sensitive variable in the model that the proposed action would alter from the existing condition is soil cover.

The GeoWEPP estimate of the hillslope sediment production rate for the existing condition is approximately 2.8 tons/ha/yr (1.10 tons/ac/yr). Approximately 2,743 tons per year of sediment is produced in the Bear_ fen 6 Management Unit. Sediment production rates from roads is estimated at 106 to 186 tons per year (using WEPP:Road sediment production rates), or 10 to 20 tons per year from roads using Korte and MacDonald's sediment production rates. Modeling for the existing condition used 99 percent cover for all slopes including the private land in the north part of the Bear Meadow Creek sub-watershed and areas that are proposed for treatment. The model showed that most sediment is produced on steeper slopes, especially headwater slopes in tributary channels of Bear Meadow Creek.

Environmental Consequences

The discussion of Environmental Consequences includes a literature review, followed by sections that describe the project's alternatives and their predicted effects. Effects of the No Action Alternative are described in terms of the potential effects of modeled wildfire.

General Discussion

The design features for soil and watershed protection are common to all action alternatives. <u>Effects of Timber Harvest on Flows and Water Quality</u> - Existing stream flow research has examined the effects of clearcutting, timber harvest, and other intensive treatments. Understanding hydrologic effects of thinning is based on inference rather than direct study (Robichaud and others 2006; Troendle and others 2006).

Researchers have concluded that if less than 10 percent of a basal area is removed, little impact on flows occurs. This is supported by paired watershed studies and by modeling (Troendle and others 2006). Flow is affected but change is not detectable with the removal of between 10 and 20 percent of basal area due to the natural variability of flow. Many investigators have found that approximately 20 percent of a basal area must be removed before a statistical change in flow is detected (Troendle and others 2006). MacDonald and Stednick (2003) state that 15 percent basal area must be removed before a change in flow can be detected in small research watersheds. Detection becomes more difficult as watershed size increases.

The percent change in basal area for each sub-watershed in each Kings River Project alternative is presented in Table 3-40. The maximum change is 12.1 percent. Most values are below 10 percent. This will be discussed further under the Environmental Consequences of each alternative.

Timber harvest can affect stream flows in several ways. Changes in precipitation; snow accumulation and snowmelt; and available soil moisture can affect stream flows. (important in snow-dominated areas but less so in rain-dominated and 'warm snow' zones such as the project area).

Changes in interception of precipitation are related to changes in canopy. Interception losses may account for 25 to 35 percent of the annual precipitation received in cold snow zone conifers, and 10 to 12 percent in deciduous forests. (Troendle and others 2006). Any reduction in stand density would increase snowpack accumulation. This effect may occur in the project area, and would be most important in the Glen_meadow_1, El_o_win_1, Bear_fen_6 and Krew_bul_1 Management Units. The management units in the Big Creek watershed receive snow, but are not snowmelt dominated. This literature review found that interception changes were also reported as proportional to changes in basal area. Changes in canopy for the different alternatives are displayed in Table 3-40. Canopy changes are slightly lower than basal area changes because the majority of trees removed are not the dominant canopy-forming trees. They are intermediate or suppressed trees that are growing under the dominant canopy.

Potential increases in peak flows are related to changes in snow accumulation and snow melt. This would apply mostly to the snow-dominated portions of the project area: El_o_win_1, Glen_meadow_1, Bear_fen_6 and Krew_bul_1. Troendle and others (2006) note that debate exists over the effects of harvest on peak flows in maritime climates, where mid-winter rain-on-snow events are responsible for highest peak flows. They state that rain-on-snow events with warm wind increase snow melt the most, suggesting that changes in wind speed at the snow surface is a key element in determining the magnitude of the effect. Turbulence theory research has shown that widely-spaced objects can reduce turbulence at the bottom surface. Thinning may result in little increase from this process. Woods and others (2004) found that snow accumulation measured at the stand scale did not change in group selection cuts where trees were left in patches. Snow accumulation increased by 35 percent when thinned trees were left evenly spaced. Both of their study units had 60 percent of the basal area removed.

Effects on snow accumulation would probably be similar to the effects of small clearcuts in the group selection patches. Woods and others (2004) cite studies that found that small clearcuts (2 to 5 tree height diameters) accumulate more snow than the surrounding forest. Large clearcuts (more than 20 tree heights in diameter) accumulate less snow because of wind scour and evaporation losses. Patch cuts proposed in this project are a maximum of three acres in size, which is similar to the small clearcut size. These openings can be expected to accumulate more snow than prior to treatment.

Table 3-40. Percent Change in Basal Area and Canopy Cover

Subwatershed Number	Alt 1 Proposed Action		Alt 2 No Action		Alt 3		Alt 4		Alt 5	
	BA	Canopy	BA	Canopy	BA	Canopy	BA	Canopy	BA	Canopy
519.0005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
519.0007	3.6	2.7	0.0	0.0	3.5	2.6	3.5	2.6	3.5	2.6
519.0008	7.3	6.1	0.0	0.0	6.6	5.6	6.6	5.6	6.6	5.6
519.0009	0.3	0.3	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.3
519.0010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
519.0011	8.0	7.4	0.0	0.0	7.5	7.0	7.5	7.0	7.5	7.0
519.0012	0.4	0.4	0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4

Subwatershed Number	Alt 1 Proposed Action		Alt 2 No Action		Alt 3		Alt 4		Alt 5	
	BA	Canopy	BA	Canopy	BA	Canopy	BA	Canopy	BA	Canopy
519.0055	4.1	3.6	0.0	0.0	3.7	3.1	3.7	3.1	3.7	3.1
519.0056	3.6	3.1	0.0	0.0	3.2	2.8	3.2	2.8	3.2	2.8
519.0057	6.4	4.6	0.0	0.0	6.3	4.5	6.3	4.5	6.3	4.5
519.2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
519.3001	5.6	3.0	0.0	0.0	5.5	3.0	5.5	3.0	5.5	3.0
519.3002	0.8	0.7	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7
519.3003	4.0	3.4	0.0	0.0	3.8	3.4	3.8	3.4	3.8	3.4
519.3004	3.1	2.6	0.0	0.0	3.0	2.5	3.0	2.5	3.0	2.5
519.3005	5.8	5.1	0.0	0.0	5.3	4.7	5.3	4.7	5.3	4.7
519.3052	12.1	9.7	0.0	0.0	11.8	9.6	11.8	9.6	11.8	9.6
519.3053	2.5	1.7	0.0	0.0	2.9	1.9	2.9	1.9	2.9	1.9
519.4001	0.2	0.1	0.0	0.0	0.2	0.1	0.2	0.1	0.2	0.1
519.4051	5.8	4.3	0.0	0.0	5.7	4.2	5.7	4.2	5.7	4.2
520.0014	3.8	3.3	0.0	0.0	3.4	3.0	3.4	3.0	3.4	3.0
520.0015	1.8	1.4	0.0	0.0	1.6	1.3	1.6	1.3	1.6	1.3
520.0016	11.3	9.5	0.0	0.0	9.9	8.5	9.9	8.5	9.9	8.5
520.0017	4.8	4.4	0.0	0.0	4.2	3.8	4.2	3.8	4.2	3.8
520.0053	0.3	0.2	0.0	0.0	0.3	0.2	0.3	0.2	0.3	0.2
520.0054	0.8	0.8	0.0	0.0	0.8	0.7	0.8	0.7	0.8	0.7
520.0055	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
520.0056	10.0	9.2	0.0	0.0	8.8	8.2	8.8	8.2	8.8	8.2
520.0057	4.4	4.2	0.0	0.0	4.3	4.0	4.3	4.0	4.3	4.0
520.1001	2.0	1.5	0.0	0.0	1.9	1.5	1.9	1.5	1.9	1.5
520.1002	1.8	1.6	0.0	0.0	1.7	1.5	1.7	1.5	1.7	1.5
520.1051	6.4	5.4	0.0	0.0	5.9	5.1	5.9	5.1	5.9	5.1
520.1101	6.2	5.1	0.0	0.0	6.0	5.0	6.0	5.0	6.0	5.0
520.1151	4.2	5.4	0.0	0.0	4.1	5.3	4.1	5.3	4.1	5.3
520.2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
520.3002	4.5	5.1	0.0	0.0	4.0	4.7	4.0	4.7	4.0	4.7
520.3052	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
520.3151	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
520.4001	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
520.4051	9.9	8.7	0.0	0.0	8.9	8.1	8.9	8.1	8.9	8.1
520.4052	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
520.5051	0.3	0.5	0.0	0.0	0.3	0.5	0.3	0.5	0.3	0.5

