Appendix I: Road Specifications

RECOMMENDATIONS FOR FOREST ROADS

The following is a simple list of *recommended* specifications for forest roads.

- Roads should follow ridges as much as possible with road grades between 2% to 10%. Grades steeper than 10% should not exceed 500 feet in length and slopes greater than 15% should not exceed 200 feet in length. By breaking or changing grade frequently fewer erosion problems will result than by using long, straight, continuous grades.

- On highly erodible soils, grades should be 8% or less, but grades exceeding 12% for 150 feet may be acceptable as long as measures are taken to prevent erosion. Graveling the road surface can help maintain stability.

- Intermittent or perennial streams should be crossed using bridges, culverts, or rock fords. Cross as close to a right angle to the stream as possible. Structures should be sized so as not to impede fish passage or stream flow (see pipe culvert recommended specifications, page 66; and size chart, page 62).

- Install water turnouts prior to a stream crossing to direct road runoff water into undisturbed areas of the streamside management zone (SMZ). Road gradients approaching water crossings should be changed to disperse surface water at least 50 feet from the stream. With the exception of stream crossings, roads should be located a minimum distance of 50 feet from any flowing or identifiable stream. Distance is measured from the bank to the edge of soil disturbance, or in case of fills, from the bottom of the fill slope.

- Outslope the entire width of a road where road gradient and soil type will permit. Usually inslope the road toward the bank as a safety precaution on sharp turns, steep road gradients, or slippery soils. Use cross drainage on inslope or crowned roads to limit travel distance of runoff water.

- Where roads are insloped or crowned, and gradients begin to exceed 2% for more than 200 feet, broad-based dips or rolling dips should be placed within the first 25 feet of the beginning of the incline.

- Haul roads that intersect highways should use gravel, mats or other means to keep mud off the highway.

- At culverts and dips, install rip-rap or other devices at the outlets to absorb and spread water, if needed.

- Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.

- Control the flow of water on road surfaces by keeping drainage systems open and intact during logging operations.

- Inspect roads at regular intervals to detect and correct potential maintenance problems.

Appendix I: Road Specifications

WING DITCHES

Definition: A water turnout, or diversion ditch constructed to move and disperse water away from the road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduced on slopes.

Purpose: To collect and direct road surface runoff from one or both sides of the road away from the roadway and into undisturbed areas.

Conditions where practice applies: Any road or trail section where water could accumulate or accelerate. The water should be diverted onto undisturbed areas so the volume and velocity is reduced.

Recommended Wing Ditch Spacing

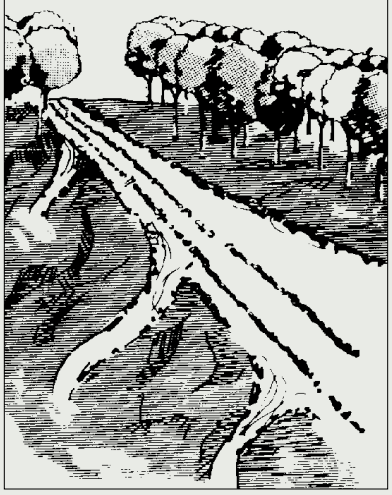
Slope Range		Maximum Distance Between Wing Ditches/ Turnouts (Feet)
Flat	2%	250
	3%	220
	4%	190
	5%	160
Moderate	6%	144
	7%	128
	8%	112
	9%	96
Steep	10%	80
	11%	60

RECOMMENDED SPECIFICATIONS

- The wing ditch should intersect the roadside ditch line at the same depth and be outsloped to a maximum grade of 2%.
- On sloping roads, the wing ditch should leave the road ditch line at a 30 to 45 degree angle to the roadbed and be downsloped less than 2% of the natural contour.
- Wing ditches may often be needed to provide stable outlets for other water control devices such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect. The spacing of wing ditches will be determined by the topography and relief of the area. Soil texture should also be considered for wing ditch spacing. On highly erodible or sandy soils wing ditches / turnouts should be spaced closer together than on clay soils.
- Wing ditches should not feed directly into adjacent drainages, gullies or channels.
- Wing ditches should be installed or cut solidly into the soil and wide enough to allow maintenance with logging equipment, such as skidders.

