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Class II-L Monitoring: Concept Proposals

Conflicts in implementing the original Class II-L rules led to passage of the regulation titled "Class II-L Identification and Protection, 2013" (Revised Class II-L Rules), which went into effect on January 1, 2014. The rule language in 14 CCR § 916.9 [936.9, 956.9] (c)(4) states that:

> *Class II-L watercourses can have greater individual effects on receiving Class I watercourse temperature, sediment, nutrient, and large wood loading than Class II standard (Class II-S) watercourses due to larger channel size, greater magnitude and duration of flow, and overall increased transport capacity for watershed products.*

The new methods used to determine a Class II-L watercourse include:

1. A contributing drainage area of ≥ 100 acres in the Coast Forest District, or ≥150 acres for the Northern and Southern Forest Districts, as measured from the confluence of the receiving Class I watercourse (**Area method**); or
2. An average active channel width of five feet (5 ft) or greater near the confluence with the receiving Class I watercourse. Where field measurements are necessary to make this determination, active channel width measurements shall be taken at approximately fifty foot (50 ft) intervals beginning at the point where the Class II watercourse intersects the Class I watercourse and lake protection zone (WLPZ) boundary and moving up the Class II watercourse for a distance of approximately two-hundred feet (200 ft). The combined average of these five (5) measurements shall be used to establish the average active channel width. Measurement points may be adjusted based upon site-specific conditions, and should occur at riffle locations and outside the influence of watercourse crossings to the extent feasible (**Width method**).

The rule language in 14 CCR § 916.9 [936.9, 956.9] (g)(1)(C) also states the following:

> ***The above method for determination of Class II watercourse type shall sunset on January 1, 2019 pending further evaluation of the efficacy of Class II WLPZ widths and operation requirements in relationship to watercourse characteristics and achievement of the goals specified in 14 CCR § 916.9 [936.9, 956.9] subsection (a). The Department shall report to the Board at least once annually on the use and effectiveness of 14 CCR §***

916.9[936.9, 956.9] subsection (g) for as long as the rule section remains effective.

The language above (Sunset Clause) calls for monitoring the effectiveness of Class II watercourse and lake protection zones (WLPZ) in achieving the following goals specified in 14 CCR § 916.9 [936.9, 956.9] subsection (a):

1. *Comply with the terms of a Total Maximum Daily Load (TMDL).*
2. *Prevent significant sediment load increase to a watercourse system or lake.*
3. *Prevent significant instability of a watercourse channel or a of a watercourse or lake bank.*
4. *Prevent significant blockage of any aquatic migratory routes for any life stage of anadromous salmonids or listed species.*
5. *Prevent significant adverse effects to streamflow.*
6. *Consistent with the requirements of 14 CCR § 916.9 [936.9, 956.9], subsections (f), (g), (h) and (v), protect, maintain, and restore trees (especially conifers), snags, or downed large woody debris that currently, or may in the foreseeable future, provide large woody debris recruitment needed for instream habitat structure and fluvial geomorphic functions.*
7. *Consistent with the requirements of 14 CCR § 916.9 [936.9, 956.9], subsections (f), (g), (h) and (v), protect, maintain, and restore the quality and quantity of vegetative canopy need to:*
    a. *Provide shade to the watercourse or lake to maintain daily and seasonal water temperatures within the preferred range for anadromous salmonids or listed species where they are present or could be restored; and*
    b. *Provide a deciduous vegetation component to the riparian zone for aquatic nutrient inputs.*
8. *Prevent significant increases in peak flow or large flood frequency.*

The Sunset Clause also calls for an assessment of the effectiveness of the area and width methods for identifying Class II-L watercourses.

Determining the effectiveness of the Class II-L WLPZ prescriptive standards in achieving the goals outlined above is considered validation monitoring and would require extensive planning, resources, and time. However, determining whether there are continuing conflicts in identifying Class II-L watercourses can be done relatively rapidly using existing resources. With this in mind, several monitoring questions, along with general approaches for answering these questions, were developed to address the requirements in the Sunset Clause language, including issues of uncertainties identified during the Class II-L negotiation and revision process.

