Exhibit 6

Apache-Sitgreaves National Forests

Best Management Practices for Road Maintenance

October 5, 2012

The following synopsis is compiled from:
Keller, Gordon and James Sherar. 2003. Low Volume Roads Engineering; Best Management Practices Field Guide. 158 pgs illustrated. Produced for US Agency for International Development (USAID) in cooperation with USDA Forest Service and Conservation Management Institute, Virginia Polytechnic Institute and State University.

This reference is available electronically (accessed August 2010) from:
http://ntl.bts.gov/lib/24000/24600/24650/Index_BMP_Field_Guide.htm

Key objectives: BEST MANAGEMENT PRACTICES

Best Management Practices are designed to accomplish the following:

A. Produce a safe, cost effective, environmentally friendly, and practical road design that is supported by and meets the needs of the users;
B. Protect water quality and reduce sediment loading into water bodies;
C. Avoid conflicts with land use;
D. Protect sensitive areas and reduce ecosystem impacts;
E. Maintain natural channels, natural stream flow, and maintain passage for aquatic organisms;
F. Minimize ground and drainage channel disturbance;
G. Control surface water on the road and stabilize the roadbed driving surface;
H. Control erosion and protect exposed soil areas;
I. Implement needed slope stabilization measures and reduce mass wasting;
J. Avoid problematic areas; and
K. Storm-proof and extend the useful life of the road.
L. Minimize the spread of noxious weeds through pressure washing equipment transported onto Forest lands from other areas.

Key Road Maintenance Items: BEST MANAGEMENT PRACTICES

Maintenance items that should be performed routinely include:

A. Grading and shaping the roadway surface to maintain a distinct in-sloped, out-sloped, or crown shape to move water rapidly off the road surface.

B. Compacting the graded roadway surface to keep a hard driving surface and prevent the loss of fines. Replace surfacing material when needed. Keep the road surface moist during grading and compacting!
C. Removing ruts through rolling dips and water bars. Reshape the structures to function properly.
D. Cleaning ditches and reshaping them when necessary to have adequate flow capacity. **Do not grade ditches that do not need it!**
E. Removing debris from the entrance and immediately upstream of culverts to prevent plugging and overtopping. Check for damage and signs of piping or scour.
F. Replacing/repairing rock armor, concrete, or vegetation used for slope protection, scour protection, or energy dissipation.
G. Trimming roadside vegetation (brushing) adequately, but not excessively, for sight distance and traffic safety. See Figure 1 below.
H. Replacing missing or damaged road information, safety, and regulatory signs.

