

The Layman's Guide to

Private Access Road Construction

*In The Southern
Appalachian Mountains*

Second Edition - 2005

The Layman's Guide to Private Access Road Construction in the Southern Appalachian Mountains

Second Edition 2005

Technical Contributions

Howard C. Tew, Area Engineer
Lane C. Price, District Conservationist
USDA Natural Resources Conservation Service

Lloyd W. Swift, Jr., Research Forester (retired)
Mark S. Riedel, Research Hydrologist
USDA Forest Service, Southern Research Station,
Coweeta Hydrologic Laboratory, Otto, NC

Funding for this publication provided by:

USDA Natural Resources Conservation Service

This edition of The Layman's Guide to Private Road Construction has been revised to include the most up to date information on mountain road construction and the impacts of poorly constructed mountain roads on stream water quality.

**This publication is also available
on the internet at:**

www.dfr.state.nc.us

Cover Photo of properly constructed access road. Photo courtesy of Kevin Harvell, Water Quality Forester, N.C. Division of Forest Resources. Mt. Holly, NC

Introduction

It is ironic that roads designed to help people enjoy the Appalachians often destroy the beautiful scenery and clear water that make the mountains so attractive. Poorly constructed access roads often cause severe erosion, and stream sedimentation. These effects can degrade water quality for decades. Erosion can be disastrous in fragile mountain environments, and the landowner must pay for frequent and costly repair of a poorly designed road.

Ultimately, if you own the land, you are responsible for ensuring that your road is properly constructed. Building an access road in the mountains to even a single home can be complicated and expensive. Regardless of the advice received, it's important to remember that there are no inexpensive "shortcuts" when building a road in the mountains. Admittedly, it is expensive to build a good road. But it is always less expensive to build a good road the first time than to repair a bad road every year!

How can you get the road you need? It can be achieved through careful planning, design and supervision. You are likely to be disappointed if you leave decisions in the hands of a construction contractor or bulldozer operator. Whether you do the planning yourself or hire a professional, some knowledge about planning, layout and construction of access roads is valuable.

This guide provides the basics. For many people and situations, the information provided may be sufficient to design and build a road. For others, professional, on-site assistance may be necessary. This booklet does not address all the problems that may be encountered in road construction. You must determine the limits of your abilities but, professional assistance certainly should be sought for complex projects.

For additional information on access road design and construction, contact your local Natural Resources Conservation Service Office or a private engineer. In addition, some useful sources are listed in section A4.



Stabilized forest access road. Note side/cut banks angled appropriately to minimize erosion.

Table Of Contents

A. Pre-construction Planning	Page 1
A1: Getting To Know The Property	1
A2: Points To Ponder As You Plan	2
A3: Deciding Where To Put The Road	3
A4: Assistance is Available	4
B. Design Guidelines	Page 5
B1: Road Grade	5
B2: Road Width	5
B3: Side Slopes	5
B4: Surface Drainage	6
· Broad-based dips	6
· Roadside ditches	7
· Culvert pipes	7
B5: Subsurface Drainage	9
B6: Curves and Switchbacks	10
B7: Intersection With Public Highways	10
B8: Surfacing	10
C. Road Layout - Locating The Road on The Land	Page 11
C1: Equipment Required	11
C2: Locating The Road On A Desired Grade	11
C3: Marking The Proposed Road	12
D. Getting Ready For Construction	Page 12
D1: Setting a Schedule	12
D2: Obtaining The Materials	13
D3: Hiring The Right Contractor	13
D4: Getting Started On The Right Foot	16
· Construction Equipment Table	
E. Constructing The Road	Page 16
E1: Clearing The Way For Construction	16
E2: During Construction	17
F. Getting Vegetation Established	Page 17
F1: Hand Seeding	17
F2: Hydroseeding	20
G. Maintenance	Page 20
G1: Maintaining Your Investment	20
Appendix I: References	Page 21

(A) Pre-Construction Planning

Planning in advance is essential for constructing a good access road. Become familiar with the property and recognize its potentials and problems. Overlooking this important phase can be an expensive mistake. The factors considered and decisions made in early planning represent the fundamental building blocks of a good road.

(A 1) Getting to Know the Property

Secure the most detailed maps available for the property. The maps that may be needed include:

1. Property Ownership Map (Survey Plat) - to locate property lines.
2. USGS Topographic Maps - to determine elevations and important landscape features.
3. Aerial photographs – to obtain a visual image of your land and the vegetation and structures on it.
4. Soil Maps - to identify general slopes and “problem areas.”

Where can these maps be obtained?

1. Property line information can often be obtained from the county land records section or a local surveyor and displayed on a scale map.
2. Quadrangle map sheets may be purchased at stores that carry camping and hiking equipment, ordered from the Geological Survey, U.S. Department of Interior, or downloaded from the Internet. Some sites allow you to view an aerial image or a USGS topographic map while online. You may be able to generate a scale map of your property and download the image or print it on your printer.
3. Aerial photographs may be inspected at county land office, Farm Service Agency, or Division of Forest Resources. Recent aerial images, topographical maps, stream data and other useful information are now available for almost all locations in the eastern United States. This information is readily available in a form that can be utilized by a Geographical Information System.
4. Soil maps may be inspected at your Natural Resources Conservation office or at county libraries.

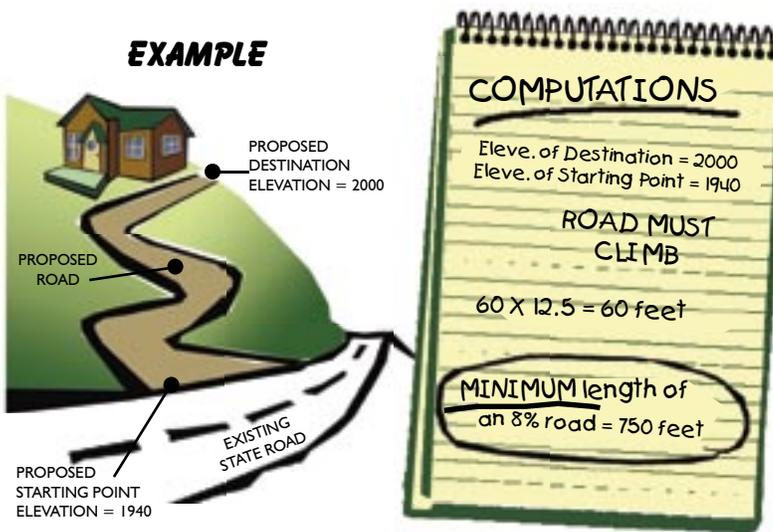
Carefully study the maps obtained and identify the property’s important features and characteristics.

Using the property map, accurately draw ownership lines on the topography and soil maps. For larger land areas you may wish to use the assistance of a consultant that has a Geographic Information System (GIS) and can make field surveys with a Global Positioning System (GPS). GPS units can be an effective method of mapping and identifying features and characteristics of the property. The longer the planned road and the larger the property involved, the more beneficial a GPS unit. A GPS unit gives the planner the capability to accurately record the location of features such as visible property corners, rock outcrops, springs, streams, important trees, existing and planned structures and even the location of a preliminary road layout. The

GPS records real world coordinates of each feature (waypoint) or line (track). GPS data can be downloaded to a computer to produce a scale map or overlaid on aerial images and/or topographical images.