Studies have found base flow increases after clearcutting. Keppeler and Ziemer (1990) found that the summer low flows in Caspar Creek in northwestern California were 14 to 55 percent higher than predicted based on the relationship between the watershed pre-harvest and an unlogged control. This change occurred after 67 percent of the timber volume in the watershed was removed. The number of days with stream flows lower than threshold value decreased by 40 percent after harvest. Hicks and others (1991) found that clearcutting in Oregon increased low flow by 25 percent for eight years, and then dropped below the unlogged control.

Remaining vegetation captures at least a portion of excess soil water when a stand is thinned, and the increase in water available for base stream flow is moderated. Troendle and others (2006) state that the potential for thinning to have an effect on streamflow due to reduced evapotranspiration depends on the amount of precipitation. A surplus of water in wet summers contributed to increased stream flow while in dry years the residual stand would probably use all of the available water. The largest changes in runoff would occur during fall and early winter in climates that are dry in the summer and rainy in the winter (Robichaud and others 2006). Management units in the Big Creek watershed are dry in the summer and rainy in the winter. Nearly all of the change in flows would occur during spring runoff in snow-dominated areas such as the management units in the Dinkey Creek watershed. Spring runoff may occur slightly sooner if reductions in canopy allow faster melting of the snowpack. Any increase in flows that result from thinning are not likely to persist for more than 5 to 10 years (Robichaud and others 2006). Lewis (2001) found that flows in a partially clearcut watershed under wet antecedent moisture conditions increased 3 percent compared to 23 percent in a clearcut watershed.

Effects of timber harvest on water quality could include increases in sedimentation caused either by the transport of eroded material out of harvested areas into stream channels, or by increased flows that result in channel erosion that in turn increases sedimentation. Best Management Practices (BMPs) are applied to minimize erosion and sediment delivery to streams. MacDonald and Stednick (2003) note that forest harvest and fuels treatments should have little effect on water quality if they are well-planned and BMPs are implemented.

Monitoring BMPs on Forest Service lands in California has shown that timber management BMPs are generally 95 to 98 percent effective (USDA 2004). Streamside Management Zones were found to be 85 percent effective due to inadequate implementation (failure to properly identify SMZs on the ground). Meadow protection was 98 percent effective. The Monitoring Report (USDA 2004) identifies a need to improve implementation and effectiveness rates of timber management BMPs, and presents a plan for accomplishing this goal that includes training and additional monitoring of BMPs. These measures are included in the Monitoring Plan for this project. The IDT has invested several days in refining treatments within SMZs (reflected in the SMZ prescription developed for Alternative 3), and in field checking the identification and application of SMZs.

Literature has shown that BMPs are effective in minimizing the erosion in harvest units and at preventing sediment from reaching streams. Wallbrink and Croke (2002) found that sediment eroded from skid trails was deposited in the harvest unit and in the 23 to 30-mile wide stream buffers. Water bars were found to be very effective at reducing coarse sediment loads. Finer sediment was deposited below water bar outlets. Stream buffers trapped more sediment per unit area than the harvested area. Norris (1993) notes that studies he reviewed indicate that buffer zones are effective at reducing sediment concentrations in runoff.

Effects of Mechanical Fuels Treatments on Flows and Water Quality - Few studies have evaluated the effects of mechanical fuels treatments such as mastication, 'brush crushing', or tractor piling. Reid (2006) notes that the change in the density of live vegetation is not expected to be great enough to change stream flows.

A Hydro-Axe treatment reviewed by Robichaud and others (2006) increased wood groundcover slightly but also slightly increased bare ground. No runoff was generated from a site that had 1.6 inches of rain within 30 minutes, at a maximum intensity of 2.4 inches per hour. Hatchett and others (2006) found that simulated rainfall on plots with post-mastication woodchip groundcover yielded no runoff during the normal rainfall rate of 2.9 inches per hour. Increasing simulated rain intensity to 4.7 inches per hour (noted to be a high, rare intensity) did yield runoff and sediment from the plot which they calculated to be 32 percent of the sediment yield from bare soil plots in their study. According to Reid (2006), the impacts of mechanical fuel treatments on erosion and sediment yield are likely to result from direct soil disturbance where these activities affect swales and low-order stream channels. Swales and Class V channels have no SMZs in this project. Mechanized access is not prohibited and could occur. Class IV channels have a 25-foot SMZ where equipment is excluded. BMPs 1 through 19 prescribe practices to mitigate the potential effects, including requiring that stream crossings on Class IV and V streams be agreed to by the sale administrator. Unscoured swales that are dry during operations receive no special protection.

Activities that would be accomplished by hand such as felling and leaving trees; hand piling; and planting are assumed to have no effect on hydrology or water quality (Robichaud and others 2006). The Soils analysis concluded that these activities are not likely to increase erosion.

Effects of Roads on Flows and Water Quality - A synthesis of existing information on the effects of forest roads (Gucinski and others 2001) lists effects of roads on hydrologic processes. They intercept rainfall on the road surface and subsurface flow at cutbanks, and they concentrate flow on the road surface or in a ditch. Both of these effects divert water from the flow paths normally taken. Roads operate as extensions of the drainage network and functionally increase drainage density when roads concentrate surface flow and deliver it to streams via surface flow paths (Wemple and others 1996). Areas with higher drainage density tend to have higher, faster peak flows as a result of precipitation. Wemple and others (1996) found 57 percent of the road length in their study was hydrologically connected to streams, which means that surface runoff was delivered directly into streams via stream crossings or gullies formed at culvert outlets. Coe (2006) found in a study of forest road segments on the Eldorado National Forest that 25 percent of the road segments surveyed were hydrologically connected. Robichaud and others (2006) note that studies in the western United States have found between 23 and 75 percent hydrologic connectivity of roads.

Robichaud and others (2006) describe three studies that were able to isolate the effects of forest roads alone (not in combination with other forest management actions) on stream flow. These studies in Colorado and Idaho were unable to detect a change in runoff from roads that occupied 2 to 4 percent of the watershed area. Jones and Grant (1996) suggested that roads could intercept increases in subsurface water resulting from clearcuts; convert it to surface water; and deliver it to streams. The literature suggests that roads may affect peak flow timing and magnitude, but do not affect annual yield (Gucinski and others 2001).

Studies have consistently shown that roads produce more sediment than other forest management practices (Robichaud and others 2006). Schnackenberg and MacDonald (1998) found that fine sediment in their study stream channels in Colorado was more strongly correlated with the number of road crossings than with the Equivalent Clearcut Area (similar to the Equivalent Roaded Acres used in this analysis, but indexed to the effects of clearcuts rather than to roads) in the watershed.