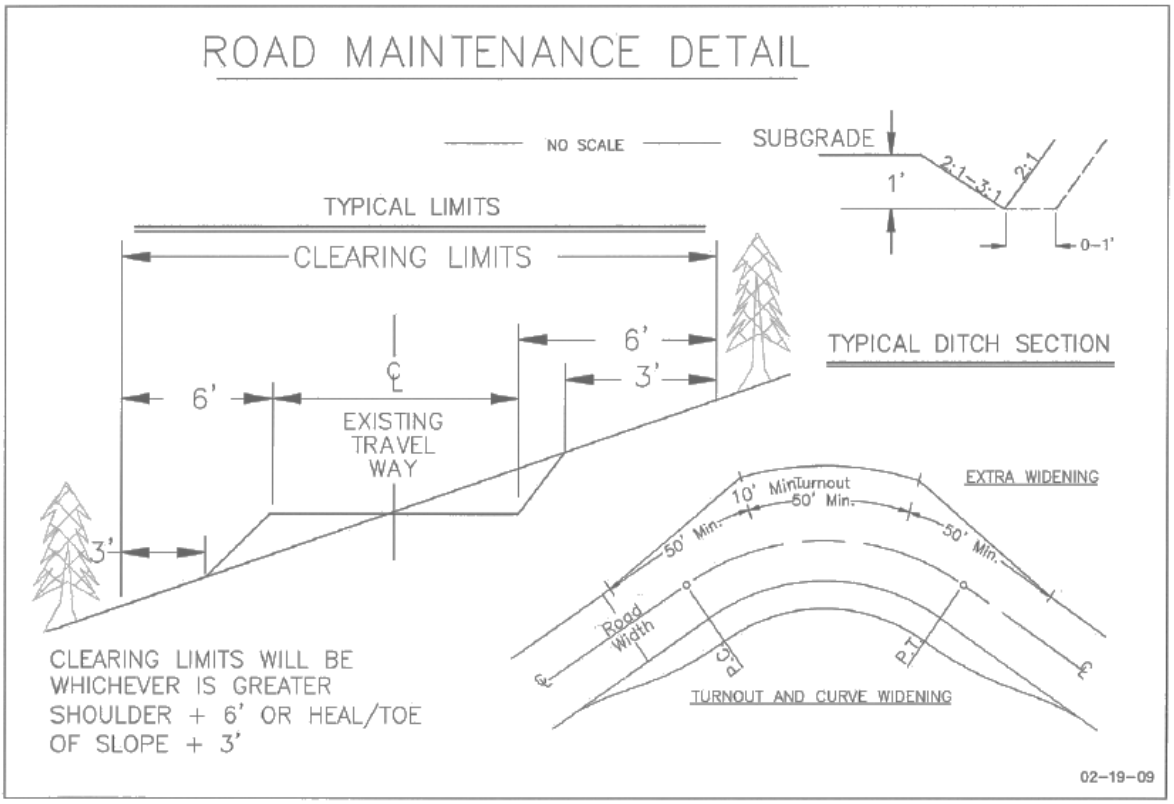

Figure 1: Vegetation clearing limits.

Recommended Practices for Road Maintenance

General Maintenance and Grading

a. Inspect the road at regular intervals, especially following periods of heavy rains.
b. Perform maintenance when needed. **DO NOT WAIT!** The longer you wait, the more on-site damage and off-site sedimentation will occur and repairs will be more costly.

c. Keep ditches and culverts free from debris, but maintain an erosion resistant surfacing such as grass or rock in the ditches. Remove debris during inspections. Also keep overflow channels clean.
d. Re-grade and shape the road surface periodically to maintain proper surface drainage. Keep the road surface moist during grading. Fill in ruts and potholes with gravel or compacted fill as frequently as possible. Keep rolling dips shaped and graded. Ideally, compact the final graded road surface.
e. Maintain positive surface drainage with an out-sloped, in-sloped, or crown roadway section using 3 - 5 % cross slopes (up to 5% is best). Provide cross drainage with culvert pipes or rolling dips. In slippery soils, either in-slope the road or add aggregate surfacing to the road. Use a crown road section on a wide road with gentle slopes or flat ground to prevent water from standing on the road surface. See Figure 2 below.

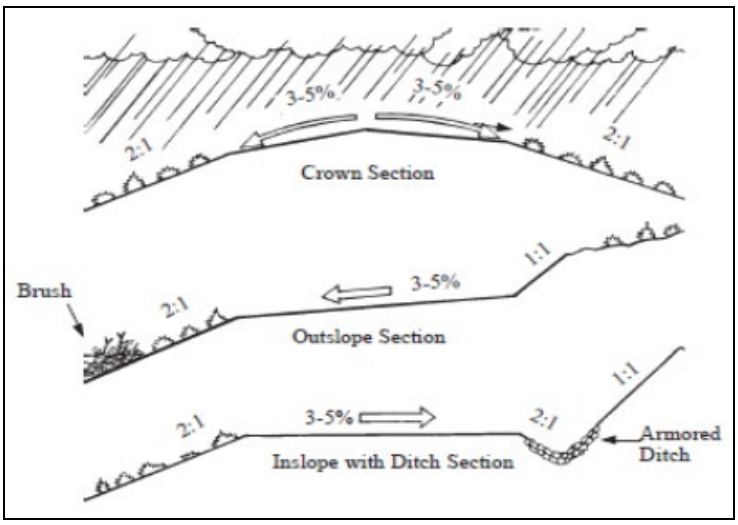

Figure 2: Road surface drainage design.

f. Roll grades or undulate the road profile frequently to disperse water, particularly into and out of stream crossings.
g. Keep the downhill side of the road free from a berm except where a berm is intentionally constructed to control water or traffic.
h. Apply a surface stabilization material, such as aggregate, cobblestone, or pavement, to the road surface to protect the roadbed from damage and reduce the frequency of maintenance needed.
i. Avoid disturbing soil and vegetation if not necessary. Leave as much vegetation (grasses) in ditches, on road shoulder areas, and on cut or fill slopes (especially grasses and low growing brush) as possible. However, ensure sight distance and that the drainage systems still function properly.
j. Remove slide material from the roadway or inside ditches where the material will block normal roadway surface drainage.
k. Avoid widening the road or over-steepening the fill slopes formed by blading surface material off the road.
l. Close the road during very wet conditions or periods of inactivity. If the following guidelines are exceeded, this may be a threshold to either temporarily close the road or schedule heavier maintenance to allow use during wet conditions.

