FOREST PRACTICE COMMITTEE

ROAD RULES WORKSHOP

August 6, 2012

Workshop Handout

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 1) **(b)** No logging roads or landings shall be planned for construction or reconstruction within (i) 150 feet of the Class I watercourse transition line, (ii) within 100 feet of the Class II watercourse transition line, (iii) within Class I, II, III, or IV watercourses or lakes,(iv) within a WLPZ, or (v) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 2) **(b)** No logging roads or landings shall be planned for construction within (i) 150 feet of the Class I watercourse transition line, (ii) within 100 feet of the Class II watercourse transition line, (iii) within Class I, II, III, or IV watercourses or lakes,(iv) within a WLPZ, or (v) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(c) No logging roads or landings shall be planned for reconstruction (i) within Class I, II, III, or IV watercourses or lakes, (ii) within a WLPZ, or (iii) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 3) **(b)** No logging roads or landings shall be planned for construction or reconstruction (i) within 150 feet of the Class I watercourse transition line, (ii) within Class I, II, III, or IV watercourses or lakes, (iii) within a WLPZ, or (iv) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 4) **(b)** No logging roads or landings shall be planned for construction (i) within 150 feet of the Class I watercourse transition line, (ii) within Class I, II, III, or IV watercourses or lakes, (iii) within a WLPZ, or (iv) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(c) No logging roads or landings shall be planned for reconstruction (i) within Class I, II, III, or IV watercourses or lakes, (ii) within a WLPZ, or (iii) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 5) **(b)** No logging roads or landings shall be planned for construction or reconstruction (i) within 150 feet of the Class I watercourse transition line, (ii) within Class I, II, III, or IV

watercourses or lakes, (iii) within a WLPZ, or (iv) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(Option 6) **(b)** No logging roads or landings shall be planned for construction or reconstruction (i) within 150 feet of the Class I watercourse transition line, (ii) within 100 feet of the Class II watercourse transition line on slopes greater than 30%, (iii) within Class I, II, III, or IV watercourses or lakes, (iv) within a WLPZ, or (v) in marshes, wet meadows, and other wet areas, except as follows:

(1) At existing logging road watercourse crossings.

(2) At logging road watercourse crossings to be constructed or reconstructed that are approved as part of the Fish and Game Code process (F&GC 1600 et seq.)

(3) At logging road watercourse crossings of Class III watercourses that are dry at the time of use.

(c) Logging roads and landings shall be planned and located to avoid unstable areas and connected headwall swales. The Director may approve an exception if those areas are unavoidable and site-specific measures to minimize slope instability due to logging road or landing

~~as a substantial aid to examining: (1) compatibility between road location and yarding and silvicultural systems or (2) possible significant adverse effects of road location on water quality, soil productivity, wildlife habitat, or other special features of the area.~~

~~**(j)** If logging roads will be used from the period of October 15 to May 1, hauling shall not occur when saturated soil conditions exist on the road that may produce sediment in quantities sufficient to cause a visible increase in turbidity of downstream waters in receiving Class I, II, III or IV waters or that violate Water Quality Requirements.~~

Amend § 923.2 [943.2, 963.2]. Design and Location for Logging Roads and Landings ~~Road Construction~~.

Logging roads and landings to be constructed or to be reconstructed shall be designed and located in accordance with their proposed use, maintenance requirements, and the approved plan:

(a) All logging roads and landings shall:

(1) Avoid or mitigate potential impacts to public safety.

(2) Avoid unstable areas and both connected and non-connected headwall swales to the extent feasible, and minimize activities that adversely affect them. Identification of unstable areas must be conducted by a certified engineering geologist.

(3) Minimize the size of cuts and fills to the extent feasible.

(4) Be outsloped where feasible and drained with waterbreaks or rolling dips in conformance with other applicable Forest Practice Rules.

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(5) Be hydrologically disconnected from watercourses and lakes as illustrated in Technical Rule Addendum No. 5.

(6) Include adequate drainage structures and facilities necessary to avoid concentrating and diverting runoff, to minimize erosion of roadbeds, landing surfaces, drainage ditches, sidecast and fills, to minimize the potential for soil erosion and sediment transport, and to prevent deposition of sediment in quantities that violate Water Quality Requirements as illustrated in Technical Rule Addendum No. 5.

(7) Avoid crossing, or locations on, 100 feet or more of lineal distance over any slopes greater than 65 percent or within 250 feet from the watercourse as measured to the watercourse transition line (WTL) on slopes greater than 50 percent that drain toward the zoned watercourse or lake. Where logging road or landing construction or reconstruction is necessary in these areas, specific measures to minimize movement of soil and the discharge of concentrated surface runoff shall be incorporated in the plan. The Director may waive inclusion of such measures where the RPF can show that slope depressions, drainage ways, and other natural retention and detention features are sufficient to control overland transport of eroded material.

(b) The Director may require removal of deposits of excess material if the deposits are in a position to adversely affect the beneficial uses of water.

(c) Excess material excavated during logging road and landing construction shall not be transported to disposal sites where it may result in deposition of sediment in quantities that violate Water Quality Requirements.

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(d) In addition to the requirements of subsection (a) above, all logging roads to be constructed or to be reconstructed shall:

(1) Be no wider than a single-lane compatible with the largest type of equipment specified for use on the logging road, with adequate turnouts provided as required for safety unless prohibited by existing contracts with the U.S.D.A. Forest Service or other federal agency.

(2) Avoid grades greater than 20% or grades greater than 15% that extend greater than 500 continuous feet. Exceptions may be approved where there is no other feasible access for harvesting of timber or where use of a gradient greater than 20% will serve to reduce soil disturbance.

(e) In addition to the requirements of subsection (a) above, all landings to be constructed or to be reconstructed shall:

(1) Be consistent with the yarding and loading system to be used.

(2) Be no larger than one-half acre unless explained and justified in the plan.

(3) Avoid construction on slopes greater than 40 percent where the landing will exceed one-quarter acre in size unless explained and justified in the plan.

~~Logging roads shall be constructed or reconstructed in accordance with the following requirements or as proposed by the RPF, justified in the THP, and found by the Director to be in conformance with the requirements of this Article.~~

~~**(a)** Logging roads shall be constructed in accordance with the approved THP. If a change in designation of road classification is subsequently~~

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~~**(u)** Slash and other debris from road construction shall not be bunched against residual trees which are required for silvicultural or wildlife purposes, nor shall it be placed in locations where it could be discharged into Class I or II watercourses.~~

~~**(v)** Road construction activities in the WLPZ, except for stream crossings or as specified in the THP, shall be prohibited.~~

Amend § 923.3 [943.3, 963.3]. Mapping and Identification for Logging Roads and Landings ~~Watercourse Crossings~~.

The following mapping and identification standards shall apply to logging roads and landings:

(a) For logging road- and landing-related mapping requirements refer to 14 CCR §§ 1034(x)(4)(A)-(B) and (5)(A)-(L), 1090.5(w)(4)-(6), 1090.5(hh), 1090.7(n)(4)-(6), and 1092.09(l)(5)(A)-(B) and (6)(A)-(L).

