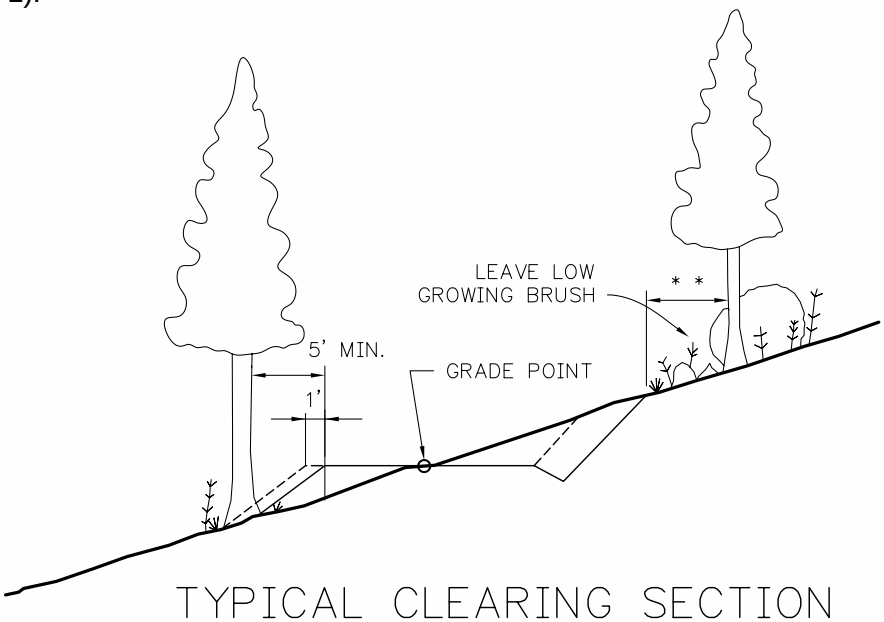
A. Scope

This standard supplies information about clearing necessary for installation of transmission line access and rights-of-way roads. Clearing with for the construction of new roads or maintenance of existing roads shall be five (5) feet beyond the edge of the roadway on level ground. On hillside cuts or fills, the clearing shall be sufficient width to install the cut or fill without interference. (See figure 1).



TYPICAL CLEARING SECTION

CLEARING DIAGRAM					
SIDE SLOPE	CUT * SLOPE	CLEARING WIDTH FOR TURNOUTS		CLEARING WIDTH	CLEARING WIDTH
		W/O DITCH	W/DITCH	W/O DITCH	W/DITCH
0%		30'	33'	24'	27'
10%	1:1	32'	35'	26'	30'
20%	1:1	33'	37'	27'	31'
30%	1:1	36'	40'	29'	32'
40%	1:1	39'	43'	31'	35'
50%	1:1	44'	49'	34'	39'
60%	3/4:1±	48'	55'	37'	44'
70%	3/4:1±	55'	62	45'	52'
80%	1/2:1±	47'	53'	37'	43'

NOTES:
1. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION ON CLEARING AND GRUBBING.
2. ± FULL BENCH.
3. ** 1/3 VERTICAL CUT, BUT NOT LESS THAN 5'.
4. * FOR CLEARING PURPOSES ONLY.

Figure 1. Road Clearing Cross Section

Where it is necessary to fell trees in streamside areas, fell trees away from streams, retain all non-hazardous vegetation. Do not skid trees in, through, or across streams.

All operations on federal government property shall comply with all applicable statutes and regulations, including stipulation contained in permits granted to Company for the rights-of-way.

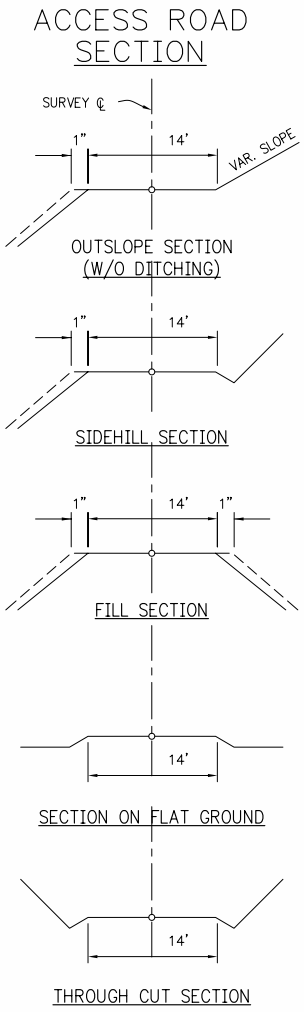
No trees shall be cut or removed before they are marked for removal.

A. Scope

This standard provides information about constructing access roads for the maintenance and construction of transmission lines. All road construction or improvements, fords, structure/equipment landings, laydown yards shall be held to a minimum. On level terrain it may only require back dragging a blade to remove brush to facilitate construction. In undulating or mountainous terrain the following standards shall apply.

B. Index

The index shown below provides a quick method to determine what figure provides detailed information about access road cross section for constructing over different slopes and conditions.



Referenced Road Cross Section
Figure 2
Figure 3 Figure 4 Figure 5
Figure 2
Figure 2
Figure 2

C. Planning

Before the construction can take place the road system must be planned and located properly.

Poor planning or road location is associated with the following most common causes of road failure (Furniss et al. 1991):

- Improper placement and construction of road fills
- Insufficient culvert sizes
- Very steep road grades
- Improper placement or sidecast of excess materials
- Removal of slope support by undercutting
- Altering drainage by interception and concentrating surface and subsurface flows.

A plan showing existing and new road locations shall be developed and shall be shown on "Access Road Charts", "Plan Maps", Transportation Plan Map, and as marked on the ground by survey stakes and blue and white striped flagging. GPS coordinates shall be obtained to define the road centerline and used to create the Transportation Plan Map and any road information placed on the transmission line Plan Maps. In the event of conflict between the drawings and the staked locations, the later shall take precedence. Revisions shall be made to the Transportation Plan Maps and the transmission line Plan Maps Any culverts and gates listed in "Access Road Charts" are required. Fords, drainage improvements, rip-rap fills and crushed rock requirements listed in the "Access Road Charts" are anticipated; however, actual requirements will be determined, based on site conditions encountered and if changes are made then the maps shall be revised to show the changes.

Because roads are long-term features, their location must be carefully chosen, to meet the landowner and company needs for safe access, avoid long-term maintenance problems, reduce potential for degrading water quality, and minimize costs over the short and long term. For more information see the references in Section H.

D. Road Construction

Roads shall be constructed in a manner that will support equipment for construction of the transmission line and to provide access roads for line inspection and maintenance equipment after the line has been constructed.

All construction access roads on federally managed public lands are subject to approval prior to construction. Other federal, state, and local land owners may require approvals before road construction may commence on their property contact with the appropriate departments will be necessary. Where side slopes exceed 60%, a full bench cut will be reburied. No side casting of material will be allowed in these areas, end haul of material will be required to a designated location approved by the federal agency or other property owner. Close coordination with the federal agency will be required.

The detail drawings provided in this standard for completing cuts and fills, providing drainage, and installing culverts are furnished as guidelines for the road construction. Actual road construction cut slopes, fill slopes, drainage requirements, rip-rap, and crushed rock needs will be determined during construction, based on site conditions encountered. Cut and fill quantities shall balance when possible, reducing the material removed or brought in for road completion.

During road construction, consideration shall be given to restoration required after construction completion, including re-vegetation, rock cover, and other drainage and erosion control factors. Clearing and grading shall be minimized to reduce the restoration requirements for disturbed

areas. The visual impact of roads on the surrounding areas shall be considered at all times during construction.

Crushed rock, shall be sound, hard, durable, angular, or sub-angular rock, suitable for road base courses. Crushed rock shall be well graded two-inch to 1/4" size (three-inch to minus size skip-graded is a minimum acceptable substitute).

Rip Rap: shall be sound, hard, durable, rock ranging in size from 2" to 8" as specified on drawings and as required by conditions encountered.

Any improvements made such as spur roads, fords, bridge requirements, equipment landings and lay down areas, shall be held to a minimum. Following completion of the work, the removal of these improvements shall be at the discretion of Company or its representative.

Roads shall be sufficiently wide, but not less than 14' feet in width. The construction shall provide bench cuts, grading, filling, compaction, and ditches necessary to accommodate heavy construction equipment and other heavily loaded vehicles. Roads shall be installed in accordance with the drawings titled in this standard.

All roads shall be constructed with a smooth, uniform surface and shall be outsloped, where practical, to provide drainage and minimum erosion. Avoid outsloped roads where they would direct runoff onto erodible fill, embankments or where they would cause off camber curves. Where outsloping is not practical, sufficient water dips, water bars, or ditching, shall be installed as shown in the Section E of this Standard and Standards TA 503 *Roads - Water Bars and Dips*, and TA 504 *Roads - Drains and Culverts* to provide proper drainage.

Outsloping a road means building the road surface so that it is tilted outward 2-3 percent so water can run off the road surface (Figure 1, Outslope Section). Outsloping works well under the right conditions.

The following conditions are favorable for use of outsloped roads with no ditch:

- Short back slopes
- Terrain slope less than 20 percent
- Road grades steeper than 3 percent
- Seasonal road use
- Light traffic
- Fast re-vegetation of cut and fill slopes.

Outslopes become a problem if maintenance is not performed when ruts begin to form. The ruts will then act as channels.

The following conditions are unfavorable for outsloping:

- Long back slopes.
- Terrain steeper than 20 percent.
- Steep continuous road grade
- Where ruts occur and allow water to concentrate and run along the road.
- Where winter hauling is required.

To minimize rutting and erosion of the right-of-way, road construction shall be completed during predominantly dry conditions. Fills, which will essentially consist of native soils, shall not be made when the moisture content of the soils will not permit adequate compaction.

As a minimum level of compaction, common fill shall be placed in 12-inch-thick, loose lifts and each lift compacted by walking or tracking in with heavy dozer or rubber-tired (pneumatic) equipment. Each lift shall be compacted by at least four passes with the equipment.

In areas of dense vegetation the surface organic material shall be stripped from the ground surface within the roadway and cut and fill areas. Stripping to a maximum depth of 6 inches will be adequate unless otherwise directed by the Company or its representative. Stripped and disturbed areas shall be compacted as specified above or as shown in the drawings or Access Road Charts.

Personnel constructing the access road system shall become aware of the definition of a wet land such that potential wet lands may be identified before work is begun. In some cases where wet lands have been identified, road construction personnel shall comply with requirements as directed by Company or its representative.

Ditches, installed culverts and/or installed surface drains to drain wet areas resulting from springs, seeps, or poor surface drainage may be required to construct the road. Drainage ditches will be shallow, not to exceed eighteen (18) inches in depth, the ditch bottom shall have a width approximately one (1) foot wide and side slopes shall not exceed 1.5 to 1 see figure 6.