Basic Specifications for Water Turnout Installation

Typical Wing Ditch Bar



Water Dispersal Area
Turns Downslope

Purposes—To safely divert water from a side ditch and disperse it onto a stable outlet.

Construction guidelines—Constructing wing ditches or water turnouts with as flat a bottom as possible:

- Begin the ditch with its bottom at the same depth as the road ditch
- Angle the turnout away from the road to direct all the water from the road ditch
- The curve the wind ditch across the hill to flatten out the grade in the ditch — however, be careful not to turn it back uphill
- Blend or feather the end onto a stable outlet to spread the water as much as possible
- avoid building turnouts that release water directly into streams

Distance guidelines—Water turnouts or wing ditches may often be needed to provide stable outlets for other water control devices such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect.

Appendix I: Road Specifications

STREAM CROSSINGS

Definition: Culverts, bridges, or rock fords that allow equipment to cross intermittent or perennial streams, or drains and drainage ditches, and insure minimal negative impact to the stream.

Purpose: To cross intermittent or perennial streams with minimal increase in stream sedimentation.

Conditions where practice applies: Used for ongoing operations where streams or drainages must be crossed by logging, site preparation, road maintenance, and fire suppression equipment.

RECOMMENDED SPECIFICATIONS

General

- Aggregate or other suitable material should be laid on approaches to fords, bridges, and culvert crossings to ensure a stable roadbed approach and minimize sediment in the stream.
- When necessary, stabilize road surfaces and cut and fill slopes using effective erosion control and water control methods (seeding, commercial erosion control material, rip-rap, etc.)
- Stream crossings will require frequent inspections during operations to determine their functional and safe condition. When needed, corrective measures should be taken immediately to restore to full functioning.
- Remove culverts and bridges from temporary stream crossings upon completion of operations and return the crossing as closely as possible to its original condition.

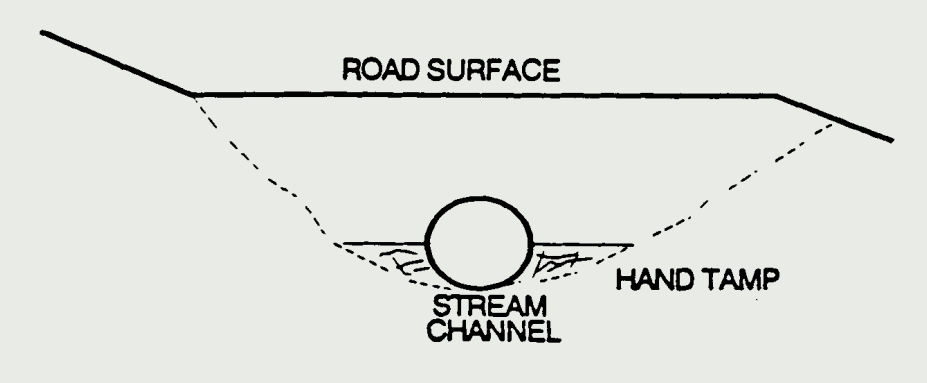
Bridges

- Bridges should be constructed with minimum disturbance to the stream bank, channel and adjacent SMZ.
- When it is necessary to protect approaches and roadbed fills near bridges, adequate erosion protection should be provided by head walls, wing walls, rip rap, etc.
- The use of temporary bridges may be necessary to minimize stream bank disturbances and provide a means of temporary access to critical areas when permanent structures are not warranted or needed.

Fords

- Rock fords may be used if no practical alternative exists. Approaches, stream banks, and stream bottoms must be hard enough or sufficiently stabilized to minimize stream bottom and bank disturbance.