Reid and Dunne (1984) found that road erosion rates tended to increase with increased traffic and with heavier vehicles. Timber harvest and other forest management projects can result in increases in the amount of heavy truck traffic.

Road design can mitigate these effects by controlling runoff and minimizing erosion. Maintenance is required on most roads to ensure that they function as designed, but Luce and Black (1999) found a short-term increase in erosion related to maintenance, especially cleaning inboard ditches. BMPs can also be used to mitigate the effects of roads. Coe's study (2006) on the Eldorado National Forest found that native surface roads produced 10 to 25 times more sediment than rocked roads.

Rocking roads and reducing the length of roads hydrologically connected to the channel system would also reduce sediment. Sediment could be reduced by as much as 250 tons per year if half of the road crossings are redesigned to reduce hydrologic connectivity, based on WEPP:Road sediment production rates; or 25 tons per year based on Korte and MacDonald's sediment production rates. This amounts to approximately two miles of road. Sediment would be reduced by as much as 2,500 tons (WEPP) to 250 tons (Korte and MacDonald) over a ten year period.

<u>Effects of Herbicides (Glyphosate and R-11) on Water Quality</u> - A review of studies by Ghassemi and others (1981) states that glyphosate rapidly attaches to organic matter and its mobility is very limited. The only mechanism for off-site movement is soil erosion and transport because of its low mobility. Hydrolysis in a stream normally would not break the attachment of glyphosate to soil particles. Should glyphosate bound to soil particles reach surface water, it would not be in a form that could be taken up by plants or animals. Glyphosate would not affect surface or ground- water quality.

Surface water adjacent to seven projects using glyphosate on the Sierra, Stanislaus, and Eldorado National Forests was monitored from 1991 to 2000. No detections were found (Bakke 2001) with detection limits ranging from 6 to 25 ppb, depending on the study.

<u>Effects of Wildfire and Prescribed Fire on Flows and Water Quality</u> - Many investigations of wildfire effects on hydrologic processes have found increases in stream flows and in sedimentation. MacDonald and Stednick (2003) state that wildfire poses the biggest threat to water quality in forested areas.

Changes in soil properties such as removal of organic ground cover and creation of water repellent (hydrophobic) conditions result in decreased infiltration capacity and increased runoff. This leads to larger and flashier peak flows and more erosion on hillslopes. Wondzell and King (2003) identify three mechanisms by which fire affects hydrology: 1) decreasing canopy interception increases the proportion of precipitation available for runoff; 2) decreasing evapotranspiration increases base flow; and 3) consuming ground cover increases runoff velocity and reduces infiltration and storage as soil moisture. Robichaud and others (2000) state that surface runoff can increase by 70 percent and erosion by three orders of magnitude when ground cover is reduced from 75 percent to 10 percent.

Fire severity has a large effect on erosion and sediment yields. Shakesby and Doerr (2006) report a study in Utah that estimated that in a burned area with 60 to 75 percent ground cover, 2 percent of rainfall contributed to overland flow. Over 70 percent of the rainfall ran off in area where only 10 percent cover remained. Benavides-Solorio and MacDonald (2001) found in a study of post-fire erosion from simulated rainfall that sediment yields from high burn severity plots was 10 to 26 times greater than from low severity and unburned plots. Ground cover accounted for 81 percent of the variability, including lower sediment yields found in older, recovering burned areas.

Sediment yield increases are usually the highest the first year following a fire (Robichaud and others 2000).Sediment yield deceases as groundcover increases; vegetation becomes established; and water repellency recovers (Neary and others 2005, Shakesby and Doerr 2006). Some studies have found that more observed sediment load increases were due to in-channel erosion than to hillslope erosion (Shakesby and Doerr 2006). Wondzell and King (2003) note difficulty in determining how large episodic sediment inputs factor into the sediment budget of a watershed. Post-fire mass-wasting events such as landslides and debris flows exert lasting effects on stream channel morphology.

Post-fire peak flows increase more in smaller drainages than in larger ones. Bigio and Cannon (as cited in Neary and others 2005) found in their compilation of post-wildfire runoff data that the average unit area discharge from watersheds less than $1 km^2$ in size was 17,660 cfs/mi^2 (193 $m^3/s/km^2$), while the average for watersheds between 1 and 10 km^2 was 2,077 cfs/mi^2 (22.7 $m^3/s/km^2$). Intense rainfall produces the greatest increases in peak flows (Neary and others 2005). Wondzell and King (2003) note the steep gradients in intensity and total precipitation of convective thunderstorms, which seldom results in a watershed receiving equal rainfall intensity over its entire area. Small watersheds are more likely to receive intense rainfall over their entire area than larger watersheds, which may help explain Bigio and Cannon’s findings.

Robichaud and others (2000) found that summer peak flows in chaparral in Arizona increased 5 to 15 fold after a wildfire, but winter peak flows did not change. They attribute this to less intense precipitation and less water repellency during the winter season.

Empirical studies have often found it difficult to demonstrate increases in water yield due to fire (Clark 2001). However, a study in Arizona found that annual water yield increased eight-fold in a 20-acre drainage the first year after a wildfire. The increase dropped to 3.8-fold the following year (Campbell 1977, as cited by Shakesby and Doerr 2006). Reviews by Shakesby and Doerr (2006) and Neary and others (2005) note a study in Washington that found a 42 percent increase in water yield the year following a fire Others that found 9 and 12% increases in water yield in Oregon and South Africa.

Prescribed fire is planned and implemented in a manner to control burn severity and specifically to limit high burn severity. The effects of prescribed fire are much smaller in magnitude than those of wildfire. MacDonald and others (2004) found in a study comparing sediment production from different sources that severely burned areas produced 1,000 times more sediment than prescribed burn areas. Little sediment yield was found in a study in the northern Sierra Nevada where ignition was allowed within the riparian area. Beche and others (2005) found that V* did not change significantly. Zwolinski (2000) reports that low-severity fires (such as most prescribed fires) generally have little or no hydrologic impacts, even though most contain a small proportion of high burn severity. Robichaud's investigation of post-timber harvest prescribed fires in Montana and Idaho found 5 and 15 percent of those areas burned at high severity (Robichaud and others 2006).

<u>Erosion and Sediment Delivery Analysis</u> - An erosion and sediment analysis was conducted for the proposed project area. The analysis consisted of two components: 1) erosion and sedimentation rates from roads in the project area; 2) and erosion and sedimentation rates from the watershed slopes under the existing conditions (no action); the proposed action; no action with a wildfire fire; and the proposed action with a wildfire. The analysis was accomplished by using GeoWEPP to estimate watershed erosion; the WEPP:Road interface for estimating erosion from roads; and a site-specific study designed to estimate erosion and sedimentation from roads by Korte and MacDonald (2005). Sediment production rates were approximated by modeling the Bear Meadow Creek sub-watershed to demonstrate the impacts of the proposed action and the effectiveness of the measures that were designed to mitigate the impacts of the proposed action. The CWE analysis concluded that mechanical treatment of the proposed project area would not alter soil cover, therefore would not increase erosion. North assumed that prescribed burning would reduce soil cover by as much as 40 percent (personal communication, 2006). Estimated sediment production rates from underburned watershed slopes are higher than estimated sediment production rates from hydrologically connected portions of roads.