All earthwork and grading, cut and fill slopes, and other disturbed areas shall be re-vegetated with seed. Unless otherwise specified, the seed mix shall consist of 45% rye grass, 45% orchard or fescue grass, and 10% clover. The seed shall be applied at a minimum of 60 pounds per acre. At locations where the ground slope is greater than 10%, the seeds shall be covered with straw or wood fiber mulch applied at a rate of one ton of mulch per acre. The seed shall be spread in early fall when weather permits.

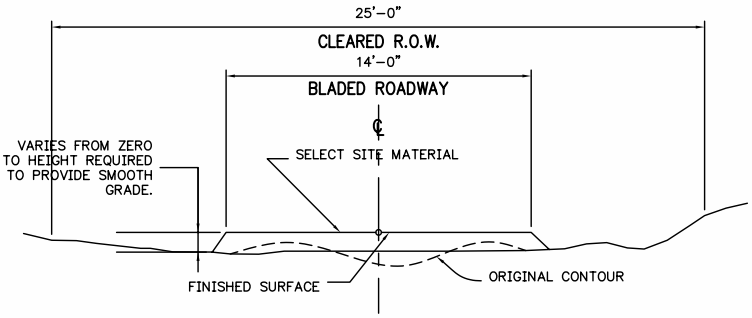
All phases of operations, including the construction of truck and tractor roads, shall be conducted to minimize as much as practical the damage to the soil and to prevent gullies and creation of other conditions conducive to soil erosion. Repair of all erosion damage shall be accomplished as soon as it occurs to prevent further loss of material into existing drainages. Cut slopes shall be stabilized. Care shall be taken to avoid creation of wet land conditions.

Crew movement on the right-of-way, including access routes, shall be limited so as to minimize damage to land or property and shall endeavor to avoid marring the lands. Ruts and scars shall be obliterated, damage to ditches, terraces, roads and other features of the land shall be corrected, and the disturbed land beyond the access roads and structure landings shall be restored as nearly as practical to its original condition before final acceptance of the work.

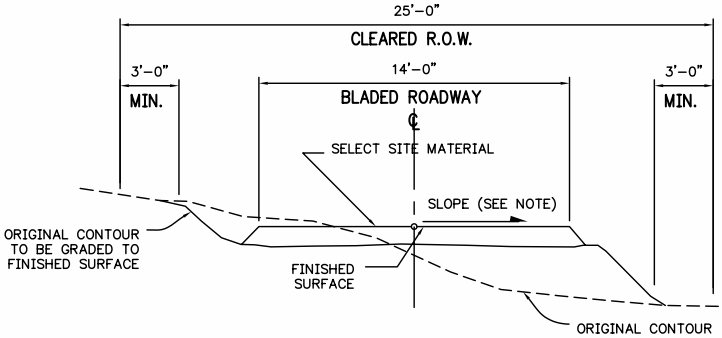
Erosion control measures shall be installed to minimize the transport of eroded sediments to streams and other waterways as required. Erosion control measures may include, but not necessarily be limited to, straw bales and silt fences.

E. Road Cross Sections

This section provides road cross sections including required dimensions, cleared rights-of-way width and other information. See general road construction notes in Section G and more information about roads in the references in Section H.

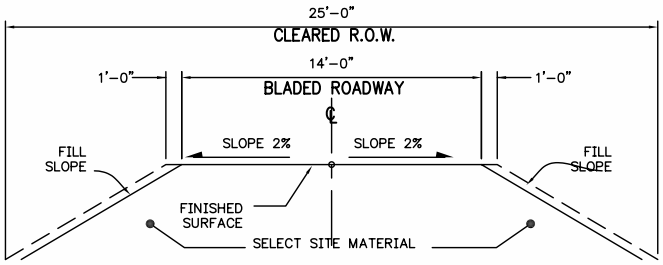


TYPICAL SECTION ON FLAT GROUND

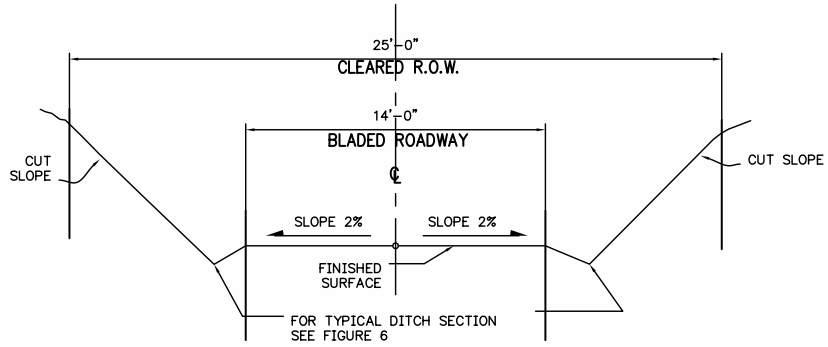


NOTE:
PROVIDE "OUTSLOPED" ROAD CROSS–SECTION, BY GRADING ROADS TO SLOPE IN THE SAME DIRECTION AS THE SURROUNDING TOPOGRAPHY. SO THAT THE UPHILL EDGE OF THE ROAD IS HIGHER THAN THE DOWNHILL EDGE. BESIDES ALLOWING RUNOFF TO EXIT THE ROADWAY IN AS SHORT A DISTANCE AS POSSIBLE. THIS ELIMINATES THE NEED FOR ROADSIDE DITCHES. PROVIDE A MINIMUM 2% OUTSLOPE ON ROADS WITH GRADES AS STEEP AS 15% ON STEEPER ROADS. PROVIDE 4% OUTSLOPE. AVOID OUTSLOPED ROADS WHERE THEY WOULD DIRECT RUNOFF ONTO ERODIBLE FILL, EMBANKMENTS OR WHERE THEY WOULD CAUSE OFF–CAMBER CURVES.

TYPICAL "OUTSLOPE" SECTION

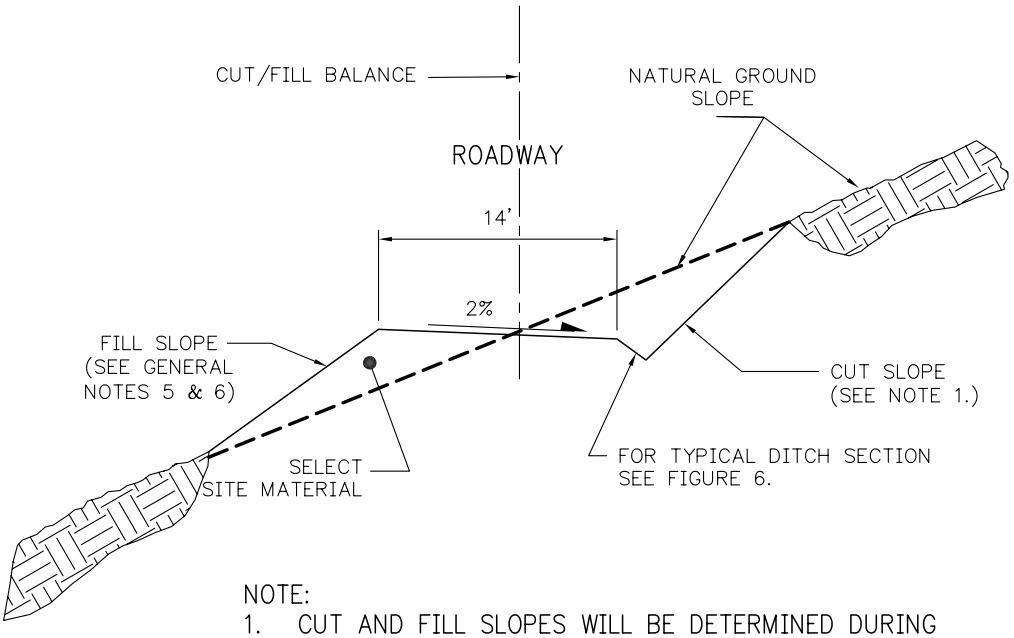


TYPICAL FILL SECTION



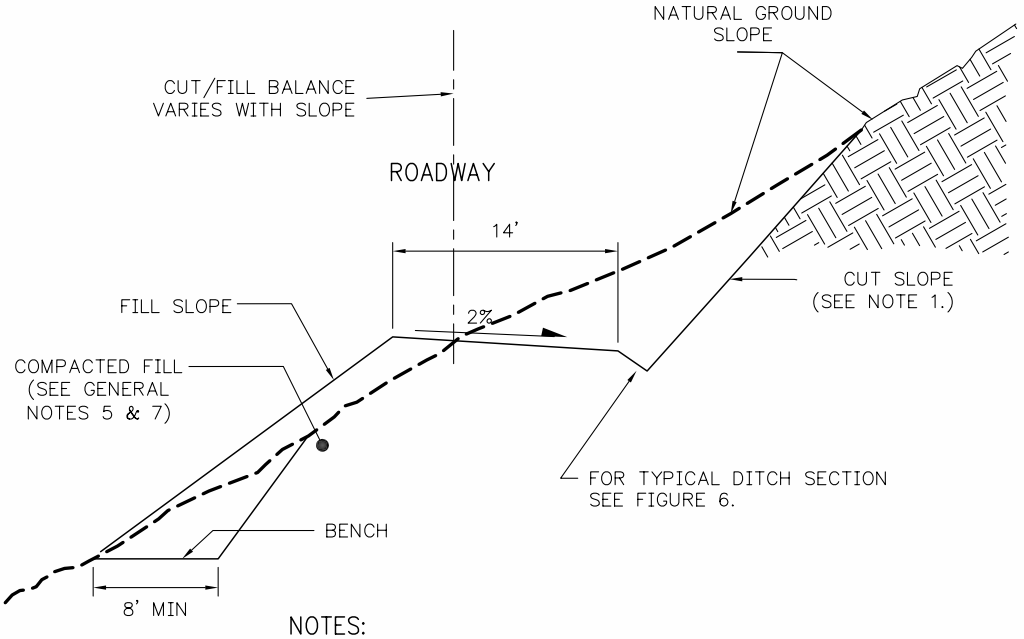
TYPICAL THROUGH CUT SECTION

Figure 2. Typical road sections for different terrains.



NOTE:
1. CUT AND FILL SLOPES WILL BE DETERMINED DURING CONSTRUCTION, BASED ON SITE CONDITIONS ENCOUNTERED AND AS APPROVED BY COMPANY.

Figure 3. Typical cut and fill insloped road section for natural side slopes less than 30% (15°).