Rationale for the Area and Width Methods

The rule language in 14 CCR § 916.9 [936.9, 956.9] (c)(4) (see gray shaded text on page 1) states that Class II-L watercourses have greater individual effects on downstream receiving waters than Class II standard watercourses due to increased fluxes of temperature, sediment, nutrients, and large woody debris. The larger fluxes from Class II-Ls are ascribed to larger channel dimensions, greater magnitude and duration of flow, and greater transport capacity for watershed products.

Both the area and width methods are consistent with the concept of hydraulic geometry. Hydraulic geometry assumes that discharge (Q) is the dominant independent variable that drives variations in channel process and form (Leopold and Maddock, 1953). Equations 1 and 2 are well known hydraulic geometry power functions, where Q is discharge, A is drainage area, W is channel width, and b, c, d, and e are empirical constants:

(1) $Q = eA^{d}$

(2) $W = cA^{b}$

The Class II-L identification method uses both drainage area and active channel width to infer channel process and function, as these are strongly related to discharge. Additionally, transport capacity (Q_t) can be defined by the stream power model:

(3) $Q_t = k(\Omega-\Omega_c)^{n\,\Omega}$

where k is an index of material mobility, Ω is stream power, Ω_c is the critical stream power for incipient motion, and n^{Ω} is an exponent between 1 and 1.5 for sediment (Bagnold, 1977). Stream power can be defined as:

(4) $\Omega = \frac{\rho g A^{d} S}{W}$

where ρg is the unit weight of water, A is area, S is channel slope, W is channel width, and d is an empirical constant (Brummer and Montgomery, 2003). Equations 1 through 4 indicate that discharge and transport capacity varies with channel width and drainage area. Both discharge and transport capacity are important controls on the downstream transport of sediment, nutrients, and large woody debris[1] (MacDonald and Coe, 2007), making the identification methods consistent with the rule language in14 CCR § 916.9 [936.9, 956.9] (c)(4) for these watershed products.

[1] The transport of large woody debris is also strongly dependent upon piece size. Small streams cannot generally move large pieces of wood via fluvial transport (Bilby and Bisson, 1998).

Conflict Regarding Class II-L Identification Methods

Given that the first iteration of the Class II-L identification methods created conflict between regulators and the regulated public, the first question is the following:

General Monitoring Question 1: Are the Class II-L identification methods resulting in conflicts between Review Team personnel and the regulated public?

General Approach: A general approach to answer this question would be to survey CAL FIRE Forest Practice inspectors to see how often Class II-L determinations were disputed during the review phase of the timber harvesting plan (THP), Modified THP, Nonindustrial Timber Management Plan (NTMP), and Sustained Yield Plan (SYP), Program Timberland Environmental Impact Report (PTEIR)/PTHP processes. Alternatively, pre-harvest inspection (PHI) reports could be evaluated to determine if Class II-L determinations were disputed within the PHI report. Both these approaches would be relatively easy, inexpensive, and could yield information to policy makers quickly. The information can be used to update the Board of Forestry and Fire Protection on an annual basis, as per the Sunset Clause.

Spatial Variation in the Drainage Area and Width Methods

The identification methods for Class II-L watercourses rely on drainage area or the active channel width to classify Class II-L watercourses. While the width method uses a fixed value of 5 ft to identify Class II-L watercourses, the drainage area method recognizes spatial variation in the drainage area required to sustain Class II-L functions and processes. Specifically, the drainage area method uses ≥ 100 acres for the Coast Forest District and ≥ 150 acres for the Northern and Southern Forest Districts. This makes sense since precipitation is generally higher in the Coast Forest District than in the Northern and Southern Forest Districts (Figure 1), and the magnitude of precipitation inputs to a watershed can drive many of the processes and functions that characterize Class II-L watercourses[2]. Also, geology is a factor that controls physiography, permeability, and runoff pathways. When considering the variability in precipitation and geology across non-federal forestlands, it stands to reason that the drainage area necessary to sustain Class II-L functions and processes might be similarly variable.

