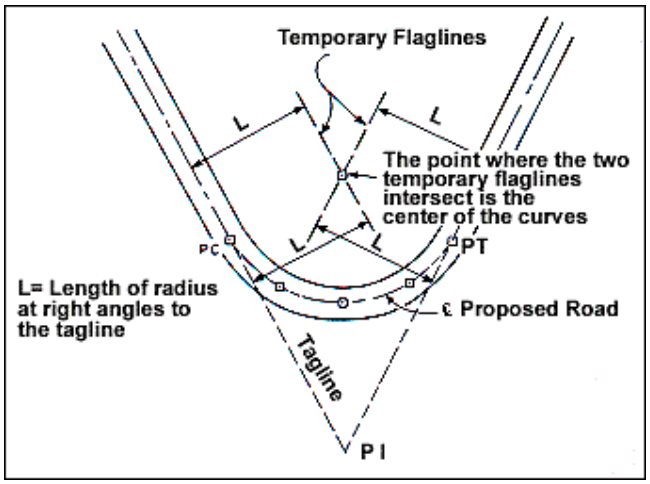

Figure 1. The center stake method of creating a horizontal curve is limited to use on gentle terrain with good visibility. (Redrawn from Figure 2.4-1, Darrach et al. 1981)

Procedure for Horizontal Curve Layout

Two simple procedures are described for creating a horizontal curve. The first is the centre stake method; the second is the stick method. The center stake method is limited to gentle terrain and good visibility. The stick method is more suited to difficult sites

A curve should always meet the minimum turning requirements of the vehicles expected to use the road. Log trucks require a minimum of a 50-foot radius curve. Flatbed trucks used to haul heavy equipment (lowboys) must have at least a 70-foot radius curve. Grade should be adjusted through the curve to provide for safe handling of heavy equipment.

Centre stake method

Using a string or tape the length of the radius, find the center of the curve by trial and error (Figure 2). Do this by moving back and forth along the straight road segments (tangents) leading into and out of the curve with the tape at a right angle to the road until a common point, the center, is found. Now scribe an arc along the ground

marking the curve. Place stakes at suitable intervals to mark the curve starting at the point of curvature (PC) and ending at the point of tangency (PT)

Curve layout-stick method

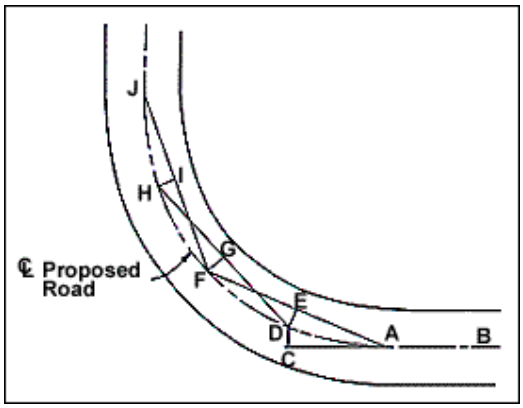

Figure 2. The stick method of creating a horizontal curve is suited to use on difficult terrain. (Redrawn from Figure 2.4-2, Darrach et al. 1981)

Adjusting for Topography and Grade
The horizontal curve layout description assumes the area is flat. Seldom is this the case. Measurements of length must then be adjusted to compensate for slopes.

Where the distance being measured is short, the tape can be held level for one measurement of the entire distance. Where the distance is longer than convenient for this leveling method, measure the distance in segments.
Grade may be maintained around the curve by running a line with the desired slope for the distance of the curve. This line will often be away from the center line of the road due to the topography (Figure 2).

Switchbacks
Where two control points cannot be connected by a road with maximum grade in a single direction, a switchback is required. It is placed at the point where there is enough room to make a switchback. Good switchback sites are areas with little side slope where the loop may be constructed with the least excavation. There should be no more excavation of the hillside above the switchback than is needed to fill along the lower side of the switchback. Reduce the grade of the road coming into and out of the switchback, to help maintain a gentler grade through the curve. The curve itself should not exceed an 8 percent grade. For instructions see Figure 4 and the box on Constructing a Switchback.

ROAD MAINTENANCE

Forest road maintenance should be evaluated in four areas*:* road surface maintenance**,** daylighting**,** drainage, and access control. We'll address each of these considerations to give you a better understanding of what you should look for on your forest road system.