(b) The RPF shall identify in the field all logging roads and landings to be constructed or to be reconstructed:

(1) Across slopes greater than 65 percent for 100 lineal feet or more.

(2) Across slopes greater than 50 percent for 100 lineal feet or more within 100 feet of the boundary of a WLPZ that drains toward the zoned watercourse or lake.

(c) The location of all logging roads to be constructed or reconstructed shall be flagged or otherwise identified on the ground prior to the pre-harvest inspection. Exceptions may be explained and justified in the plan and agreed to by the Director if flagging is

Deleted: **(b)** For logging road- and landing-related disclosure and description requirements refer to 14 CCR §§ 1034(bb)

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unnecessary as a substantial aid to examining: (1) compatibility between logging road location and yarding and silvicultural systems, or (2) possible significant adverse effects of logging road location on the factors listed under 14 CCR § 923(b) [943(b), 963(b)].

~~Watercourse crossing drainage structures on logging roads shall be planned, constructed, reconstructed, and maintained or removed, according to the following standards. Exceptions may be provided through application of Fish and Game Code Sections 1600 et seq. and shall be included in the THP.~~

~~**(a)** The location of all new permanent watercourse crossing drainage structures and temporary crossings located within the WLPZ shall be shown on the THP map. If the structure is a culvert intended for permanent use, the minimum diameter of the culvert shall be specified in the plan. Extra culverts beyond those shown in the THP map may be installed as necessary.~~

~~**(b)** The number of crossings shall be kept to a feasible minimum.~~

~~**(c)** Drainage structures on watercourses that support fish shall allow for unrestricted passage of all life stages of fish that may be present, and shall be fully described in the plan in sufficient clarity and detail to allow evaluation by the review team and the public, provide direction to the LTO for implementation, and provide enforceable standards for the inspector.~~

~~**(d)** When watercourse crossings, other drainage structures, and associated fills are removed, the following standards shall apply:~~

BOARD OF FORESTRY TECHNICAL RULE ADDENDUM NO. 5 HYDROLOGIC DISCONNECTION, ROAD DRAINAGE, AND DIVERSION POTENTIAL

Introduction

The purpose of this technical rule addendum is to provide a method to inform Registered Professional Foresters (RPFs), Licensed Timber Operators, Timberland Owners, and agency personnel regarding forest road hydrologic disconnection and adequate road drainage. The following guidelines are presented as performance standards for addressing the requirements stated in 14 CCR § 923 *et seq.* [943 *et seq.*, 963 *et seq.*], logging roads, landings and logging road watercourse crossings. The rule requirements are stated in those sections. This addendum provides guidance on how to conform with the rules, recognizing that modifications may be proposed by RPFs in plans based on site-specific conditions.

A. Hydrologic Disconnection, Drainage Facilities, and Drainage Structures

As defined in 14 CCR § 895.1, hydrologic disconnection means the removal of direct routes of drainage or overland flow of road runoff to a watercourse or lake by directing drainage or overland flow onto stable portions of the forest floor to dissipate energy, facilitate percolation, and resist or prevent erosion or channelization. The goal of hydrologic disconnection is to minimize sediment delivery from road runoff to a watercourse by routing overland flow onto an effective filter strip with dense vegetation. Hydrologic connection is an indicator of the potential for the road segment to deliver road-derived sediment and road chemicals, including spills, to a watercourse. Hydrologic connectivity also increases the drainage density of the watershed, producing hydrologic changes that alter the magnitude and frequency of runoff delivery to watercourses. The proportion of road prisms that are hydrologically connected is strongly controlled by road location, road design, local topography, and factors that control the amount of road runoff (e.g., the amount of annual precipitation).

Connected roads can deliver sediment-laden water via inside ditches that drain to a watercourse crossing; by a connected road drainage structure or facility (i.e., ditch drain culvert, rolling dip, waterbreak, or lead-off inside ditch that delivers runoff to a watercourse channel); or by direct runoff from the road running surface to a watercourse. In the western U.S., road-watercourse crossings account for the majority of the connected road length, followed by gullies formed by concentrated runoff at drainage structure or facility outlets. Evidence of connection below a road drainage structure or facility is provided by: (1) presence of surface flow between the drainage structure outlet and a defined channel or a flood prone area; (2) a channel that extends from a road drainage structure outlet to the high water line of a defined channel or a flood prone area; (3) a sediment deposit that reaches the high water line of a defined channel or a flood prone area; or (4) observation of turbid water reaching the watercourse during runoff events.

Primary mechanisms for decreasing hydrologic connectivity are: (1) decreasing ditch drain (relief) culvert spacing for roads with inside ditches; (2) converting crowned, or insloped roads with inside ditches, to outsloped roads with rolling dips; (3) removing or breaking outside berms on crowned or outsloped roads; (4) applying treatments to limit flows and sediment movement at road drainage outlets; and (5) decreasing the likelihood of gully or landslide initiation below road drainage outlets. In particular, the distance between a watercourse crossing and the first upslope adequately functioning and sized road drainage facility or structure is of high importance because this distance has a large influence on the volume of water and sediment delivered to a watercourse.

Not all road segments are hydrologically connected. For example, low delivery potential road segments include road segments on flat terrain that do not intersect watercourse channels. Where there is hydrologic connection, 14 CCR § 923.1(d) [943.1(d), 963.1(d)] requires that an evaluation of how to disconnect the road segment is to be conducted. Total hydrologic disconnection is not possible for most roads. In particular, insloped roads with an inside ditch will have a small segment of their total length still hydrologically connected between the watercourse and road drainage disconnection facility or structure located above watercourse crossings (Figure 1).

Identification of High Risk Factors

High risk factors to consider when evaluating the adequacy of existing forest road drainage structures and facilities associated with a given road segment include, but are not limited to:

- Insloped or crowned road segments with ditches.
- Crowned or outsloped road segments with outside berms.
- Steeper road or ditch grades (e.g., > 7 percent).
- Roads located on steeper hillslope gradients (e.g., > 40 percent).
- Road segments located short distances from watercourses (< 200 feet are very high risk).
- Roads located on lower hillslope positions (as opposed to mid-slope and upper hillslope positions).
- Throughcut road segments that are difficult to adequately drain.
- Soil types with a high erosion potential (e.g., non-cohesive soils such as decomposed granitic soils).
- Areas with a high natural drainage density (e.g., California Coast Ranges).
- Areas with relatively high hillslope instability (e.g., Franciscan mélange terrain).
- Areas with high precipitation amounts and intensity (e.g., portion of the California Coast Ranges located in Santa Cruz County).
- Unsurfaced or inadequately surfaced road segments prone to surface erosion.
- Unsurfaced or inadequately surfaced road segments with wet weather use.

- Areas below road drainage structure or facility outlets close to watercourses.
- Areas with little surface roughness or vegetative cover (e.g., areas recently burned).
- Roads constructed within the past 5 years.
- Unsurfaced roads that are graded on a regular basis.
- Inside ditches that are graded on a regular basis.
- Roads with high traffic volumes (e.g., primary roads in a road network, as opposed to secondary, low-use roads).
- Roads with maintenance issues and limitations regarding ownership or control (e.g., public roads, private non-appurtenant roads).