The results of the analysis suggest that sediment delivery rates would be double the background hillslope delivery rate. Approximately 5.6 tons/ha/yr would be produced from underburning, with approximately 2,743 tons/yr of sediment produced in the Bear Meadow Creek sub-watershed (see Table 3-41). Modeling for the proposed action used 60 percent cover for all proposed underburn slopes and 99 percent cover for all the private land in the north part of the Bear Meadow Creek. SMZs in Class I, II and III channels were assumed to have 75 percent cover in the outer 50 feet and 90 percent cover in the remaining inner portion. Sediment production the second year after the underburn treatment was predicted to return to background rates. Sediment is mostly produced on the steeper slopes as in the existing condition, especially headwater slopes in the tributary channels of Bear Meadow Creek. This is probably due to the high density of channels and an assumed 60 percent soil cover in steep headwater slopes. Soil cover monitoring would validate this assumption.

Table 3-41. Bear Meadow Erosion and Sedimentation Watershed Analysis

Scenario	Erosion (ton/ha/yr)	Sediment Yield (ton/ha/yr)	SDI	Sediment Discharge from outlet (tons/yr)
Existing	12.2	2.8	.231	2743
Proposed	46.28	5.6	.121	5424
Proposed 2nd Yr	30.11	2.8	.093	2688
Proposed w/ Fire	12.86	7.4	.575	8946
No Action w/ Fire	52.31	10.2	.195	12322

GeoWEPP analysis of the effectiveness of SMZs as sediment filter strips shows that SMZs filter 32% of sediment produced on treated slopes above. This sediment filtering effect seems to be low and may actually be higher especially since most of the ground is covered with bear clover and small woody debris. Monitoring would validate this assumption. Areas that are proposed for light-on-the-land harvest systems, like cut-to-length or whole tree yarding systems with grapple piling would result in at least 95% ground cover, reduced soil disturbance and sediment would not be increased over background rates.

Sediment produced in sub-watersheds that are over their lower TOC would be mitigated by implementing the watershed restoration component of the proposed action. In-stream sediment would be reduced by implementing restoration of the WIN sites identified in the proposed action. The estimated amount of sediment reduced by implementing the watershed restoration projects is approximately 10 to 15 tons per year. Rocking roads and reducing the length of roads hydrologically connected to the channel system would also reduce sediment. Prescribed burning cannot be mitigated to the same degree as other treatments. Increases in sediment would be mostly in the steep headwater slopes in proposed underburn areas. Not treating in Class I, II and III SMZs would also have an effect of less fuel on the ground and more ground cover after under burning.

Riparian Conservation Objectives Consistency Analysis - An analysis was conducted to determine the level of consistency of each alternative with the Riparian Conservation Objectives outlined in the Sierra Nevada Forest Plan Amendment (2004). The results are described in the following effects section for each alternative (refer to the project files for the full report).

Alternative 1 – Proposed Action, Uneven-aged Strategy

Direct Effects

Design measures for all action alternatives include using light-on-the-land harvest and slash treatment methods, when feasible. These may include cut-to-length and feller buncher harvest methods, and grappler piling for slash treatment.

Direct effects from mechanized equipment operation and skidding of logs during timber harvest and mechanical fuels reduction would occur under this alternative in swales without channels and in Class V channels. These areas are not protected by SMZs (see BMP 1-8). These impacts are not expected to affect flows, but may increase sediment available for transport downstream for a few years following activity (Reid 2006). Literature supports that the volume of sediment available generally drops dramatically after the first year and is recovered within three years (Stednick 2000). The number, length, and location of these areas are unknown. The first order streams on the stream layer in GIS are assumed to be Class IV and would receive 25-foot SMZs. This approach should minimize the number of drainage features with no SMZ, and thereby minimize this potential effect. The forest has consistently demonstrated the ability to maintain at least 50 percent ground cover during mechanical treatments, made up of small wood debris and resilient groundcover vegetation such as bear clover. Impacts are also minimized by having the sale administrator approve equipment crossing locations on Class IV and V streams (BMP 1-19); operating when these areas are dry (BMP 1-5); and by performing rehabilitation and erosion control prior to leaving the unit (BMP 1-19). The effect of these impacts would be a possible short-term increase in V* near these disturbances.

Class I, II, and III channels have specified SMZs where mechanized equipment is prohibited. Stream crossings for equipment must be approved by a hydrologist, aquatic biologist or soil scientist (BMP 1-19).

Road construction and reconstruction would result in short-term increases in channel disturbance and sedimentation, and long-term decreases in sediment delivery due to improvements in road drainage design and reduction of hydrologic connectivity. BMPs (listed in Appendix D) would minimize short-term increases. The WEPP:Road model suggests that sediment contributions could be reduced by up to 3.44 tons per year at each native surface crossing by reducing the hydrologic connectivity of the road. The effect of these impacts would be a short-term increase in V* downstream of the disturbances, followed by a reduction in V* in the long-term. The length of time between the increase and the decrease would be dependent on the length of time needed for the disturbed area to stabilize. This stabilization is estimated to occur within three years, with sharp reductions after the first year and the occurrence of stream flows that are capable of transporting the sediment produced prior to stabilization downstream. Sand-sized material is transported annually in this system. The time period for reductions in V* are expected to occur within three years in the immediate vicinity of the disturbance, and in approximately 10 years in the lower reaches of Big Creek and Dinkey Creek.

Design measures for all action alternatives specify that in sub-watersheds currently over the lower TOC for cumulative watershed effects, hydrologic connectivity would be reduced during road reconstruction. The effect on stream flow is not expected to be measurable. Reducing connectivity should reduce the impact of existing roads on the magnitude and timing of peak flows. Controlling road drainage of peak flows would reduce the amount of sediment delivered from the road to the stream network. Sediment could be reduced by as much as 0.35 tons per year from hydrologically connected crossings on native surface roads according to the WEPP model.

Direct effects could occur from water drafting, which requires a vehicle to approach very near to the stream bank and usually requires repeated access. BMP 2-21 specifies protective measures including measures to reduce erosion and the impacts to stream flow from water drafting. Direct impacts to stream banks would be minimized by BMP 2-21, and any unexpected or unacceptable impacts to stream banks would be rehabilitated after use.

A slight risk of direct effects exists from an accidental glyphosate spill reaching surface water. This risk is minimized by implementation of BMP 5-7 which limits the transporting of herbicides to designated routes and specifies batching and mixing locations, and BMP 5-10 which requires a Spill Contingency Plan that is approved by the Forest Service prior to operations. No increase in glyphosate concentration is expected. Glyphosate is not expected to be detectable in surface waters after application. Prescribed burning is not expected to change stream flows but may increase in-channel sediment in the short-term. The results of the GeoWEPP analysis suggest that sediment would be doubled from background sediment delivery rates. Approximately 5.6 tons/ha/yr would be produced from underburning. Burns are planned with a low burn intensity objective, and no fire ignitions within the SMZ would occur (except in KREW study watersheds). Burn patterns typically form a mosaic with unburned or lightly burned areas inter-fingered with a few moderate severity areas. Although some proportion of the area is likely to burn at high severity, the proportion is expected to be small as found by Robichaud (Robichaud and others 2006). Any overland flow or eroded material that leaves a severely burned spot would be filtered in the unburned, low or moderate severity areas down slope. High severity burn could occur at or near stream banks. However, soil and fuel moistures are likely to be higher near stream channels, and this limits the potential for high burn severity. The effect of unfiltered overland flow from burned areas entering streams would be a potential increase in V*. Any such increase would likely occur in an isolated stream reach and is not likely to be measurable in the next higher-order channel downstream. Sediment production the second year after the underburn treatment was predicted by the GeoWEPP model to be at the same level as the existing condition. Sediment is mostly produced on the steeper slopes, especially the headwater slopes in the tributary channels of Bear Meadow Creek.