NOTES:
1. CUT AND FILL SLOPES WILL BE DETERMINED DURING CONSTRUCTION, BASED ON SITE CONDITIONS ENCOUNTERED AND AS APPROVED BY COMPANY.

Figure 4. Typical cut and fill insloped road section for natural side slopes greater than 30% (15°) and less than 60% (30°).

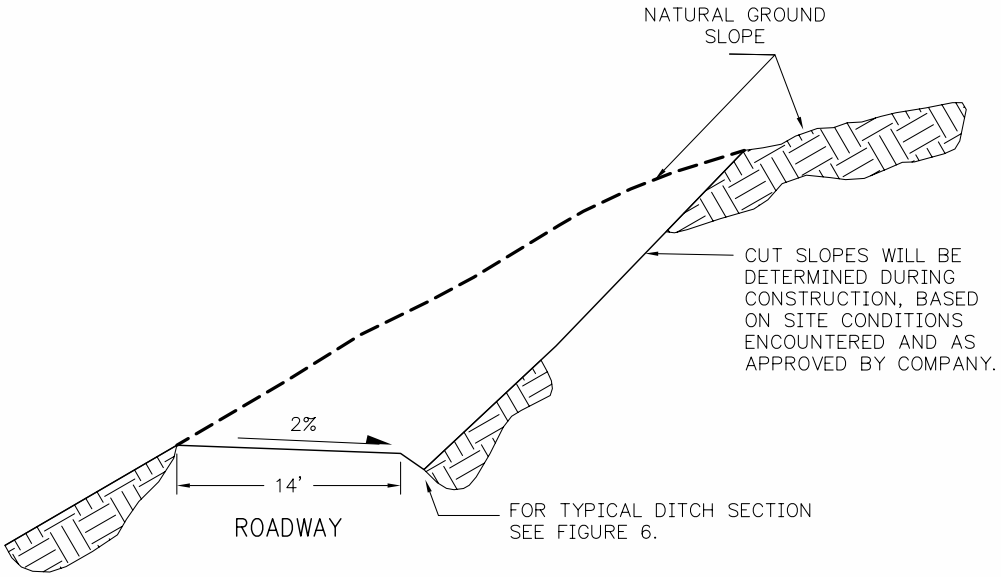


Figure 5. Typical cut and fill section for natural side slopes greater than 60% (30°).

F. Typical Ditch Section

Typical ditch construction is depicted in Figure 6 many of the road cross section show above use this ditch construction.

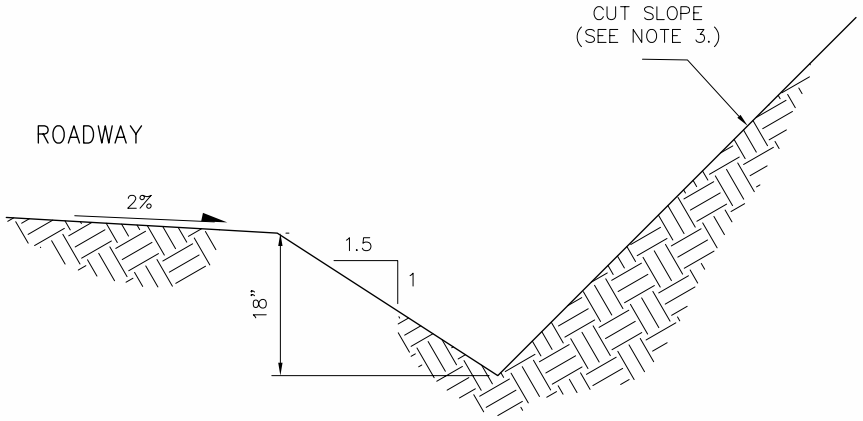


Figure 6. Ditch Section

Notes:

1. Slope the ditch so that it will drain; ditch shall have a minimum slope of 1% and not to exceed 3%.
2. Remove all soil, rock, and other material from ditch, which was loosened by grading.
3. Cut slopes will be determined during construction, based on site conditions and as approved by company or company representative.

G. General Road Construction Notes

1. Roads shall follow natural contours much as practical.
2. Maximum grade for roads shall be 10%. Grades up to 20% will be allowed for a distance of 1000 feet where unavoidable and approved by company.
3. Radius of curves shall be 200 feet, with a minimum of 80 feet when approved by company. When curves are less than 200 feet, roadbed shall be widened as shown in Table 1.
4. Cut and fill slopes will be determined during construction based on site conditions encountered and as approved by company.
5. Unless specified otherwise by company, fill material shall consist of site material excavated from RG-1 cuts. Fill material shall have a maximum particle size of 12 inches.
6. Fills placed on side slopes of 30% or less shall be placed in nominal 9" lifts and compacted by walking in with at least four passes of earthwork equipment.
7. Fills placed on side slopes greater than 30% shall be placed in nominal 12 inch thick lifts and compacted to at least 90% of the maximum dry density as determined by the ASTM D 696 method of compaction.
8. Allow 1 foot additional road width on fill slopes for sloughing. When fills are over 6 feet high at shoulder allow 2 feet additional road width.

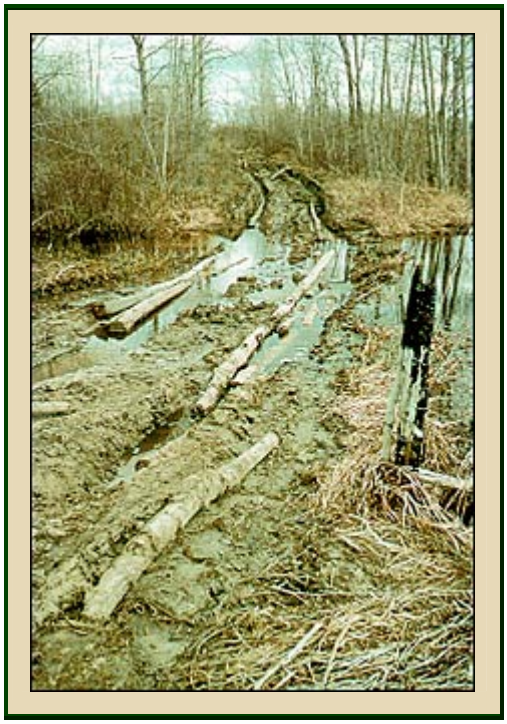


Figure 7. Poor road construction practices in wetland areas can cause problems during construction.

9. Road construction across wetland areas may require placement of fragmented 6 inch minus rock. Rock shall be placed in 8 inch thick lifts and compacted by a heavy dozer or vibratory roller until well keyed. RB-(1) rock will be provided and installed by the contractor. Proper construction shall be use in wetland so conditions as shown in Figure 7 do not developed.
10. Geotextile fabric material shall consist of MIRAF1212 OHP or equivalent, as approved by company.

Table 1 Road Width for Different Road Curve.

Curve Radius (feet)	Roadbed Width (feet)
200 or >	14
150 to 200	16
100 to 150	18
80 to 100	20

H. References

1. *Handbook for Forest and Ranch Roads*, William E. Weaver, PHD. and Danny K. Hagans, 1994.
2 *A Landowner's Guide to Building Forest Access Roads,* United States Department of Agriculture, Forest Service, Northeastern Area State and Private Forestry. July 1998

A Scope

This Standard describes drainage methods such as water bars, water dips, ditches, and outsloping that can be used where no intermittent or permanent streams cross the road. Depending on the method used, drainage structures would be installed during or after basic road construction. For information on ditches and culverts see TA 504 *Ditches and Culverts*.

B Water Bars and Dips

Water bars are narrow structures that may be shallow or deep depending on the need. The deep bars are usually used on roads to be closed to vehicle traffic. Figure 1 shows a picture of a typical shallow water bar constructed across a road.

Figure 1: A water bar effectively intercepts surface water and diverts it from the road

Water bars can be constructed with hand tools, but bulldozers are most commonly used. It is best to start at the end of the road and work outward so the bars are not damaged by frequent crossing by heavy machinery.

Water bars should be installed at about a 30-degree angle downslope. Figure 2 shows dimensions for construction of water bars and water dips with and without drainage ditches to be used on access and Rights-of-Way roads. The outflow end of the water bar should be open to keep water from accumulating and should not flow directly into a stream, this will allow the sediment to settle out of the water and to prevent erosion. As a supplement to water bars on roads that will be closed, logging slash can be lopped and scattered on the road, grass can be planted, or both. Table 1 shows recommended spacing between water bars for different grade roads.