GIS can help automate the planning process. The GIS is a computer software package for compiling and analyzing various layers of feature and image data. The experienced GIS user can generate and analyze a scale map of the property and the proposed road location using digital aerial photography, topographical maps, GPS data, and other information.

Using the soil and topographic maps, identify problem areas that should be avoided if possible. These include very steep, wet or rocky areas, and soils that are shallow to rock, are highly erosive or that have a mass-movement (landslide) hazard. The high technology digital mapping tools do not take the place of careful and methodical on-site evaluation of the property.



A soil map is an invaluable tool at this stage of planning. For assistance in interpreting the soils information, contact your local Soil and Water Conservation District. Soils information is also very helpful in locating alternative home sites.

Using the topographic map, determine the minimum length for the road. For example:

On a topographic map, locate control points -- places through which the road must pass. Examples are the home site and access entrance, or high and low points in the road's path. Determine the total elevation difference between consecutive control points. Multiply each elevation difference by 12.5 to determine the minimum length of road required

between the control points. This length assumes a road constructed on an average grade of 8 percent. If you plan a road that will be shorter than this approximation, you may be headed for trouble. See Section B1 for more on road grades.

(A 2) Points to Ponder as You Plan

Know the state and local laws, ordinances, and regulations. Ordinances and regulations regarding access roads vary from state to state and county to county.

Regulations may include land use zoning, subdivision ordinances, sediment and erosion control, or others. An erosion control plan on construction sites may be required in accordance with the State Sedimentation and Pollution Control Act and/or other applicable local ordinances. Off-site sediment damages are in violation of state and local laws and can result in civil suits.

Plan ahead for possible future state maintenance. If you plan for the state Department of Transportation to assume responsibility for the maintenance of your road, it should be constructed according to state standards. The state will not assume maintenance for a road that fails to meet its standards. This booklet is not intended to provide guidance to meet these standards, which are available from the office of the Division of Highways Engineer.

Be prepared to pay the cost of constructing a good road. The cost of constructing a road will vary greatly from site to site. The cost may increase due to the following:

- Steep land - costs increase due to more earth-moving on steep slopes.
- Winter construction - costs increase because it takes longer to build.
- Rocky land - the costs of moving or blasting rock are high.
- Drainage needed - surface and subsurface water must be managed.
- Low stability soils - extra precautions are required on such sites.
- Clearing required - wooded areas must be cleared.

Don't give your land away! Erosion control should be a normal part of all construction procedures, and therefore, erosion control practices are incorporated throughout this document. Take every precaution to keep your soil on your property.

(A 3) Deciding Where to Put the Road

Get to know the property by walking over it - several times. With the fundamentals in mind, walk over the property making notes of any features that are different or were not as indicated on the map. Working in a downhill direction may provide you with a better view of the terrain.

Approximate Cost Per Linear Foot of Road



Remember this important truth - if you cut corners during planning and construction, you will pay more for future maintenance!

Be sure to identify property boundaries and avoid locating the road within 50 feet of any boundary. Construction crews may venture across property lines without knowing it.

Choose a starting point elevation on the existing road as close as

possible to your destination's elevation to minimize your proposed access road's length and grade.

Choose an entrance that provides good visibility from all directions. A permit from the state Department of Transportation or other public body may be required before establishing access from a public road. See section B7.

Avoid streams and springs whenever possible. If streams must be crossed, make crossings at right angles to the flow of the stream. Otherwise maintain an undisturbed strip of a minimum of 100 feet from all streams. On flat terrain, and with effective sediment barriers such as silt fences or hay bales, this buffer may be reduced to 50 feet. Keep well away from springs and wet areas and route the road above wet areas.

(A 4) Assistance is Available

If at this point road construction already seems like an overwhelming task for the novice, don't give up! Help is available, but do not expect someone else to plan and construct your road for you unless you are willing to pay for it. Assistance is available to guide you through the decisions and actions that will lead to the desired properly constructed road. The table below is provided as a guide to locate sources of information or services helpful in planning, designing and constructing your road. The services of each source listed may vary somewhat on a county- to-county basis and this table should only be used as a general guide.

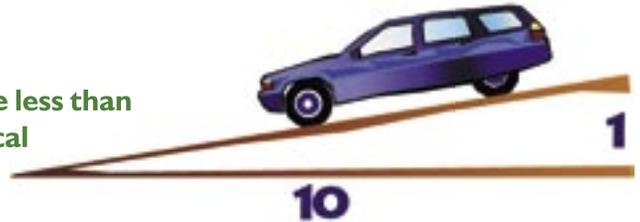
A GENERAL GUIDE TO AVAILABLE ASSISTANCE							MAPS				
Suggested Source	Permits	Seeding/ Vegetation	Weather	Aerial Photos	On-site Assistance	Erosion Control	Soils	Geology	Topography	Road	Property
FEDERAL											
Natural Resources Conservation Service		✓	✓	✓	✓	✓	✓	✓	✓		
US Forest Service		✓					✓	✓	✓		
Farm Services Agency				✓			✓				
Geological Survey								✓	✓	✓	
National Oceanic and Atmospheric Administration			✓								
Army Corps of Engineers	✓										
STATE											
NC Forest Service		✓		✓	✓	✓	✓		✓		
Geologist								✓	✓		
Universities			✓				✓	✓	✓		
Highway Department	✓									✓	
Department of Environment and Natural Resources	✓	✓				✓					
Soil and Water Conservation District		✓	✓	✓	✓	✓	✓	✓			
COUNTY											
Register of Deeds											✓
Cooperative Extension Service		✓	✓				✓				
Road Department	✓									✓	
Sediment/Erosion Control Agencies	✓	✓				✓					
Government	✓									✓	
CITY											
Library			✓				✓	✓	✓	✓	
Government	✓									✓	
PRIVATE											
Consultants, Engineers					✓	✓	✓	✓	✓		
Land Surveyors										✓	✓
Bookstores		✓	✓					✓	✓	✓	

(B) Design Guidelines

This booklet should help the landowner understand the basics of designing roads before trying to locate or position a road on the land. The standards to which roads are constructed vary with their intended use. A road built solely to accommodate temporary or intermittent logging operations does not meet the demanding standards of a subdivision road. A road built to open a home development or provide access to a homesite has many of the same characteristics as a correctly designed logging road. Ease of access, simple maintenance and low construction cost are important to both. However, the potential need to upgrade such a new road to carry expanded future traffic must be considered during its location and design.

(B 1) Road Grade

The grade of the roadbed should be less than 10% for best results (10 ft. vertical in 100 ft. horizontal).



Maximum sustained grades should never exceed:

- 6 percent for natural soil and grass surface
- 10 percent for gravel or crushed stone surface
- 16 percent if paved

These grades may be increased up to 15 percent on gravel roads (if crushed stone is used) and 20 percent on paved roads for short reaches (200 feet or less) where no other alternative exists. Grades can be determined using techniques described in Section C2.