Broadcast burning of 146 acres in the N_soaproot_2 Management Unit is the highest intensity burn planned. These acres are not located within sub-watershed 519.3053, which is over the lower TOC. The potential for generating increased sediment is greater in this unit than in the other prescribed burn areas; therefore, the risk of increasing V* in these tributaries to Rush Creek is higher than elsewhere in the project area. The target intensity is still moderate severity rather than high severity, and at least 50 percent ground cover would be maintained. This is expected to minimize effects.

Burning piles would create small isolated spots of high burn severity. These spots would be completely surrounded by unburned area which is expected to provide an adequate filter for any runoff or eroded material leaving the spot. No piles burned would be burned in the SMZ or in the RCA where habitat for Western pond turtle or relictual slender salamander habitat occurs. Avoiding burning in SMZs and RCAs would provide adequate filtering for any overland flow and sediment leaving these areas.

Watershed restoration would reduce sediment by 10 to 15 tons per year. Various localized hydrologic problems would be corrected and conditions would be restored to closer to natural.

Indirect Effects

This project has the potential to indirectly affect stream flows through various processes as a result of thinning trees; other vegetation manipulation actions; road construction and reconstruction; and maintenance.

Thinning trees is not expected to affect annual yield or increase peak flows. Many studies have shown that basal area must be reduced at least 10 percent in small research watersheds to detect any effect. Generally a 20 percent reduction is required before a detectable change in flow occurs (Troendle and others 2006). This alternative would reduce basal area by a maximum of 12.1 percent in sub-watershed 519.3052 (See Table 3-40). A total of four sub-watersheds would have between 9.9 and 12.1 percent reductions. Eight sub-watersheds would have 5 to 8 percent and the remaining sub-watersheds would have less than a 5 percent reduction in basal area. A slight increase in snow accumulation may occur in group selection patches in the Dinkey Creek watershed (the sub-watersheds that begin with 520) where snow is a more dominant process. This may increase peak flows slightly, but not measurably. The overall effect on stream flow in terms of annual yield and peak flows is not expected to be detectable.

Base flows may be augmented by the reduction in vegetation. The effect is not likely to persist into the dry summer season where it would be detectable. Increases in soil moisture would be utilized by the remaining vegetation and would not be available for stream flow.

Road construction could indirectly affect stream flow and sediment, especially where new roads cross stream channels. BMPs 2-1, 2-3, 2-5, 2-8 and 2-9 would help to minimize impacts to stream channels and reduce the potential for sediment to be generated both during construction and once the roads are in place.

Road reconstruction could also affect stream flows and sediment. Road reconstruction would result in fewer resource impacts by establishing an effective drainage design. Watershed design measures specify that in sub-watersheds that are currently over the lower TOC for cumulative watershed effects, hydrologic connectivity would be reduced during road reconstruction. The effect on stream flow is not expected to be measurable, but theoretically reducing connectivity would reduce the impact of the existing roads on the magnitude and timing of peak flows. Controlling road drainage would reduce the amount of sediment delivered from the road to the stream network. Any culverts that are added or replaced would be sized to current standards to minimize the risk of culvert failure.

High severity burn could occur in riparian areas during prescribed burning, and result in riparian mortality. This could reduce the effectiveness of the streamside buffer and allow overland flow and eroded material to enter a stream channel. This effect has a low probability of occurring as a result of any given burn operation. This effect is more likely to occur on a small area than a large area). The effect would last for one to three years until groundcover is reestablished and water repellency recovers (Robichaud and others 2006).

Sediment in channels has the potential to result in increased channel erosion either due to aggradation or to the increased erosive power of sediment-laden high flows, especially at the known locations with sensitive channel types identified in Table 3-35. These areas are the most likely to adjust to changes in flow and sediment that result from any cause, including natural disturbances such as fire or floods. Increased channel erosion is not expected to occur widely across the project area to be severe enough to trigger adjustments of channel reach width to depth ratios or sinuosity although the potential is slightly increased by this proposal.

Watershed restoration would increase the resilience of the restored areas to disturbances that could result from other events such as large storm events or wildfire. Watershed restoration would minimize the erosion that would occur as a result of such events.

<u>Indirect Effects with wildfire in 2015</u> - The implementation of fuels reduction activities would reduce the area that burns at high severity if a wildfire would occur (see the Vegetation and Fuels sections). Watershed damage including sedimentation rates would be less for the proposed action compared to the No Action Alternative in the event of a wildfire. Slopes would have at least 60 percent ground cover after treatment. Overland flows would remain normal and major channel modification would not likely occur. Modeling of the No Action Alternative with a fire in the year 2015 predicted 10.2 ton/ha/yr or a total of 12,322 tons of sediment produced in the Bear Meadow Creek watershed. Modeling of the proposed action with a fire in the year 2015 predicted 7.4 tons/ha/yr, or a total of 8,946 tons of sediment. This comparison suggests that the proposed action would result in a smaller effect from wildfire. Sediment could be increased by 350 percent under the No Action Alternative. The proposed action followed by a fire results in a predicted sediment increase of 250 percent if a wildfire occurred in Bear Meadow Creek (Bear fen 6). This suggests that treating the proposed area would result in a significant decrease in sediment production after a fire, compared to the No Action Alternative.

Cumulative Effects

Cumulative Watershed Effects (CWE) are all effects on beneficial uses of water that result from additive effects of multiple management activities within a watershed that are accumulated in the fluvial system. Effects can be adverse or beneficial. Adverse effects may result from multiple land use activities which combine to cause detrimental changes in watershed hydrology or sedimentation. Beneficial effects may result from management actions such as watershed improvement projects and special project mitigation. The CWE analysis is thoroughly documented in the Baseline and Detailed reports (Gallegos 2006a and 2006b).

Nine sub-watersheds in the analysis area (519.0009, 519.0057, 519.3053, 519.4051, 520.0014, 520.1002, 520.1051, 520.1101, and 520.1151) were identified as currently over their lower threshold of concern (TOC). Refer to Table 3-42 for a summary of the information considered in the Detailed Assessment of these nine sub-watersheds. Table 3-42 displays the conclusions of the Detailed Assessment for these same nine sub-watersheds. The potential for CWE to occur from increased sedimentation is a risk based assessment dependent on the occurrence of large storm events that occur in these sub-watersheds. The risk of CWE response increases should large storm events (10 or 20 year storm events) occur. The risk of CWE is reduced if a proposed treatment area has below normal precipitation the following winter, and storm events are less then 2-year events. The vulnerability of a sub-watershed for CWE is within the first year of the disturbance and significantly decreases after the 2^{nd} and 3^{rd} years. Risk is defined with 4 classes; “Unlikely” is expected to withstand a twenty-year storm event without incurring a CWE response; “Low” is expected to withstand a ten-year storm event; “Moderate” is expected to withstand a five-year storm event; and “High” is expected to incur a CWE response from a 2-year storm event.

Additional design measures are specified for Alternative 1, 3, 4, and 5 in the watersheds where CWE are a concern, which would reduce the potential for cumulative watershed effects (CWE). These additional design measures include watershed restoration, light-on-the land logging systems, grapple piling and road treatments.