1. Unpaved Local Terminal and Service roads: 6 – 8 inch rutting for a maximum of 75 feet not to exceed 10% of total road length. Where surfacing has been placed on the road, see standard for Collector road.
2. Collector and Arterial Roads: 3 inch rutting for entire length of road if surfaced. If unsurfaced the guideline will be the same as for Local Service.
3. Drainage: Existing grade dips. If rutted to the point of being non-functional, grade dips will be restored before hauling can continue. Lead-out ditches, roadside ditches, and catch basins will be maintained in a functional state.

Natural Stream Crossings

a. Use drainage structures that best conform to the natural channel and that are as wide as the active stream channel (bankfull width). Minimize natural channel changes and the amount of excavation or fill in the channel.
b. Limit construction activity to periods of low flow in live streams. Minimize use of equipment in the stream. Stay out of the stream!
c. Design structures and use construction practices that minimize impacts on fish and other aquatic species or that can enhance fish passage.
d. Cross drainage channels as infrequently as possible. When necessary, cross streams at right angles except where prevented by terrain features.
e. Keep approaches to stream crossings to as gentle a grade as practical. Roll grades into and out of the crossing to disperse water.
f. Stabilize disturbed soil around crossings soon after construction. Remove or protect fill material placed in the channel and floodplain.
g. Use bridges, low-water fords or improved fords, and large arch pipes with natural stream bottoms wherever possible to maximize flow capacity, minimize the possibility of a plugged pipe, and minimize impacts on aquatic species.
h. Locate crossings where the stream channel is straight, stable, and not changing shape. Bedrock locations are desirable for concrete structures.
i. For overflow protection, construct fills over culverts with an armored low point near the pipe in low fills or add an armored rolling dip on native ground just beyond a large fill to return water to the drainage and prevent off-site damage.
j. Stabilize roadway approaches to bridges, fords, or culvert crossings with gravel, rock, or other suitable material to reduce road surface sediment from entering the stream. Install cross-drains on both sides of a crossing to prevent road and ditch runoff from entering the drainage channel.
k. Construct bridges and culvert fills higher than the road approach to prevent road surface runoff from draining directly into the stream -- but ONLY if likelihood of culvert failure is VERY small. Typically, the crossing should be designed to minimize the amount of fill.
l. Equipment should be clean from weed seeds / plant parts and petroleum products (leaks) working in and around live streams.

Fords and Low Water Crossings

a. Use an adequately long slab or structure to protect the “wetted perimeter” of the natural flow channel. Add protection above the expected level of the high flow. Allow for some freeboard, typically 12 to 18 inches in elevation, between the top of the reinforced driving surface (slab) and the expected high water level. The flow capacity of a ford, and thus the high water level, can be estimated using a “Broad-Crested Weir” formula.

b. Protect the entire structure with cutoff walls, riprap, gabions, concrete slabs, or other scour protection. The downstream edge of a ford is a particularly critical location for scour and needs energy dissipaters or riprap protection because of the typical drop in water level off the structure and the accelerated flows across the slab.
c. For simple rock fords, use large graded rock in the roadbed through the creek, large enough to resist the flow of water. Fill the voids with clean, small rock or gravel to provide a smooth driving surface. This small rock will have to be periodically maintained and replaced.
d. Use fords for crossing seasonally dry streambeds or streams with low flows during most periods of road use. Use improved (vented) fords with pipes or concrete box culverts to pass low water flows. Accommodate fish passage where needed using box culverts with a natural stream channel bottom.
e. Locate fords where stream banks are low and where the channel is well confined. For moderately incised drainages, use improved fords with pipe or box culverts.
f. Place foundations into scour resistant material (bedrock or coarse rock) or below the expected depth of scour. Prevent foundation or channel scour with the use of locally placed heavy riprap, gabion baskets, concrete reinforcement or dense vegetation.
g. Use well placed, sturdy depth markers at fords to advise traffic of dangerous water depths.