It can be argued that the active channel width is a more effective indicator of Class II-L functions and processes than drainage area, since channel width scales more directly with discharge and sediment transport capacity than drainage area. However, as demonstrated in Eq. 2 and in Figure 2, there is a relationship between drainage area

[2] The rational method predicts peak runoff as a function of drainage area, runoff coefficient, and rainfall intensity.

and channel width. A refinement of the area and width methods would ideally relate drainage area to active channel width so that there is consistency between the two metrics.

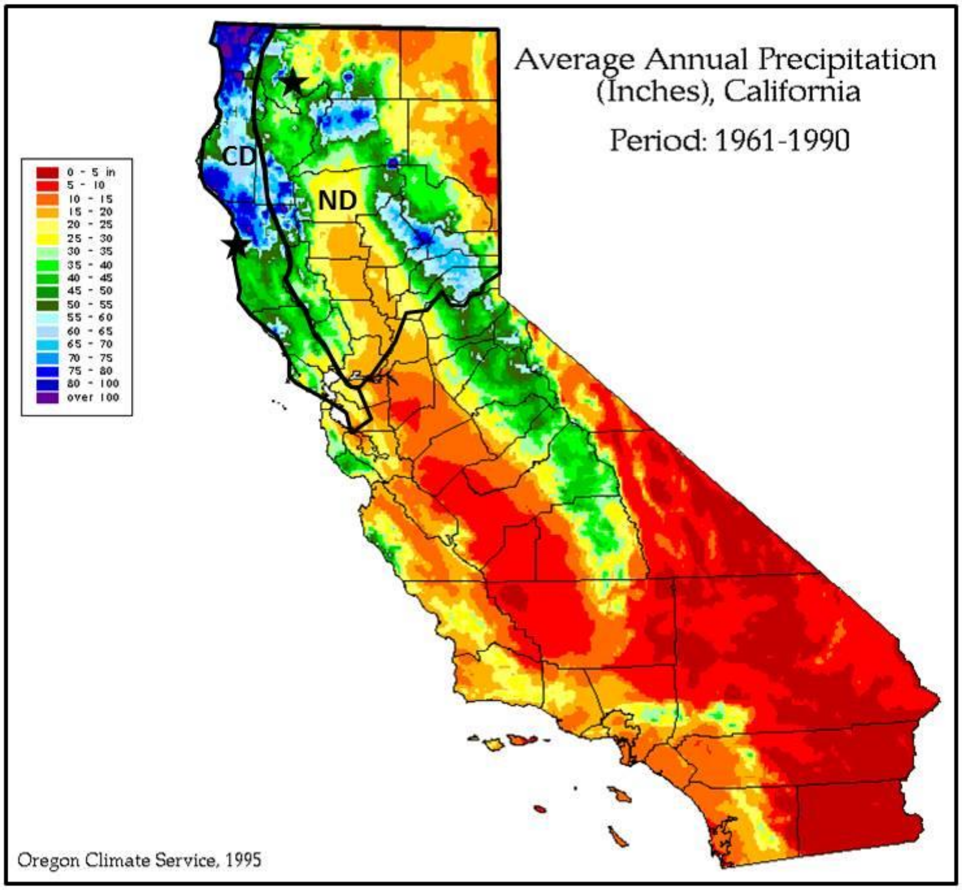

Figure 1. Mean annual precipitation for California for the period between 1961and 1990 (taken from www.wrcc.dri.edu). Polygons represent the approximate boundaries for the Coast (CD) and Northern (ND) Forest Districts. Stars represent the approximate geographic area where the channel width-drainage area surveys in Figure 2 took place.

General Monitoring Question(s) 2: Are the drainage area values consistent with an active channel width of five feet?

General Approach: More surveys relating drainage area to active channel width will be performed in the Coastal and Northern Forest Districts. Figure 2 indicates that either the drainage area necessary to sustain an active channel width of 5 feet can vary by approximately a factor of 2.5 between Forest Disticts. However, Figure 2 represents a very limited sample. Additional sampling will attempt to capture a range of precipitation and geomorphic provinces. Multiple regression can be used to determine the appropriate drainage area based on multiple environmental factors.