Basic Specifications for Culvert Design and Installation



Definitions

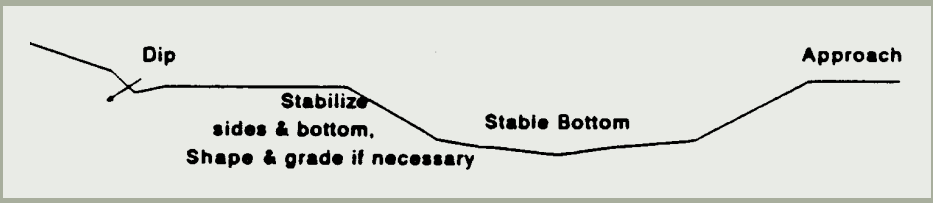
Peak runoff is the accumulated amount, in cubic feet per second, of a storm's runoff from an entire drainage area. Factors that affect runoff include vegetative cover, slopes and soils. The design guidelines included in this section are calculated on a 5-inch, 24-hour storm occurrence.

Head is the vertical column of water that is temporarily stacked over the culvert's entrance. Head provides the energy needed to force water through the culvert. The greater the head, the more water that can be forced through the pipe.

Construction guidelines

- Culverts should be placed in straight sections of stream channels
- The stream should have as straight an entrance and outlet as possible
- The inlet should be placed on the stream bed, not above it
- The approach to the stream crossing should be at right angles to the stream
- Seat the culvert on firm ground, not fill, and compact the earth at least halfway up the side of the culvert
- 18" of compacted fill over culverts is recommended

Basic Specifications for Installation of Fords



If fords (low-water crossings) are used

- Look for stream crossings that have low banks and solid stream beds
- Look for stream sections that can accommodate approaches of about 50 feet on both sides, and that are reasonably level
- Stabilize immediately, and if necessary use heavy applications of gravel
- Make crossings at right angles to the stream and only in straight sections, never in bends
- Install wing ditches, waterbars or dips before the crossing; this will drain water off the side of the road rather than into the stream
- Use other stream crossing methods such as culverts or bridges if water quality is important for domestic use, livestock water, fishponds, etc.
- Never use during high water periods

Appendix I: Road Specifications

CULVERTS FOR ROADS

Definition: Pipe made of metal, plastic, or other suitable material installed under haul roads to transmit water from the road side ditch, storm runoff, seeps and drains.

Purpose: To collect and transmit water safely from side ditches, seeps or natural drains under haul roads and skid trails without eroding the drainage system or road surface.

Conditions where practice applies: Culverts can be used for any size operation where cross drainage of water is needed. In some cases, a culvert is necessary for temporary drainage crossings. Permanent installation should be periodically inspected for obstructions.

RECOMMENDED SPECIFICATIONS

- Pipe length should be long enough so both ends extend at least one foot beyond the side slope of fill material.
- The culvert should be placed 1% to 2% downgrade to prevent clogging and laid so the bottom of the culvert is as close as possible to the natural grade of the ground or drain.
- The culvert should be angled 30 to 45 degrees to the direction of water flow.
- Erosion protection should be provided for outflows of culverts to minimize erosion downslope or downstream of the outfall; it may also be needed on the upstream end of culverts on flowing streams. This protection can be in the form of headwalls, rip rap, geotextile filter cloth, large stone, or prefabricated outflow and inflow devices.
- Culverts should be firmly seated and earth compacted at least halfway up the side of the pipe. Cover, equal to a minimum of half the culvert diameter (preferably 1 foot fill per 1 foot culvert diameter), should be placed above the culvert — but never use less than one foot of cover. The distance between pipes in a multiple culvert application should be a minimum of half the pipe diameter.

Culvert Size Chart

Acres Drained	Light Soils (SANDS)			Medium Soils (LOAMS)			Heavy Soils (CLAYS)		
	Flat (%) 0–5	Mod (%) 5–15	Steep (%) 15+	Flat (%) 0–5	Mod (%) 5–15	Steep (%) 15+	Flat (%) 0–5	Mod (%) 5–15	Steep (%) 15+
	Culvert Diameter in Inches								
5	18	18	18	18	18	21	21	21	24
10	18	18	18	21	24	27	27	27	36
20	18	18	18	24	27	36	36	36	42
30	18	18	18	27	30	36	36	42	48
40	18	18	18	27	36	42	42	48	
50	18	18	18	30	36	48	48	48	
75	18	21	21	36	42				
100	21	21	24	36	48				
150	21	24	24	42					
200	24	30	30	48					
250	27	30	30						
300	30	36	36						
350	30	36	42						
400	36	36	42						

Appendix I: Road Specifications

BROAD-BASED DIPS

Definition: A surface drainage structure specifically designed to drain water from an access road, while allowing all vehicles to maintain normal travel speeds.