Table 1. Distance needed between water bars

Road grade (percent)	Distance (feet)
2	250
5	135
10	80
15	60
20	45
25	40
30	35

Source: Kochenderfer 1970, p. 28

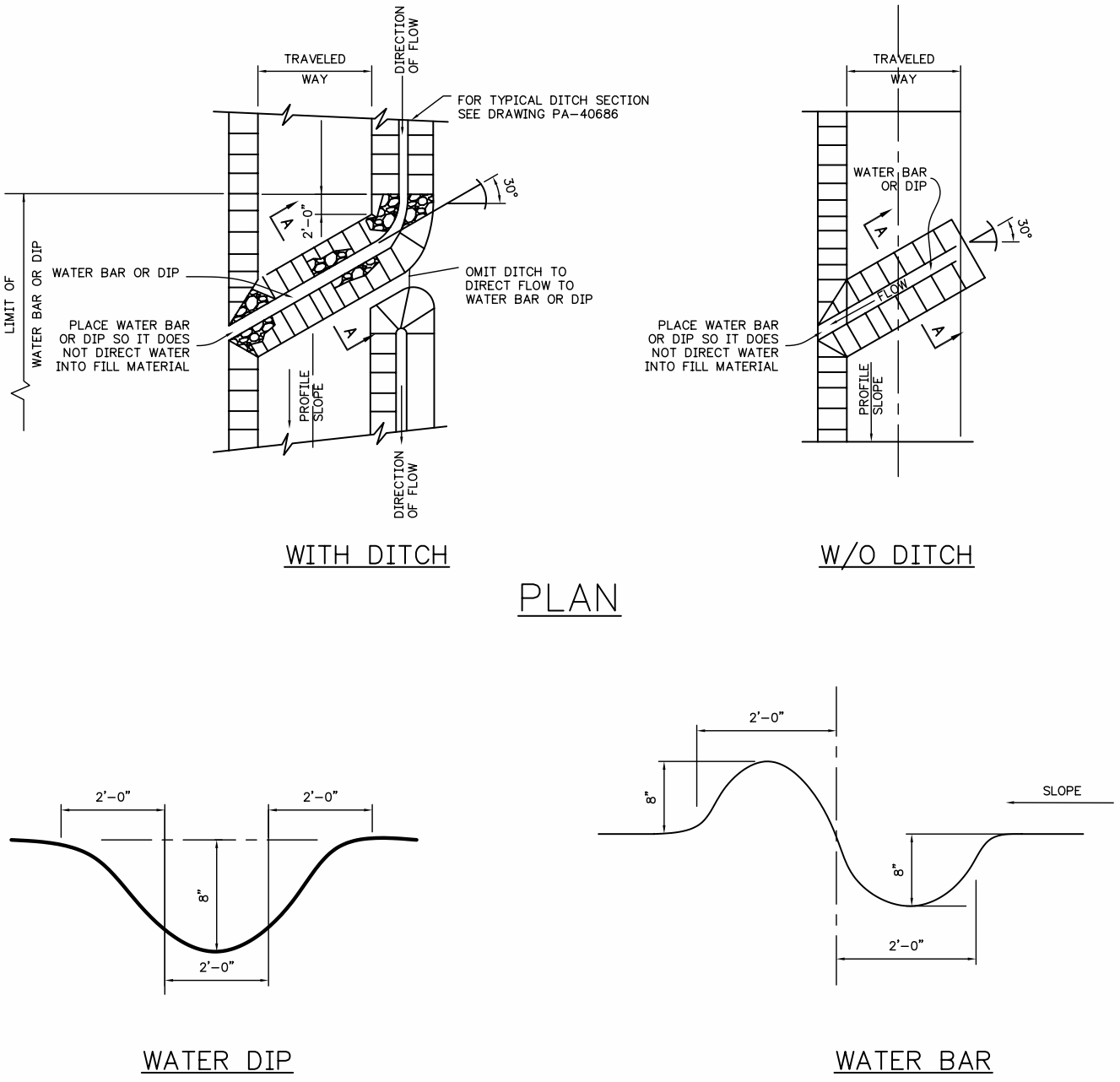


Figure 2. Water bar and dip construction plan and profile.

B Broad-Based Drainage Dips

Broad-based drainage dips, which are easily maintained, do not increase wear on vehicles or reduce hauling speed when properly installed. Because of construction characteristics, these dips should not be used on a road with a grade in excess of 10 percent (Figure 3).

Table 1. Minimum distance needed between water bars

Road grade (percent)	Distance (feet)
2 - 4	300 - 200
5 - 7	180 - 160
8 - 10	150 - 140

Source: Kochenderfer 1970, p. 19, 25

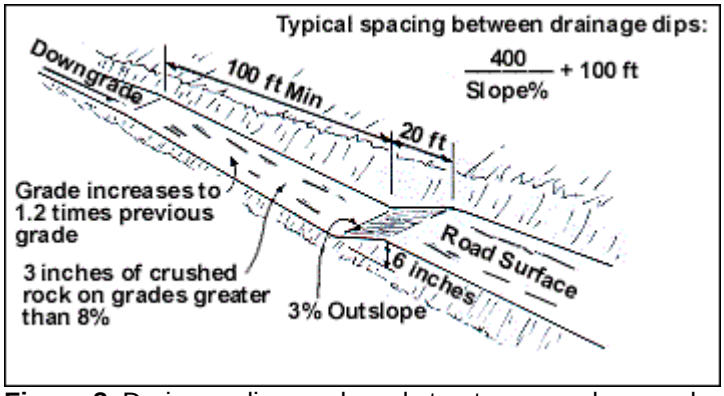


Figure 3. Drainage dips are broad structures used on roads with grades of 10 percent or less.

As with a water bar, care should be taken to ensure adequate drainage at the outflow of a dip. It should never be designed to discharge directly into a stream. The discharge area should be protected with stone, grass, sod, heavy litter cover, brush, logs, or anything that will reduce the velocity of the water. Natural litter may be adequate in many cases if the terrain is not too steep.

Table 1 presents the spacing of broad based dips as computed with the formula shown in the figure. (Kochenderfer 1970)

Close attention should be paid to construction of broad-based dips, because they are often made too small. Figure 3 shows minimum dimensions. Dips should be armored with crushed rock or gravel. Figure 4 shows a practical example of how a broad based drainage dip could be used.

Figure 4. A drainage dip is effective in controlling water on the road and does not significantly slow the speed of vehicles.

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A Scope

This standard provides information about the construction of surface drainage and the installation of culverts. It is impossible to over-emphasize the importance of drainage in maintaining stable roads and protecting water quality. Roads should be designed and constructed to cause minimal disruption of natural drainage patterns. Provisions for two components of road drainage should be included in every road project: 1) road surface drainage (including drainage which *originates* from the cutbank, road surface and fillslope) and 2) hill slope drainage (including drainage from large springs, gullies and streams which *cross* the road alignment).

B Culvert Sizing

Use pipe no smaller than 24-inch in diameter. A drainage table provides help in determining the proper size culvert (Tables 1 and 2). An example of how to use these tables is provided in the box; however, it is generic. Table 3 can also be used to determine proper culvert size and is easier to use (Helvey and Kochenderfer 1988).

Use of Drainage Table

The following example illustrates how to use the drainage table (Table 2) and choose pipe size (Table 1). Note: you will need information on slope, soils, and cover.

Example: The area to be drained is 70 acres on steep slopes with heavy soils and moderate cover. In Table 2 under C opposite 70, find area required—10.3 square feet. Under the area table for round pipe (Table 1), this falls between a 42-inch and a 48-inch pipe. Use 42-inch pipe with an area of 9.6 square feet. If a wood or other type of box culvert is planned, one 3 feet by 3.5 feet would furnish the required area.

Table 1. Size of round pipe needed for area of waterway listed in Table 2

Area (square feet)	Pipe diameter (inches)
1.25	24
1.80	24
3.10	24
4.90	30
7.10	36
9.60	42
12.60	48
15.90	54
19.60	60
23.80	66
28.30	72
33.20	78
38.50	84
44.20	90

Source: Figure 45, Haussman and Pruett 1978, p. 36

Table 2. Drainage table based on Talbot's formula for rainfall of 1¼ inches per hour

Area required for waterway								
Acres	**Impervious 100% runoff** †C=1.00	**Steep slopes Heavy soils Moderate cover** C=0.80	C=0.70	**Moderate slopes Heavy to light soils Dense cover** C=0.60	C=0.50	**Gentle slopes Agricultural soil & cover** C=0.40	C=0.30	**Flatland Pervious soils** C=0.20
Square Feet								
2	0.5	0.4	0.4	0.3				
4	0.9	0.7	0.6	0.5				
6	1.2	1.0	0.8	0.7	0.6	0.5		
8	1.5	1.2	1.0	0.9	0.7	0.6		
10	1.7	1.4	1.2	1.0	0.9	0.7	0.3	
20	2.9	2.3	2.0	1.8	1.5	1.2	0.5	
30	4.0	3.2	2.7	2.4	2.0	1.6	0.5	0.3
40	4.9	3.9	3.4	3.0	2.5	2.0	0.9	0.4
50	5.8	4.7	4.0	3.5	2.9	2.3	1.2	0.6
60	6.7	5.4	4.6	4.0	3.4	2.7	1.5	0.8
70	7.5	6.0	5.2	4.5	3.8	3.0	1.8	1.0
80	8.3	6.7	5.8	5.0	4.2	3.3	2.0	1.2
90	9.1	7.3	6.3	5.5	4.6	3.6	2.3	1.4
100	9.9	7.9	6.8	5.9	4.9	3.9	2.5	1.5
150	13.5	10.6	9.3	8.0	6.7	5.4	2.7	1.7
200	16.6	13.4	11.5	10.0	8.4	6.7	2.9	1.8
250	19.8	15.8	13.6	11.9	9.9	7.9	4.0	2.0
300	22.9	18.1	15.5	13.6	13.5	9.0	5.0	2.7
350	25.5	20.3	17.5	15.3	12.7	10.1	5.9	3.3
400	28.0	22.5	19.5	17.0	14.0	11.1	6.8	4.0
450	30.9	24.9	21.0	18.5	15.3	12.1	7.5	5.1
500	33.4	26.4	23.0	20.0	16.6	13.3	8.4	5.6
600	38.5	30.8	26.3	23.0	19.0	15.2	9.0	6.2
700	43.0	34.2	29.8	26.0	21.5	17.0	9.9	6.6
800	48.0	38.1	32.9	28.5	23.8	19.0	11.4	7.7
900	52.0	41.5	35.9	31.1	26.0	20.8	12.9	8.6
1000	56.5	45.0	38.9	34.0	28.3	22.5	14.3	9.5

*See Table 1 for size of pipe needed.

† C is the constant factor based on a combination of how much water the soil can hold, slope, and cover. C=.70 is adequate for most conditions prevailing in the Northeast. C=1.00 represents complete runoff of precipitation (e.g. rock).

If you need help determining the size of a culvert, a private consultant may need to be consulted. Make sure they do not size the culverts for a 50- or 100-year storm, unless that is what is required. For low traffic or temporary roads, a flood frequency of 20 years can be used.

Table 3. Culvert sizes for drainage areas ranging from 10 to 200 acres. To use this table, determine the size of the drainage area above the stream crossing and the expected life of the culvert (recurrence interval 10, 20, or 50 years). The 20-year values are adequate in most cases. The 50-year values should be used in costal and western mountain locations.

Area (acres)	Recurrence interval (years)		
	10	20	50
10	24	24	18
20	24	24	20
30	24	24	24
40	24	24	26
50	24	24	28
60	24	24	28
70	24	26	30
80	24	26	30
90	24	28	32
100	26	28	34
125	28	30	36
150	28	32	38
175	30	34	40
200	32	36	42

Source: Table 3, Helvey and Kochenderfer 1988, p. 125

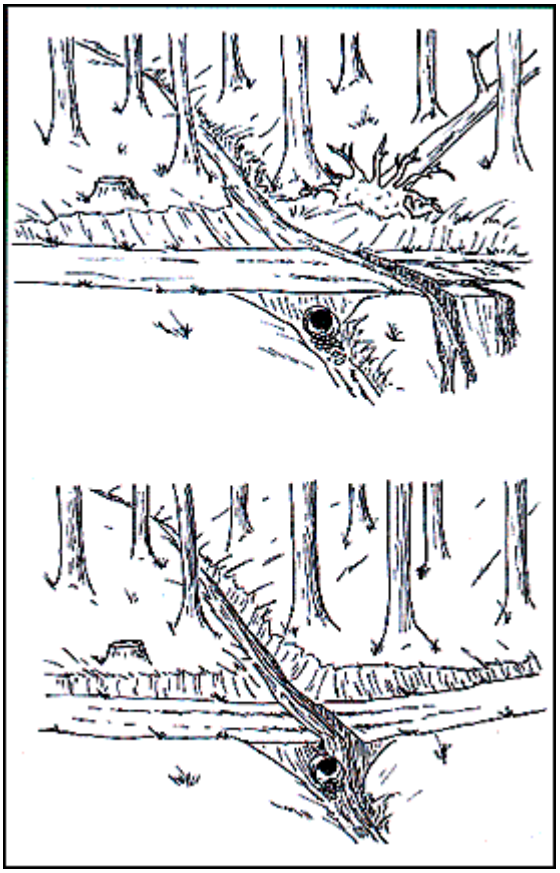


Figure 1. It is important to plan for the failure of a stream crossing, to reduce the amount of sediment that would enter the stream channel should the crossing fail. (From Furniss et al. 1991, p. 310)