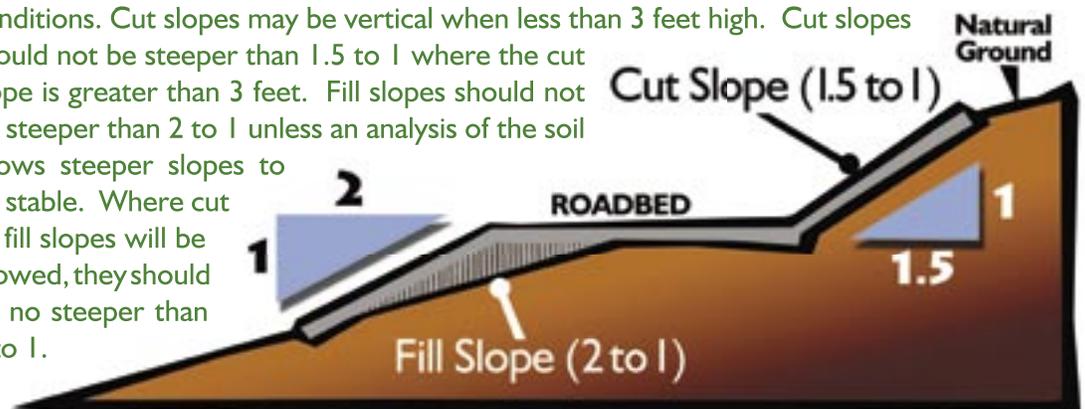
Steep grades should always be avoided at road curves or intersections.

(B 2) Road Width

The minimum width of the roadbed is 14 feet for one-way traffic and 20 feet for two-way traffic. The minimum tread width is 10 feet for one-way traffic and 15 feet for two-way traffic. The minimum shoulder width is 2 feet on each side of tread width. Increase all widths by 4 feet if expected traffic include towed trailers of any kind.

(B 3) Side Slopes

All roadcuts and roadfills should have side slopes that are stable for the particular soil and conditions. Cut slopes may be vertical when less than 3 feet high. Cut slopes should not be steeper than 1.5 to 1 where the cut slope is greater than 3 feet. Fill slopes should not be steeper than 2 to 1 unless an analysis of the soil shows steeper slopes to be stable. Where cut or fill slopes will be mowed, they should be no steeper than 3 to 1.



(B 4) Surface Drainage

No other aspect of road design is more important and less understood than surface drainage along the road. And unfortunately, this is the area where road-builders may try to “save money” -- an expensive mistake!

The surface water from all sources must be conveyed off the roadway at frequent locations to control roadbed soil erosion, maintain a stable road surface and reduce future maintenance and repairs. Surface drainage must be planned for water from the following sources:

- Rainfall on the roadbed, as well as on cut and fill slopes;
- Overland storm flows from the watershed above the road;
- Springs or live streams intercepted by the road.

If possible, shape the road to drain itself by means of out-sloping and broad-based dips. Out-sloping refers to the purposeful shaping of a road from the cut slope to the fill slope to allow surface water to flow across (and off) the road rather than down the length of the road. Out-sloping should be less than one-half inch in one foot or about six inches for a one-lane road. See the following chart for drainage suggestions.

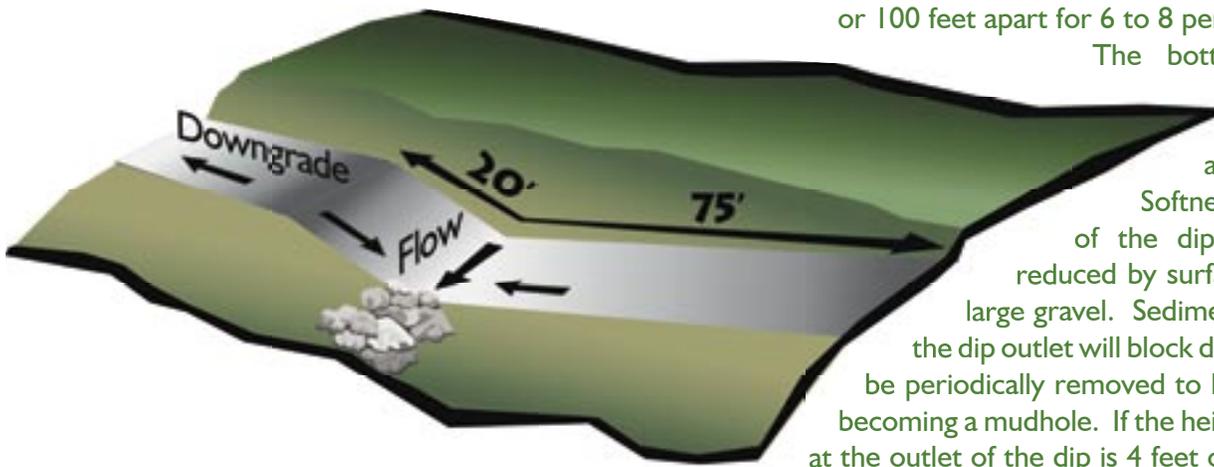
Single-Family Access Roads or Other Seldom Used Roads		Single-Family Access Roads and All Development Access Roads	
Out-sloped road without broad-based dips	In-sloped road with broad-based dips (Not Recommended)	Out-sloped or crowned bed with roadside ditch and culverts	In-sloped with roadside ditch and culverts
			
Cross-section view of road			
Most acceptable design for low-use roads	Only for short distances	Generally the most acceptable design	Where road grade is too steep for dips
Where overland flow from above road during storms is insignificant	Only where out-sloping is dangerous and overland flow from above road during storms is small	Where overland flow from above road during storms is expected or groundwater seeps are intercepted	Where overland flow from above road during storms is expected or groundwater seeps are intercepted
Road water flows freely off outside edge of roadbed	Safer on roads that are often slippery, wet, frozen or icy	Road water flows freely off outside edge of roadbed	Safer on roads that are often slippery, wet, frozen or icy
Only requires culverts in the draws and low or wet areas	Often requires culverts in the draws and low or wet areas	Requires culverts at draws or low areas and periodic culverts to remove ditch water	Requires culverts at draws or low areas and periodic culverts to remove ditch and road water

Broad-based dips

Broad-based dips are an inexpensive way to carry surface water off the roadway. Properly constructed broad-based dips allow a smooth crossing without bumping or bottoming out. On sections of a road where broad-based dips are the primary means of surface drainage, construct dips at the following places:

- At the top of each downgrade to reduce downhill flow on roadbed.
- On either side of, and away from, each stream crossing to prevent stormwater from entering the stream.
- At side ridges, not in draws or wet areas.
- Use culverts instead of dips to drain roadside ditches, seeps and streams.

Add additional dips to assure that none are more than 200 feet apart in flat terrain. Consider closer spacing for steeper road grades, such as 150 feet apart for 3 to 6 percent road grades



or 100 feet apart for 6 to 8 percent road grades. The bottom of the dip may collect sediment and retain water. Softness and erosion of the dip bottom can be reduced by surfacing the dip with large gravel. Sediment that collects at the dip outlet will block drainage and should be periodically removed to keep the dip from becoming a mudhole. If the height of the fill slope at the outlet of the dip is 4 feet or greater, protect the fill with a coating of large rock or an anchored erosion mat.