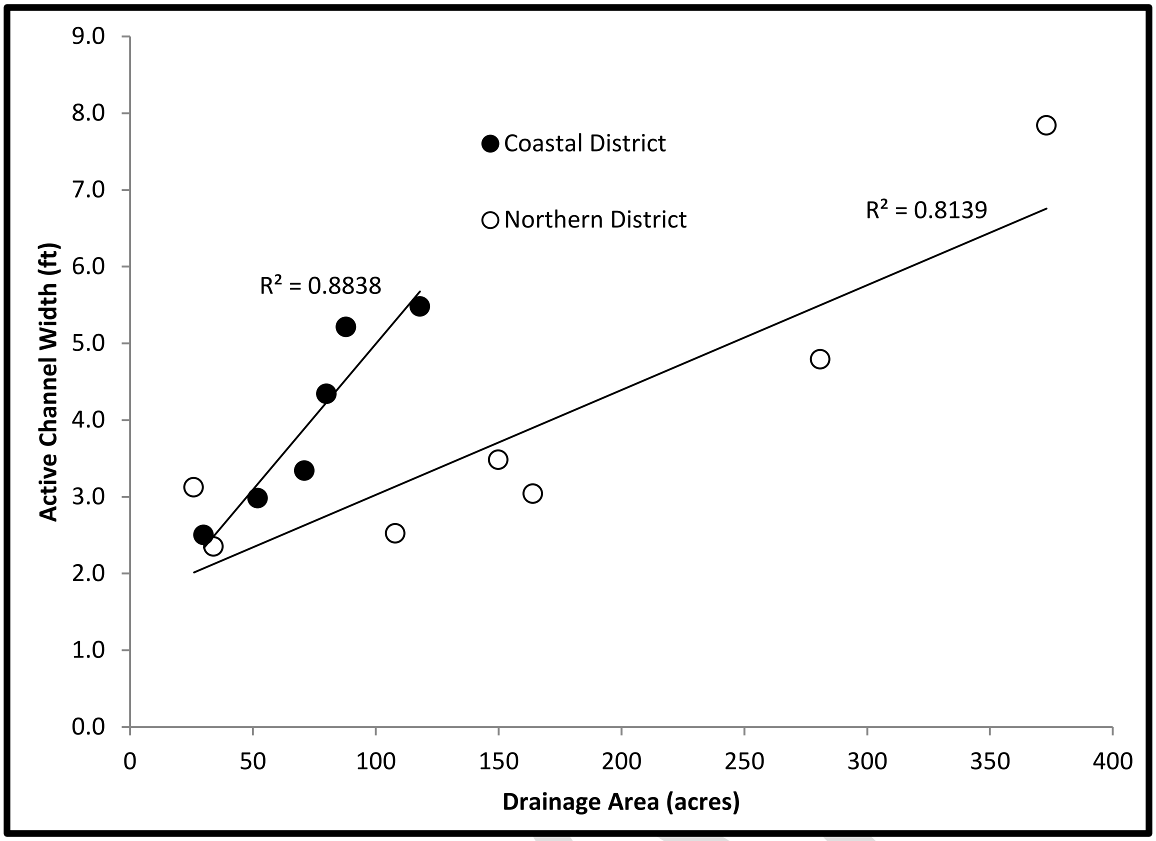

Figure 2. Active channel width versus drainage area for watercourses in the Coast and Northern Forest Districts. Surveys in the Coastal District were performed in the Ten Mile River watershed and Jackson Demonstration State Forest; surveys in the Northern District took place in the Etna and French Creek watersheds.

<u>Effectiveness of Class II-L Identification Methods in Identifying Streams Susceptible to Heat Transfer</u>

The new methods are less certain for identifying watercourses with the potential to transfer heat in the downstream direction. Analytical expressions of hydraulic geometry (e.g., equations 1, 2, and 4) assume a dominant or channel-forming discharge (e.g., bankfull discharge), and are better predictors of channel form and process during higher magnitude discharges. Water temperature increases are typically an issue during the summer months when flows are at or near the annual minimum. As such, it is necessary to determine whether the area or width methods relate to the potential for downstream heat transfer from Class II to Class I watercourses during low flow periods. This was recognized during the Class II-L revision process, where both North Coast Regional Water Quality Control Board and Department of Fish and Wildlife representatives expressed concern that the new rule language did not adequately address thermal impacts.