The risk of a CWE response would be reduced under all action alternatives. This would be especially true in sub-watershed 520.1051, which is at a moderate risk for all Action alternatives for a CWE response. The additional design measures help to balance the possible effects of the harvest, fuels, and burning actions. The risk for CWE could be further reduced in the Bear_fen_6 Management Unit by implementing underburning in multiple years rather than in one year. The risk of CWE for each sub-watershed under this alternative is displayed in Table 3-42 (refer to Table 3-45 for the definition of risk). Table 3-43 shows the mitigation measures that would apply to each sub-watershed and Table 3-44 shows the estimated reductions in sediment from implementing watershed restoration and road treatments under this alternative and all action alternatives.

Table 3-42. Conclusions of Detailed CWE Assessment – Alternatives 1

Sub-watershed Number	Management Unit	Main Stream Name	Risk of CWE Response
519.0009	N_soapro	Ackers Cr	Unlikely
519.0057	Prov_1	Big Cr	Low
519.3053	N_soapro	Rush Cr	Low
519.4051	Prov_1	Summit Cr	Low
520.0014	El_o_win Glen_mdw Krew_prv	Dinkey Meadow Cr	Unlikely
520.1101	Bear_fen	Oak Flat Cr	Moderate
520.1151			Moderate
520.1002		Bear Meadow Cr	Low
520.1051			Moderate

Table 3-43. Mitigation Measures for Sub-watersheds Currently Over Their Threshold of Concern. This applies to all action alternatives.

Management Unit	Sub-watershed Number	Miles of Stream whose SMZ has No Harvest	# Stream Crossings Subject to Design Criteria	Number of Watershed Restoration Sites to be repaired	Other Mitigation
N_soapro	519.3053	1.7	8	4	Light-on-the-land harvest system; Grapple piling; Subsoiling compacted skid trails or landings in excess of 15% of area; Multi-year underburning in Bear_fen
Prov_1	519.0057 519.4051	7.5 4.0	45 16	9 0	
El_o_win	520.0014	1.2	19	0	
Glen_mdw		0.2		0	
Bear_fen	520.1002 520.1051 520.1101 520.1151	4.1 2.5 4.8 1.1	21 29 41 8	0 9 0 0	

Table 3-44 – Showing Number of Road Channel Crossings and WIN Sites and Estimated Reduction in Sediment.

Subwatershed	Road channel crossings	Win Sites	Sediment Reduction (tons per year)
519.3053	8	4	3 to 28
519.0057	45	9	7 to 75
519.4051	16	0	5 to 55
520.0014	19	0	2 to 21
520.1101	41	0	7 to 77
520.1151	8	0	2 to 22
520.1002	21	0	5 to 51
520.1051	21	9	4 to 55

Table 3-45. Effects of each Alternative on Indicators Selected for the Watershed Analysis

Indicator	Peak Flows	Annual Water Yield	Base Flows	WQ: Glyphosate	WQ: V*	Risk of CWE Response
Alt. 1 No Wildfire	No measurable change	No measurable change	No measurable change	Not detectable-meets WQ objectives	Slight risk of increase, especially in Bear_fen	One high risk, two moderate risk – all in Bear_fen
Alt. 1 Wildfire	Increase	Increase	Decrease	Not detectable-meets WQ objectives	High risk of increase, especially in Bear_fen	Moderate and high risk
Alt. 2 No Wildfire	No change	No change	No change	Not detectable-meets WQ objectives	Slight risk of increase in 519.305.3 due to other land uses	All watersheds recovering from past activities
Alt. 2 Wildfire	Greater increase than under Alt. 1	Increase	Potentially greater decrease than under Alt. 1	Not detectable-meets WQ objectives	Higher risk of increase than under Alt. 1	Moderate and high risk
Alt. 3 No Wildfire	No measurable change	No measurable change	No measurable change	Not detectable-meets WQ objectives	Slight risk of increase similar to Alt. 1	Three moderate risk in Bear_fen – change unlikely in other units
Alt. 3 Wildfire	Increase similar to Alt. 1	Increase similar to Alt. 1	Decrease similar to Alt. 1	Not detectable-meets WQ objectives	High risk of increase than under Alt. 1	Moderate and high risk
Alt. 4 No Wildfire	No measurable change	No measurable change	No measurable change	Not detectable-meets WQ objectives	Slight risk of increase similar to Alt. 1	Three moderate risk in Bear_fen – change unlikely in other units
Alt. 4 Wildfire	Increase similar to Alt. 1	Increase similar to Alt. 1	Decrease similar to Alt. 1	Not detectable-meets WQ objectives	High risk of increase than under Alt. 1	Moderate and high risk
Alt. 5 No Wildfire	No measurable change	No measurable change	No measurable change	Not detectable-meets WQ objectives	Slight risk of increase similar to Alt. 1	Three moderate risk in Bear_fen – change unlikely in other units

Indicator	Peak Flows	Annual Water Yield	Base Flows	WQ: Glyphosate	WQ: V*	Risk of CWE Response
Alt. 5 Wildfire	Increase similar to Alt. 1	Increase similar to Alt. 1	Decrease similar to Alt. 1	Not detectable-meets WQ objectives	Higher risk of increase than under Alt. 1	Moderate and high risk

Indirect and Cumulative Effects if Wildfire occurs in 2015 - The measures designed to reduce watershed impacts that apply to this alternative could reduce post-wildfire erosion at some sites, but overall the benefits would be negligible in the case of a wildfire.

Design criteria and watershed restoration have been specified to reduce or offset the risk for CWE. Activities would be carried out using light on the land mechanical systems (i.e., cut-to-length harvest system, low ground pressure feller/buncher system, excavator debris piling) in all sub-watersheds that are over the lower TOC.

Watershed improvement restoration would be implemented. Monitoring of channel condition (SCI), sediment accumulation (V*), and other aquatic habitat indicators would occur according to the Monitoring and Adaptive Management Plan. These measures are summarized in Table 3-46. The discussion of the likelihood of cumulative effects responses in these sub-watersheds follows the table.

Table 3-46. Mitigation Measures for Sub-watersheds Currently Over their Threshold of Concern

Management Unit	Sub-watershed Number	Number of Watershed Restoration Sites	Other Mitigation
N_soaproot_2	519.3053	4	Light-on-the-land harvest system Subsoiling compacted skid trails or landings in excess of 15% of area
Providence_1	519.0057 519.4051	9 0	
El_o_win_1	520.0014	0	
Glen_mdw_1		0	
Bear_fen_6	520.1002 520.1051 520.1101 520.1151	0 9 0 0	

*In this Alternative, standard road design measures would be applied which would result in some drainage improvements even though the design criteria that specifies reducing hydrologic connectivity does not apply.

Sub-watershed 519.0057 – Approximately 498 acres of mechanical treatment units in the Providence_1 Management Unit is proposed to be treated in this sub-watershed, with seven acres of underburning in an un-named tributary of Big Creek and Big Creek between Summit and Providence Creeks. The proposed treatments for this sub-watershed would result in ERA of 13.73 percent. Sediment could be increased by as much as eight tons from underburning seven acres. Sediment would be reduced at nine WIN sites.

CWE would be mitigated by using light-on-the-land harvest methods identified in the project's design measures. These measures would control current sources of sediment and reduce the risk of initiating an additional CWE response. A moderate risk that CWE would occur exists in this sub-watershed.

Sub-watershed 519.3053 – Approximately 60 acres of mechanical treatment and no acres of underburn in the Providence_1 Management Unit are proposed in this watershed in Rush Creek. The proposed ERA is 9.16 percent. The ERA value is expected to be 8.25 percent by the year 2011, which is lower then the existing ERA. The ERA is expected to be 2.31 percent by the year 2033. Sediment should not be increased because under burning is not proposed in this sub-watershed. Mechanical treatment impacts would result in no change in soil cover. Cumulative watershed effects would be reduced by mechanically treating the area with a light on the land harvest system; sub-soiling all major skid roads and trails to reduce runoff; and implementing the watershed restoration described in the Proposed Action (from the Soaproot Watershed Restoration Plan). Implementation of these mitigations would result in watershed improvement; a reduced risk of initiating additional CWE response; and recovery over a shorter time period. A low risk of CWE exists in this sub-watershed.