Roadside Ditches

Construct roadside ditches on the inside of all roads that have overland flow from above the road during rain storms. Minimize the length and number of roadside ditches. Remember, the ditch you construct can become a gully that will erode and undermine the edge of your roadbed and the cut slope. Flat bottom ditches with flat areas two feet or more



in width provide for greater driver safety and reduced maintenance than do deeper "V" shaped ditches. Line ditches that may erode with large rock. Clean out ditches only when they fill with sediment and threaten to divert storm water back onto the roadbed or block the culvert inlet or turnout. If a ditch fills with sediment, look for the source and stop that erosion. Do not empty a ditch into any stream or low area that drains to a stream. Ditches may be drained by cross-culverts or by turnouts. A turnout is a side extension of the ditch that directs water away from the road and into a sediment trap or onto protected soil.

Culvert Pipes

Culverts are required to drain roadside ditches and to protect stream crossings. Cross-culverts should be placed every 130 to 200 feet on all in-sloped roads to move ditch line water to the outside edge of the roadway in smaller, less erosive flows. Install culverts in streambeds and on natural surface in draws and low areas that may carry water in large storms.

What type of culvert pipe should be used?

- Corrugated Steel Pipe
 - Most common type in use
 - Heavy duty and can take fairly "rough handling"
 - More tolerant of improper installation practices
- Corrugated Aluminum Pipe
 - Lighter and easier to handle than steel
 - Will last longer than steel if properly installed
 - More expensive than steel
 - Damages easily with rough handling

- Corrugated Plastic Pipe
 - Lightest, flexible and most easily handled
 - Less expensive in the 12-inch to 18-inch sizes
 - Very easily crushed by inadequate cover or poor compaction of fill material

Use the culvert design procedure to determine the proper culvert size. Many factors affect the culvert size, including size of drainage area, watershed land use, local rainfall, soil type, slope of pipe and fill over pipe. All culverts should be designed using the two-year, 24-hour storm as a minimum. The designers should also evaluate the impact of the 10-year, 24-hour storm.

No culvert less than 15 inches in diameter should be used.

To be eligible for state maintenance in North Carolina, culverts must carry a 25-year, 24-hour storm. For additional information on culvert design, consult your Soil and Water Conservation District or a private engineer.

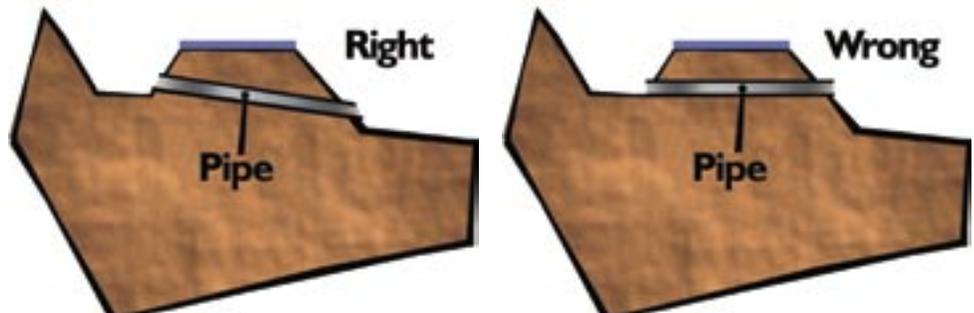


Overflow Channels should be approx. 12' wide and 6" deep.

Where it is impractical to install the proper size of culvert, an adequate overflow area should be provided to allow stormwater to flow over the top of road and discharge on natural ground, not fill material. The overflow surface should be protected to prevent road washouts or erosion.

How should culverts be installed?

- **Install culverts with the inlets at or below natural ground.** The deeper the pipe inlet is installed (or the more fill over the pipe), the more water it will carry. In addition, pipes with shallow cover are easily crushed by heavy vehicles.
- **Extend culvert outlets to or beyond the toe of the slope.** Erosion protection, such as rock rip-rap, is often necessary at the outlet of culverts. Never allow a culvert outlet to flow directly on to fill material without such protective measures. It is usually less expensive to extend the culvert to stable natural ground than to protect the fill material against erosion by water falling from the culvert outlet.



- **Ensure each culvert has an adequate inlet.** Most culverts never carry as much water as they should due to poorly constructed inlets. The culvert may be large enough to carry the required flow, but the inlet may not let the water into the culvert. Be sure the roadside ditch is wide and deep enough to allow flowing water easy entry into the pipe. The optional culvert inlets shown below can provide effective, low-maintenance water flow through your drainage culverts.
- **Use watertight connecting bands when connecting two joints of culvert pipe.** Since pipe generally comes in 20-foot sections, properly installed culverts on sloping roads will often require connecting bands. Connecting bands should result in strong watertight joints. Rod and Lug type or “hugger” type bands provide secure, trouble-free joints if properly installed. “Dimple Bands” are not acceptable and should not be used.



Rod and Lug Band with Neoprene (Rubber) Gasket



Hugger Band



Dimple Band

- **Carefully compact soil material placed around culvert pipes.** The soil used to backfill around the pipe should be placed in layers and compacted. Avoid placing rocks next to pipe or including woody material in the fill. Hand-tamping is usually required. Ensure that soil is placed all around and under the pipe. This is especially important when using plastic pipe.

Cross-section View of Culvert Installation



(B 5) Subsurface Drainage

Subsurface drainage refers to water that is below the normal ground surface. Subsurface drainage may be a natural condition or it may be created by failure to properly remove surface water.

Road construction on poorly drained soils should be avoided when possible. Poorly drained roads fall apart in bad weather with even minimal traffic. Stone placed as road surfacing sinks into wet foundation soils and may need to be repeatedly replenished. Erosion control and stability of fill and cut slopes are impossible to maintain without proper drainage.

Locate poorly drained soils on soil survey and watch for signs of subsurface drainage problems before and during construction. The following may be signs of wet soils with subsurface drainage problems:

- Soils that are grayish in color.
- Low areas or ground with a soft, mushy surface.
- Areas predominated by water-tolerant plants such as alders, black walnut, poplar, cattails, reeds, etc.

If drainage problems are encountered in the roadbed, it is recommended that the road be relocated to a drier site. If relocation is not feasible, consider one or more of the following in order to reduce the impact of poor drainage:

- Improve surface drainage.
- Remove nearby shade trees to let sunlight dry the road.
- Use large (3-inch) stone for the road surface.
- Install fabric filter cloth (geotextile or other porous road building fabric) under the surface gravel to prevent stone from sinking and disappearing into the soft soil.
- Install subsurface drainage.

(B 6) Curves and Switchbacks

The minimum radius of curvature of the center line of the road should be as follows:

- 35 feet for short-bodied vehicles
- 50 feet for tractor trailers

Radius of curvature defines the “sharpness” of the turn. In recreational areas, the radius may need to be increased to accommodate towed or larger vehicles.