Thermal inputs, hydrologic connectivity of surface flows, surface flow magnitude, and the duration of flow during the summertime are determinants for downstream heat transfer. Several studies have looked at the spatial and temporal distribution of perennial low flows for headwater streams (e.g., Roth 2010). The Variable Source Concept (VSC) explains that surface water expands headward during storm events and retreats during recessional flows and baseflow conditions (Hewlett and Nutter, 1970). The VSC suggests that perennial low flow is more likely to be found near the Class II/I confluence. Recent studies from the Pacific Northwest, however, have suggested that perennial flow during the summer months does not follow the pattern suggested by the VSC, and that perennial flow retreats headward towards the channel head (Hunter et al., 2005; Jaeger et al., 2007). Source areas for perennial flow were found to be related to lithology, with sedimentary lithologies requiring less drainage area to sustain perennial flow than basaltic lithologies (Figure 3). Streams draining sandstone lithologies also demonstrated downstream movement of perennial flow as drier conditions developed, whereas perennial flow remained more fixed in place as summer progressed in basaltic streams (Jaeger et al., 2007). The spatial occurrence of perennial flow during the summer months was also strongly tied to precipitation magnitude during springtime (Hunter et al., 2005).

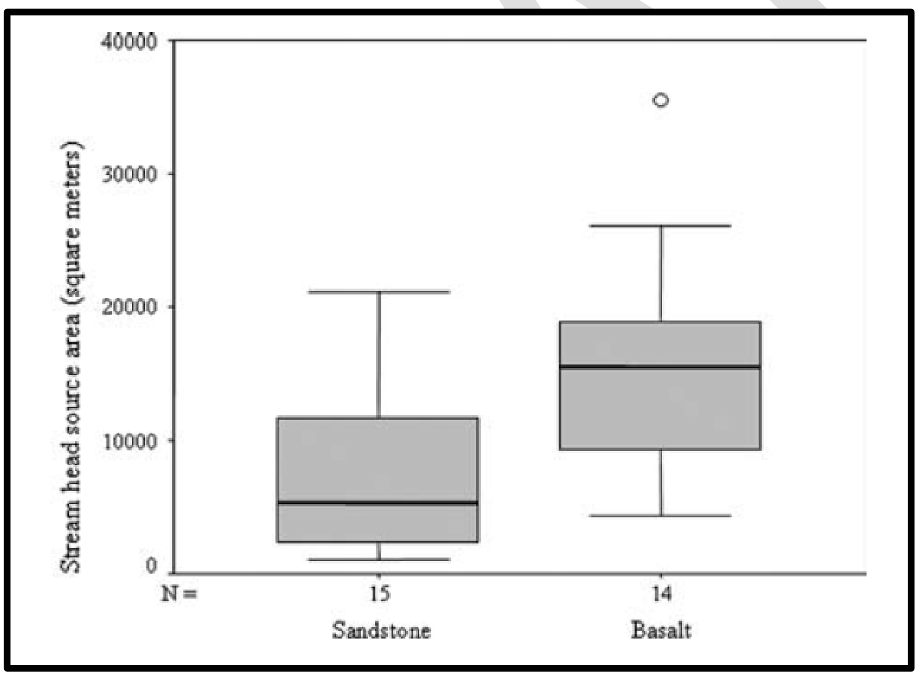

Figure 3. Source area for perennial flow for watersheds underlain by sandstone versus basalt lithologies (from Jaeger et al., 2007). Median source areas varied by approximately a factor of three between lithologies.

Considering that the conceptual framework of the Class II-L identification methods are uncertain for issues related to temperature flux in streams, we pose the following question:

General Monitoring Question(s) 3: Are the Class II-L identification methods effective in identifying watercourses that have the potential to translate thermal impacts to Class I watercourses? Is one method (i.e., width vs. area) better than the other?