Indicators of Significant Problems or Potential Problems

In general, past studies have found that sediment delivery from inside ditch erosion increases as ditch relief spacing increases. Similarly, erosion at road drainage outlets (e.g., outlets of culverts, dips, berm breaks) increases with increased distance (spacing) between drainage structures. Indicators of significant problems or potential problems with the existing road drainage conditions include, but are not limited to:

- Ditch scour or downcutting resulting from excessively long undrained ditches with infrequent ditch drain (relief) culverts or other outlet structures or facilities. This condition can result from design inadequacies (e.g., steep ditch gradient), geomorphic conditions, and inadequate prevention practices (e.g., lack of armoring).
- Evidence of direct sediment entry into a watercourse or a flood prone area (e.g., ponded sediment, sediment deposits, delivery of turbid runoff from drainage structures during rainfall events).
- Inadequate energy dissipation below drainage structure or facility outlets, resulting in erosion.
- Gullies below road drainage structure outlets, including ditch drain culverts, with transport or a high likelihood of transport to a watercourse.
- Existing or high potential for cutbank sloughing or erosion into inside ditches.
- Native-surfaced road composed of soil types with high likelihood of sediment transport into ditches.
- Native surfaced road exhibiting erosion into ditches.
- Rilled or gullied road approaches to crossings.
- Existing ditch drain (relief) culverts or other road drainage structures with significant plugging from sediment or small woody debris, or both.
- Existing ditch drain (relief) culverts or other road drainage structures with decreased capacity due to maintenance activities (e.g., crushed or bent inlets).
- Decreased structural integrity of ditch drain (relief) culverts or other road drainage structures (e.g., excessive pipe corrosion).

Appropriate Treatment Measures

Treatment measures are dictated by site-specific field observations that consider high risk factors and problem indicators. These measures apply to existing, new, and reconstructed logging roads.

If high risk factors and problem indicators are observed during the evaluation required under 14 CCR § 923.1(d) [943.1(d), 963.1(d)], then appropriate treatment measures for applicable logging road, landing and logging road watercourse crossing segments shall be prescribed in context with additional requirements specified under 14 CCR § 923.2(a)(5) [943.2(a)(5), 963.2(a)(5)], 923.5(a) [943.5(a), 963.5(a)], and 923.6(c) and (g) [943.6(c) and (g), 963.6(c) and (g)].

Appropriate treatment measures to hydrologically disconnect logging road segments include, but are not limited to:

- Installation of a road drainage disconnection facility or structure as close as possible to the watercourse crossing so that the discharge can be prevented from entering the watercourse. Typically, this distance is 50 to 100 feet above the crossing (Figure 1). Depending on the road drainage design, the road drainage disconnection facility or structure can be a ditch-relief culvert, rolling dip, waterbreak, or other effective facility or structure. Note that the distance is to be adjusted based on site-specific conditions and may exceed 100 feet where necessary to provide effective sediment filtration, especially for installation of ditch drain (relief) culverts. Note that this spacing may be closer than the maximum distance specified under 14 CCR § 923.5(f) [943.5(f), 963.5(f)], or as needed for conformance with 14 CCR § 923.5(g) [943.5(g), 963.5(g)].
- All road segments with an inside ditch will have a small portion of their total length still connected even following implementation of 14 CCR §§ 923.2(a)(5) [943.2(a)(5), 963.2(a)(5)], 923.5(a) [943.5(a), 963.5(a)], and 923.6(c) and (g) [943.6(c) and (g), 963.6(c) and (g)]. Studies show this percentage of the total road length may be at least 5-10%.[1]
- Installation of an appropriate size, number, and location of additional road drainage facilities or structures above the road drainage disconnection facility or structure in conformance with 14 CCR § 923.5(b) and (c) [943.5(b) and (c), 963.5(b) and (c)].

- **[Option 1]** Waterbreak spacing for roads is specified under 14 CCR § 923.5(f) [943.5(f), 963.5(f)]; rolling dip spacing is specified in Table 1. Ditch-relief spacing requires a sufficient number of cross drains to be installed to prevent ditch scour, prevent exceedance of cross drain hydraulic capacity, and prevent erosion at cross-drain outlets. Spacing of

[1] Past studies have shown that approximately 15% to more than 50% of road length in studied western U.S. watersheds are hydrologically connected to the stream network due to the existence of inboard ditches or gullies formed below ditch drainage facilities or structures.

ditch-relief cross-drains at regular intervals, as displayed in Table 1, is to be modified based on the site filtering capacity at proposed installation locations and avoidance of potentially unstable areas (additional factors are listed in the following section). In THPs, NTMPs, and PTHPs, RPFs may propose the use of other published spacing tables that better match the field conditions where their plans are proposed. Local experience and knowledge of geologic material present may be taken into account when designing adequate spacing. If ditch lining materials are used, cross drain spacing can be increased (with the provision that erosion at the outlets is mitigated) and should be based on hydraulic calculations. In general, if ditch-relief culverts are used, they are recommended to be at least 18-inch diameter to limit the potential for plugging from soil and small woody debris.

- **[Option 2]** Appropriate ditch drain (relief) spacing requires a sufficient number of cross-drains to be installed to prevent ditch scour, prevent exceedance of cross-drain hydraulic capacity, and prevent erosion at cross-drain outlets. Spacing of ditch drains at regular intervals is to be modified based on the site filtering capacity at proposed installation locations and avoidance of potentially unstable areas (additional factors are listed in the following section). If ditch lining materials are used, cross drain spacing can be increased (with the provision that erosion at the outlets is mitigated) and should be based on hydraulic calculations. In general, if ditch relief culverts are used, they are recommended to be at least 18-inch diameter to limit the potential for plugging from soil and small woody debris.

Location of Drainage Facilities and Structures

In addition to drainage structures and facilities being located: (1) to disconnect road drainage upslope of watercourses, and (2) at a sufficient interval (spacing) to avoid volume concentrations and associated erosion, as discussed above, there are additional factors that should be considered prior to placing drainage structures and facilities in the field. To assist in identifying sites best suited for a drainage structure or facility, the following criteria should be considered. These criteria are to be considered and appropriately weighted based on site-specific conditions, so that the effectiveness of the drainage structure or facility will be maximized and problems associated with a poorly placed drainage structure or facility will be avoided or minimized. In order of decreasing importance, drainage structures and facilities should be placed:

1. To discharge away from unstable or potentially unstable areas, such as known active landslides, hummocky ground, concave headwalls, or steep fillslopes.
2. Before hydrologic divides to prevent water from one hydrologic basin mixing with, and potentially impacting, another hydrologic basin not conditioned to receiving the additional flows.

3. To discharge onto divergent (convex) (preferred) to planar slopes where possible, to allow for better dispersion and infiltration (Figure 2).
4. To drain localized or emergent groundwater, springs, and wet areas present in the road prism.
5. Above breaks in the road grade that transition from low-gradient to high-gradient to remove the water off of the road before it gains velocity and erosive power on the downslope steep road segment.