Maintenance of Drainage Systems

a. Use roadway cross-drain structures (either rolling dips, pipe culverts, or open top culverts (flumes) to move water across the road from the inside ditch to the slope below the road. Space the cross-drain structures frequently enough to remove all surface water. Tables in the reference document give recommended cross-drain spacing.
b. Maintain roads with rolling grades to minimize concentration of water. Provide filter strips or infiltration areas to trap sediment between drain outlets and waterways. Keep roads and streams (any natural drainage way) disconnected!
c. Construct **rolling dips** rather than culvert cross-drains for typical, low volume, low speed roads with grades less than 12%. Construct rolling dips deep enough to provide adequate drainage, angled 0-25 degrees from perpendicular to the road, with a 3-5% out-slope, and long enough (50 to 200 feet) to pass vehicles and equipment. In soft soils, armor the mound and dip with gravel or rock, as well as the outlet of the dip. See Figure 3 and Table 1 below.
d. Construct **water bars** on infrequently used roads or closed roads to control surface runoff. Construct frequently spaced water bars angled at 0-25 degrees with an out-slope of 3-5% and a depth of 12 to 18 inches. Spacing of water bars is shown in tables below.
e. Use **catch water ditches** (intercept ditches) across the natural ground above a cut slope only in areas with high intensity rainfall and overland flow. These ditches are useful to capture overland sheet flow before it pours over the cut slope and erodes or destabilizes the cut. However, be aware that catch water ditches are that are not properly maintained can become a counterproductive pool for water above the slope, increasing the probability of a slope failure.
f. Avoid the use of **outside ditches**, along the outside edge of the road, except in specific areas that must be protected from sheet flow off the road surface. Preferably, use berms. Note that an outside ditch or berm necessitates additional road width.

Table 1: Recommended Maximum Distance Between **Rolling Dip or Culvert** Cross Drains (feet)

Road Grade %	**Drainage Spacing (ft)**
0-3	250
4-6	165
7-9	130

Table 2: Recommended **Water Bar** Spacing (feet)