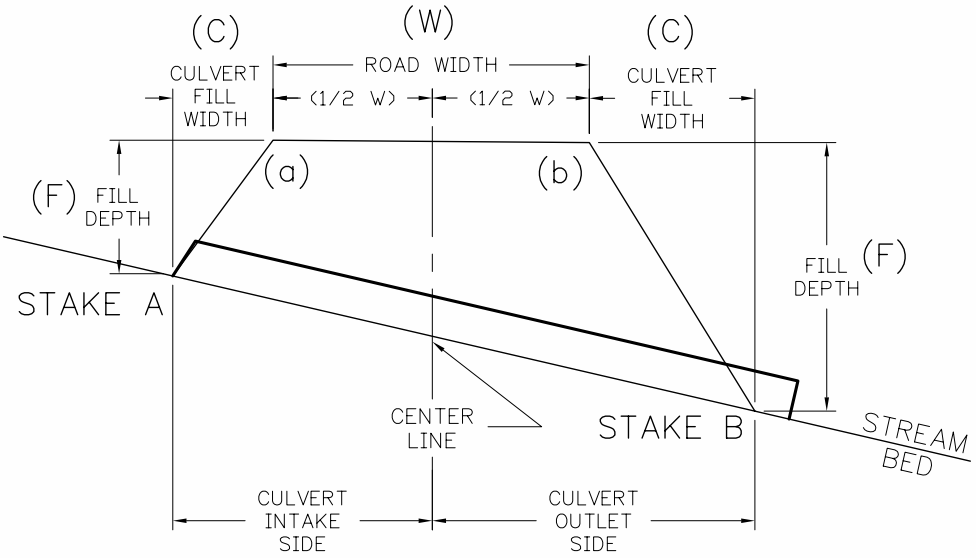
C. Determining Needed Culvert Lengths

The following simplified procedure can be used to determine culvert lengths needed for installation of a new stream crossing or a ditch relief drain. Refer to Figure 2 for specific locations and distances described in the step-by-step procedure. A complete example follows the step-by-step instructions.

STEPS DO THIS...

1. Estimate the depth of the fill (F) at the running surface on the inside of the road above the culvert inlet (point "a").
2. Additional width (C) due to fill is then estimated as 1.5 times the fill depth (F) (that is, all fill slopes are assumed to be 1.5:1 in steepness)

3. Add half the road width (1/2 W) and the fill width (C). Measure this distance horizontally upstream from the center line of the road and place stake at location A. The horizontal distance must be converted to slope distance before you can tape it off on the ground. Converting horizontal distance to slope distance (on-the ground distance) is simple using the following chart.



DETERMINGNG CULVERT LENGTH

Figure 2. Culvert length.

4. Repeat steps 1 through 3 for the culvert outlet side of the crossing and place stake at location B.

5. Measure the slope length between stakes A and B. This measurement, plus two to four extra feet, is the length of culvert needed for the installation. The extra several feet are added to extend the inlet and outlet beyond the edge of the fill.

For example: 44 feet horizontal distance equals 52.4 feet slope distance on a 65% slope.

horizontal distance X correction factor = Slope distance

(44ft) X (1.19) = 52.4ft

Example problem: What culvert length is needed for a 14 foot wide road crossing a stream with a 55% gradient? The estimated inside fill depth, above the culvert inlet, will be 6 feet and the fill depth above the outlet will be 13 feet.

Step 1: Estimated depth of fill (F) at culvert inlet = 6 feet

Step 2: (C) = 1.5 x 6 = 9 feet

Step 3: Want 14 foot wide road (W), so 1/2 x 14 = 7 feet

Stake A (the location of the culvert inlet) should be placed on the ground a distance of (9+7) = 16 horizontal feet up the stream channel from the flagged centerline of the

road. According to the correction table, 16 feet horizontally on a 55% slope is 18.2 feet slope distance (16' x 1.14 = 18.2'). *Place the inlet stake (A) 18.2 feet up the channel from the centerline of the road.*

Step 4: Estimated depth of fill (F) at culvert outlet =13 feet

Step 5: (C) = 1.5x13 = 20 feet2

Step 6: Want 14 foot wide road (W), so ½ x 14 = 7 feet

Stake B (the location of the culvert outlet) should be placed on the ground a distance of (13 + 20) = 33 horizontal feet down the stream channel from the flagged centerline of the road. According to the correction table, 33 feet horizontally on a 55% slope is 37.6 feet slope distance (33' x 1.14 = 37.6'). *Place the outlet stake (B) 37.6 feet down the channel from the centerline of the road.*

Step 7: Length of culvert needed = 18.2' + 37.6' = 55.8' or about 56 feet. Approximately two to four feet should be added to this length to make sure the culvert inlet and outlet extend sufficiently beyond the base of the fill.

Final culvert length to be ordered and delivered to the site = 56' + 4' = 60 feet

Table 4. Slope correction factors to (C) on vertical horizontal distance to slope distance.

Hill slope or stream channel gradient (%)	Correction factor (multiplier)	Hill slope or stream channel gradient (%)	Correction factor (multiplier)
10	1.00[1]	45	1.10
15	1.01	50	1.12
20	1.02	55	1.14
25	1.03	60	1.17
30	1.04	65	1.19
35	1.06	70	1.22
40	1.08	75	1.25

[1] for a slope of 10% or less, no correction factor is needed.

D. Ditch Relief Culvert Installation

Insloped roads should be constructed only where road surface drainage discharged over the fillslope would cause unacceptable erosion or discharge directly into stream channels, where fillslopes are unstable, or where outsloping would create unsafe conditions for use. It is generally preferable to outslope road surfaces in order to disperse road surface runoff before it has a chance to concentrate.

Insloped roads should be built with an inside drainage ditch to collect and remove road surface runoff see TA 501. Roads steeper than about 8 percent may be too steep for an inside ditch because of the potential for gullying in the ditch. Inside ditches should also be drained at intervals sufficient to prevent ditch erosion or outlet gullying, and at locations where water and sediment can be filtered before entering a watercourse. "Filtering" can be accomplished by thick

vegetation, gentle slopes, settling basins, or filter windrows of woody debris and mulches placed and secured on the slope.

As with outsloped roads, steep insloped road surfaces may be difficult to quickly drain. Rolling dips (Figure 3) (for permanent, surfaced roads and seasonal roads) or waterbars (TA 503) (for seasonal or temporary, unsurfaced roads) should be constructed at intervals sufficient to disperse road surface runoff from steep road segments.

Ditches and culverts need occasional maintenance to operate correctly and to carry the flows they were designed to handle. The most important type of maintenance is annual and storm period inspections which can prevent small problems from growing into large failures. When ditches become blocked by cutbank slumps, they need to be cleaned and the spoil deposited in a stable location. However, excessive maintenance (mostly grading) can cause continuing and persistent erosion, sediment transport and sediment pollution to local streams during storm runoff. It may also remove the rock surfacing.

Figure 3. A drainage or rolling dip is effective in controlling water on the road and does not significantly slow the speed of vehicles. (See TA 502)

Ditch relief culverts should be designed and installed at intervals along the road that are close enough to prevent erosion of the ditch and at the culvert outfall, and at locations where collected water and sediment is not discharged directly into watercourses (Table 5). On new roads, ditch flow should be put into a culvert and discharged into buffer areas and filter strips before it reaches a watercourse crossing (Figure 4). Ditches should neither be discharged directly into the inlet of a watercourse crossing culvert, nor should ditch relief culverts discharge into a watercourse without first directing flow through an adequate filter strip. In addition to installing ditch relief culverts on either approach to watercourse crossings (Figure 6), it is also advisable to consider installing ditch drains before curves, above and below through-cut road sections, and before and after steep sections of the road.

Table 5. Maximum suggested spacing for ditch relief culverts (ft)

Road grade (%)	Soil Credibility				
	Very High	High	Moderate	Slight	Very Low
2	600-800				
4	530	600-800			
6	355	585	600-800		
8	265	425	525	600-800	
10	160	340	420	555	
12	180	285	350	460	600-800
14	155	245	300	365	560
16	135	215	270	345	490
18	118	190	240	310	435

If a ditch is capable of transporting and delivering sediment to a Class I or Class II watercourse during a flood event, it can be said to function the same as a Class III watercourse. It has a bed and a bank, and it can transport sediment. Ditches

which drain directly into watercourse crossing culverts should be treated and protected from disturbance and erosion, just as is a Class III watercourse. Ditch relief culverts should be installed across ditched roads before water course crossings so that water and sediment can be filtered before reaching the stream.

Ditch relief culverts do not need to be large, since they carry flow only from the cutbank, springs and a limited length of road surface. In areas of high erosion and/or storm runoff, nominal ditch relief culvert sizes should be 18 inches, but ditch relief culverts should never be less than 15 inches diameter. Smaller culverts are too easily plugged (figure 5). Generally, culverts should have a grade at least 2 percent greater than the ditch which feeds it to prevent sediment buildup and blockage. Where possible, ditch relief culverts should be installed at the gradient of the original ground slope, so it will emerge on the ground surface beyond the base of the fill. If not, either the fill below the culvert outlet should be armored with rock, or the culvert should be fitted with an anchored downspout to carry erosive flow past the base of the fill. Culverts should never be "shot-gunned" out of the fill, thereby creating highly erosive road drainage "waterfalls."

A 10 percent grade to the culvert will usually be self cleaning. The culvert should be placed at a 30 degree skew, similar to how a water bar is angle across a road, to the ditch to improve inlet efficiency and prevent plugging and erosion at the inlet. The pipe should be covered by a minimum of 18 inches of compacted soil, or to a depth of 1.5 times the culvert diameter, whichever is greater. Finally, inlet protection, such as rock armoring or drop structures, can be used to help minimize erosion, slow flow velocity and settle-out sediment before it is discharged through the pipe.

E. Culvert Installation for Stream Crossings

The importance of proper planning for stream crossings cannot be overstated. If stream crossings are not planned and located before road construction begins, you have set the stage for serious problems in the future, including unintended damage to other resources. Requirements for stream crossings vary from State to State. Often a permit is required; check with the water division of the local natural resources agency.