Energy Dissipators

Energy dissipators (e.g., slash, rock armor, flow diverters, downspouts, etc.) can be placed at outfalls of drainage structures and facilities to disperse flows and promote infiltration, consistent with the requirements stated in 14 CCR § 923.5(h) [943.5(h), 963.5(h)]. The use and selection of an appropriate energy dissipator should be based on field conditions and is a function of flow, erosion characteristics of the soils, slope gradient, slope roughness and cover, and distance to a receiving watercourse. Effective energy dissipators commonly used in the forest setting, include, but are not limited to:

- Heavy vegetative cover.
- Wood slash that is "packed" into place with a piece of equipment (ideally) or by hand.
- Pit-run rock. Generally composed of competent local rock that has a range of rock sizes.
- Stilling basins.

B. Outsloping and Rolling Dips

Outsloped roads are built with a slight angle of the road surface towards the fill slope (Figure 3). This configuration allows road surface runoff to drain in a dispersed manner over the fillslope onto undisturbed forest soils. As defined in 14 CCR § 895.1, outsloping means shaping the road surface to drain toward the outside edge.

Rolling dips are typically constructed on outsloped roads to help drain the road surface. As defined in 14 CCR § 895.1, a rolling dip means a drainage facility that is constructed to remain effective while allowing passage of motor vehicles at reduced road speeds.

An outsloped road does not require an inside ditch and is considered hydrologically disconnected as long as outside berms are not present and the road prism does not encroach into the watercourse. Rolling dips should be installed on outsloped roads to ensure that surface flow is routed off the road surface rapidly without concentrating flow or eroding the fill (Figure 4). Outsloped roads with rolling dips are typically not appropriate for roads with a gradient in excess of 10 percent because of the steepness of the dip approach grades that would be required and the added difficulty to effectively drain the road surface.

Outsloped roads are not appropriate in all situations due to safety concerns, timing of use, or expected traffic (e.g., winter use in snow zones).

[Option 1]
Spacing of rolling dips is a function of road grade and soil erodibility; appropriate spacing is shown in Table 1. In THPs, NTMPs, and PTHPs, RPFs may propose the use of other published spacing tables that better match the field conditions where their plans are proposed. As with ditch-relief culvert location, spacing is to be modified based on the site filtering capacity at proposed installation locations and avoidance of potentially unstable areas.

[Option 2]
Spacing of rolling dips shall be in conformance with 14 CCR § 923.5(g) [943.5(g), 963.5(g)]. As with ditch drain (relief) culvert location, spacing is to be modified based on the site filtering capacity at proposed installation locations and avoidance of potentially unstable areas.

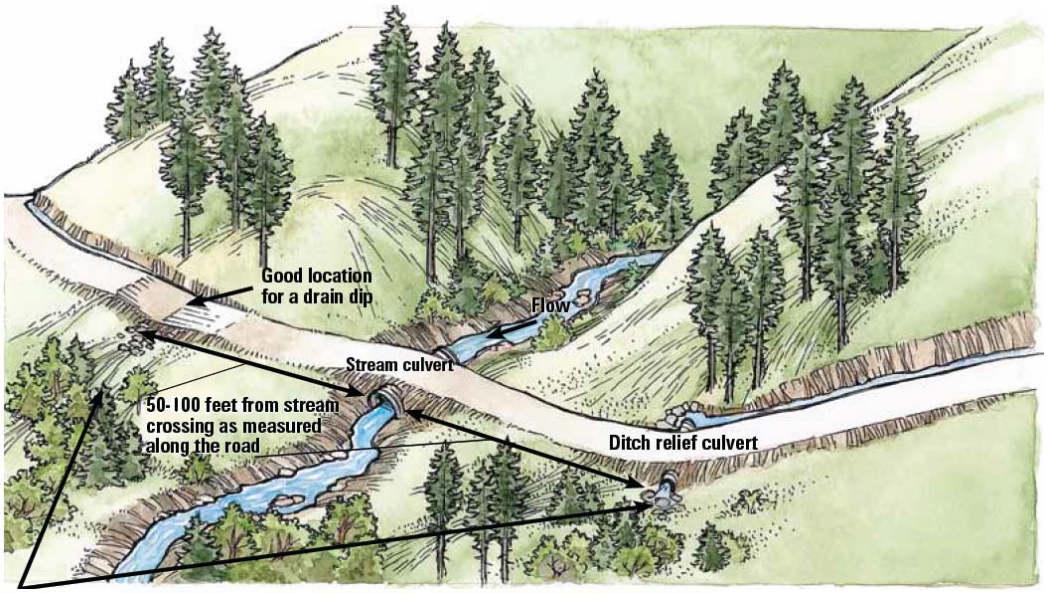
C. Diversion Potential

Watercourse crossings have diversion potential if overflow from a plugged culvert inlet diverts the watercourse down the road rather than over the crossing and back into the natural watercourse channel. Diverted flows can create excessive erosion where the flows erode non-channeled surfaces and where they exceed the channel capacity of non-original channels (Figure 5). Diversion potential exists on roads that have a continuous climbing grade across the crossing or where the road slopes downward away from the crossing in at least one direction. California Forest Practice Rules 14 CCR §§ 923.10(g) [943.10(g), 963.10(g)], 923.11(g) [943.11(g), 963.11(g)], and 923.13(h) [943.13(h), 963.13(h)] require diversion potential on new and existing roads to be addressed; similar requirements have existed since 1990. Monitoring work conducted on randomly selected THPs that have been completed has shown, however, that approximately 10 percent of watercourse crossings still have diversion potential. In order to address diversion potential, a critical dip is to be installed that will intercept flow and prevent it from moving away from its original channel (Figure 6); other methods of prevention may be proposed in the plan. The dip should be constructed downgrade of the crossing at the point where the potential for the loss of fill is minimized.

Table 1. Ditch-relief culvert and rolling dip spacing guidelines (from Kocher et al. 2006, adopted from Keller and Sherar 2003).

Road Grade (percent)	Soil Erodibility	
	Low to Non-erosive soils	Erosive soils
0-3%	400'	250'
4-6%	300'	160'
7-9%	250'	130'
10-12%	200'	115'
12+	160'	100'

Note: (1) **Low Erosion Soils** = Coarse Rocky Soils, Gravel, and Some Clay
(2) **High Erosion Soils** = Fine, Friable Soils, Silt, Fine Sands



Ditch drainage should be directed into vegetation and undisturbed soil filter, and not allowed to continue flowing down the ditch and into the stream.

Figure 1. Diagram showing implementation of road drainage disconnection facilities/structures to limit sediment delivery into a watercourse (modified from Oregon Forest Resources Institute 2011, 2nd Ed., used with permission (to be obtained)).