Road Grade %	**Drainage Spacing (ft)**
0-5	130
6-10	100

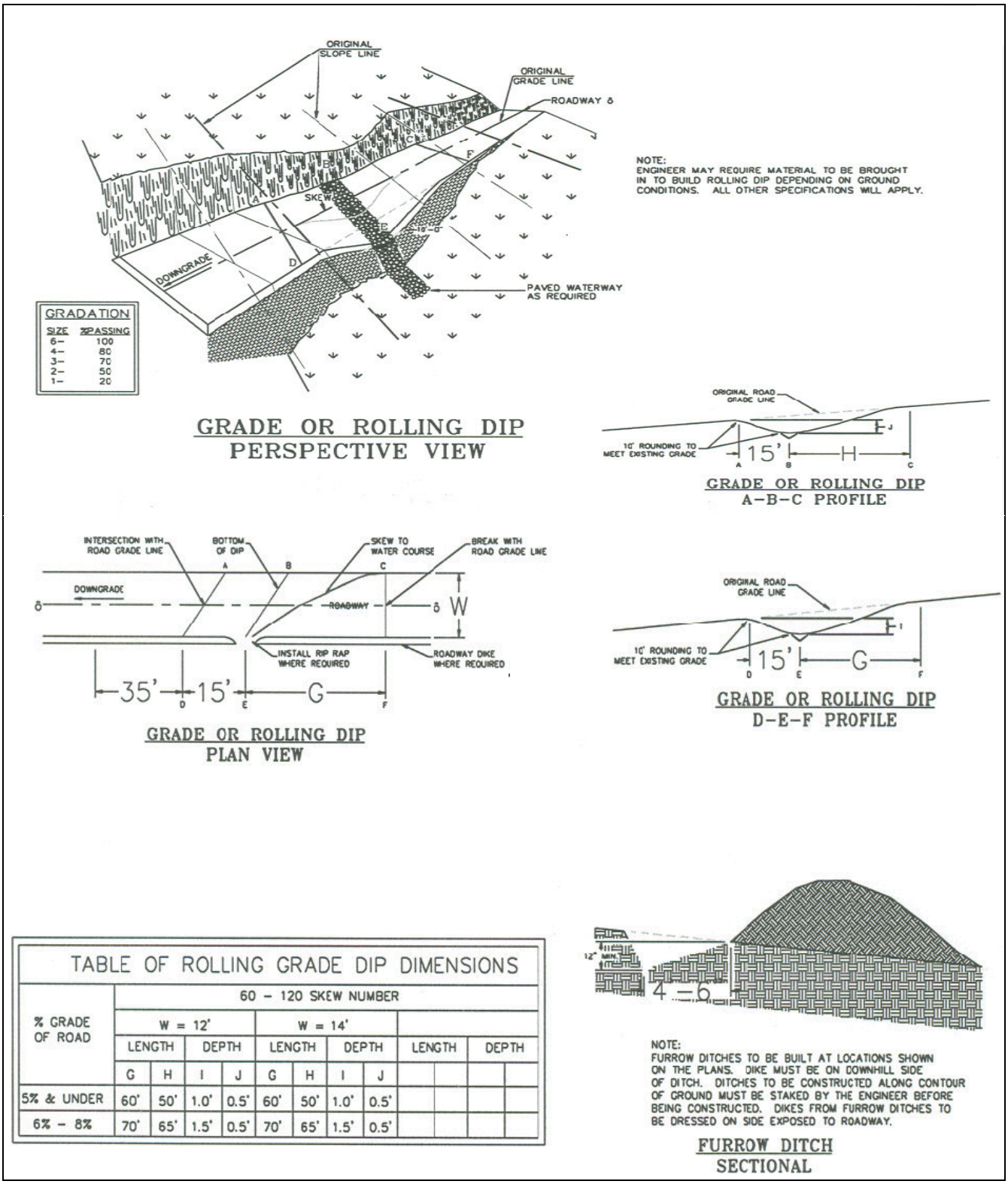

TABLE OF ROLLING GRADE DIP DIMENSIONS

% GRADE OF ROAD	60 – 120 SKEW NUMBER											
	W = 12'				W = 14'							
	LENGTH		DEPTH		LENGTH		DEPTH		LENGTH		DEPTH	
	G	H	I	J	G	H	I	J				
5% & UNDER	60'	50'	1.0'	0.5'	60'	50'	1.0'	0.5'				
6% – 8%	70'	65'	1.5'	0.5'	70'	65'	1.5'	0.5'				

Figure 3: Grade Dip Typicals.

Ditch Relief or Cross-Drain Culverts

a. **Protect cross-drain outlets** with rock (riprap), brush, or logging slash to dissipate energy and prevent erosion, or locate the outlet of cross drains on stable, non-erosive soils, rock, or in well vegetated areas.
b. Install **culvert cross-drains** with an angle of 0-30 degrees perpendicular to the road, using an out-slope of 2% greater than the ditch grade to prevent plugging. Use culvert cross-drains on roads with an inside ditch and moderately fast vehicle speeds.
c. **Ditch relief cross-drains should exit at the toe of the fill** near natural ground level, at least 1.5 feet beyond the toe of the fill slope. Armor the pipe outlet. Don't discharge the pipe on unprotected fill material, unstable slopes, or directly into streams.

Control at Culvert Inlets & Outlets

1. When ditch grade control is needed, use drop inlet structures with culvert cross-drains to prevent ditch down-cutting or where space is limited against the cut bank. Alternately, use catch basins excavated into firm soil.
2. Discharge culverts and cross-drain dips at natural ground level, on firm, non erosive soil or in rocky or brushy areas. If discharged on the fill slopes, armor outlets with riprap or logging slash, or use down-drain structures. Extend the pipe 1.5 to 3 feet beyond the toe of the fill slope to prevent erosion of the fill material.
3. In erosive soils, armor roadway ditches and leadoff ditches with rock riprap, masonry, concrete lining or, at a minimum, grasses. Ditch dike structures can also be used to dissipate energy and control ditch erosion. Discharge roadway drains in an area with infiltration capability or into filter strips to trap sediment before it reaches a waterway. **Keep the road and streams hydrologically "disconnected."**