General Approach: A general approach to answer this question is to determine whether the drainage area or channel width default can adequately predict the presence of connected perennial flow near the Class I/II confluence during the dry season. A methodology would include the characterization of flow magnitude and connectivity near the Class II/I confluence for watercourses with active channel widths greater than 5 feet or with drainage areas greater than 100-150 acres (Figure 4). The sampling should be stratified by lithology and mean annual precipitation, as these appear to be drivers of perennial flow location and duration. Monitoring should ideally be conducted over multiple seasons to account for interannual variability. A large enough dataset could be used to determine if either the drainage area or width method is better at predicting the conditions that allow for downstream heat transfer. Depending upon the findings of the study, an alternative identification method can be developed that targets temperature issues. This monitoring approach would require a larger investment of time and resources, but is a necessary step to determine if the existing identification methods take into account the potential for thermal impacts to Class I watercourses.

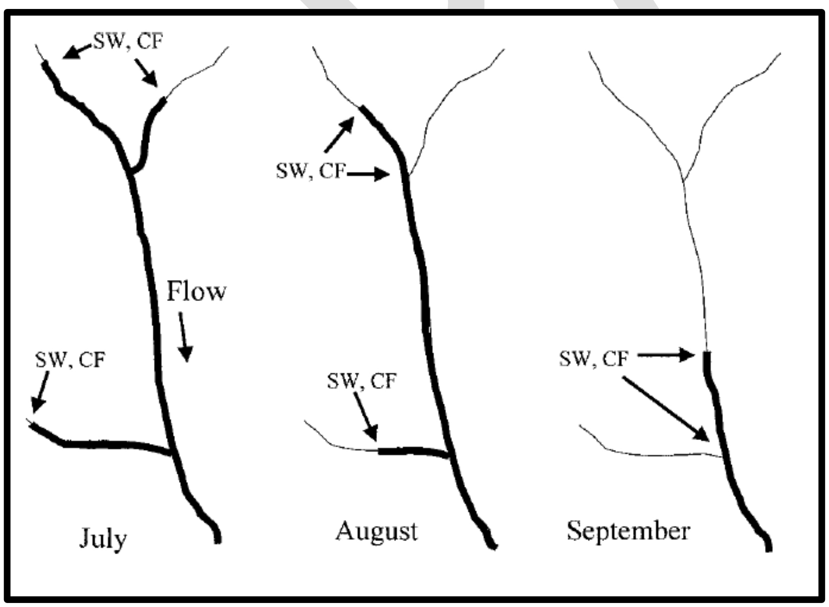

Figure 4. Graphic representation of the spatial incidence of surface water (SW) and connected perennial flow (CF) for a channel network over time (from Hunter et al., 2005). Connected perennial surface flow is more likely to transmit heat downstream.

Similar methods to Hunter et al. (2005) and Jaeger et al. (2007) can be used to determine whether Class II-L identification methods are sufficient to identify streams with the potential to transmit heat during summer months.

Effectiveness of Class II-L Identification Methods in Identifying Watercourses with the Potential to Transport LWD to Class I Watercourses

The transport of LWD from Class II to Class I watercourses is likely to be associated with debris flows or extreme floods (May, 2002; Abbe and Montgomery, 2003; Hassan et al., 2005; Figure 5), but fluvial transport is rare because LWD tends to be large relative to watercourse dimensions and the size of peak flows (Bilby and Bisson, 1998; May and Gresswell, 2003). Mobile wood generally has a length less than the channel width (Flanagan, 2004). Since large wood by definition ranges from 2-3 m long, there is very little fluvial export of large wood from most small streams (Flanagan, 2004).

The area and width methods reflect increasing transport capacity with increasing drainage area and active channel width. However, it is unclear whether they can identify Class II watercourses that transport LWD to Class I watercourses via mass wasting processes.