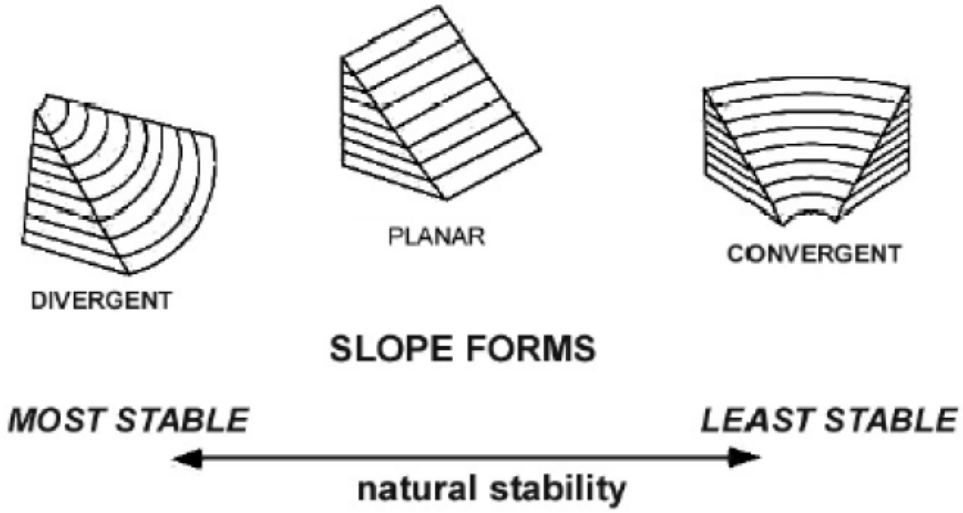


Figure 2. Three major slope forms; water is to be discharged into divergent (convex) to planar slopes where possible (from WFPB 2004).

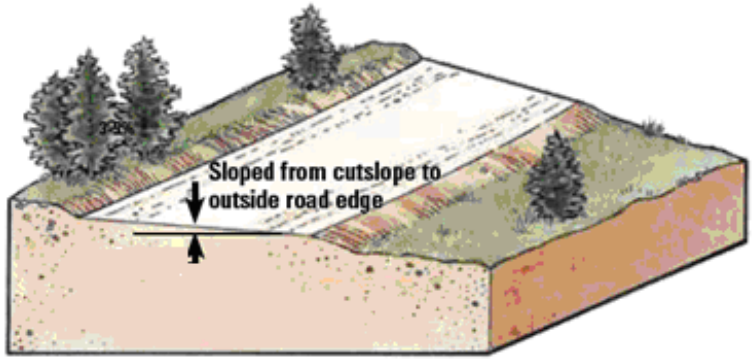
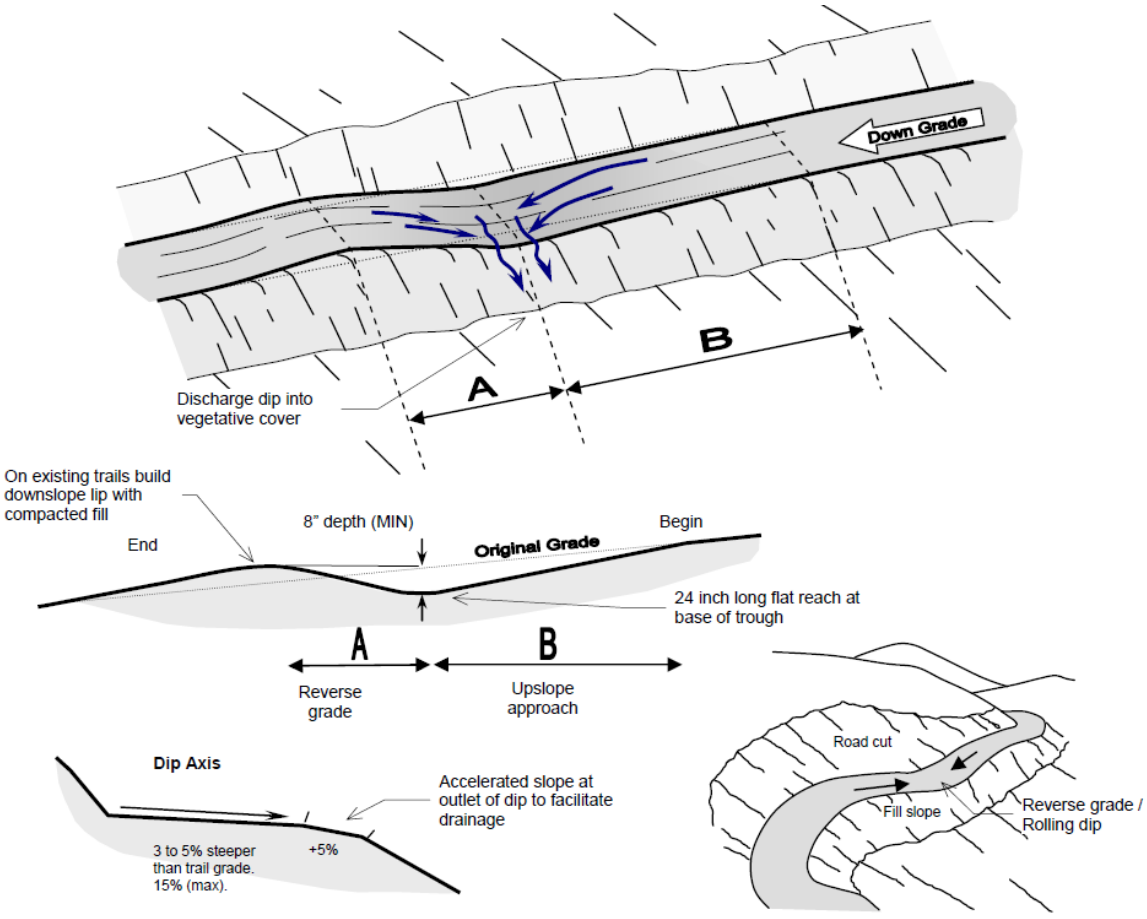


Figure 3. Diagram displaying a typical outsloped road (modified from Oregon Forest Resources Institute 2011, 2nd Ed., used with permission (to be obtained).



ROAD GRADE (%)	TROUGH	A: REVERSE GRADE	B: UPSLOPE APPROACH	
	Depth below downslope crest	Distance and grade from trough axis to downroad crest (ft)	Distance from up-road start of rolling dip to trough axis (ft)	Grade (%)
<5%	8"	7 feet at 10% to 15 feet at 5%	17	10%
10%			30	15%
15%			60	20%
>15%		7 feet at 10%	60	25%

Figure 4. Typical rolling dip specifications (provided by Tim Best, CEG).