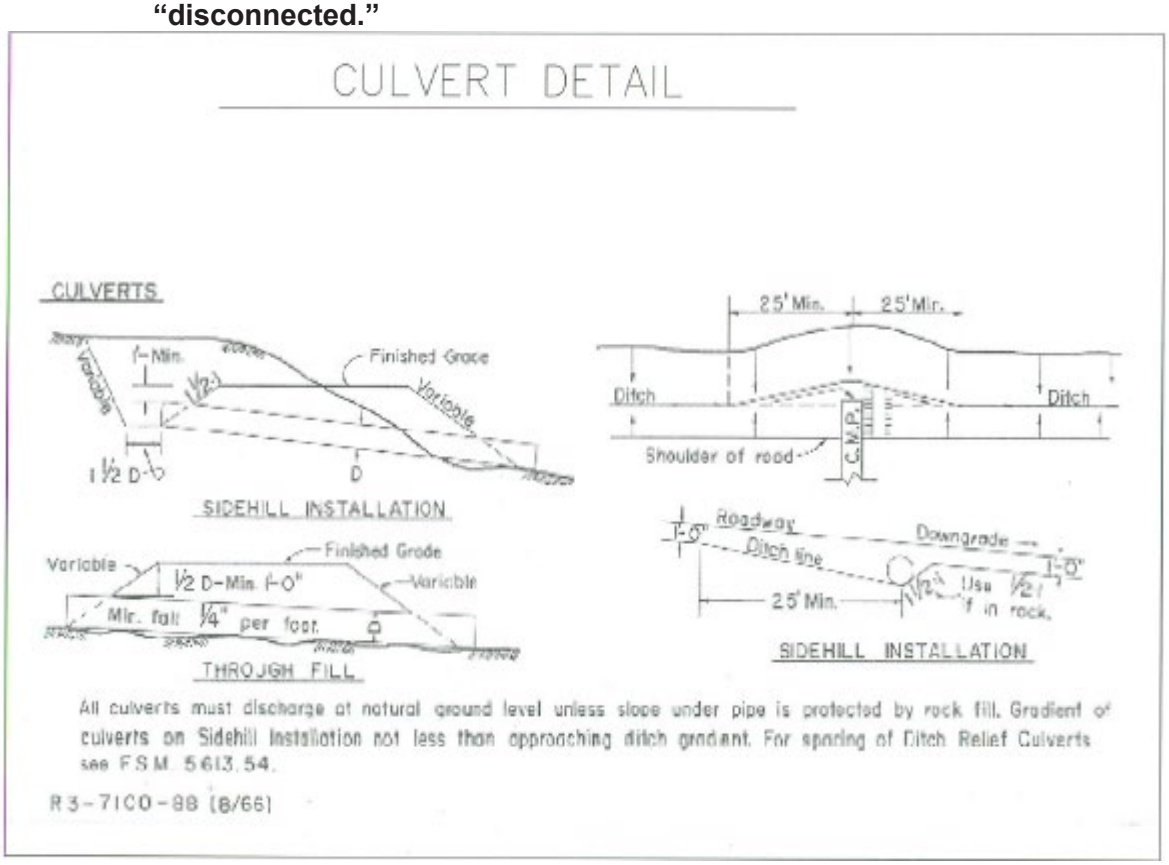

Figure 4: Culvert details.

Drainage Crossing Culverts

a. Install permanent culverts with a size large enough to pass design flood flows plus anticipated debris. Design for 20- to 50-year storm events. Sensitive streams may require designs to pass a 100-year flood. Pipe size can be determined using general design criteria, but is ideally based upon site-specific hydrologic analysis.
b. Consider impacts of any structure on fish passage and the aquatic environment. Select a structure such as a bridge or bottomless arch culvert that is as wide as the ordinary high water width (bankfull width), that minimizes channel disturbance, and that maintains the natural channel bottom material.
c. Make road crossings of natural drainages perpendicular to the drainage to minimize pipe length and area of disturbance.
d. Use single large pipes or a concrete box versus multiple smaller diameter pipes to minimize plugging potential in most channels (unless roadway elevation is critical). In very broad channels, multiple pipes are desirable to maintain the natural flow spread across the channel.
e. For sites with limited height, use “squash pipe” or arch pipes and box culverts that maximize capacity while minimizing height.
f. Use concrete or masonry headwalls on culvert pipes as often as possible. The advantages of headwalls include: preventing large pipes from floating out of the ground when they plug; reducing the length of the pipe; increasing pipe capacity; helping to funnel debris through the pipe; retaining the backfill material; and reducing the chances of culvert failure if it is overtopped.
g. Install culverts long enough so that both ends of the culvert extend beyond the toe of the roadway fill. Alternatively, use retaining walls (headwalls) to hold back the fill slope.
h. Align culverts in the bottom and middle of the natural channel so that installation causes no change in the stream channel alignment or stream bottom elevation. Culverts should not cause damming or pooling or increase stream velocities significantly.
i. Firmly compact well-graded fill material around culverts, particularly around the bottom half, using placement in layers to achieve a uniform density. Use slightly plastic sandy gravel with fines. Avoid the use of fine sand and silt rich soils for bedding material because of their susceptibility to piping. Pay particular attention to culvert bedding and compaction around the haunches of the pipe. Do not allow the compaction to move or raise the pipe. In large fills, allow for settlement by installing the pipe with camber.
j. Cover the top of metal and plastic culvert pipes with fill to a depth of at least 30 cm to prevent pipe crushing by heavy trucks. Use a minimum cover of two feet of fill over concrete pipe. For maximum allowable fill height, follow the manufacturer’s recommendations.
k. Examine stream channels for the amount of debris, logs, and brushy vegetation. In channels with large amounts of debris, consider using a **low-water ford**, oversized pipes, or placing a trash rack upstream of the pipe entrance.
l. Install overflow dips off the side of the culvert in drainage channels with a large fill that could be overtopped. Also use overflow dips on long sustained road grades where a plugged culvert could divert water down the road, plugging subsequent culverts and causing extensive off-site damage.