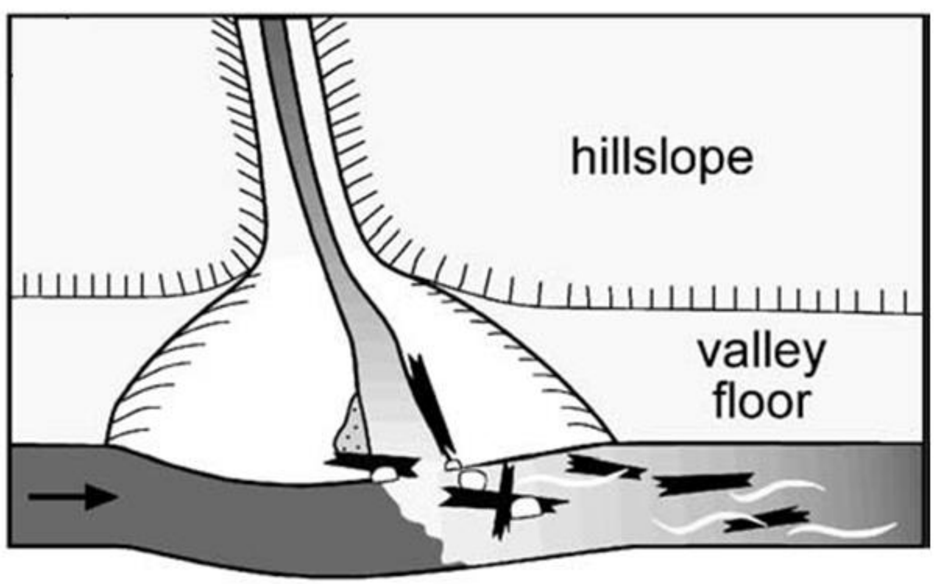

Figure 5. Illustration of debris flow deposit of large wood into a Class I watercourse from a steep gradient, second order ephemeral channel located in a watershed with unstable areas subject to debris slides, flows, and torrents (from May and Gresswell, 2004).

Debris flows typically require initiation on steep hillslope source areas (i.e., slopes > 60 percent), although debris flows can initiate within and erode steep watercourses (i.e., 15-60 percent) (Benda et al., 2005). Depending upon flow properties and characteristics, debris flow material is usually transported through watercourses ranging from 10-25 percent, with deposition occurring on watercourse slopes as high as 25 percent, but generally lower than 10 percent (Benda et al., 2005). Watercourse slope can be empirically related to drainage area:

(5) $S = kA^{-\Theta}$

where S is watercourse slope, A is drainage area, and k and Θ are coefficients that reflect watercourse profile steepness and concavity (Brummer and Montgomery, 2003). This indicates that debris flow prone channels with the potential to transport LWD can theoretically be identified using the area method and indirectly using the width method (see Equation 2). However, this does not take into account the initiation of debris flows from hillslope source areas.

General Monitoring Question 4: Are the Class II-L identification methods effective in identifying watercourses that have the potential to transport LWD to Class I watercourses through debris flow processes?

General Approach: A general approach to answer this question is to determine whether the drainage area or channel width default can adequately predict the presence of debris flow deposits at or near the Class II/I confluence. However, a more refined approach (e.g., stratification by landslide risk) would have to be developed in consultation with staff from the California Geological Survey. Answering monitoring question four is lower priority than answering monitoring questions one through three.

<u>Validation of Class II WLPZ Standards</u>

The Sunset Clause in the Revised Class II-L Rules calls for the validation of Class II WLPZ standards (see yellow highlighted language, goals 1 through 8). This results in the following question:

General Monitoring Question 5: Are the Class II WLPZ riparian standards effective in achieving the goals outline in 14 CCR § 916.9[936.9, 956.9] subsection (a)?

General Approach: Question 5 belies the complexity of proving the effectiveness of Class II WLPZ standards. This general question would generate multiple sub-questions, and an even larger number of testable hypotheses. The complexity of this task means that it is best incorporated into the study design of an intensively monitored watershed, such as Caspar Creek, Little Creek, or Judd Creek. If necessary, the effectiveness of the WLPZ standards in achieving a specific goal (e.g., achieving temperature standards for TMDL compliance) could be done in isolation.   A primary benefit of this type of study is that it will determine whether two types of Class II protection standards are necessary. It would also be a necessary step towards water quality certification of the California Forest Practice Rules by the US Environmental Protection Agency (EPA) as BMPs.

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