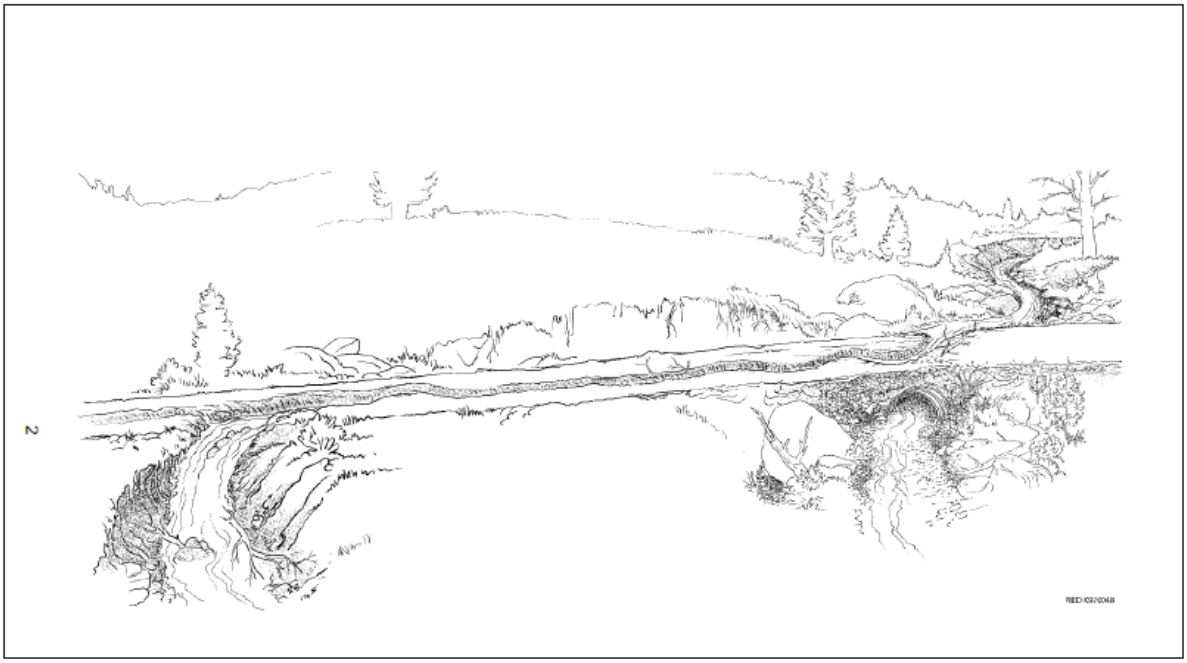


Figure 5. Diagram illustrating diversion occurring at a plugged watercourse crossing, producing considerable erosion (from Furniss et al. 1997)

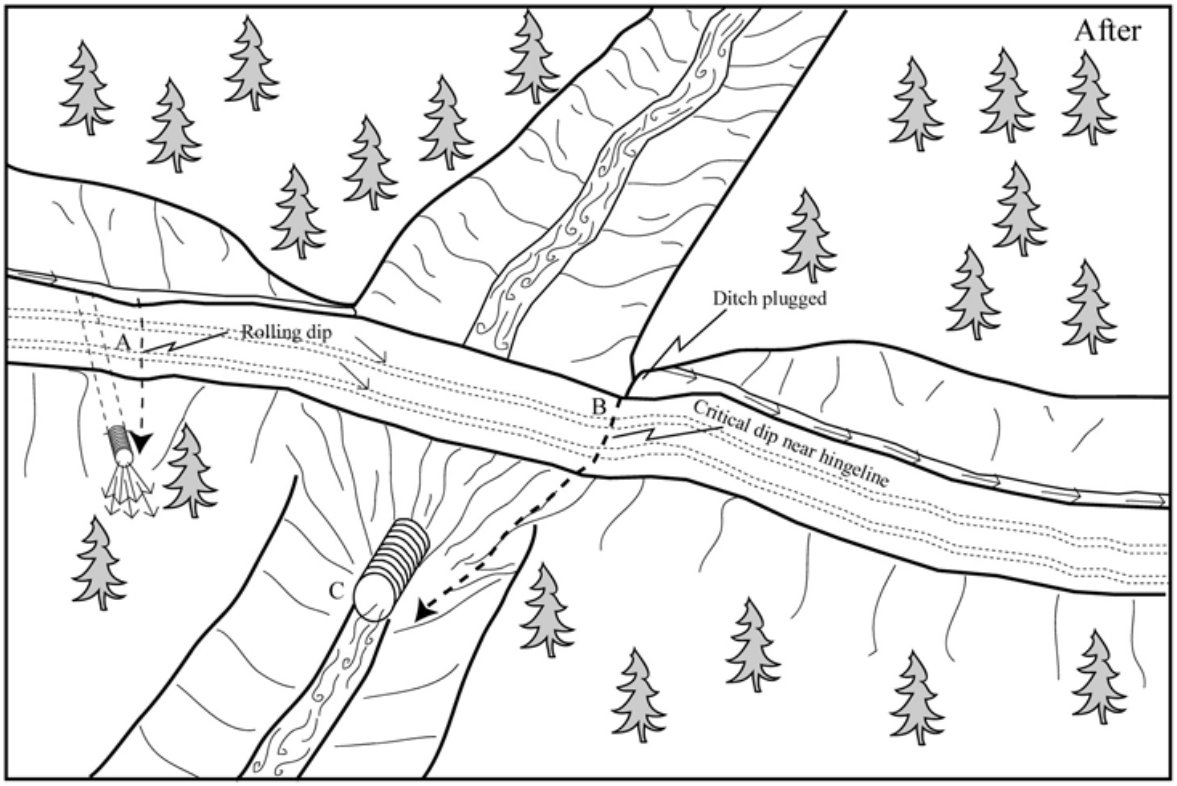


Figure 6. Illustration of a critical dip installed at a watercourse crossing to remove diversion potential (from DFG 2006).

Comment L6-7: § 923.1(h)(2)
"In paragraph (h) 2 that follows, the word 'feasible' should be removed.

The revised language should read: "Planned use of existing logging roads and landings should be minimized in the flood prone area.""

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§ 923.2 [943.2, 963.2]. Design and Location for Logging Roads and Landings ~~Road Construction~~.

Comment L6-11:
"…there is no guidance in the plead regarding distances from a road to a Class II watercourse. This needs to be clarified unless the intent is to use the same road to watercourse distances for Class II's as those required for Class I watercourses."

Comment L9-19: § 923.2(a)(1)
"Avoid or mitigate potential impacts to public safety. How has this become a concern and how does the Board have any authority to regulate it? (a similar concern is listed later also)."

Comment L8-12: § 923.2(a)(2)
""Unstable areas" are a common theme in the Road Rules, and as explained in the comments of CEG Ray Waldbaum (pgs. 2-3), such areas must be identified and assessed by a professional geologist: "in the State of California, RPFs are not qualified to address issues of geologic stability and any attempt to do so constitutes illegal, unlicensed practice of geology. Therefore, the rules must be changed to make this point clear." In order for the Road Rules package to be clear about this highly important issue, the Rules must add statements which make explicit that the identification and assessment of unstable areas can only be conducted by a certified engineering geologist. This should occur in the following instances (edits are underlined):

Rule 923.2(a)(2): "All logging roads and landings shall: . . . Avoid unstable areas. . . and minimize activities that adversely affect them. Identification of unstable areas must be conducted by a certified engineering geologist.""

Comment L9-20: § 923.2(a)(2)
"'Avoid unstable areas...' same as page 27. This appears to be duplicative."

Comment L10-14: § 923.2(a)(2)
"Amended rule 14 CCR 923.2(a)(2) line 8 page 35 states that all logging roads and landings shall avoid unstable areas and connected headwall swales and minimize activities that adversely affect them. The rule seems to focus on connected headwall swales, but not non-connected headwall swales. Geologically speaking, there are an innumerate variety of 'unstable areas' that may affect the feasibility of construction and use of roads and landings. The precautionary approach to addressing the potential impacts of construction and use of roads and landings across 'unstable areas' and headwall swales would include a requirement that all such proposed operations be reviewed by a Certified Engineering Geologist. Furthermore, there does not seem to be any justification for discounting the potential impacts of logging roads on non-connected headwall swales. A precautionary principle approach would be to avoid differentiating between connected and non-connected headwall swales and to avoid operations on all such features to the extent that such operations are avoidable."