Roadway Materials and Materials Sources

a. Stabilize the roadway surface on roads that form ruts or ravel excessively. Common surface stabilization techniques include using 4-6 inches of crushed aggregate; local pit run or grid roll rocky material; cobblestone surfacing; wood chips or fine logging slash; or soils mixed and stabilized with cement, asphalt, lime, lignin, chlorides, chemicals, or enzymes.

b. For heavy traffic on soft subgrade soils, use a single, thick structural section consisting of at least 8-12 inches of surfacing aggregate. Alternatively, use a structural section consisting of a 4-12 inch thick layer of base aggregate or coarse fractured rock, capped with a 4-12 inch thick layer of surfacing aggregate. Note that soft clay-rich soils and heavy tire loads may require a thicker structural section. The structural depth needed is a function of the traffic volume, loads and soil type.
c. Maintain a 3-5% road cross-slope with insloping, outsloping, or a crown to rapidly move water off the road surface.
d. Grade or maintain the roadway surface before significant potholes, washboarding, or ruts form.
e. Compact the embankment material, road surface material or aggregate during construction and maintenance to achieve a dense, smooth road surface and thus reduce the amount of water that can soak into the road.
f. “Spot” stabilize local wet areas and soft areas with 4-6 inches of coarse rocky material. Add more rock as needed.
g. Stabilize the road surface in sensitive areas near streams and at drainage crossings to minimize road surface erosion.
h. Control excessive road dust with water, oils, wood chips, or use of other dust palliatives.
i. Blend coarse aggregate and fine clay-rich soil (when available) to produce a desirable composite roadway material that is coarse yet well-graded with 5-15 % fines for binder.
j. Use project construction quality control, through visual observation and materials sampling and testing, to achieve specified densities and quality, well-graded road materials.
k. On higher standard, high traffic volume roads (collectors, principals, or arterials) use appropriate, cost effective surfacing materials such as oils, cobblestone, paving blocks, bituminous surface treatments (chip seals), and asphalt concrete pavements.

MAINTENANCE PRACTICES TO AVOID

a. Long sustained road grades that concentrate flows.
b. Discharging water onto erosive, unprotected soils.
c. “Eyeballing” grades in flat terrain. Use a clinometer, abney level, or survey equipment to ensure that you have proper slopes or grades.
d. Working with equipment in an unprotected natural streambed.
e. Adversely impacting fisheries with a stream crossing structure.
f. Allowing runoff from roadside ditches to flow directly into streams.
g. Crossing wet areas unnecessarily.
h. Concentrating water flow in meadows or changing the natural surface and subsurface flow patterns.
i. Placing culverts below the meadow surface elevation.

Culverts

a. Discharging a cross-drain pipe or dip onto any unprotected fill slope or barren, erosive soil.
b. Discharging cross-drain pipes mid-height on a fill slope.
c. Discharging cross-drain pipes or dips onto unstable natural slopes.

Fords

a. Constructing sharp vertical curves on fords that can trap long trucks or trailers.
b. Placing approach fill material in the drainage channel.
c. Crossing fords during high water flows.
d. Placing low-water crossings on scour susceptible, fine grained soil deposits, or using designs without scour protection.

e. Constructing fords that block upstream and downstream passage of fish.

Roadway Materials

a. Construction operations or heavy traffic during wet or rainy periods on roads with clay rich or fine-grained soil surfaces that form ruts.
b. Allowing ruts and potholes to form over 2 to 4 inch deep in the roadway surface.
c. Road surface stabilization using coarse rock larger than about 3 inches. Coarse rock is difficult to drive upon or keep stabilized on the road surface, and it damages tires.
d. Using surfacing materials that are fine grain soils, soft rock that will degrade to fine sediment, or clean, poorly graded coarse rock that will erode, ravel, or washboard.
e. In-stream channel gravel extraction operations and working with equipment in the stream.

Recommended Road Closure Practices

Road Closure Best Management Practices

a. Involve the affected population or road users in decisions regarding road closure, typically using an interdisciplinary process.
b. Temporarily close roads using gates, barricades, or large berms.
c. Install water bars on closed roads to divert water off the road surface.
d. Remove berms that may impede surface drainage on closed roads.
e. Decommission roads with closure structures, drainage control, and erosion protection, but without re-contouring the road template, if future use of the road is likely.
f. Obliterate unneeded roads whenever possible and where cost-effective to provide the highest degree of road removal and land reclamation.
g. Remove all drainage and stream crossing structures in permanently closed roads.
h. Close roads by reshaping the roadbed to maintain natural surface drainage patterns and avoid concentration of water. Revegetate exposed soil on closed roads. A common treatment includes scarification, seeding, and a mulch application to promote grass and brush growth. Trees may be planted. On grades, water-bars should be added.