Road Surface Maintenance

Many forest road surfaces consist only of native soil. This earthen surface frequently is adequate, and maintenance is required only when wheel ruts created in the road surface cause water to remain in the roadway. This may reduce vehicle traction, or cause sediment to be transported down to a stream. Occasional grading with a motor grader or farm tractor with a box blade is all that is usually required. But if some type of road surfacing were present, less grading would be required. The most durable road surfacing material is crushed rock or gravel. This material provides protection to the road subsurface, and should be applied thick enough to the road subgrade from the type of vehicles that will use the road. Rock surfaces, which can be tailgate spread directly from a dump truck, or spread with a motor grader, can be expensive. This is especially true as the distance to your road from a rock quarry or borrow pit increases.

A more frequent forest road surface material is grass. A grass surface is a much lower cost material than rock, and provides control of soil movement almost as well as rock. However, if heavy vehicle traffic, such as log trucks or traffic during wet weather is expected, a grass surface will not hold up. If primarily pick-up trucks and other light vehicles will use the road, and this use will occur when the road surface has dried so that ruts are not made in the roadway, a grass surface may be a good option. It not only protects the road surface and minimizes sediment movement, but properly selected grass species can also provide wildlife forage options. You can ask your County Extension Agent or Natural Resources Conservation Service Conservationist for information on grass species to plant in your area.

Maintenance of a grass surface mainly entails mowing every year or two. Grassing works best on outsloped roads, but if used on crowned and ditched roads, the ditches should also be mowed rather than "pulled" with a motor grader blade. Fertilization every fourth or fifth year will also strengthen the surface and provide greater nutritional value for wildlife. However, when wheel ruts are formed, grading with a motor grader becomes difficult. Frequently, the part of the road that has been badly rutted must be reshaped and re-grassed.

Daylighting

It is important to keep the roadway and an adequate right-of-way open to allow sunlight and wind to reach the surface in order to minimize road maintenance. Frequently, we want to grow trees on every available square foot of forestland. However, when trees and vegetation are allowed to grow too close to the roadway, shading can occur and wind movement is reduced. Both of these factors can reduce the usability of your forest road. When sunlight is allowed to reach the road surface, drying speed can be enhanced. Likewise, if there is a minimal amount of canopy

vegetation to retard air movement, the road surface will dry more quickly after a rainfall event.

A good rule to follow for daylighting the road is to allow 2 or 3 times the road width for total cleared area. Control of vegetation in this area is usually accomplished by mowing, but chemical control of woody vegetation can be used if label directions are followed.

Drainage

Rainfall that is allowed to accumulate and remain in or adjacent to the roadway can result in expensive maintenance problems. A wet road surface or saturated foundation often will not support the weight of a vehicle. This can result in irregular access, impassable sections of roadway, and potential environmental degradation. Therefore it is important to keep your road drainage structures free of obstructions and insure that water is directed away from the roadway.

Water turnouts must be free of sediment accumulations so runoff will flow at a velocity that will carry water and suspended sediment out of the drainage channel. Vegetative undergrowth growing in the turnout channel should be cut whenever the roadway is mowed.

Cross-drain culverts should be inspected as you drive on your roads. Look for debris that might obstruct flow into the culvert. You should also construct some form of inlet control that will direct water moving in the lateral ditches into the inlet. An earthen, rock or some type of berm will usually prove adequate for this requirement.

Broad-based dips are frequently used to remove water from outsloped roads. These structures should be sloped away from the road so they will readily drain. If the road will be used during or immediately after a rainfall event, protection of the bottom of the dip with crushed rock should also be considered. This will reduce the creation of wheel ruts, which will hold water.

Access Control

Allowing traffic to use a forest road when the road surface is saturated is an invitation to maintenance problems. Many times, wheel ruts created on the road surface can be the beginning of a costly maintenance problem. Off-road vehicles used for recreational purposes can cause major damage to the road surface. A road entrance that is "gated" or otherwise blocked is a good investment. It can keep unwanted traffic off of your woods road especially during periods when damaging ruts can be created. If you have closed a temporary road to traffic, use a large water bar that ties into adjacent obstacles such as stumps or large rocks. You should use care when blocking the road access to make sure that the blocking structure is clearly visible. Poorly visible or camouflaged devices such as cables strung across the road entrance can be significant legal liabilities.

Reference

Forest Road Maintanance for Forest Landowners

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