Comment L15-3: § 923.2(a)(2)
"It is not always possible to completely avoid unstable areas. I would add language to subsection 2 to have it match other subsections. '(2) Avoid unstable areas and connected headwall swales to the extent feasible and minimize activities that adversely affect them.'"

Comment L6-8: § 923.2(a)(2)
Insert the term "non-connected swales" so that the language reads: "Avoid unstable areas and both connected and non connected swales" etc.

Our DFG experts report that non-connected swales may be the most dangerous type of headwall swale in that they have not yet released i.e. (failed) and are difficult to recognize.

Comment L17-13: § 923.2(a)(4)
"This rule section as proposed is confusing since language on line 22 of page 34 indicates that it only applies to constructed or reconstructed logging roads and landings while language on line 25 on page 34 indicates that it applies to all logging roads and landings. In addition, while our logging roads primarily rely upon outsloping with rolling dips for drainage, it would not be appropriate to mandate outsloping of all logging roads. Professional judgement and flexibility needs to be provided in the rule package for the selection of road shape. Sometimes it is feasible to outslope a road but better for drainage to inslope the road. A better standard would be to state that road shapes should be selected which are consistent with the intended use of the road and which mitigate significant adverse effects."

Comment L1-33: §§ 923.2(a)(5), 923.5(a), 923.5(i), 923.6(c), 923.6(g), 923.14(a)(1), 923.14(a)(2)
"This comment addresses two issues—the term "surface geometry configurations" and the requirement for hydrologic disconnection. Both issues are common to two of the listed subsections—923.5(a) and 923.14(a)(1). The remaining subsections pertain to the issue of hydrologic disconnection.

"Surface geometry configurations" is used in two of the subsections and is a fancy and potentially confusing phrase. CAL FIRE suggests amending the subsections to use "logging road surface shaping" instead.

All of these subsections command the registered professional forester or licensed timber operator to hydrologically disconnect the logging road, landing or logging road watercourse crossing to the extent feasible. This is a good goal that will be difficult in practice and open to much interpretation in the field. Complete hydrologic disconnection will likely not be achievable. To assist resource professionals that will be trying to implement this new requirement on the ground, CAL FIRE suggests modifying the language to direct the user to a technical rule addendum. CAL FIRE has begun to develop this technical rule addendum. Work is on-going and involves other agency staff and private sector users.

Suggested text for 923.2(a)(5) is: "Be hydrologically disconnected from watercourses and lakes as illustrated in Technical Rule Addendum No. 5 ~~to the extent feasible~~."

Suggested text for 923.5(a) is: "All logging road and landing surfaces shall be adequately drained through logging road surface shaping ~~the use of surface geometry configurations~~ in combination with the installation of drainage structures or facilities and shall be hydrologically disconnected from watercourses and lakes as illustrated in Technical Rule Addendum No. 5 ~~to the extent feasible~~."

Suggested text for 923.5(i) is: "Where logging road and landing surfaces, road approaches, inside ditches and drainage structures cannot be hydrologically disconnected as illustrated in Technical Rule Addendum No. 5, and where there is existing or the potential for significant sediment discharge, necessary and feasible treatments to prevent the discharge shall be described in the plan."

Suggested text for 923.6(c) is: "Log hauling or other heavy equipment uses shall be limited to logging roads and landings, which are hydrologically disconnected from watercourses as illustrated in Technical Rule Addendum No. 5 ~~to the extent feasible~~ and exhibit a stable operating surface. Use may occur on limited segments of roads or landings that do not exhibit a stable operating surface when the road segment or landing is completely, and at all times, hydrologically disconnected from a watercourse as illustrated in Technical Rule Addendum No. 5 and equipment can operate under its own power."

Suggested text for 923.6(g) is: "Logging roads and landings used for log hauling or other heavy equipment uses during the winter period shall ~~have~~ only occur on a stable operating surface and, where necessary, be surfaced with rock to a depth and quantity sufficient to maintain such a surface. Use is prohibited on roads that are not hydrologically disconnected as illustrated in Technical Rule Addendum No. 5 or ~~and~~ exhibit saturated soil conditions. Exceptions may be proposed by the RPF, when locations are disclosed and justified in the THP, consistent with 14 CCR 923.6(c), and approved by the Director."

Suggested text for 923.14(a)(1) is: "Adequate surface drainage at logging road watercourse crossings shall be provided through logging road surface shaping ~~the use of surface geometry configurations~~ in combination with the installation of drainage facilities, ditch drains, or other necessary protective structures to hydrologically disconnect the road from the crossing as illustrated in Technical Rule Addendum No. 5 ~~to the extent feasible~~."

Suggested text for 923.14(a)(2) is: "Drainage facilities and ditch drains shall be installed adjacent to logging road watercourse crossings, as needed, to hydrologically disconnect ~~to the extent feasible~~ the logging road approach from the crossing as illustrated in Technical Rule Addendum No. 5, to minimize soil erosion and sediment transport and to prevent significant sediment discharge during and upon completion of timber operations. See 14 CCR § 923.5(d)-(j) [943.5(d)-(j), 963.5(d)-(j)]~~, subsections (d)-(i).~~""

Comment L4-12: § 923.2(a)(5)
"The Regional Water Board staff support designing roads with the conscious goal to be hydrologically disconnected."

Comment L17-14: § 923.2(a)(5)
"We see that hydrologic disconnection has been a source of considerable discussion at the field trips associated with the rule package. Our input regarding the concept of hydrologic disconnection is that the assessment be focused on impacts to watercourses (significant sediment discharge). If the focus is on reducing hydrologic connectivity just to reduce it a bigger problem could be created through installation of a drainage structure in an inappropriate location which reduces hydrologic connectivity but increases sediment delivery to a watercourse. In addition, there are methods to reduce the sediment impacts of hydrologically connected road segments besides reducing their length (i.e. road surface rocking, sediment barriers, etc)."

Comment L1-34: § 923.2(a)(6)
"This paragraph addresses logging road and landing design factors, which include diversion potential. This is one factor that CAL FIRE suggests should be dealt with in a technical rule

addendum. CAL FIRE has begun to develop this technical rule addendum. Work is on-going and involves other agency staff and private sector users. CLA FIRE suggests amending the paragraph to mention that logging road and landing design should be done in consideration of the technical rule addendum.

Suggested text is: "Include adequate drainage structures and facilities necessary to avoid concentrating and diverting runoff, to minimize erosion of roadbeds, landing surfaces, drainage ditches, sidecast and fills, to minimize the potential for soil erosion and sediment transport, and to prevent significant sediment discharge as illustrated in Technical Rule Addendum No. 5.""

Comment L6-9: § 923.2(a)(6)
"The spacing for water bars shown in the plead on page 53 should not be used to determine cross drain spacing. Our DFG sources tell us that on the North Coast, soil characteristics are such that drain spacing needs to be less than that shown in the table on page 53 "Maximum Distance Between Water Breaks". Again, a guidance document covering cross drain design, layout and spacing is needed to guide RPF's in the field."