Plan switchbacks and curves on grades as flat as possible.

(B 7) Intersection with Public Highways

For safety, the angle of intersection of a proposed access road and a public highway should be no less than 85 degrees, and the clear sight distance to each side should be no less than 300 feet. You will need a driveway permit from NC DOT.



(B 8) Surfacing

Choose the type of surfacing material by considering traffic load, frequency of usage, grade of road, soil type in natural roadbed, available materials, cost and aesthetics.

Crushed rock or gravel surfacing should be applied as soon as possible after construction (while soil surface is still freshly disturbed and soft) to ensure a good bond between the soil and surfacing material and provide early protection against soil erosion.

(C) Road Layout: Locating the Road on the Land

Road layout is the most important step of road construction. Now that you've become familiar with your property, design and road construction, it's time to actually lay out the road. Laying out a road consists of staking or flagging the centerline of the road, identifying

locations for broad-based dips and culverts and possibly staking cut and fill slopes. Proper layout and design will result in a generally stable road that requires minimal maintenance. A poorly designed road will always be problematic. It is often best to do road layout during fall or winter when leaves will not obscure your view. Flag any problem areas such as dry stream channels, springs, seeps or sinkholes that should be avoided during road construction.

Road layout is the most important step of road construction.

(C 1) Equipment Required

Obtain the following equipment for laying out the road:

- Clinometer or Abney level - hand-held tools to measure road grade. May be obtained where forestry supplies are sold.
- 50 or 100 foot measuring tape - To measure road width, length, distance between dips, cut/hill slopes, etc.
- Survey flags, colored plastic tape or stakes - To mark the proposed route and location of culverts, dips, edges of cut/fill slopes, etc.
- An ax or brush hook - To drive stakes and to cut dense vegetation.
- Compass - To determine aspect and stay oriented.
- Notepad and a map or aerial photo - To make useful notes about the location of the road and potential problems.

(C 2) Locating the Road On A Desired Grade

One-person Method:

1. Tie colored plastic tape at eye-level to a tree, bush, limb, etc. at the starting point of the road.
2. Walk a short distance out the proposed route of the road. Using a clinometer or Abney level, sight back to the colored tape with the Abney/clinometer set at the planned grade.
3. Move up or down the hill until the desired grade is reached, and then flag this position (again at eye-level).
4. If a road construction obstacle (e.g. rock outcrop, wet area, property line) is encountered between the two established points, it may be necessary to adjust the planned grade to avoid the obstacle.
5. Walk further out the proposed route and repeat the procedure above, always sighting back on the previous tape.

Two-person Method:

1. This method is similar to the above procedure except that instead of sighting back to the previous tape, the person with the level (the "instrument person")

sights forward out the proposed road to another person (the “flag person”). Before using this two-person method, the instrument person should locate his/her eye level on the flag person, and always sight this same spot on the flag person during the survey.

2. The instrument person directs the flag person to move up or down the hill and flag a position marking the desired road grade.



3. The flag person may mark the position (to be the centerline of the road) with plastic survey flags, wooden stakes, paint on trees or colored tape.

The desired end of the road may be missed following a planned grade or as a result of making adjustments to avoid obstacles. When this occurs, the road locators should work backward from the endpoint and connect the two surveys at the most convenient point. It may be necessary to repeat earlier surveys several times working in

both directions to find the best route. Nobody said it would be easy!

(C 3) Marking the Proposed Road

Using plastic survey flags, wooden stakes, colored tape or paint, mark the following clearly:

- Centerline of the road
- Location of culverts and broad-based dips
- Curves and switchbacks
- Edges of cut and fill slopes on very steep areas
- Any planned turnouts, parking or passing areas

(D) Getting Ready for Construction

When do I start? • What materials do I use? • Who do I get to do the work?

(D I) Setting a Schedule

Plan the timing of the actual road construction to occur during the milder, drier seasons of the year.

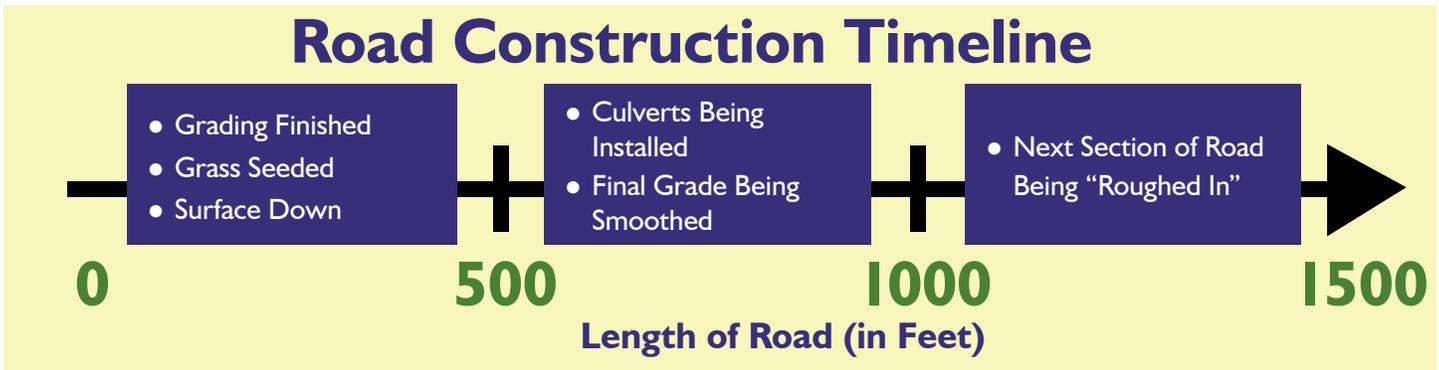
Road Construction Calendar

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BAD TIME	EXCELLENT TIME		BAD TIME		GOOD TIME		BAD TIME				
Snow and Ice Slows Construction Too Cold for Seeding	Good Weather Excellent Time for Seeding		Too Hot and Dry for Permanent Seeding		Good Weather Good for Seeding		Cold Weather Approaching Too Late for Permanent Seeding				

(These seasons vary with altitude and rainfall pattern. Contact your local Soil and Water Conservation District office for specific guidance on construction in your locality).

Establish a construction schedule that will require road completion in segments of 500 feet or less.

Maximum effectiveness is ensured when stone surfacing and seeding are performed while cuts and fills are still fresh.



(D 2) Obtaining the Materials

Develop a bill of materials for each segment of the road. Check early with suppliers about availability, shipping times, price, terms and other specifics. Be sure to specify the details on the type of materials desired. Culverts, drop inlet boxes, silt fences, erosion control netting, fabric filter cloth, crushed stone, rip rap, seed, fertilizer, lime and mulching materials may be needed.

Plan to have materials BEFORE they will actually be used. Have you ever started a job only to find you didn't have everything needed to finish? Failure to have materials on hand when they are needed results in unnecessary delays. Such delays are expensive. Planning is the key!