Stream crossings, such as culverts, can be considered dams that are designed to fail. The risk of culvert failure is substantial for most crossings, so *how* they fail is critical. In the upper sketch in Figure 1, the crossing has failed and the road grade has diverted the stream down the road, resulting in severe erosion and downstream sedimentation. Such damage to aquatic habitats can persist for many years. Stream diversions are easy to prevent, as illustrated by the lower sketch, in which the road grade was such that a failed crossing caused only the loss of some road fill (Figure 1) (Furniss et al. 1991).

Culverts should be installed as the road work progresses. The culvert and its related drainage features should be installed in the following order:

1. Place debris and slash to be used as a filter system, if needed.
2. Construct sediment ponds, if needed.
3. Complete downstream work first, such as energy dissipating devices and large rock riprap.
4. Route stream around work area until pipe is installed.
5. Construct pipe inlet structure.
6. Install culvert pipe.

A culvert inlet should be placed on the same level as the stream bottom. In some instances where the culvert inlet has to be lower than the drainage gradient, a drop box can be constructed. This box, which is a place for sediment to settle out before water enters the culvert, needs frequent maintenance.

Figure 4. Culverts not installed at the same level as the stream cause water to back up.

Install culvert pipes as near as possible to the gradient of the natural channel and so there is no change in the stream bottom elevation. Culverts should not cause damming or pooling. Seat the culvert on firm ground and compact the earth at least halfway up the side of the pipe to prevent water from leaking around it. Pipe culverts must be adequately covered with fill; the rule is a minimum of 30 inches or one and half times the culvert diameter, whichever is greater.

If adequate cover cannot be achieved, then an arch pipe or two small culverts should be installed. The cover must also be compacted to prevent settling in the road. Debris-laden material should not be used to cover pipe culverts.

The following are additional guidelines for installing culverts in streams:

Limit construction activity in the water to periods of low or normal flow. Minimize use of equipment in streams.

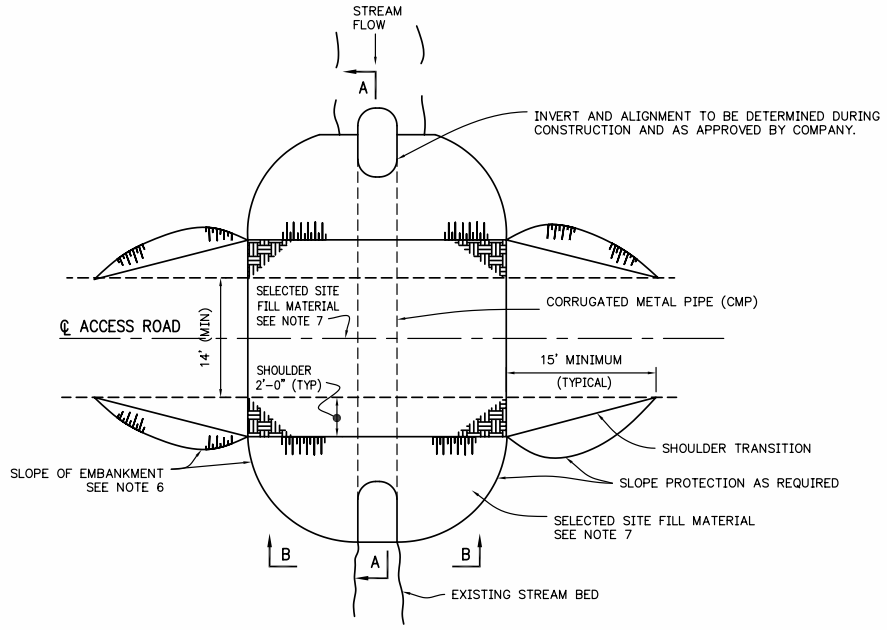
Use soil stabilization practices on exposed soil at stream crossings. Seed and mulch and install temporary sediment control structures, such as silt fences made of straw bales or geotextiles immediately after road construction, to minimize erosion into streams. Maintain these practices until the soil is permanently stabilized.

Use materials that are clean, does not erode, and is nontoxic.

To prevent erosion and under-cutting of the inlet end of the culvert, provide a headwall. Sandbags containing some cement mixed with the sand, durable logs, concrete, or hand-placed riprap are suitable.

Figure 5. Undersized culverts can become plugged with sediment.

A culvert not installed at the existing stream gradient can degrade the stream channel.



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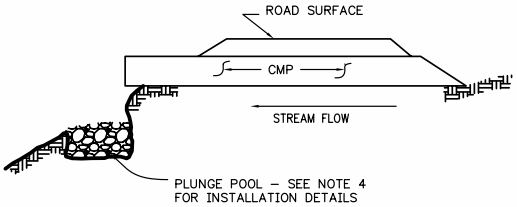
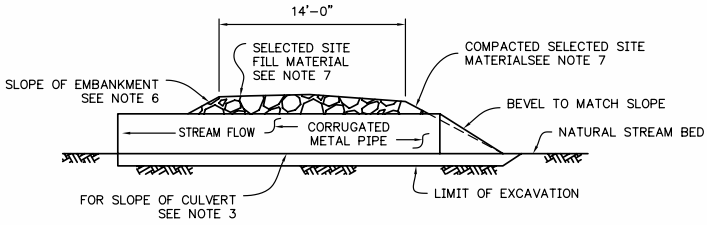
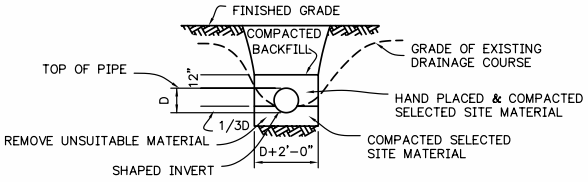


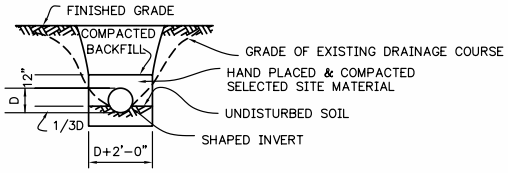
PLUNGE POOL INSTALLATION



SECTION A–A



PIPE INSTALLATION DETAIL
(UNSUITABLE BEARING COND)



PIPE INSTALLATION DETAIL
(NORMAL BEARING COND)

SECTION B–B

Figure 6 Stream Crossing culverts.

Installation Notes for Figure 6:

1. Culverts for existing drainage shall be aligned with the existing drainage.
2. Culverts for roadway and ditch drainage shall be oriented at an angle of 30 to 45 degrees to the roadway. See drawing TA 503 for water bar or dip installation.

3. Culverts shall be sloped a minimum of 1% or at least 1% steeper than the existing drainage.
4. When culvert outlet is above grade, a plunge pool shall be constructed with length and width equal to two pipe diameters and depth of one pipe diameter. Line plunge pool with geotextile fabric filled with 2 to 8 inch rock.
5. Culvert clogging debris located within 50 feet of a culvert inlet shall be removed.
6. Cut and fill slopes will be determined during construction based on site conditions encountered and as approved by company.
7. See drawing TA 501 for general road construction information.
8. Cover over culverts shall be 18" or 1.5 times the culvert diameter, whichever is greater. To minimize damage from culvert failure, height of fill over culverts shall be as close to minimum as practical.
9. Outlets on culverts with pipe slopes greater than 3% shall be protected with a 30' x 10' strip of geotextile fabric fastened to culvert as a bib. Fabric shall be weighted down with 6"to 8" rock to slow runoff.
10. Bottom of culvert shall be cushioned with fine grain site material when installed over large rocks.

F. Fords

A ford is an alternative way to cross a water course under the following circumstances:

1. The streambed has a firm rock or coarse gravel bottom, and the approaches are low and stable enough to support traffic.
2. Fords work well on small to medium sized streams where there is a stable stream bottom and vehicle traffic is light.
3. Water depth is less than 3 feet.
4. If corduroy, coarse gravel, or gabion is used to create a driving surface, it should be installed flush with the streambed to minimize erosion and to allow fish passage.
5. Crossings should be at right angles to the stream.
6. Stabilize the approaches by using nonerodible material. The material should extend at least 50 feet on both sides of the crossing.

Fords can be an economical method of crossing streams under certain low water conditions and when properly designed and located.

Requirements for stream crossings vary from State to State. Often a permit is required; check with the water division of the local natural resources agency.

Dry fords can often be installed and used with minimal impact to the channel system.

A. Scope

This standard provides information for obtaining or constructing three different types of fence gates.

B. Pipe Frame Gate

These gate can be obtained in 12, 14 or 16 foot lengths and are constructed of 16 gauge 1.66 inch diameter steel tubing. The hinges shall be made using 3/4" diameter by 12" long rod. The latch shall be a 36" chain with a keeper. A 36" chain shall also be supplied to secure the hinge end of the gate. The gate can either be painted with good quality paint or galvanized.

Length (ft)	Weight (lbs)
12	97
14	116
16	129

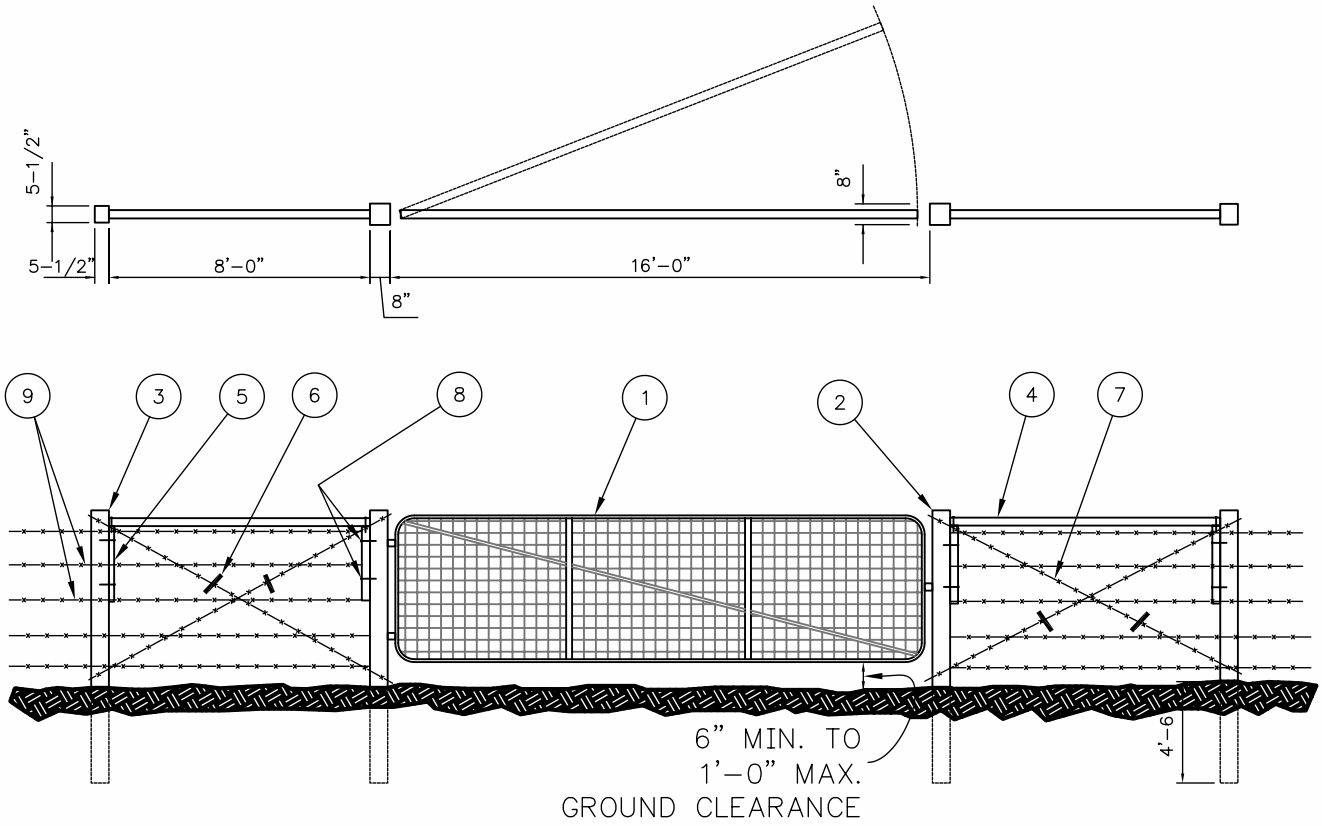
Weights are for Powder River Gates.