Comment L17-15 § 923.2(a)(7)
"The language change is suggested because logging roads are only proposed when necessary, especially on these areas which inherently are associated with expensive road building costs. The revised language better focuses the discussion on potential mitigations rather than necessity.

…Where logging road or landing construction or reconstruction is ~~necessary~~ proposed in these areas, specific measures to minimize movement of soil and the discharge of concentrated surface runoff shall be incorporated in the plan.'"

Comment L8-20: § 923.2(b)
"Rule 923.2(b) states that "The Director may require removal of deposits of excess material if the deposits are in a position to adversely affect the beneficial uses of water and if the removal of the material is feasible."

The phrase "and if the removal of the material is feasible" should be removed because, as explained in the comments of CEG Ray Waldbaum (p. 10), no one should be allowed to avoid cleaning up a mess of their own making just because it may be expensive to do so. Put another way, "deposits of excess material" will only exist in the first instance because the operator has caused them to exist; therefore, the operator should not be allowed to avoid its own mistakes under the argument that removal is not feasible."

Comment L9-21: § 923.2(c)
"'disposal site' implies that a designated site is planned for disposal of excess material. By inference, this would be a good 'site' to place this material. 'Location' may be a better term."

Comment L6-10: § 923.2(c)(7)
"On line 5 change the minimum distance of a road to a Class I WLPZ from 100 ft. on a 50% slope to a minimum of 250 ft. from the watercourse as measured to the watercourse transition line (WTL). The rationale for this change is explained earlier in paragraph 1., Public Trust Principle/Precautionary Principle. Besides changing the distance from a road to a watercourse, the plead should also describe appropriate distances to the watercourse for slopes other than 50%. A possible guide for this is shown in the Weaver and Hagans Handbook for Forest and Ranch Roads on page 14. "Recommended minimum widths of buffer strips between wild land roads and streams".

Comment L9-22: § 923.2(d)(1)
"The reference to USDA USFS contracts is new, and could this could be problematic. Does USFS take precedence over 'safety?'"

Comment L13-2: § 923.2(e)
"The proposed rule includes a prohibition against any landing in excess of one-half acre or in excess of one-quarter acre when on slopes greater than 40%. This seems an undue burden given that the existing rules do allow for such landings when explained and justified in the THP. The language proposed below is intended to maintain the flexibility to allow for larger landings when appropriate and properly explained.

'**(e)** In addition to the requirements of subsection **(a)** above, all constructed and reconstructed landings shall:

(1) Be consistent with the yarding and loading system to be used.
(2) Be no larger than one-half acre unless explained and justified in the THP.
(3) Avoid construction on slopes greater than 40 percent where the landing will exceed one-quarter acre in size unless explained and justified in the THP.'

Comment L9-23: § 923.2(e)(2-3)
"Landing sizes. Landing shall '...be no larger than one-half acre.' There needs to be a provision for exceptions to this (helicopter, biomass, etc). Also, 'avoid constructions on slopes greater than 40 percent where the landing will exceed one-quarter acre in size.'

Same comment applies—exceptions need to be made (e.g., 'as justified in the plan and accepted by the Director.')"

Comment L17-16: § 923.2(e)(2)
"The proposed change to the language makes it consistent with the existing 923 [943,963].5(d). Large landings are sometimes needed to safely conduct timber operations such as helicopter logging.

'(2) Be no larger than one-half acre unless explained and justified in the plan.'"

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§ 923.3 [943.3, 963.3] Mapping and Identification for Logging Roads and Landings ~~Watercourse Crossings~~.

Comment L9-24: § 923.3(a)
"This simply directs one to the specific provisions of 1034(x). The actual changes to 1034(x) are listed in a later section. It seems unnecessary to have a rule simply refer to another rule. Most RPF's know exactly where to look for all mapping requirements (i.e., 1034 x). This section is clumsy and unnecessary."

Comment L15-4: § 923.3(b)
"This reference is confusing in that this rule section addresses mapping and identification of logging roads and landings where the referenced rule section states that a plan shalt have a 'winter operating plan where appropriate that addresses proposed logging road or landing construction, reconstruction. (Refer to 14 CCR § 923.4(k) [943.4(k), 963.4(k)]).' The rules referred to herein state '(k) Construction or reconstruction of logging roods or landings shall not take place during the winter period unless the approved plan incorporates a complete winter period

operating plan pursuant to 14 § CCR 914.7 [934.7, 954.7], subsection (a) that specifically addresses such logging road or landing construction or reconstruction.' The next referenced rule section describes the limitations on timber operations in the winter period, the contents of the winter operating plan, and optional measures in-lieu of a winter operating plan.
I suggest removing this rule subsection.

Comment L10-15: § 923.3(c)(2)
"For amended Rule 14 CCR 923.3 (c) (2), page 42. Change the minimum distance of a road to a Class I WLPZ from 100 ft. on a 50% slope to a minimum of 250 ft. from the watercourse as measured to the watercourse transition line (WTL). Besides changing the distance from a road to a watercourse, the rules should also describe appropriate distances to the watercourse for slopes other than 50%. A possible guide for this is shown in the Weaver and Hagans Handbook for Forest and Ranch Roads on page 14 "Recommended minimum widths of buffer strips between wild land roads and streams."

Comment L9-25: § 923.3(d)
"Do the requirements for flagging roads also encompass the special requirements listed above on that same page in (1) steep slopes and (2) close to WLPZ? This is unclear. There is also a provision for exceptions, which may not be necessary. Also the rest of that paragraph (lines #10 to 14) is very difficult to understand. This is too complicated and wordy."

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§ 923.4 [943.4, 963.4]. Construction and Reconstruction for Logging Roads and Landings ~~Road Maintenance~~.

Comment L5-18: Insert reference to hydrologic disconnection in this section.
"NMFS is aware the constructed and reconstructed roads are intended to be constructed specific to the design specifications in 923.2 which require hydrologic disconnection of roads. However, the constructed/reconstructed road in some cases can be different than what was intended to be designed. In which case, the RRN should have consequences for the deviation especially if the constructed/reconstructed product is unintentionally hydrologically connected. In reviewing the Construction and Reconstruction chapter (923.4) there does not appear to be a section which requires roads to be constructed/reconstructed in accordance with their intended design in accordance with 923.2 or to be hydrologically disconnected. Therefore, NMFS recommends the hydrologic disconnection standard should be inserted in 923.4."

Comment L9-26: § 923.4
"The sentence 'If a change in designation...' is redundant. That pertains to the rules regarding amending the plan. There is no need to have rule language telling you to go to another section of the rules, another redundancy created by the construct that all rules pertaining to roads were taken out of their original context and had to be put in to this article, even if the rule here tells you to go back to the old rule."

Comment L17-17: § 923.4(b)
"It would be beneficial to have the FSOR clearly explain that the 'as specified in the plan' portion of this sentence allows for the construction or reconstruction of logging roads and landings in WLPZs, etc."

Comment L6-12: § 923.4(c)
"See comment above in 923.2 (a) (2) regarding connected and non-connected swales.