Bill of Materials for Access Road (Section 1)

Quantity	Item
3	15" Corrugated Steel Culverts - 30 ft. long
1	18" Corrugated Steel Culverts - 40 ft. long
4	Drop Boxes for Culvert Inlets
8 tons	Rock Rip Rap for Culvert outlets
<u>Seeding</u>	
1 ton	Agricultural Lime
50 lbs.	Fertilizer
30 lbs.	Grass Seed
40 Bales	Straw Mulch
<u>Surfacing</u>	
40 tons	Washed Gravel
30 tons	Crushed van stone

Materials to be used should be inspected upon arrival and substandard materials rejected. For example, if "dimple bands" are delivered when "hugger" bands were specified, send them back!

(D 3) Hiring the Right Contractor

Hire a contractor who has the right equipment for the job. Since the cost of equipment time will be a major portion of the total expense of the initial road construction, the "right" equipment will save money. (Would you hire a carpenter by the hour who uses a rubber hammer for driving nails?) See the Construction Equipment Table. Some type of survey equipment will be needed to properly grade the roadbed and the cut and fill slopes. A qualified contractor will have either a tripod or a hand held level to assure that the road is built to your specifications.

Hire a contractor experienced in mountain road building. Just because a contractor has heavy equipment does not mean he can build roads. Check around a bit:

- Get out and look at some roads built by different contractors.
- Talk to landowners who have hired the contractor in the past.

If the contractor has any objections to the above, be suspicious!

Hire a contractor with an attitude toward high quality. Find another contractor if the one you are thinking of choosing says:

- “I’m too busy to do the work in the months you want it done but, I can do it after Christmas!”
- “I know a lot of shortcuts to save you money...”
- “The standards you want just aren’t needed for a good road ...”
- “I don’t need or want anybody’s help. I already know all there is to know about road-building ...”
- “I don’t like to be supervised ...”
- “I’m not supposed to give you the names of people we have worked with in the past...”

Equipment Table Instructions

1. The letters (A through H) in the table refer to specific types of construction equipment as shown below the table.
2. Letters in parentheses indicate equipment that is marginally acceptable when the desired equipment is unavailable.
3. Read the “Complicating Factors” vertically on the left side of the table. Check off those factors that will be involved in your road.
4. Determine the length of the road and find the proper column horizontally across the top of the table.
5. Copy all letters in the blocks at the intersection of the “Length of Road” column and the “Complicating Factors” rows that you checked. Eliminate duplicate letters.
6. Using these letters, determine the equipment that will be required. If your list contains the letters A or B or C together, use the larger pieces of equipment.

The following equipment table helps determine the equipment that will be required to build a road with any complicating factors.

Complicating Factors	Length of Road			
	Less Than 500 Feet	500 - 1000 Feet	1000 Feet - 1 Mile	1 Mile or More
None	B (C)	B (C)	B (A)	A (B)
Average Land Slope Between 10% & 20%	B (A)	B (A)	A (B)	A (B)
Average Land Slope Between 20% & 30%	B (A)	A (B)	A	A
Average Land Slope Greater Than 30%	A (B)	A	A	A
Average Cuts & Fills of 5 - 10 Feet	B (A)	A (B)	A, F (E)	A, F (E)
Cuts & Fills Greater Than 10 Feet	A (B), D, F	A, D, E (F)	A, D, E (F)	A, D, E (F)
*Drop Inlet and Culverts	H	H	H, G	H, G
*Subsurface Drainage or Many Culverts	H, G	H, G	H, G	H, G
Appreciable Rock to Be Removed	F	F	A, F	A, F



A - Angle Blade Bulldozer 100 h.p. or greater, 20,000 lbs. or greater. Powerful enough for big, difficult jobs and heavy enough to handle steep slopes and rock.



B - Angle Blade Bulldozer 75 h.p. or greater, 15,000 lbs. or greater. Adequate for small and medium jobs where cuts and fills average less than 5 feet and little rock is to be moved.



C - Fixed Blade Bulldozer 75 h.p. or greater, 15,000 lbs. or greater. Fixed blade restricts the usefulness of this equipment. Use only when larger equipment is not available and only for small jobs.



D - Sheepsfoot Roller Pulled by dozer. Used to compact fill material as fill is spread.



E - Motor Scraper (Pan) Used to load and haul large volumes of material over distances of 300 feet or more.



F - Front-end Loader and Dump Truck Used together for loading and hauling earth or rock. Front-end loader is not used for cutting roads.



G - Backhoe/Excavator Used for excavating trenches, digging out stumps and installing pipes and culverts.



H - Motorized Hand Tamp Used for compacting earth around pipes and other structures.

(D 4) Getting Started on the Right Foot

Discuss your plans and specifications with the contractor. Establish the rules. Walk over the site with the contractor. Give him a copy of the specifications you have developed for your road and discuss each point. Resolve any questions. Consider his suggestions, but do not allow him to change the specifications to save money (his money) at the expense of quality (your money).

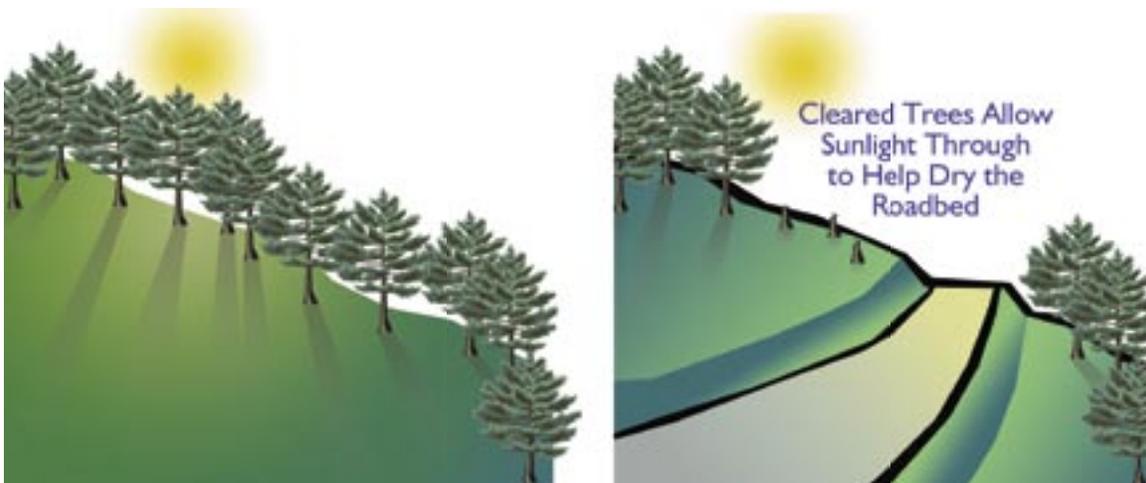
Agree on the dollars and “sense.” Many earth-moving contractors insist on payment by the hour. This relieves the contractor of any risk. Lump sum payment on a job-basis is usually advantageous to the landowner who knows the kind of finished product he wants and maintains close supervision of the contractor’s work to ensure that quality work is performed. Using either payment method, never pay the contractor more than 50 percent of the agreed price until you are completely satisfied with the finished job. Usually, “you get what you pay for.” If you hire the cheapest contractor in the county, don’t be surprised if you receive a “cheap looking” job.