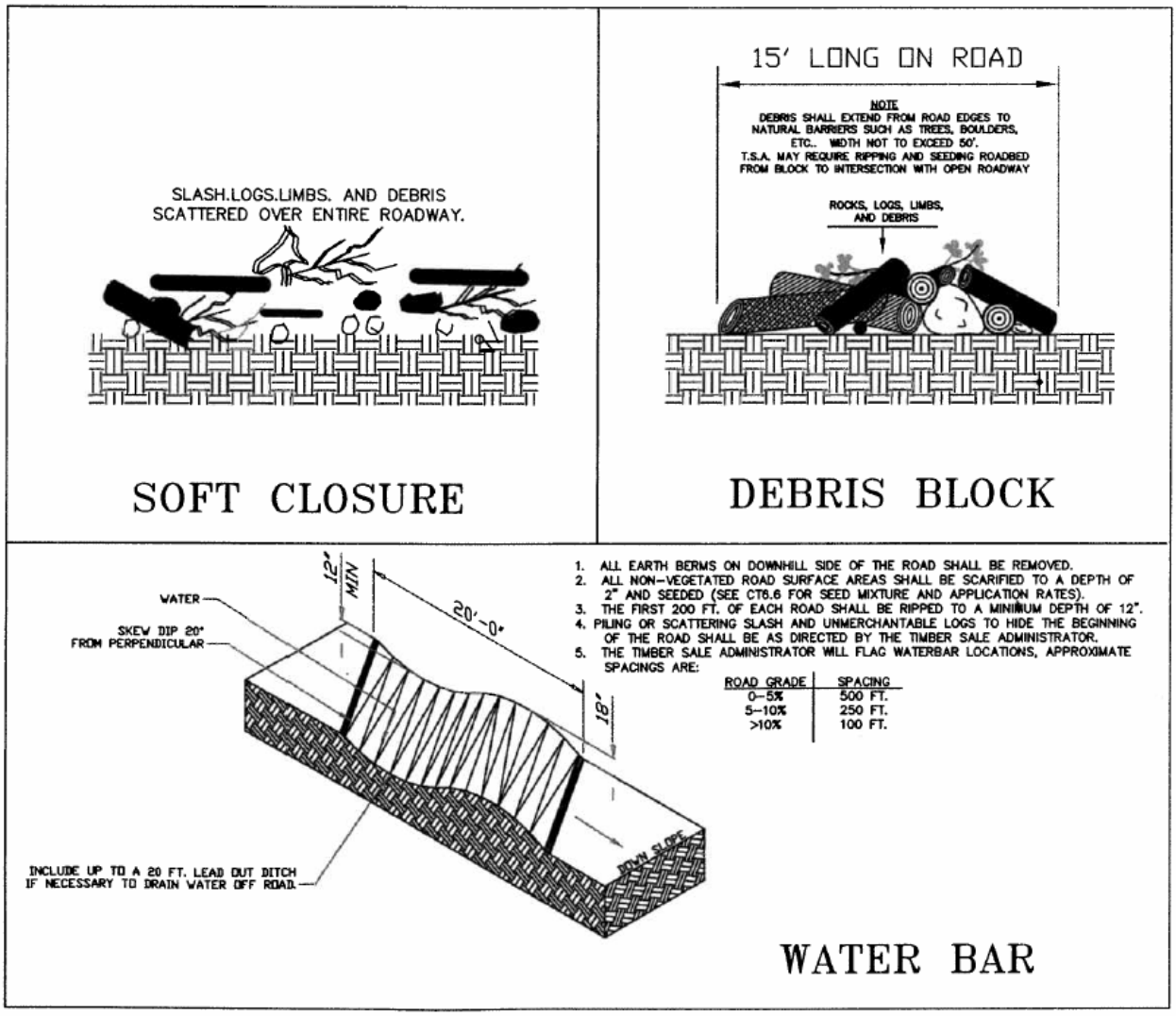

Figure 5: Road closure details.

ROAD CLOSURE PRACTICES TO AVOID

a. Leaving drainage structures on closed (decommissioned or obliterated) roads.
b. Neglecting temporarily closed roads.