Purpose: To gather surface water and direct it off the road to prevent buildup of surface runoff and subsequent erosion, while allowing passage of traffic.

Conditions where practice applies: Used on truck haul roads and heavily used skid trails having a gradient of 8% or less. Should not be used for stream crossings.

Recommended Broad-based Dip Spacing

Slope (%)		Distance Between Broad-based Dips (Feet)
Flat	2%	300
	3%	233
	4%	200
	5%	180
Moderate	6%	166
	7%	157
	8%	150

RECOMMENDED SPECIFICATIONS

- Installation should take place following basic clearing and grading for roadbed construction.
- A 20-foot long, 3% reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location.
- The cross drain outslope will be 2% to 3% maximum.
- An energy absorber such as rip rap and, in some cases, a level area where the water can spread, should be installed at the outfall of the dip to reduce water velocity thus minimizing erosion.
- On some soils the dip and reverse grade section may require bedding with three inches of crushed stone to avoid rutting the road surface.
- Broad-based dips are very effective in gathering surface water and directing it safely off the road. Dips should be placed across the road in the direction of water flow.
- Approximate recommended spacing table for broad-based dips.

Appendix I: Road Specifications

ROLLING DIPS

Definition: Rolling dips are a cross between water bars and broad-based dips. Like broad-based dips they have a reverse grade (except its shorter) and they direct water off the road. Like water bars they may rely on a mound of soil at the downhill side. Rolling dips should be used on roads with a steeper grade than where a broad-based dip is used.

Purpose: To gather water and direct it safely off the road to prevent buildup of surface runoff and subsequent erosion, while allowing passage of traffic.

Recommended Rolling Dip Spacing

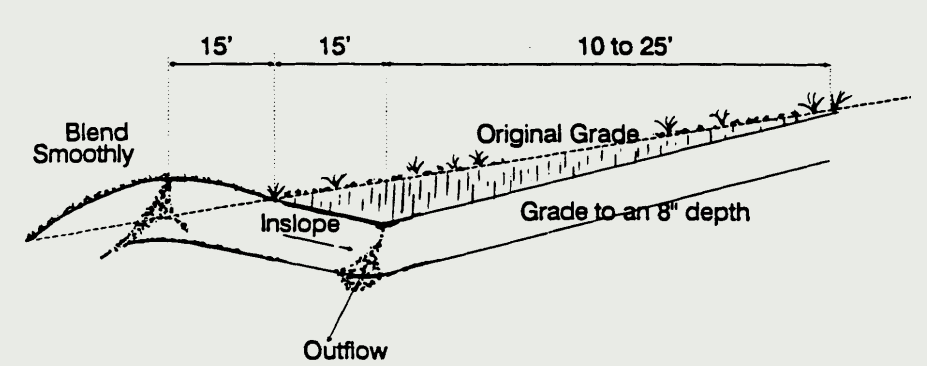
Slope (%)		Distance Between Broad-based Dips (Feet)
Flat	2%	300
	3%	233
	4%	200
	5%	180
Moderate	6%	167
	8%	150
Steep	9%	144
	11%	136
	13%	131
	15%	127

Conditions where practice applies: Used on truck haul roads and heavily used skid trails having a gradient of 15% or less. Should not be used for crossing streams, springs, and seeps.

RECOMMENDED SPECIFICATIONS

- Installation following basic clearing and grading for roadbed construction or on skid trails after logging is completed.
- A 10 to 15-foot long, 3% to 8% reverse grade is constructed into the roadbed by cutting from upgrade to the dip location and then using cut material to build the mound for the reverse grade.
- In hills, rolling dips are located to fit the terrain as much as possible. They should be spaced according to the slope of the planned roadbed.
- Spacing rolling dips can be determined from the adjacent table.