Plan to have someone knowledgeable of your road specifications to supervise or periodically check the progress of construction. This is one of the most neglected aspects of any type of construction. Supervision is imperative to ensure that you end up with a quality road. If you have no one capable of providing construction supervision, contact your local Soil and Water Conservation district office well in advance. Assistance may be available for construction supervision.

(E) Constructing the Road

(E 1) Clearing the Way for Construction

Clear the vegetation from a right-of-way at least wide enough for the roadbed and cut and fill slopes. Access roads in wooded areas require that trees and brush be removed prior to cutting in the road. Where deep cuts or fills are required, it will be necessary to clear a wider area. At curves, the area cleared should provide good visibility of traffic from both directions. Where snow and ice on the roadbed may present problems, it is a good practice to remove enough vegetation to allow maximum penetration of sunlight to the roadbed. This is known as “daylighting” the road.



Make plans in advance to use or sell the timber, pulpwood or firewood cleared from the roadway, if possible. If many large mature trees will be removed, consult a forester for an estimate of their value.

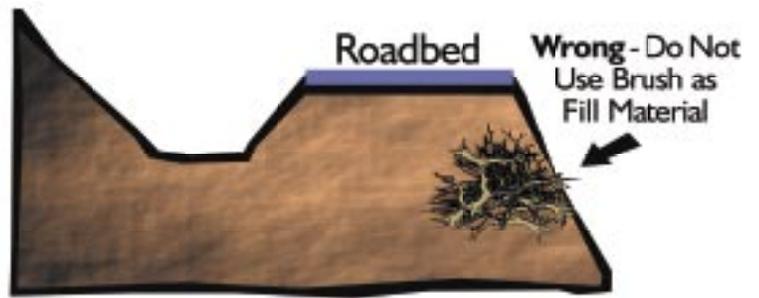
To aid in removing stumps, some bulldozer operators prefer to have the trees cut 3 or 4 feet above the ground, rather than at ground level.

Do not place trees or brush in areas to be covered by soil fill material!

Always remove all trees from the area to be filled with soil.

It is impossible to compact soil adequately around brush.

Also, buried trees will decompose leading to future unstable road fills. Brush should be burned, removed from the site or preferably piled below the toeslope of the fill to trap sediment.



(E 2) During Construction

Make sure after clearing that all your flags and stakes remain and are understood by the contractor's crew.

Be alert for problem areas such as wet or unstable soils, and correct immediately as previously discussed.

Do not allow the equipment to "rough in" more than 1,000 feet of road until the first 500 feet are completed. Drainage structures such as culverts should be installed, fill material properly compacted and surfacing material put down as construction progresses. Seeding should begin on segments as soon as the grading on that segment is completed.

Have an agreement with the contractor that he will check with you before placing any surfacing material (gravel or pavement). Before surfacing the road, be sure that drainage structures are installed properly; that adequate erosion and sediment control measures are maintained; and that the roadbed's in-sloping or out-sloping is satisfactory.

Maintain close supervision and make sure your plans are followed. Ask questions if something does not look right.

(F) Establishing Vegetation

(F 1) Hand Seeding

If the ground surface has become hard or crusty, scarify or "roughen up" the surface. Seedbed preparation may be done with a farm tractor and disk, a garden tiller or even a hand rake. (The latter may be the only way possible for steep roadbanks or cut/fill slopes). Do not disturb the ground too deeply- just enough to break the surface crust.

Apply dolomitic or agricultural lime per soil test or at a rate of two tons per acre. (This is about 90 lbs. per 1,000 sq. ft.)

Apply fertilizer per soil test or as follows:

- Grasses- 1,000 lbs. 10-10-10 per acre (25 lbs. per 1,000 sq. ft.)



- Legumes or grass/legume mixture - 1,000 lbs. 5-10-10 per acre (25 lbs. per 1,000 sq. ft.)

Use the seeding table below to determine the proper type of vegetation and seeding rates in lbs.

Seeding Table (G=Grass / L=Legumes)												
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1) Permanent Plantings on Sunny, Dry Sites												
Ky 31 Tall fescue (60 lb) *			G	G	G			G	G			
Weeping Lovegrass (5 lbs)				G	G							
Sericea Lespedeza (scarified) (50 lbs)				L	L							
Crownycetch (15 lbs) & Tall Fescue (20 lbs) or Lovegrass (3 lbs)			G	G	G							
Lathco Flatpea (20 lbs) & Tall Fescue (20 lbs) or Lovegrass (3 lbs)			L	L	L							
Sericea Lespedeza (scarified) (50 lbs) & Tall Fescue (30 lbs) or Lovegrass (5 lbs)				G	G			G	G			
Sericea Lespedeza (unscarified) (60 lbs) & Tall Fescue				L	L			L	L			
Tall Fescue (50 lbs) & White Clover (4 lbs)				G	G							
2) Permanent Plantings on Shady, Dry Sites												
Creeping Red Fescue (50 lbs) *			G	G	G							
3) Permanent Plantings in Partial Shade												
Ky 31 Tall fescue (30 lbs) & Creeping Red Fescue (20 lbs) *			G	G	G							
Creeping Red Fescue (30 lbs) & Lathco Flatpea (20 lbs)				G	G							
				L	L							
4) Permanent Plantings on Wet Sites												
Reeds Canarygrass (20 lbs)			G	G	G	G						
5) Temporary or Short-Term Covers												
Oats (3 Bu or 90 lbs) or Rye (3 Bu or 120 lbs)		G	G							G	G	
Ryegrass (40 lbs)		G	G							G	G	
Sudangrass (45 lbs) or Browntop Millet (40 lbs)						G	G	G				
Mulch With no Seeding	M											M
*Also Include 30 lbs. of Rye if a Quick Cover is Needed												

Since the seeding list to control erosion was developed, many concerns over the use of exotic seed and wildlife beneficial seeding mixtures have arisen. In an effort to offer seeding alternatives to landowners with multiple-use goals or for any area where critical stabilization is not warranted, please consider the following **seeding alternatives** highlighted on the next table.

Native Or Non-invasive Seeding Alternatives For Access Road Stabilization

Full Sun, Droughty Soils

Permanent grass/ legume erosion control mix for dry steep road banks & cut slopes.

Broadcast, drill, or hydroseed the following mix in early spring.

Deertongue 'Tioga' - 5 lbs. / acre
 Creeping Red Fescue - 10 lbs. / acre
 Korean Lespedeza - 10 lbs. / acre

Grows 1-3 feet in height; can be left unmown to provide seed and cover for gamebirds. Note: deertongue may take up to two years to fully establish so best to seed as mix where erosion control is needed.

Dry Shady Sites

Permanent planting for road banks under trees.

Broadcast, drill, or hydroseed in spring or fall.

Creeping Red Fescue - 20 lbs. per acre alone

Grows 1-3 feet in height; has weeping growth habit if left unmown.

Sunny to Partial Shade - Normal Soil Moisture

Permanent grass/ legume planting for road edges and moderate to gentle slopes.

Broadcast, drill, or hydroseed the following mix in spring or fall.