Sub-Watershed 519.4051 – Approximately 359 acres of mechanical treatment and no acres of underburning are proposed in the Providence_1 Management Unit located on the south side of Summit Creek. The proposed treatment would increase ERA to 10.20 percent. ERAs are expected to be 8.06 percent in 2011, and 1.74 percent in 2033. Sediment should not be increased because under burning is not proposed in this sub-watershed. Mechanical treatment impacts would result in no change in soil cover. Cumulative watershed effects would be reduced by mechanically treating the area with light on the land harvest methods; sub-soiling all major skid roads and trails to reduce runoff; and implementing the project's watershed restoration projects identified in the Proposed Action (from the Providence 1 Watershed Restoration Plan). Implementation of these mitigations would result in watershed improvement; a reduced risk of initiating additional CWE response; and recovery over a shorter time period. A low risk that CWE would occur exists in this sub-watershed.

Sub-watershed 520.0014 – Approximately 228 acres of mechanical treatment units from the El_o_win_1 and Krew_prv_1 Management Units are located in this sub-watershed with 84 acres of underburn in Dinkey Meadow Creek. The project's proposed treatments would result in ERA 10.81 percent. The ERA value is expected to be 9.30 percent by the year 2011. The ERA is expected to be 2.32 percent by the year 2033. Sediment could be increased by as much as 95 tons from under burning 84 acres. Cumulative watershed effects would be reduced by mechanically treating the area with light on the land harvest methods and sub-soiling all major skid roads and trails to reduce runoff. A low risk that CWE would occur exists in this sub-watershed.

Sub-watershed 520.1101 – Approximately 656 acres of mechanical treatment are proposed in 2007 with 413 acres of underburn in upper Oak Flat Creek. ERAs would be increased to 11.53% percent. ERAs are expected to be 10.08 percent in 2011, and 4.51 percent in 2033. Sediment could be increased by as much as 468 tons from underburning. Cumulative watershed effects would be reduced by mechanically treating the area with light on the land harvest methods and by sub-soiling all major skid roads and trails to reduce precipitation runoff. A moderate risk that CWE would occur exists in this sub-watershed.

Sub-watershed 520.1151 – Approximately 321 acres are proposed for mechanical treatment in 2007 with 321 acres of underburn in lower Oak Flat Creek. The ERA would be increased to 8.16 percent and is expected to recover to 7.40 percent in 2011, and 3.76 percent in 2033. Sediment could be increased by as much 363 tons from under burning. Cumulative watershed effects would be reduced by mechanically treating the area with light-on-the-land harvest methods and by sub-soiling all major skid roads and trails to reduce precipitation runoff. A moderate risk that CWE would occur exists in this sub-watershed.

Sub-watersheds 520.1002 – Approximately 301 acres of mechanical treatment are proposed in 2008 with 297 acres of underburn in the upper Bear Meadow Creek sub-watershed. ERA would be increased to 9.8 percent. ERAs are expected to be 8.18 percent in 2011, and 2.51 percent in 2033. Sediment could be increased by as much 337 tons from under burning 297 acres. Cumulative watershed effects would be reduced by mechanically treating the area with light-on-the-land harvest methods and by sub-soiling all major skid roads and trails to reduce precipitation runoff. A low risk that CWE would occur exists in this sub-watershed.

Sub-watershed 520.1051 – Approximately 559 acres of mechanical treatment are proposed to be treated in 2008, with 485 acres of underburn in the lower Bear Meadow Creek sub-watershed. ERA would be increased to 11.72 percent. ERAs are expected to be 9.82 percent in 2011, and 2.52 percent in 2033. Sediment production in this sub-watershed could be increased by as much as 323 tons. Sediment produced in sub-watersheds 520.1002, 520.1101 and 520.1151 would be transmitted downstream and into this sub-watershed. Cumulative watershed effects would be reduced after implementing the proposed “Bear Meadow Watershed Restoration Plan”. CWEs would be reduced by mechanically treating the area with light-on-the-land harvest methods and by sub-soiling all major skid roads and trails to reduce precipitation runoff. A moderate risk that CWE would occur exists in this sub-watershed.

Other Sub-watersheds Affected by the Proposed Action - Fifteen sub-watersheds that are currently below their lower TOC for Cumulative Watershed Effects (CWE) would exceed their threshold after project implementation. These sub-watersheds would be evaluated in a “Detailed Assessment” after each phase of treatments in order to determine whether the project has resulted in a CWE response. The project’s sub-watershed design measures would be applied to remaining phases of implementation if these sub-watersheds are found to be at increased risk for CWE response at any time.

The fifteen sub-watersheds whose management would be adapted according to an adaptive management strategy are: 519.0007; 519.0008; 519.0009; 519.0011; 519.0056; 519.3002; 519.3003; 519.3004; 519.3052; 520.0015; 520.0016; 520.0056; 520.0057; 520.3002; and 520.4051. Additional sub-watersheds may be evaluated for CWE response based on factors other than from the ERA model through adaptive management techniques.

Other Projects and Uses Considered in the Cumulative Effects Analysis – The ERA model addressed the project's vegetation management projects (Past, Present, and Reasonably Foreseeable Actions). The discussion of cumulative effects includes all known conditions and problems that are related to other activities. The project file contains more information about the rationale behind the consideration of cumulative effects that could result from each action.

Beneficial Uses - Hydropower uses at Pine Flat Dam could be enhanced by the small increase in annual water yield. Slight increase in sediment delivered to streams could also slightly increase the rate of sedimentation in Pine Flat Reservoir. The increase is not predicted to be large enough to significantly affect the reservoir's rate of filling.

Contact and non-contact recreation may be affected if CWE responses increase. The reaches most likely to affect recreational experience are in the main Big Creek channel, such as the reach adjacent to Bretz Campground in sub-watershed 519.0057, and others downstream where dispersed campsites are situated on the banks. These reaches have been identified as likely exhibiting a CWE response. An additional CWE response would be reflected as more fine sediment accumulation in the channel. The potential difference is not likely to further affect recreational experience since these areas already have accumulated sand and pools are completely filled. The potential for effects on beneficial uses related to aquatic habitat are discussed in the Aquatics section.

Summary of Effects of Alternative 1 - Peak flows, annual water yield, and base flows would not be altered. The water quality objective for glyphosate would be met. The water quality objective for sediment may be compromised. Increases in V* could occur. Erosion of channel banks in reaches with high sensitivity to disturbance could be increased. The increase would probably not be enough to significantly affect channel function, but could increase V*. Watershed restoration and road reconstruction would both reduce existing sediment inputs, but may not be enough to offset the increases from other activities. A moderate risk of a cumulative watershed effects response occurring exists in the Bear_fen_6 Management Unit. Beneficial uses related to hydropower and recreation would probably not be affected. See the Aquatics section for a discussion of the effects on beneficial uses related to aquatic habitat.