Basic Specifications for Rolling Dip Installation



Definition — Rolling dips are a cross between water bars and broad-based dips. Like broad-based dips, they have a grade (a shorter one) and they direct water from the roadway. Like water bars, they may also rely on a mound of soil at the down-hill side.

Purposes

- To gather water and direct it safely off the roadway
- To provide cross-drainage of inside ditches

Where suitable

- Not for handling live (constantly running) water
- On roads that will be used
- Can be employed on steeper grades than broad-based dips

Construction guidelines

- Place across the road in the direction of flow
- Outslope the dip only, not the road
- Mound excavated material from the dip on the down-hill side
- Blend the mound to as gentle a slope as possible, to make traveling over it easier

Appendix I: Road Specifications

WATERBARS

Definition: A diversion dam constructed across a road or trail to remove and disperse surface runoff in a manner which adequately protects the soil resource and limits sediment transportation.

Purpose: To gather and shed surface water off a road, firebreak, trail, etc. ; To prevent excessive erosion until natural or artificial revegetation can be established; To divert water from an inside (uphill) ditch.

Conditions where practice applies: This is a practice that can be utilized on limited use roads, trails and firebreaks and abandoned or retired roads and trails where surface water runoff may cause erosion of exposed soil.

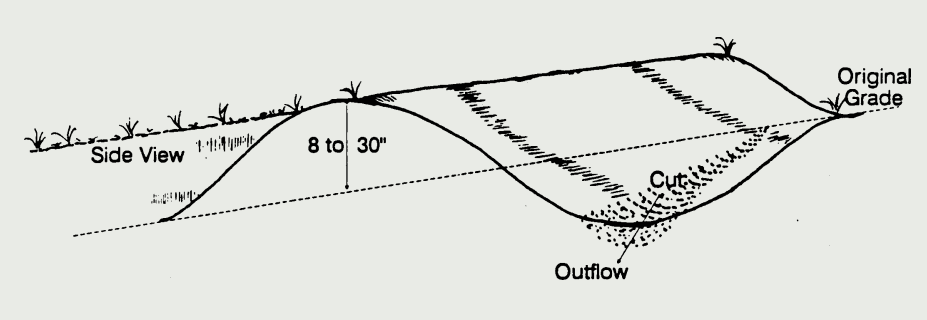
Recommended Waterbar Spacing

Grade of Road		Distance Between Waterbars (Feet)
Flat	2%	250
	3%	220
	4%	190
	5%	160
Moderate	6%	144
	7%	128
	8%	112
	9%	96
Steep	10%	80
	11%	60

RECOMMENDED SPECIFICATIONS

- Waterbars should be placed at an angle of 30 to 45 degrees to the road, firebreak or trail. Waterbars are not dams. Waterbars intercept and / or divert surface water runoff.
- Recommended proper spacing between waterbars can be determined from the table, below left.
- The outflow end of the waterbar should be fully open and extend far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor. The outlet should fall no more than 2%.
- Specifications for waterbar construction on forest roads, trails and firebreaks must be site specific and should be adapted to existing soil and slope conditions.

Basic Specifications for Waterbar Installation



Purposes

- To gather and shed surface water off a road, trail, firebreak, etc.
- To divert water from an inside ditch
- To prevent excessive erosion until revegetation can be established

Where suitable

- Roads and trails that will have no or very limited traffic
- Abandoned or retired roads and trails
- Firebreaks

Construction guidelines

- Angle across the road in the down-grade direction
- Tie the upper end into the inside ditch's bank, when present
- Empty onto stable outlets
- Can be constructed mechanically or by hand

Note: *See the waterbar spacing guidelines displayed in the small table on the opposite page. In addition to distance between waterbars, consider taking advantage of factors such as slope changes, curves and presence of stable outlets.*

Smurfit-Stone Container Corp. photo

Tree farmers practice sustainable forestry. That means they share a unique commitment to produce wood for America's needs while protecting our soil, water, and wildlife resources and providing recreation from our woodlands.