Orchard Grass - 6 lbs. / acre
 Red Clover - 4 lbs. / acre

Grows 2-4 feet in height; can be mowed in mid-summer if needed, or left unmown to provide forage and cover for game.

Sunny, Open, Wet Sites

Permanent plantings for ditch outlets, retention basins, swales, moist stream banks.

Broadcast, drill, or hydroseed in spring (preferred) or fall.

1. Eastern Gamagrass - 8 lbs. per acre alone

Grows in clumps 3-6 feet in height. Does not require mowing.

2. Switchgrass - 8 lbs. per acre alone

Grows 4-6 feet in height. Provides food, cover, and nesting for wildlife.

Temporary or Quick Seasonal Cover; Companion Crop in Mix

Broadcast, drill, or hydroseed.

1. Oats (spring) - 80-100 lbs. / acre alone or 30 lbs. / acre in mix, or

2. Foxtail Millet (spring) - 30 lbs. / acre alone or 20 lbs. / acre in mix, or

3. Buckwheat (summer) - 50-75 lbs. / acre alone, or

4. Crimson Clover (fall) - 30 lbs. / acre alone or 10 lbs. / acre in mix, or

5. Wheat (fall) - 80-100 lbs. / acre alone or 40 lbs. / acre in mix

Mulch the seeded areas with 60-80 bales of straw or hay per acre. This equals about 1-2 bales per 1,000 sq. ft. About 25 percent of the ground surface should be visible after mulching. Hay is usually less expensive than straw; however, it is more difficult and time-consuming to spread. Hay may also contain undesirable weed seeds.

Areas to be vegetated where water has a concentrated flow should have the mulch anchored with some type of erosion control netting. Netting, usually made of wood shavings (excelsior), straw or plastic material, is held to the ground by large wire staples. Contact your Soil and Water Conservation District for more information on sources and installation of netting and other erosion control materials.

(F 2) Hydroseeding

Specify that the following materials be applied:

- 1,000 lbs. of agricultural lime per 1/4 acre or per soil test
- 250 lbs. of 10-10-10 per 1/4 acre (for grasses) or per soil test or 5-10-10 (for grass-legume mixtures) or per soil test
- Suitable seed according to the rates and season on the seeding tables.
- 270 lbs. of wood cellulose mulch or comparable material per 1/4 acre. (On south-facing slopes, mulch with additional small grain straw).

(G) Maintenance

Even the best planned and constructed roads will require some maintenance.

(G 1) Maintaining Your Investment

Schedule periodic inspections of the entire road in early March and August, especially after large storms. A suggested method is to walk the entire length of the road examining culverts, cut slopes and the roadbed itself. Make sure the drainage dips and out-sloped grades are still functioning and the roadbed is free of ruts and ridges. Then walk back along the toe of the fill slope examining the drainage outlets and the general condition of the fill slope. Check for excessive amounts of sediment leaving the roadway as indicating need for erosion control.

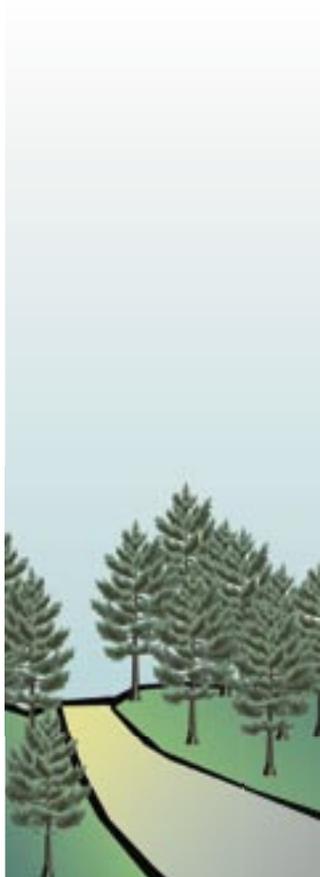
Any blockage or damage to culverts or drainage structures should be repaired immediately.

Bare or eroding areas should be reseeded according to Section F or stabilized by some other means. Where repairs are made in mid-winter, it may be best to only mulch the disturbed areas and perform the seeding later in the proper season. Rills 10 inches or less in size can be reshaped with hand tools. Larger rills or gullies will require that additional fill be hauled in and some may require machine shaping. Be sure to compact new fill very well to prevent it from being washed out by subsequent rains. At culvert outlets rock or rip rap, underlain by fabric filler cloth, may be needed.

Maintain all vegetation along roads (including road shoulders, cut and fill slopes and other areas), as follows:

- Apply 2 tons lime per acre (or per soil test) during late fall or winter every 4-5 years.
- Apply fertilizer annually per soil test or as follows:
 - Grasses alone:
500 lbs. 10-10-10 per acre in early fall.
 - Legumes alone:
500 lbs. 0-10-20 per acre in early spring.
 - Grass-legume mixture:
500 lbs. 5-10-10 per acre in late winter or early spring.

Trim or remove vegetation that crowds the roadway, prevents surface water from flowing freely to drainage structures or shades problem areas.



Layman's Guide to Access Road Construction: References

Baussman, Richard F. and Emerson V. Pruett

1978, Permanent Logging Roads for Better Woodlot Management
NA-FR-18
USDA Forest Service, Northeastern Area

Darrach, Alfred G.

1981. Building Water Pollution Control Into Small Private Forest and Ranchland Roads
USDA Forest Service. Portland, Oregon

Keller, Gordon and James Sherar

2003. Low-Volume Roads Engineering: Best Management Practices
Field Guide
US Agency for International Development (USAID)
USDA Forest Service, Conservation Management Institute, Virginia Tech
and State University

Kochenderfer, James N.

1970. Erosion Control on Logging Roads In the Appalachians
Research Paper NE-15S. USDA Northeastern Forest Experiment Station

Oellberg, Robert A.

1982. Roadbuilding Guide for Small Private Roads
Mendocino County Resource Conservation District Ukiah, California

Swift, Lloyd. W. Jr. and R.G. Burns

1999. The Three R's of Roads.
Journal of Forestry, 97(8):40–45.
USDA Natural Resources Conservation Service
North Carolina Technical Guide Section IV
Standards and Specifications
Practice Standard No. 560 - Access Road.
April, 1991

Although stone can be expensive, it is crucial for long term use of your roads.



Photo Courtesy of the NC Division of Forest Resources

Acknowledgement

The authors have drawn freely from the publications listed. The reader is encouraged to consult these publications if detailed information beyond the scope of this booklet is desired.

This document was originally prepared for publication by Howard C. Tew and Lane C. Price of the USDA Soil Conservation Service (now the Natural Resources Conservation Service) and Lloyd W. Swift Jr. of the USDA Forest Service. The initial printing by Haywood Press, Waynesville, NC, was made possible by a grant from the Tennessee Valley Authority.



Photo Courtesy of the NC Division of Forest Resources



State of North Carolina
Michael F. Easley, Governor



United States Department of Agriculture



USDA Forest Service,
Southern Research Station,
Coweeta Hydrologic Laboratory



North Carolina Division of Forest Resources
Stanford Adams, Director



North Carolina Department of Environment and Natural Resources
William G. Ross Jr., Secretary