Indirect and Cumulative Effects if Wildfire occurs in 2015 - Peak flows and annual water yields would increase in watersheds affected by wildfire for several years following an event. Base flows would be reduced in the watersheds experiencing fire due to decreased infiltration and soil moisture storage. The water quality objective for glyphosate would not be affected by the wildfire. Water quality objectives for sediment would be more likely to be compromised in the watershed should wildfire occur than without a wildfire. Modeling using GeoWEPP suggests that the sediment produced by activities under this alternative plus the effects of wildfire would be approximately 70 percent less than sediment generated by wildfire under the No Action Alternative. Beneficial uses related to hydropower would probably not be affected. Recreation uses could be affected in the short-term by ash and additional sediment in streams. See the Aquatics section for a discussion of the effects on beneficial uses related to aquatic habitat.

Alternative 2 - No Action

Direct and Indirect Effects

No actions would be taken; therefore, none of the direct effects described under Alternative 1 would occur. Indirect effects related to this alternative would occur, however. Roads that are in need of maintenance or reconstruction would not be treated and would continue on their current trend. The trend is road deterioration in most cases including erosion and contributing sediment to streams. Road recovery is the trend in some cases with contributions to stream flows and sediment being negligible.

Watershed restoration sites would not be repaired and would continue on their current trend until they become a district-wide priority of the watershed restoration program. Funding to repair watershed restoration sites is in place. Restoration could take many years because hundreds of sites are currently on the district's WIN inventory. More sites are added each year, and between 3 to 10 sites are repaired. Identified sites are actively eroding and degrading watershed conditions in all cases. The amount of sediment that would continue to be contributed from these sites is approximately 10 to15 tons per year.

Cumulative Effects

The ERA model shows continuing recovery from previous disturbances. Other planned actions that are not part of this decision would still occur but the total ERA in the project sub-watersheds would be lower than if this project was implemented.

Roads would continue their current sediment contributions to cumulative watershed effects. Some segments may deteriorate but the overall cumulative impact from the roads probably would not change relative to the current condition.

Stream channel conditions in reaches identified as having high sediment loads would probably not change. Sediment may continue to accumulate in Rush Creek (particularly in sub-watershed 519.3053) as a result of construction of the Wildflower subdivision. This activity began recently and an increase in sediment has been detected. OHV uses described in this sub-watershed would also contribute to elevated sediment loads.

Peak flows, annual yield and base flows would not change under this alternative. V* would probably also not change, except in Rush Creek where recreation; actions on private land; and actions taken under other decisions (particularly South of Shaver) would continue and have the potential to cause an increase in V*.

<u>Indirect and Cumulative Effects should Wildfire Occur</u> - Increased wildfire severity increases the risk of water quality degradation under the No Action Alternative. The Vegetation section identifies Bear_fen_6 and El_o_win_1 as management units with the most pronounced wildfire effects under this alternative. This suggests that Oak Flat and Bear Meadow Creeks (in Bear_fen_6) and Dinkey Meadow Creek (in El_o_win_1) are at highest risk for severe impacts from wildfire. This does not mean that fire is more likely to occur in these areas than in other areas, only that if a wildfire were to occur here the

effects are more likely to be severe than if a wildfire were to occur in other areas. The effects described below are general, but can be considered to be more pronounced in these two management units than in the others.

Sedimentation rates could increase by orders of magnitude and V* would increase significantly within and downstream of burned areas. Some areas that currently meet the desired condition would probably exceed it for several years following a fire. Infiltration would be reduced in areas that burned at high severity. Data from previous fires on the forest indicate infiltration could be in the range of 20 to 30 percent. This would result in increased overland flow which would increase peak flows. Decreased soil moisture would reduce summer low flows. Post-wildfire peak flows have been found to increase by up to three orders of magnitude (Neary and others 2005). Baseflows have been reported to increase due to reductions in evapotransipiration (Neary and others 2005). Baseflows decrease due to increased overland flow and decreased infiltration, resulting in lower soil moisture and less subsurface flow to streams. The effect on baseflows is likely related to site-specific factors including the degree of vegetation mortality; the degree of soil water repellency; and increases in runoff and how these relate to the site's water balance.

Modeling of the No Action Alternative with a wildfire predicted 10.2 tons/ha/yr with a total of 12,322 tons of sediment produced in the Bear Meadow Creek watershed, which is greater than the 7.4 tons/ha/yr (total of 8,946 tons) of sediment modeled for the proposed action with a wildfire. Sediment could be increased by 350 percent if a wildfire occurred under the No Action Alternative. A wildfire could increase sediment by 250 percent under the project's action alternatives. These model results suggest that the effects of a wildfire on erosion, sedimentation, and increases in V* would be higher under Alternative 2 (No Action) than for the project's action alternatives.

Alternative 3 – Retain Largest Trees, Uneven Aged Strategy

Direct and Indirect Effects

Design features for soil and watershed protection are common to all action alternatives. Alternative 3 would not create 92 acres of new openings for regeneration. This would lessen the amount of snow accumulation in openings compared to Alternative 1. Any difference in effects on base flow would not be measurable. Effects of this alternative would be essentially the same as those described under Alternative 1.

Cumulative Effects

Cumulative effects would be essentially the same as in Alternative 1.

Alternative 4 – Fisher Emphasis

Direct and Indirect Effects

Design features for soil and watershed protection are common to all action alternatives. Alternative 4 would not create 92 acres of new openings for regeneration. This would lessen the amount of snow accumulation in openings compared to Alternative 1. Any difference in base flow would not be measurable. Effects of this alternative would be essentially the same as those described under Alternative 1.

Cumulative Effects

Cumulative effects would be essentially the same as in Alternative 1.

Alternative 5 – Thin from Below

Direct and Indirect Effects

Design features for soil and watershed protection are common to all action alternatives. Alternative 5 would not create 92 acres of new openings for regeneration. This would lessen the amount of snow accumulation in openings compared to Alternative 1. Any difference in effects on base flow would not be measurable. The size limit for harvest would be 20 inches, rather than 35 inches in the proposed action. This would reduce somewhat the amount of potential soil disturbance and any potential changes in soil cover and its hydrologic function. Overall effects of this alternative are expected to be similar to those described for Alternative 1.

Cumulative Effects
The effects would be essentially the same as in Alternative 1.

AQUATIC SPECIES

Affected Environment

Seven federally listed aquatic species may be affected by activities occurring within the Kings River Project (KRP) area. Please refer to the Aquatic Species Biological Assessment and Biological Evaluation report and supplements for the Kings River Project (KRP) – Initial Eight Management Units (Sanders 2006b) and Kings River Project – Initial Eight Management Units Management Indicator Species Report (Sorini-Wilson and Smith 2008) for general information and the rationale for inclusion or exclusion of all listed aquatic species on the Sierra National Forest species lists. Seven aquatic species and their habitats are found within the Kings River Project area's eight management units. The species are:

- California red-legged frog (Threatened; CRLF), *Rana aurora draytonii*
- Foothill yellow-legged frog (Forest Service Sensitive; RABO), *Rana boylii*
- Lahontan cutthroat trout (Threatened; LCUTT) *Oncorhynchus (=Salmo) clarki henshawi*
- Mountain yellow-legged frog (Candidate and Forest Service Sensitive; RAMU) *Rana muscosa*
- Relictual slender salamander (Forest Service Sensitive; RSS), *Batrachoseps relictus*
- Western pond turtle (Forest Service Sensitive; WPT), *Clemmys marmorata* (Subspecies *marmorata* and *pallida*)
- Yosemite toad (Candidate & Forest Service Sensitive; BUCA), *Bufo canorus*

Five species or their habitats are found within the project's eight management units and two species or their habitats are found near the Kings River Project. Each species is known to occur; has habitat within or adjacent to the project area; or is historically (prior to 1980) known to have occurred within the project area (Table 3-47).