The gate shall be installed between two 8 inch x 8 inch x 10 foot treated posts buried 4.5 to 5 feet in the ground. See figure 1 below. Use manufactures instruction for installation of gate on posts.

Figure 1. Installed gate.

These gates can be supplied by any of the following companies HW Brand, Powder River, Dry Creek Fencing System, and Pacific Steel & Recycling and may be purchased through local granges or farm supply stores.

B. Pipe & Wire Mesh Gate



NOTES:
GATES WILL BE 54" HT, 16 FT. HEAVY WEIGHT GALVANIZED STEEL, 11 GA. FILLER, 1–3/8" O.D. TUBULAR STEEL FRAME, WITH DIAGONAL TENSION WIRE.

Figure 2. Mesh gate installation details.

Table 1 Components

ITEM	QTY	DESCRIPTION
1	1	Gate, Galv., 54" X 16'-0", See Notes
2	2	Post, Treated, 8" X 8" X 10'-0"
3	2	Post, Cedar, 5 1/2" X 5 1/2" X 10'-0"
4	2	Post, Cedar, 3 5/8" X 3 5/8" X 8'-0"
5	4	Fir Strip, 1 5/8" X 3 5/8" X 2'-0"
6	4	Fir Hub, 2" X 2" X 1'-6"
7	100'	Iron Wire No. 8 (Annealed)
8	1 LB.	Nail, Galv., 20 D. Common
9	1 LB.	Staples, Galv., 1 1/2" Long

The 16' gate shown in Figure 1 can be substituted for the wire mesh gate shown.

C. Wire Access Gate

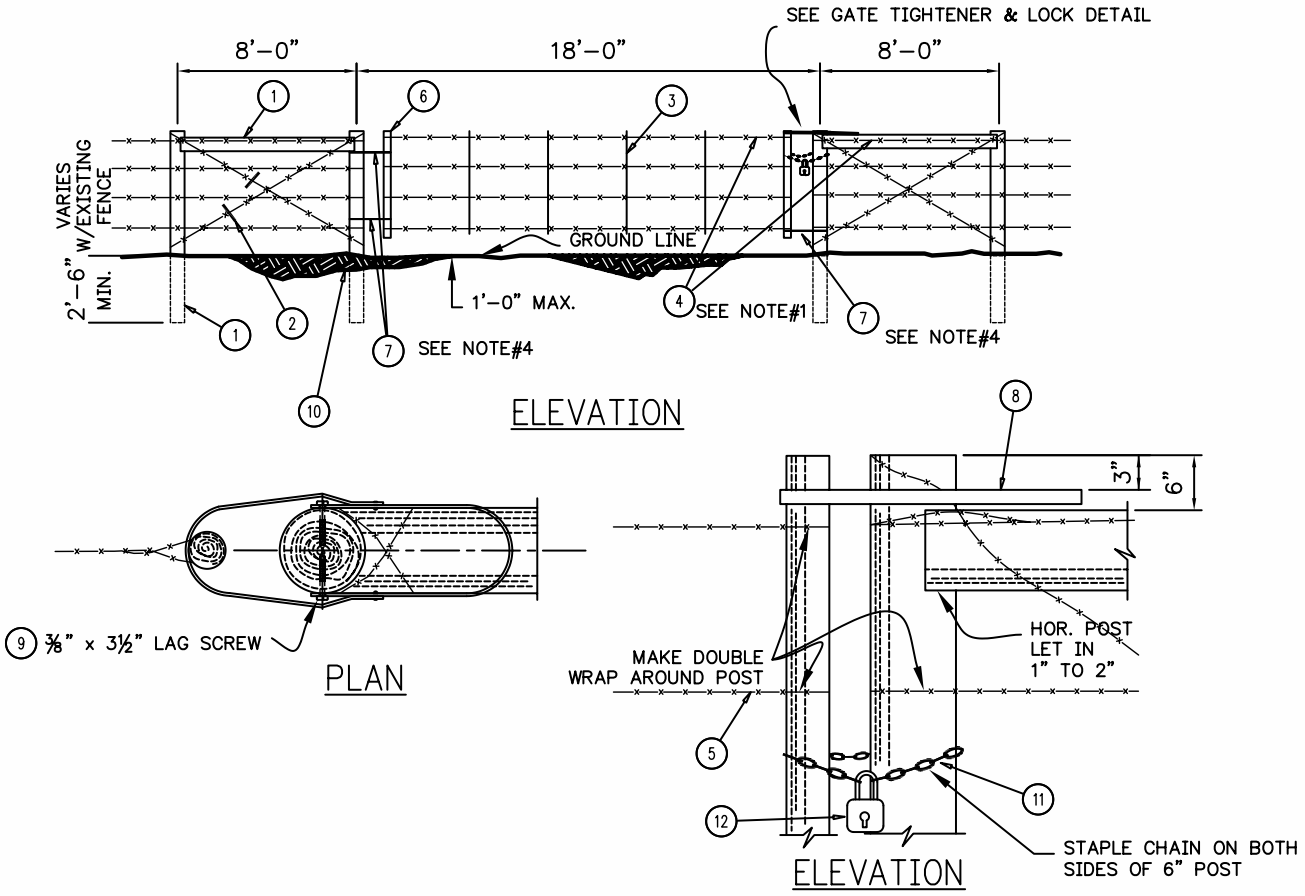


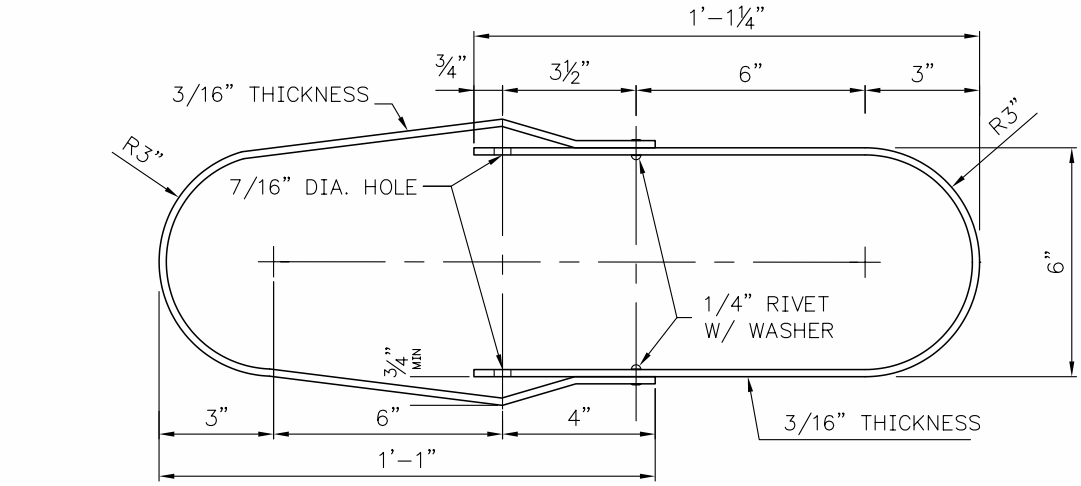
Figure 3. Barbed wire gate

Table 2. Components for Wire Access Gate

ITEM	QUAN	DESCRIPTION
1	6	Post, Cedar, Butt Treated, 6" Dia. X 8'-0"
2	4	Douglas Fir Hub, 2" X 2" X1'-6"
3	4	Wire Stays
4	150'	Barbed Wire Min. #14 Ga., 2 Point
*5	23	Copper Crimpit, Burndy #YC4C4 Or Equal
6	2	POST, CEDAR, 3" DIA X 5'-0"
7		#9 Wire, Galv.
*8	1	Gate Tightener, Figure 4 TA 520
9	2	Lag Screw, Galv., 3/8" X 3"
10		Staples
11	1	Wire Chain, Size #2 10-Ga, Galv.
*12	1	Lock

Notes:

1. This drawing is intended as the minimum standard gate. If the fence encountered has more rows of wire or contains woven wire the gate shall be constructed accordingly.
2. All wire splices made with copper crimpits.
3. Make triple loop of #9 wire and staple both sides of post.
4. Omit items 11 & 12 if not required by property owner.



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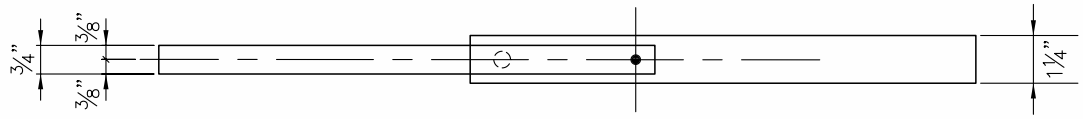

ELEV.

NOTES:

1. STEEL SHALL BE IN ACCORDANCE WITH A.S.T.M. A-36, LATEST REVISION.
2. USE TWO COATS OF ZINC RICH PAINT (Z.R.C.-MFG. BY SEALUBE CO.) OR EQUAL.

Figure 4 Gate Tightener (SI# 647808).

A. Scope

This standard provides plans for the construction of a road closure gate suitable for use on BLM or Forest Service land. All material shall be supplied by the installer crew.

B. Construction Notes

1. Pipe sizes shown are for standard weight steel pipe.
2. Road closure sign shall be “FR11-2 centered on the gate as shown in figure 1.
3. Gate posts shall be warned with reflective yellow Type 2, 6” by 12” panel, object markers, both sides of locked closed post and one side of locked-open post, position as show in figures 1 and 2. On the hinge post , marker shall be mounted to face traffic when the gate is locked open.
4 Weld two bolt studs for attaching signs and markers. See figure 2 for details
5. Barricade markers shell be fabricated using 1’-0” by 3’-0” panels, White with 3” wide red diagonal stripes.
6. Road closure sign, gate post object marker and barricade markers shall be furnished by gate fabricator or installer.
7. After fabrication all gate components shall be cleaned to remove all rust, scale and oily substances and galvanized. After galvanizing the washer and nuts for the attachment of signs shall be put on all stud bolts, nuts shall be able to be installed using fingers till tight against sign. All underground parts shall be painted with coal tar “bitumastic” or equivalent.

Table 1. Gate Components

Item	Qty	Unit	Description
1	1	EA	Tube, steel, 3/16” x 2-1/2” x 2-1/2” x 10’
2	1	EA	Tube, steel, 3/16” x 2” x 2” x 10’
3	1	EA	Tube, steel, 1/8” x 2-1/2” x 2-1/2” x 10’
4	1	EA	Pipe, standard, 3” diameter by 6’-6” long, thread top to install pipe cap (Item 8)
5	1	EA	Tube, steel, , 3/16” x 3” x 3” x 6’-1 3/4”
6	8	EA	Angle, steel., 3/16” x 1 3/4” x 1 3/4” x 40”
7	1	EA	Tube, steel, 3/16” x 4” x 4” x 2’-9”
8	1	EA	Cap, pipe, treaded, to fit 3” diameter pipe.
9	1	EA	Ring, cut from 3 1/2” diameter standard pipe
10	2	EA	Plate, steel, 1/4” x 24” x 24”
11	1	EA	Plate, steel, 1/4” thick, lock close top plate
12	2	EA	Tube, steel, 3/16” x 6” x 6”, 6” length
13	1	EA	Plate, steel, 1/8” x 2” x 2” end cap
14	4	EA	Marker, barricade, (BM-R-36), 12” x 36” white with 3” red diagonal stripes
15	2	EA	Sign, Road Closure, “FR11-2”, 12” x 24” white with black letters.
16	5	EA	Marker, Object, Type 2 , Reflective Orange.
17	22	EA	Bolt, Stud, for Marker Attachment, 3/8” by 1 1/4”, /w nut & washer
18	1	EA	Plate, steel, 1/4” thick, lock open top plate
19	2	EA	Link, oblong, weld together per figure 2, from Carson Steel
20	1	EA	Plate, steel, 1/4” x 12” x 12”

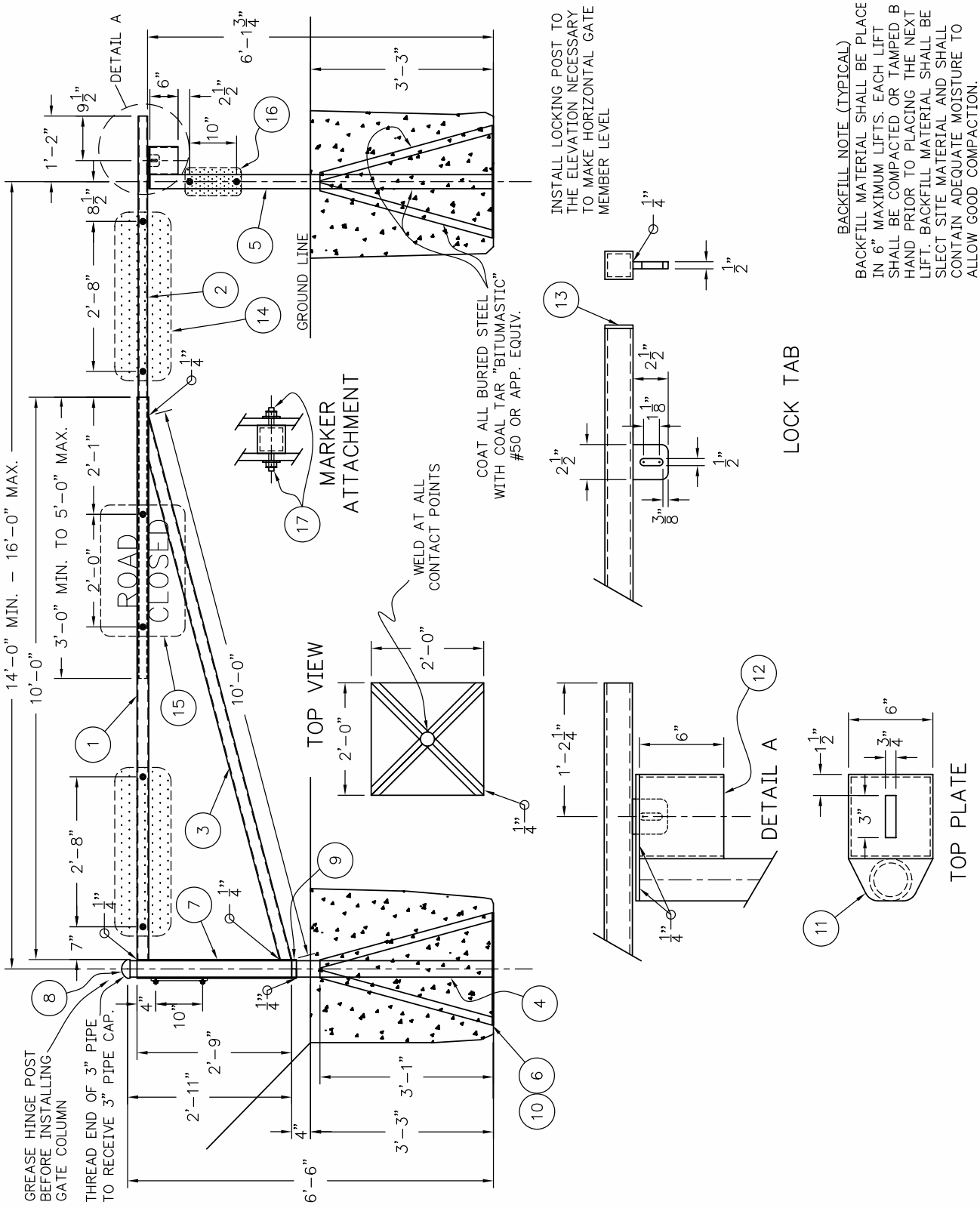

Figure 1. Gate Construction Details

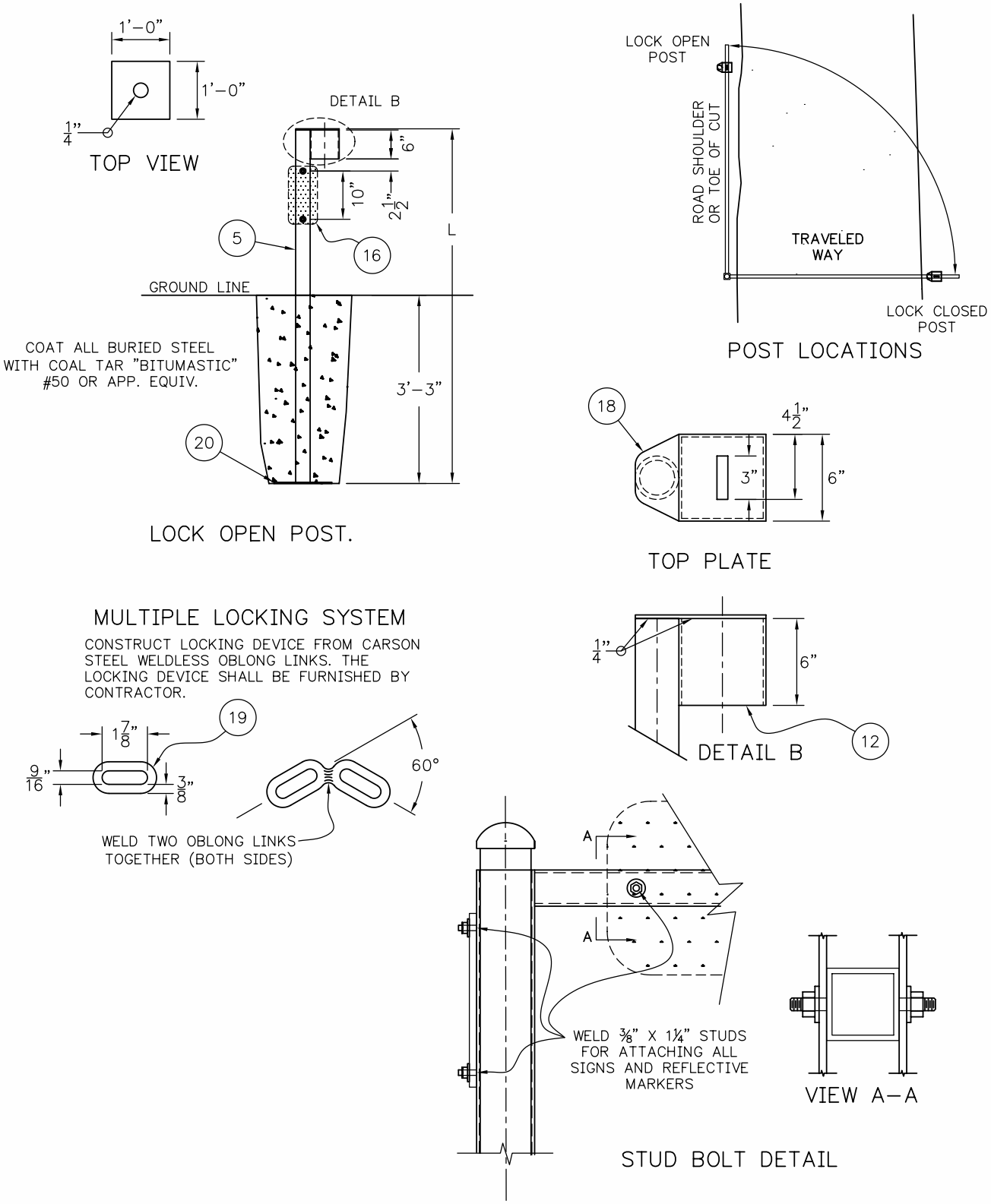

Figure 2. Lock Open Post, Locking Mechanisms and Stud Bolt Detail.

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